Distribution, Abundance, and Breeding Activities of the Least Bell's Vireo at Marine Corps Base Camp Pendleton, California

2008 Annual Report

Prepared for:

Assistant Chief of Staff, Environmental Security
U.S. Marine Corps Base Camp Pendleton

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
WESTERN ECOLOGICAL RESEARCH CENTER

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By Suellen Lynn and Barbara E. Kus

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2009

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Cover photograph by Michelle Rogne

Recommended citation:

Lynn, S. and B. E. Kus. 2009. Distribution, abundance and breeding activities of the least Bell's vireo at Marine Corps Base Camp Pendleton, California. 2008 Annual Report. Prepared for Assistant Chief of Staff, Environmental Security, Marine Corps Base Camp Pendleton.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

EXECUTIVE SUMMARY

Surveys for the endangered least Bell's vireo (*Vireo bellii pusillus*) were conducted at Marine Corps Base Camp Pendleton, California, between 31 March and 14 July 2008. Drainages containing riparian habitat suitable for vireos were surveyed two to seven times. Seven hundred and thirty-eight territorial male vireos and 31 transient vireos were detected on 18 out of the 23 drainages/sites surveyed. Ninety-six percent of all vireo territories occurred on the ten most populated drainages, with the Santa Margarita River containing 61% of all territories on Base. Seventy-eight percent of male vireos were confirmed as paired.

In 2008, the overall size of the vireo population was similar to 2006 and 2007 populations and was within the range of approximately 700-1000 territories observed on Marine Corps Base Camp Pendleton over the past 13 years. The number of territories on 78% (18/23) of drainages surveyed differed from 2007 by fewer than four territories, and 61% (14/23) of drainages differed by zero to one territory. Six drainages increased in vireo numbers, eight decreased, and nine showed no change. Overall, the vireo population on Base increased by 4.5% from 2007 to 2008.

The majority of vireo territories occurred in habitat characterized as Willow Riparian, with 75% of males in the study area found in this habitat. An additional 10% of birds occupied willow (*Salix* spp.) habitat co-dominated by cottonwoods (*Populus fremontii*) or sycamores (*Platanus racemosa*). Seven percent of territories were found in Riparian Scrub, dominated by mule fat (*Baccharis salicifolia*) and/or sandbar willow (*Salix exigua*). Six percent of the vireos used drier habitats including areas dominated by a mix of sycamores and oaks (*Quercus agrifolia*) (1% of total) or upland vegetation (5%). Fewer than 1% of vireos occupied alder (*Alnus rhombifolia*) habitat. Approximately 1% of vireo territories were placed in habitat dominated by non-native vegetation.

A total of 335 least Bell's vireos were banded during the 2008 season. These included 54 adult vireos and 281 hatch-year birds. The 54 adult vireos and 13 hatch-year birds were banded with unique color combinations. The remaining 268 birds were nestlings, banded with a single gold numbered federal band on the left leg. Ninety least Bell's vireos banded prior to the 2008 breeding season were resighted on Base in 2008. Sixteen of the 90 vireos were originally banded off Base, all on the San Luis Rey River. Adult birds of known age ranged from 1-4 years old. Adult survivorship, or the proportion of individuals known to survive from one year to the next, was 40% (31/77). Survivorship of first year birds fledged from Camp Pendleton in 2007 and documented on Base in 2008 was 12% (14/117), based on the number of uniquely banded individuals. First year survivorship may be as high as 26% (30/117) if we include birds with single gold federal bands that probably fledged in 2007 but were not recaptured to confirm fledge year. Eleven of the 13 uniquely color banded first year birds detected were male.

The majority of returning adult vireos showed strong between-year site fidelity. Overall vireo territory fidelity between 2007 and 2008 was 80% (24/30). The average dispersal distance for returning adult vireos was 0.2 ± 0.6 km (SD). Dispersal distance of first year vireos fledged from Camp Pendleton nests ranged from 0.4-2.6 km. Four first year vireos that fledged from nests on the San Luis Rey River were documented on Base. One was female and three were male. Overall, the average distance first year vireos dispersed was 2.6 ± 3.9 km (SD).

Adult survivorship for vireos on giant reed (*Arundo donax*) Removal sites and Reference sites was 50% and 68%, respectively. First-year survivorship was 19% and 6%, respectively. One-hundred percent of adults at Removal sites and 92% at Reference sites returned to the same territory in 2008. Six 2007 nestlings from Removal sites returned to Removal sites in 2008 (five males and one female), and three male nestlings from Removal sites dispersed outside of monitoring sites. Three 2007 nestlings from Reference sites returned to Reference sites in 2008 (two males and one female), and one male nestling from a Reference site dispersed outside of monitoring sites in 2008.

Nesting activity was monitored in 60 territories within four giant reed (*Arundo donax*) Removal and Reference monitoring areas. A total of 130 nests were monitored during the breeding season; however, 11 of these were not completed and were excluded from calculations of nest success and productivity.

The majority of pairs attempted to re-nest after their first nesting attempt in 2008, regardless of the outcome of their first nesting attempt. Sixty percent of pairs at Removal sites and 19% of pairs at Reference sites fledged young from two nests in 2008. There was no difference in timing of first nesting attempts at Removal and Reference sites, although the first nests overall in 2008 were initiated earlier than in previous years.

Nest success was higher for pairs breeding in Removal sites compared to Reference sites. Seventy-seven percent (43/56) of Removal nests and 52% (33/63) of Reference nests successfully fledged young. First nesting attempts were more likely to be successful at Removal sites (84%) than at Reference sites (38%), and the 61% of successful nest attempts in 2008 was higher than in previous years. Predation was believed to be the primary source of nest failure at both sites. Predation accounted for 77% (10/13) and 80% (24/30) of nest failures at Removal and Reference sites, respectively. One nest contained infertile eggs and showed no signs of development by the expected hatch date. Two nests may have failed by Argentine ant (*Linepithema humile*) predation. No nest parasitism of least Bell's vireos by brown-headed cowbirds (*Molothrus ater*) was documented. Overall, most productivity measures of least Bell's vireos nesting at Removal and Reference sites were similar. In 2008, average clutch size was not statistically different between Removal and Reference sites. However, the average number of young fledged per pair was significantly higher at Removal sites than at Reference sites in 2008. When data from 2005-2008 were analyzed, a significant year effect was found, with the average clutch size and average number of young fledged per pair significantly higher in 2008 than in 2007.

Density of vireo territories increased at both Removal and Reference sites in 2008, and averaged higher at Removal sites, though not significantly. Density at Removal sites was lowest in 2002, during and immediately following giant reed removal, and has increased since then to a high in 2008.

Primary productivity and the types of prey consumed by vireos have been shown to vary with annual precipitation (Cody 1981, Grant and Grant 1987). We found that annual precipitation, and by association primary productivity and prey abundance, did not affect vireo productivity between 2005 and 2008, and thus did not explain the annual differences we

observed. However, annual precipitation was positively associated with the total number of vireo territories on Camp Pendleton during the subsequent breeding season.

In 2008, successful and unsuccessful nests within Removal and Reference sites did not differ statistically in average nest height, although at Reference sites, successful nests were placed closer to the edge of the host plant and at Removal sites, successful nests were placed in shorter host plants. Overall, vireo nests at Removal sites were placed significantly higher above ground, in taller host plants, and built further from the edge of the host plant than nests at Reference sites, possibly reflecting the available host species at these sites. A total of 15 plant species (14 species and one "dead" category, which included all dead woody species) were used as hosts for vireo nests in 2008. Seventy-two percent of nests were placed in arroyo willow (*S. lasiolepis*), sandbar willow, and mule fat.

Recent stability and slight increases in the vireo population on Camp Pendleton generally reflect similar population trends on the nearby San Luis Rey River. The general stability in the Camp Pendleton vireo population from 2006 to 2008 is reflected in the relatively balanced gains and losses of vireo territories from different drainages. Such redistribution of the vireo population may reflect changing conditions at different sites, where habitat suitability changes, either by catastrophic changes such as fire or flood scouring, or by gradual changes in floristic structure or composition. Redistribution of the vireo population may also be driven by demographic parameters, particularly site fidelity, where older vireos have a strong tendency to return to the same breeding site each year and younger vireos tend to disperse. Vireos moved between Camp Pendleton and surrounding drainages, most frequently detected moving from the San Luis Rey River to Camp Pendleton. Vireos from Camp Pendleton were detected on the San Luis Rey River, the San Diego River, and near Burbank, California.

Productivity in general was higher in 2008 than in the preceding years, possibly associated with an early commencement of the breeding season coupled with high success rate for first nests. This increase in productivity was also evident in the lower San Luis Rey vireo population. Assuming that Removal and Reference sites were equal in all characteristics except for our test variable (the timing of giant reed removal), it may be concluded that at least in 2008, Removal sites were superior to Reference sites with respect to vireo breeding habitat. The increase in number of fledglings produced per pair in 2008 may indicate that recent giant reed Removal sites are providing better nesting habitat for vireos than the Reference plots.

Vireo density decreased at Removal sites immediately following intensive giant reed removal, most likely in response to decreased understory structure caused by the removal of giant reed. We saw an increase in vireo breeding productivity (clutch size and number of young fledged per pair) in 2008 over 2006 and 2007, loosely associated with annual precipitation.

Nest site characteristics did not differ greatly between successful and unsuccessful nests, either at Reference sites or at Removal sites. We did not measure available habitat characteristics, but it is possible that the selection of host plants reflects the presence of more large trees at Removal sites.

INTRODUCTION

The least Bell's vireo (*Vireo bellii pusillus*; hereafter "vireo") is a small, migratory songbird that breeds in southern California and northwestern Baja California, Mexico from April through July. Historically abundant within lowland riparian ecosystems, vireo populations began declining in the late 1900s as a result of habitat loss and alteration associated with urbanization and conversion of land adjacent to rivers to agriculture (Franzreb 1989, USFWS 1998, RHJV 2004). Additional factors contributing to the vireo's decline have been the expansion in range of the brown-headed cowbird (*Molothrus ater*), a brood parasite, to include the Pacific coast (USFWS 1986; Franzreb 1989; Brown 1993; Kus 1998, 1999), and the introduction of invasive exotic plant species, such as giant reed (*Arundo donax*), into riparian systems. By 1986, the vireo population in California numbered just 300 territorial males (USFWS 1986).

In response to the dramatic reduction in numbers of least Bell's vireos in California, the California Fish and Game Commission listed the species as endangered in 1980, and the U.S. Fish and Wildlife Service followed suit in 1986. Since listing, the vireo population in southern California has rebounded, largely in response to cowbird control and habitat restoration and preservation (Kus and Whitfield 2005). As of 2006, the statewide vireo population was estimated to be approximately 2,500 territories (USGS, unpublished data), roughly a third of which occurred on Marine Corps Base Camp Pendleton.

Male least Bell's vireos arrive on breeding grounds in southern California in mid-March. Male vireos are conspicuous, and frequently sing their diagnostic primary song from exposed perches throughout the breeding season. Females arrive approximately 1-2 weeks after males and are more secretive, but are often seen early in the season traveling through habitat with the male. The female, with the male's help, builds an open cup nest in dense vegetation approximately 1 m above the ground. Clutch size for least Bell's vireos averages 3-4 eggs. Typically, the female and male incubate the eggs for 14 days, and young fledge from the nest at 11-12 days of age. It is not unusual for vireos to re-nest after a failed attempt provided ample time remains within the breeding season. Vireos rarely fledge more than one brood in a season. Nesting lasts from early April through July, but adults and juvenile birds remain on the breeding grounds into late September/early October before migrating to their wintering grounds in southern Baja California, Mexico.

The purpose of this study was to document the status of least Bell's vireo at Marine Corps Base Camp Pendleton in San Diego County, California. Specifically, our goals were to (1) determine the size and composition of the least Bell's vireo population at the Base, (2) characterize habitat used by vireos, (3) band a subset of vireos to facilitate the estimation of vireo survivorship and movement, and (4) assess the short-term effects of giant reed removal on vireo fecundity, nest success, and productivity by intensively monitoring vireos within established nest monitoring sites that had recently undergone giant reed removal and at reference sites in which giant reed had been removed 9-11 years earlier, between 1997 and 1999.

In October and November 2007, wildfires burned a substantial portion of several drainages on Camp Pendleton, including Aliso Canyon, Las Flores Creek, Horno Canyon, Piedra

de Lumbre Canyon, San Onofre Creek, and sections of the Santa Margarita River (Fig. 1). While this project did not include a specific study design to determine the effects of fire on vireos, these data may be used to track vireo response to the fire and post-fire habitat recovery. When combined with data from other years, these data will inform natural resource managers about the status of this endangered species at Camp Pendleton, and guide modification of land use and management practices as appropriate to ensure the species' continued existence.

This work was funded by the Assistant Chief of Staff, Environmental Security, Resources Management Division, Marine Corps Base Camp Pendleton, California.

STUDY AREAS AND METHODS

Field Surveys

All of Camp Pendleton's major drainages, and several minor ones supporting riparian habitat, were surveyed for vireos between 31 March and 14 July 2008 (Fig. 1). Field work was conducted by Rudy Badia, Ursula Carliss, Aaron Gallagher, Scarlett Howell, Barbara Kus, Suellen Lynn, Melanie Madden-Smith, Eric Nolte, Jeff Ritterson, Michelle Rogne, Jennifer Scott, and Michael Wellik. The specific areas surveyed are as follows:

1. ***Santa Margarita River:***
   a. Between Interstate 5 upstream to the confluence with De Luz Creek, including all riparian habitat within Stagecoach Canyon and Ysidora Basin east of Vandegrift Road (Appendix A, Figs. 15 and 16).
   b. From the confluence with De Luz Creek upstream 1.3 km to the Fallbrook Naval Weapons Station (FNWS) boundary, a 7 km section of shared boundary with FNWS, and then upstream 2.3 km to the Base boundary (Appendix A, Fig. 15).

2. ***De Luz Creek,*** between the confluence with the Santa Margarita River and the Base boundary (Appendix A, Fig. 15).

3. ***Roblar Creek,*** approximately 1.6 km of stream beginning approximately 1 km upstream of the confluence with De Luz Creek and ending at the gate to 409 Impact Area (Appendix A, Fig. 15).

4. ***Lake O'Neill/Fallbrook Creek:***
   a. All riparian habitat around Lake O'Neill (Appendix A, Fig. 15).
   b. Between Lake O'Neill and the Base boundary with the Fallbrook Naval Weapons Station (Appendix A, Fig. 15).

5. ***Basilone and Roblar Roads,*** a small patch of habitat straddling Basilone Road at the intersection of Basilone and Roblar Roads (Appendix A, Fig. 15).

6. ***22 Area,*** all riparian habitat within the 22 Area, east of Vandegrift Road and the Supply Depot (Appendix A, Fig. 16).

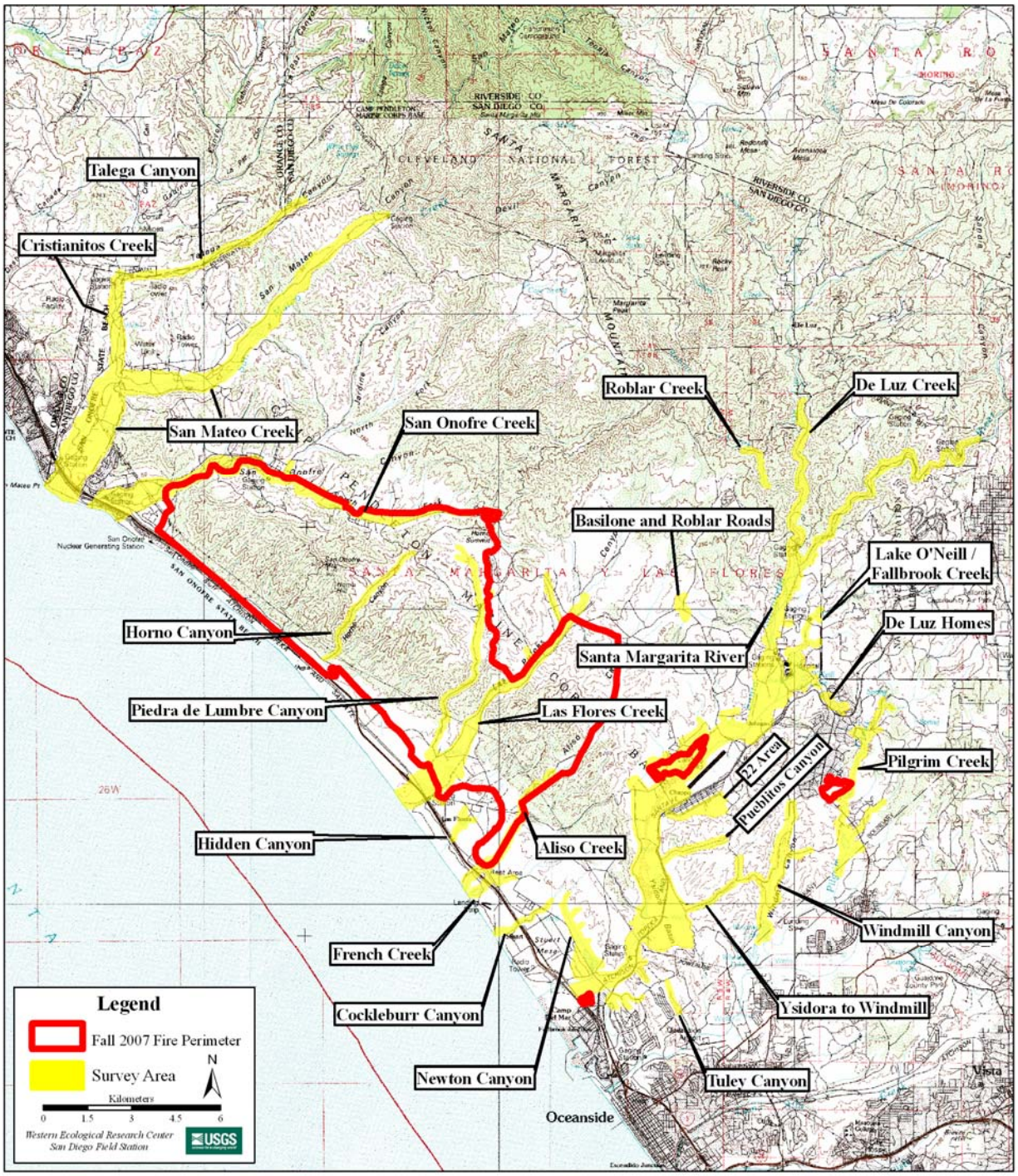

Fig. 1. Least Bell's vireo survey areas and the Fall 2007 fire perimeter at Marine Corps Base Camp Pendleton, 2008.

7. ***Pueblitos Canyon,*** between Vandegrift Road and a point approximately 2.5 km upstream (Appendix A, Fig. 16).

8. ***Tuley Canyon,*** between the Base boundary and a point approximately 1.1 km upstream (Appendix A, Fig. 16).

9. ***Newton Canyon,*** between the confluence with the Santa Margarita River and the upstream limit of riparian habitat (Appendix A, Fig. 16).

10. ***Cockleburr Canyon,*** between the Pacific Ocean and a point 0.25 km east of Interstate 5 (Appendix A, Fig. 16).

11. ***French Creek,*** between the Pacific Ocean and the Edson Range Impact Area (Appendix A, Fig. 16).

12. ***Aliso Creek,*** between the Pacific Ocean and 0.5 km upstream of the electrical transmission lines (Appendix A, Fig. 16).

13. ***Hidden Canyon,*** between Interstate 5 and Stuart Mesa Road (Appendix A, Fig. 17).

14. ***Las Flores Creek (within Las Pulgas Canyon):***
    a. Between Stuart Mesa Road and the high voltage electrical transmission lines (Appendix A, Fig. 17).
    b. Between the Pacific Ocean and Stuart Mesa Road (Appendix A, Fig. 17).
    c. From the high voltage electrical transmission lines upstream to the Zulu Impact Area, approximately 0.75 km upstream of Basilone Road (Appendix A, Fig. 17).

15. ***Piedra de Lumbre Canyon,*** between the confluence with Las Flores Creek and the upstream limit of riparian habitat, approximately 2.7 km upstream of Las Pulgas Lake (Appendix A, Fig. 17).

16. ***Horno Canyon,*** between Old Highway 101 and the upstream limit of riparian habitat (Appendix A, Fig. 17).

17. ***San Onofre Creek:***
    a. From the Pacific Ocean to the south fork/north fork confluence, and upstream on the south fork to Basilone Road (Appendix A, Figs. 17 and 18).
    b. From Basilone Road upstream to the access road to Range 219 (Appendix A, Fig. 17).

18. ***San Mateo Creek:***
    a. From the Pacific Ocean upstream to San Mateo Road, including habitat south of the creek and south and east of the agricultural fields (Appendix A, Fig. 18).
    b. From San Mateo Road upstream to the Base boundary (Appendix A, Figs. 18 and 19).

19. ***Cristianitos Creek,*** between the confluence with San Mateo Creek and the Base boundary (Appendix A, Fig. 18).

20. Talega Canyon, between the confluence with Cristianitos Creek and a point approximately 6.5 km upstream (Appendix A, Fig. 18).

21. Pilgrim Creek:

a. Between the southern Base boundary and Vandegrift Boulevard, including the two side drainages east of Pilgrim Creek (Appendix A, Fig. 20).
b. From Vandegrift Boulevard upstream to the limit of riparian habitat (Appendix A, Fig. 20).

22. Windmill Canyon, from the Base boundary past the golf course to the upstream extent of habitat (includes both of the 2004 Windmill Canyon and Horse Pasture sites) (Appendix A, Fig. 20).

23. Ysidora Basin to Windmill Canyon, between Upper Ysidora Basin and Windmill Canyon/ Pueblitos Canyon (Appendix A, Fig. 20).

24. De Luz Homes Habitat, patches of habitat adjacent to the De Luz Homes development (Appendix A, Fig. 20).

The majority of drainages were surveyed from 3-7 times at least 10 days apart. Sites surveyed seven times throughout the breeding season were: Santa Margarita River (1a), Lake O'Neill/Fallbrook Creek (4a and 4b), Las Flores Creek (14a and 14c), and Pilgrim Creek (21a). Sites surveyed six times included: De Luz Creek, Roblar Creek, Aliso Creek, Las Flores Creek (14b), San Onofre Creek (17a), San Mateo Creek (18a), and Cockleburr Canyon. Sites surveyed three times were: Basilone and Roblar Roads, 22 Area, Pueblitos Canyon, Newton Canyon, French Creek, Hidden Canyon, Horno Canyon, Piedra de Lumbre Canyon, San Onofre Creek (17b), San Mateo Creek (18b), Pilgrim Creek (21b), Windmill Canyon, Ysidora Basin to Windmill Canyon, Cristianitos Creek, and De Luz Homes habitat. The upper portion of the Santa Margarita River (1b), Tuley Canyon, and Talega Canyon were surveyed twice for vireos. A 7 km section of the upper Santa Margarita River forms a boundary between Camp Pendleton and the Fallbrook Naval Weapons Station (FNWS). This section was surveyed for vireos by FNWS, while USGS biologists surveyed the reaches upstream and downstream of the boundary zone. USGS biologists noted the occurrence of vireos within the boundary zone while surveying for southwestern willow flycatchers (*Empidonax traillii extimus*) along the upper Santa Margarita River in a separate project (Howell and Kus 2009). These data are reported here, and will be replaced with the FNWS vireo data when they become available.

Biologists followed standard survey techniques described in the USFWS least Bell's vireo survey guidelines (USFWS 2001). Observers moved slowly (1-2 km per hour) through the riparian habitat while searching and listening for vireos. Observers walked along the edge(s) of the riparian corridor on the upland and/or river side where habitat was narrow enough to detect a bird on the opposite edge. In wider stands, observers traversed the habitat to detect all birds throughout its extent. Surveys were conducted between dawn and early afternoon, depending on wind and weather conditions.

All male least Bell's vireos were detected and confirmed audibly by hearing their diagnostic song. Attempts were made to observe males visually to note banding status but were not required to confirm the identity of the species as the song was considered the most diagnostic field characteristic. The presence of a female vireo within a territory was confirmed either audibly through the detection of the "pair call" elicited between mated birds, or visually when observed traveling quietly with the male. For each bird encountered, investigators recorded age (adult or juvenile), sex, breeding status (paired, unpaired, undetermined, or transient), and whether the bird was banded. Birds were considered transients if they were not detected on two or more consecutive surveys after an initial detection. Vireo locations were mapped on 1:12,000 aerial photographs as well as 1:24,000 USGS topographic maps, using a Garmin 12 Global Positioning System (GPS) unit with 1-15 m positioning accuracy to determine geographic coordinates (WGS84). Dominant native and exotic plants were recorded, and percent cover of exotic vegetation estimated using cover categories of <5, 5-50, 51-95 and >95%. The overall habitat type within the territory was specified according to the following categories:

Mixed willow riparian: Habitat dominated by one or more willow species including 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 cottonwood (*Populus fremontii*) is a co-dominant.

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

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

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

Upland scrub: Coastal sage scrub adjacent to riparian habitat.

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

Nest Monitoring

We monitored least Bell's vireo nests to evaluate the effects of giant reed removal on nest success and productivity. Giant reed is a highly invasive, non-native plant within riparian systems in southern California. Originally introduced for bank stabilization in the 1800s, giant reed has become a major component of many riparian systems, becoming the dominant vegetation within streams and rivers. As part of a riparian restoration effort, Marine Corps Base Camp Pendleton has been removing large quantities of giant reed on the Santa Margarita River. Areas that have recently undergone giant reed removal tend to consist of patches of native woody plants surrounded by areas of bare earth. These open areas are typically populated by

native and non-native herbaceous plants until the appropriate conditions arise that allow for the establishment of native woody species, such as mule fat, sandbar willow, black willow, arroyo willow, and red willow. We monitored vireos within four established monitoring areas: two sites in areas where extensive giant reed removal occurred between 2000 and 2002, with limited, on-going maintenance (hereafter "Removal" sites) and two sites in areas where some peripheral giant reed removal occurred mainly between 1997 and 1999 and the native vegetation has recovered (hereafter referred to as "Reference" sites) (Fig. 2).

We compared vireo breeding productivity and factors that potentially influence productivity between Reference and Removal sites and across years (2005-2008) to determine whether giant reed removal influenced vireo productivity and how productivity responded to recovery of native habitat where giant reed had been removed. The following parameters were examined: clutch size, hatching rate, fledging rate, nest success, re-nesting rate, total number of fledglings per pair, nest placement, predation rate, and cowbird parasitism rate.

We also attempted to determine the effects of giant reed removal on adult and juvenile survivorship, site fidelity, and movements of adults and juveniles between years to determine patterns of attraction or avoidance of Removal and Reference sites. To this end, we attempted to band all adult and juvenile vireos at monitored nest sites and recapture or resight all banded vireos within Reference and Removal sites and the surrounding areas to identify individuals and compile a history of their territory occupation across years and their movements into and out of Reference and Removal sites.

Finally, we compiled annual density within Removal and Reference sites by delineating the boundary of each Removal and Reference site (Fig. 2), then counting the number of vireo territories that occurred within those boundaries each year from 1997 through 2008. We examined these data to look for trends in local population size and density, particularly in response to the recover of native habitat following giant reed removal.

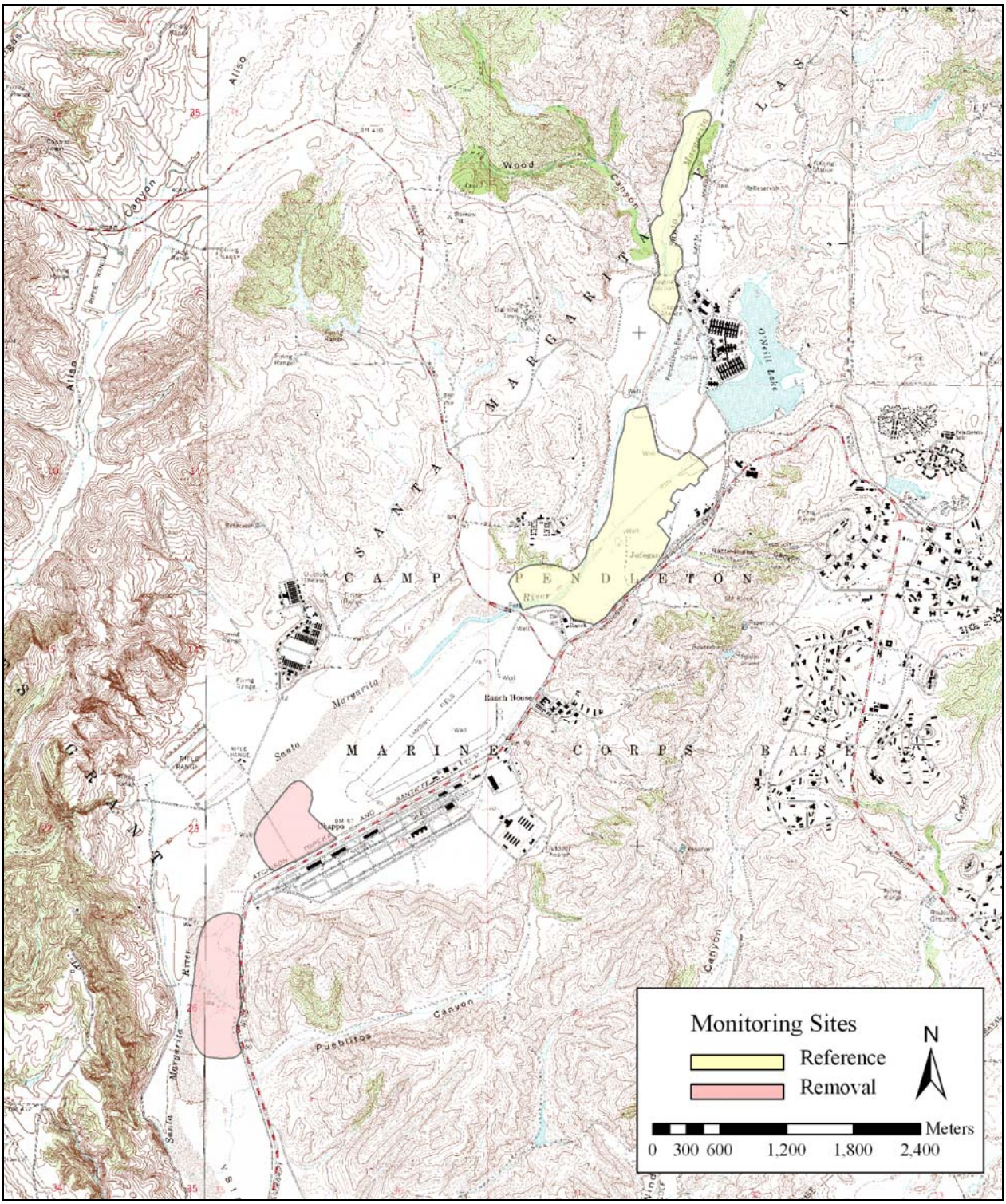

Fig. 2. Location of least Bell's vireo nest monitoring areas at Marine Corps Base Camp Pendleton, 2008.

Nesting activity was documented for 26 pairs in Removal sites and 25 pairs in Reference sites throughout the breeding season. A subset of nests was monitored for nine additional pairs where nests were found and monitored opportunistically. Pairs were chosen based on their location within areas that were monitored in previous years and in order of their detection on-site during the first vireo survey to ensure a complete record of activity within the territory. Pairs were observed for evidence of nesting, and their nests were located. Nests were visited as infrequently as possible to minimize the chances of leading predators or brown-headed cowbirds to nest sites; typically, there were 3-5 visits per nest. The first visit was timed to determine the number of eggs laid, the next few visits to determine hatching and age of young, and the last to band nestlings. Fledging was confirmed through detection of young outside the nest, or, rarely, the presence of feather dust in the nest (SUC). Unsuccessful nests were placed into one of four nest fate categories. Nests found empty or destroyed prior to the estimated fledge date and where the adult vireos were not found tending fledgling(s) were considered depredated (PRE). Previously active nests that were subsequently abandoned by adult vireos after one or more brown-headed cowbird eggs were laid in the nest were considered to have failed because of nest parasitism (PAR). Any nests that fledged cowbird young without fledging vireo young were also considered to have failed because of nest parasitism (PAR). Nests failing for reasons such as poor nest construction or the collapse of a host plant that caused a nest's contents to be dumped onto the ground, or the presence of a clutch of infertile eggs, were classified as failing because of other causes that were known (OTH). Nests that appeared intact and undisturbed but were abandoned with vireo eggs and/or nestlings were classified as having failed because of unknown causes (UNK). Characteristics of nests, including height, host species, host height, and the distance nests were placed from the edge of the host plant, and to the edge of the vegetation clump in which they were placed were recorded following abandonment or fledging of young from nests.

Camp Pendleton implements an intensive annual cowbird control program on Base, and parasitism of least Bell's vireo nests is extremely rare. Nevertheless, we were prepared to follow our standard protocol for manipulating nest contents in the event cowbird eggs or nestlings were detected in vireo nests. In nests with fewer than three vireo eggs, cowbird eggs are removed no sooner than the seventh day of incubation to minimize the possibility of nest abandonment in response to the removal. Cowbird eggs are removed from nests containing three or more vireo eggs as they are found. Cowbird nestlings are removed immediately from nests.

Precipitation Data

Precipitation has been associated with bird population dynamics, especially in arid environments (Boag and Grant 1984; Rotenberry and Wiens 1989, 1991; Chase *et al*. 2005), primarily through its influence on primary productivity (Cody 1981, Grant and Grant 1987). We examined precipitation data from three weather stations on Camp Pendleton: Las Flores, Target Range, and Ammo Dump (WRCC 2008), which surround the Reference and Removal monitoring sites. We chose to use precipitation data from the Target Range weather station because 1) the Target Range weather station presented the most complete set of precipitation data and 2) data from the other two weather stations correlated well with the Target Range data set (Las Flores x Target Range $R^2 = 0.76$, $P = 0.001$, $n = 11$; Ammo Dump x Target Range $R^2 = 0.77$, $P = 0.02$, $n = 6$). Annual precipitation was compiled for each bioyear (July through June),

which measures precipitation during the winter prior to the year of associated vireo demographic data (e.g., precipitation from July 2004 through June 2005 is associated with vireo data from 2005). We analyzed the relationships between annual precipitation and total number of territories, average clutch size, and number of young fledged per pair.

Banding

The primary goals of banding least Bell's vireos on Camp Pendleton were: 1) to better understand adult vireo site fidelity within a potential source population, 2) to investigate natal dispersal on Base, and the role Camp Pendleton young play in potentially supporting vireo populations off Base, and 3) to understand how giant reed removal affects vireo demography. Nestlings from monitored nests were banded at 6-7 days of age with a single anodized gold numbered federal band on the left leg. A subset of adult vireos within Removal and Reference sites were captured in mist nets and banded with a unique combination of colored plastic and anodized metal bands, including either an anodized gold or orange plastic band to designate Camp Pendleton as the bird's site of origin Adults previously banded with a single numbered federal band were target netted to determine their identity, and their original band was supplemented with other bands to generate a unique color combination.

Data Analyses

We conducted statistical tests to determine whether there were differences in vireo territory density, nest success, productivity, or nest site characteristics between pairs nesting at Removal and Reference sites. We used Chi-square and Fisher's Exact tests to determine if there were differences in overwinter survivorship, re-nesting rate, re-nesting after successful or unsuccessful nests, overall nest success, success of first nesting attempt, nests reaching nestling stage, egg hatching rate, and vireo population density between Removal and Reference sites, and to determine if there were differences in first and second nesting success rates by year. Chi-square tests were used when sample sizes were sufficient; Fisher's Exact tests were used when one or more category contained fewer than five samples. We used *t*-tests and Mann-Whitney *U*-tests to determine if there were differences in the number of nesting attempts, the initiation of first nesting attempts, average clutch size, average brood size, average number of young/pair, nest height, host plant height, distance to the edge of the host plant, distance to the edge of the vegetation clump, and distance to the edge of the riparian vegetation in which the nest was located between Removal and Reference sites, and to determine if there were difference in nest placement characteristics between successful and failed nests within Removal and Reference sites. *T*-tests were used when distributions were normal and variances were similar; Mann-Whitney *U*-tests were used when the data violated these assumptions. We used logistic regression to determine if the date of first nesting attempt predicted nest success. We used Analysis of Variance (ANOVA) and Tukey's post-hoc pairwise comparisons to determine if there were differences in the timing of the first nesting attempt by year, clutch size by year between Removal and Reference sites, and young per pair by year between Removal and Reference sites. We used simple Pearson's correlations to determine if annual precipitation correlated with clutch size, number of young/pair, and total number of vireo territories on Camp Pendleton. If nests were parasitized by brown-headed cowbirds, rescued by removing the cowbird egg(s) and/or nestling(s), and subsequently fledged vireo young, all success and productivity calculations were rerun treating successful rescued nests as failed nests to estimate

the potential impact(s) of cowbird parasitism on the Pendleton vireo population. Data were analyzed using SYSTAT statistical software (SYSTAT Software, Inc. 2005). Two-tailed tests were considered significant if $P < 0.10$. All data from Camp Pendleton from 2005, 2006, and 2007 used in comparisons with current data can be found in Rourke and Kus 2006a, Rourke and Kus 2007a, and Rourke and Kus 2008.

RESULTS

Population Size and Distribution

Seven hundred and sixty-nine least Bell's vireo sites were identified during Base-wide surveys (Table 1, Appendix B, Figs. 21-38). This included 738 territorial male vireos, 79% of which were confirmed as paired, and 31 transients. Transient vireos were observed on 11 of the 24 (46%) drainages/sites surveyed. Ninety-six percent of all vireo territories occurred on the ten most populated drainages/sites (i.e., Santa Margarita River, Las Flores Creek, San Mateo Creek, San Onofre Creek, Pilgrim Creek, De Luz Creek, Lake O'Neill/Fallbrook Creek, Windmill Creek, the 22 Area, and Aliso Creek), and the majority of vireo territories (61%) occurred along the Santa Margarita River, the largest expanse of riparian vegetation on Base (Tables 1, 2). The remaining 14 drainages/sites each contained 10 or fewer territories.

The number and distribution of least Bell's vireo territories documented on Base in 2008 was similar to that in 2007 (Fig. 3, Table 2). In 2008, the number of territories on 78% (18/23) of drainages surveyed differed by fewer than four territories compared to 2007, while 61% (14/23) of drainages differed by one or fewer territories. Six drainages increased in vireo numbers, eight decreased, and nine showed no change. The drainage with the largest numeric increase in vireo numbers was the Santa Margarita River, increasing by 40 territories (9%), although the section that burned in 2007 lost 12 territories (52%). The site with the largest numeric loss in vireo numbers was Las Flores Creek, losing 11 territories (14%), 9 of which occurred within the section that burned in 2007. Aliso Creek lost two territories in areas that burned, but gained four territories in other sections. San Onofre Creek lost nine territories in areas that burned but gained six territories in other sections. Piedra de Lumbre lost two territories in areas that burned. Overall, the vireo population on Base increased by 4.5% from 2008 to 2007.

Least Bell's vireos began arriving on Base during the last week of March (Fig. 4), with 54 territories established by 31 March. By 1 April 2008, 9% of males had established territories. By 15 April 50% of males were present, and by the end of April, 70% of males were detected at their territories. This represents the highest proportion of established territories on Camp Pendleton by the end of April in the past four years.

Table 1. Number and distribution of least Bell's vireos at Marine Corps Base Camp Pendleton, 2008.

Drainage/Survey Site	Known Pairs	Single/ Status Undetermined	Transient	Total Territories
Santa Margarita River:				
I-5 to De Luz Creek	364	59	7	423
De Luz Creek to Base Boundary	25	4	0	29
De Luz Creek	21	4	3	25
Roblar Creek	0	0	0	0
Lake O'Neill/Fallbrook Creek	10	1	0	11
Basilone-Roblar Roads	0	0	0	0
22 Area	1	10	0	11
Pueblitos Canyon	2	0	0	2
Newton Canyon	4	0	2	4
Cockleburr Creek	1	0	1	1
French Canyon	2	0	0	2
Aliso Creek	9	2	1	11
Hidden Canyon	0	4	0	4
Las Flores Creek:				
Pacific Ocean to Stuart Mesa Road	7	1	0	8
Stuart Mesa Road to Power Lines	27	1	2	28
Power Lines to Zulu Impact Area	27	7	5	34
Piedra de Lumbre Canyon	2	1	1	3
Horno Canyon	0	0	0	0
San Onofre Creek:				
Pacific Ocean to Basilone Road	14	26	1	40
Basilone Road to Access Road to Range 219	0	1	0	1
San Mateo Creek				
Pacific Ocean to San Mateo Road	40	9	5	49
San Mateo Road to Yankee Training Area	2	2	0	4
Cristianitos Creek	4	0	0	4
Talega Canyon	0	0	0	0
Tuley Canyon	0	0	0	0
Pilgrim Creek:				
Base Boundary upstream to Vandegrift Boulevard	8	8	0	16
Vandegrift Boulevard to upstream riparian limit	1	9	0	10
Windmill Canyon	10	2	0	12
Ysidora Basin to Windmill Canyon	0	4	2	4
De Luz Homes	1	1	1	2
Total	582	156	31	738

Table 2. Number of territorial males at Marine Corps Base Camp Pendleton, by drainage, 2004-2008. Numeric change is the positive or negative change in the number of vireo territories between 2007 and 2008.

	Number of Territorial Males					Numeric
Drainage	**2004[a]**	**2005**	**2006**	**2007**	**2008**	**Change**
Santa Margarita River[b]	440	472	417	423	463	+40
De Luz Creek	26	18	25	24	25	+1
Roblar Creek	1	0	0	0	0	0
Lake O'Neill/Fallbrook Creek	16	20	10	9	11	+2
Pueblitos Canyon	3	5	3	2	2	0
Newton Canyon	9	8	8	5	4	-1
Cockleburr Creek	0	2	2	2	1	-1
French Canyon	5	6	4	2	2	0
Aliso Creek	21	21	11	9	11	+2
Hidden Canyon	5	8	5	4	4	0
Las Flores Creek	84	85	76	81	70	-11
Piedra de Lumbre Canyon	5	8	9	6	3	-3
Horno Canyon	0	1	0	0	0	0
San Onofre Creek	56	52	43	44	41	-3
San Mateo Creek	68	56	59	46	53	+7
Cristianitos Creek	8	6	8	8	4	-4
Talega Canyon	0	1	0	0	0	0
Pilgrim Creek	37	36	23	26	26	0
Windmill Canyon	20	12	7	8	12	+4
Ysidora Basin to Windmill Canyon	8	4	6	5	4	-1
De Luz Homes	5	4	2	3	2	-1
Basilone-Roblar Roads	-	2	0	0	0	0
Tuley Canyon	2	-	0	0	0	0
Total	819	827	718	707	738	+31

[a] 2004 sites not listed: Vandegrift Hills (1), Kilo 1/ Kilo 2 Hills (2); 2004 total = 822 territories
[b] Includes vireo territories detected within the 22 Area.

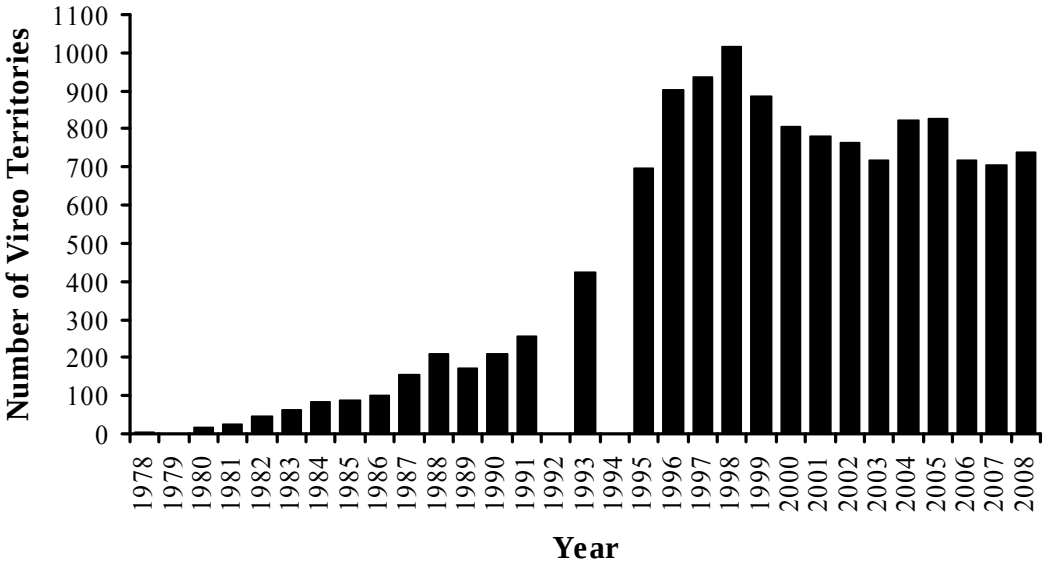

Fig. 3. Number of least Bell's vireo territories at Marine Corps Base Camp Pendleton, 1978–2008. (Source: Griffith Wildlife Biology 2004, Rourke and Kus 2006a, 2007a, 2008).

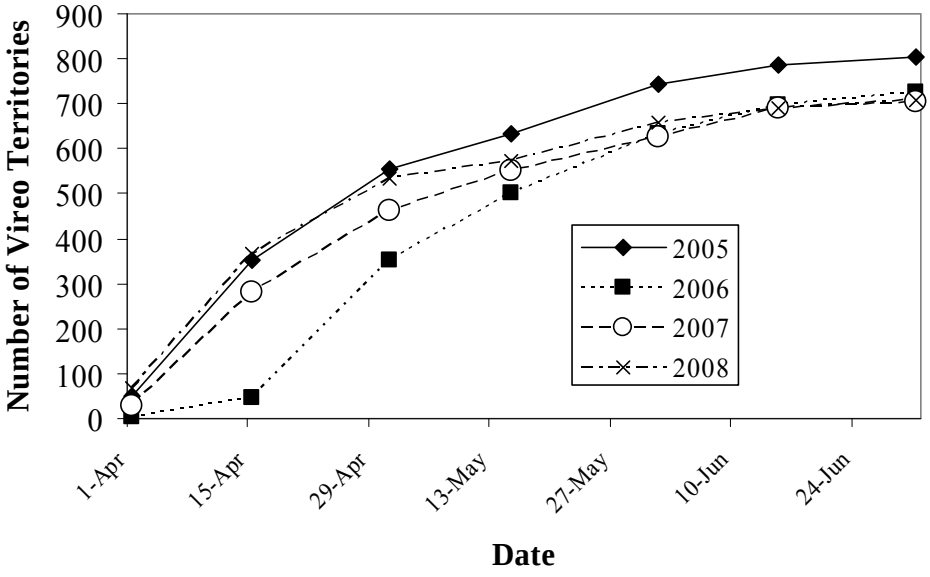

Fig. 4. Territory establishment of least Bell's vireos at Marine Corps Base Camp Pendleton, 2005-2008.

Habitat Characteristics

Vireos used a number of different habitat types ranging from willow-dominated thickets along stream courses to upland vegetation along roads and channel margins (Table 3). The majority of vireo territories occurred in habitat characterized as Willow Riparian, with 75% of males in the study area found in this habitat. An additional 10% of birds occupied willow habitat co-dominated by cottonwoods or sycamores. Seven percent of territories were found in Riparian Scrub, dominated by mule fat and/or sandbar willow. Six percent of the vireos used drier habitats including areas dominated by a mix of sycamore and oaks (1% of total) or upland vegetation (5%). Fewer than 1% of vireos occupied alder (*Alnus rhombifolia*) habitat, all of which occurred along upper Las Flores Creek. Approximately 1% of vireo territories were placed in habitat consisting exclusively of non-native vegetation.

Table 3. Habitat types used by least Bell's vireos at Marine Corps Base Camp Pendleton, 2008.

	Number of Territories			
Habitat Type	**>50% Native**	**>50% Exotic**	**Total**	**Percent of Total**
Mixed Willow	505	26	531	75%
Willow/Cottonwood	1	0	1	<1%
Willow/Sycamore	58	13	71	10%
Alder	2	0	2	<1%
Riparian Scrub	44	6	50	7%
Sycamore/Oak	7	0	7	1%
Upland Scrub	24	8	32	5%
Non-native	1	7	8	1%
Total	642	60	702	100%

More vireo territories were documented in exotic vegetation in 2008 than in 2007 (Table 4). Nine percent of vireo territories (60/703) in 2008 were in areas where exotic species such as giant reed, poison hemlock (*Conium maculatum*), black mustard (*Brassica nigra*), and salt-cedar made up 50% or more of the habitat versus 3% (20/707) of vireo territories the previous year. Moreover, in 2008 more drainages contained territories dominated by non-native vegetation than in 2006 and 2007. Exotic vegetation dominated at least one territory on nine drainages in 2008 compared to eight drainages in 2006 and five drainages in 2007. 2005 remained the year with the highest number of drainages containing at least one vireo territory dominated by exotic vegetation, with 13.

Table 4. Proportion of least Bell's vireo territories dominated or co-dominated by exotic vegetation, by drainage, 2005-2008. Numbers in parentheses are the number of territories on the drainage.

	Proportion of Territories							
Drainage	**2005**		**2006**		**2007**		**2008**	
Windmill Creek	0.67	(12)	0.14	(7)	0.13	(8)	0.67	(12)
Piedra de Lumbre Canyon	1.00	(8)	0.00	(9)	0.00	(6)	0.67	(3)
Newton Canyon	0.63	(8)	0.13	(8)	0.00	(5)	0.50	(4)
Pueblitos Canyon	0.00	(5)	0.00	(3)	0.00	(2)	0.50	(2)
Las Flores Creek	0.02	(85)	0.14	(76)	0.00	(81)	0.29	(68)
Ysidora Basin to Windmill Canyon	0.25	(4)	0.50	(6)	0.00	(5)	0.25	(4)
San Mateo Creek	0.66	(56)	0.12	(59)	0.00	(46)	0.14	(50)
San Onofre Creek	0.23	(52)	0.00	(43)	0.00	(44)	0.13	(40)
Santa Margarita River[a]	0.17	(472)	0.05	(417)	0.04	(423)	0.03	(434)
Cristianitos Creek	0.50	(6)	0.13	(8)	0.25	(8)	0.00	(4)
Aliso Creek	0.05	(21)	0.00	(11)	0.11	(9)	0.00	(11)
Lake O'Neill/Fallbrook Creek	0.15	(20)	0.00	(10)	0.11	(9)	0.00	(11)
De Luz Creek	0.06	(18)	0.04	(25)	0.00	(24)	0.00	(25)
Horno Canyon	1.00	(1)	0.00	(0)	0.00	(0)	0.00	(0)
Total	0.19	(827)	0.06	(718)	0.03	(707)	0.09	(703)[b]

[a] Includes vireo territories detected within the 22 Area.
[b] Data not recorded at all known vireo territories in 2008.

Banded Birds

We were able to observe 998 least Bell's vireos (641 males, 83% of all males, and 357 females, 62% of all females) on Base well enough to determine banding status in 2008. Ninety of these had been banded prior to the 2008 breeding season (Appendix C). Sixty of these vireos were identifiable by unique color band combinations: five vireos banded on Base in 2005, 14 banded on Base in 2006, and 31 banded on Base in 2007 returned to established territories in 2008 (Table 5). Of the returning birds originally banded in 2007, 17 were returning adults, 13 were banded as nestlings (captured in 2008 and given color bands) or fledglings, and one was of unknown age when banded. Ten additional vireos with unique color band combinations, originally banded off Base on the San Luis Rey River (Ferree and Kus 2007, 2008, Kus unpubl. data), were resighted in established territories. Adult birds of known age ranged from 1-4 years old.

Thirty vireos (9 males and 21 females) with a single numbered metal band were resighted in 2008 (Table 6). Six of these individuals were banded as nestlings off Base on the San Luis Rey River and twenty were banded as nestlings on Base. Four other resighted vireos had single silver metal bands and may have been banded at one of the two Monitoring Avian Productivity and Survivorship (MAPS) Stations on Base or may have originated from another banding project off Base. Efforts to recapture and identify these vireos were unsuccessful. It is likely that many of these birds were first year adults banded as nestlings in 2007, but because we did not recapture them, we could not confirm this.

Table 5. Number of least Bell's vireos individually identified by bands at Marine Corps Base Camp Pendleton in 2008, by original year banded, age, original banding location, and sex.

Year Banded	Age in 2008	Number of Vireos Observed by Origin			
		Camp Pendleton		San Luis Rey River	
		Male	Female	Male	Female
2005	≥ 4 yrs.	0	2	0	1
	3 yrs.	3	0	0	0
2006	≥ 3 yrs.	8	0	0	0
	2 yrs.	5	1	5	0
2007	≥ 1 yr.	16	1	0	0
	1 yr.	11	2	3	1
	Unknown	1	0	0	0
Total		44	6	8	2

Table 6. Banding location and sex of least Bell's vireos with single metal numbered federal bands observed on Marine Corps Base Camp Pendleton in 2008.

Original Banding Location	Males	Females
Camp Pendleton	2	18
San Luis Rey River	5	1
MAPS/Other[a]	2	2
Total	9	21

[a] Vireos with metal silver numbered federal bands may have been banded off Base at unassociated banding stations.

A total of 335 least Bell's vireos were banded during 2008 (Table 7). These included 54 adult vireos that were banded with a unique color combination (42 target netted and 12 caught at one of the Base's two MAPS stations), and 281 hatch-year birds (268 of which were banded as nestlings with a single gold numbered federal band and 13 of which were incidentally caught either while attempting to target net an adult vireo or at one of the Base's two MAPS stations).

Table 7. Summary of new least Bell's vireos captured and banded on Marine Corps Base Camp Pendleton in 2008.

Age Banded	Males	Females	Unknown Sex
Adult	21	13	20
Juvenile[a]			13
Nestling[b]			268
Total	21	13	301

[a] Incidentally captured post-fledging, given unique color band combinations.
[b] One vireo was originally banded as a nestling in 2008, then was incidentally recaptured and given a unique color band combination later in 2008.

Survivorship, Fidelity, and Movement

Base-wide Survivorship

The recapture and resighting of banded birds allowed us to determine the rate at which vireos previously documented on Base returned to hold territories or were resighted in 2008. Although this is the minimum number of vireos known to survive and does not include all birds that dispersed off Base or that we may have failed to detect/resight, it can be used as an inference to calculate minimum annual survivorship for the vireo population on Base.

Of 77 uniquely color banded adult vireos present on Base during the 2007 breeding season, 40% (31/77) returned to Camp Pendleton in 2008 (Table 8). An additional 14 adult vireos were detected in 2008 that were not detected in 2007, increasing the adult survivorship to 49% (45/91). Eight of the twenty-one adult female vireos known to be alive in 2007 were resighted in 2008, an over-winter survivorship rate of 38%. Thirty-seven of the sixty-four adult male vireos known to be alive in 2007 were resighted in 2008, an over-winter survivorship rate of 58%. The remaining 38 females and males, plus 6 vireos of unknown sex in 2007, were not resighted in 2008. The discrepancy in sex-related over-winter survivorship may be attributed to difficulty in resighting females. In any given year, the proportion of females that are resighted is lower than for males. Therefore, the chances of resighting a particular female are correspondingly smaller.

Table 8. Number of banded adult least Bell's vireos detected in 2007 at giant reed (*Arundo donax*) Removal sites, Reference sites, and other areas on Marine Corps Base Camp Pendleton, and those that returned in 2008.

Year/Sex	Removal Sites	Reference Sites	Other Areas	Total
2007				
Male	21	15	20	56
Female	5	4	6	15
Unknown	0	0	6	6
2008				
Male	12	12	5	29
Female	1	1	0	2

Of the fourteen vireos that were not observed in 2007 but were detected on Base in 2008, nine vireos (eight males and one female) were banded as nestlings in 2006 and three vireos (all females) were banded as nestlings in 2005. Two other nestlings that were originally banded on Base in 2005 and 2006 were recaptured and given unique color band combinations in 2008 on the San Luis Rey River (Ferree and Kus 2009) and the San Diego River (Wellik *et al*. 2009), respectively. These detections increase the first year survivorship estimate for 2006 from 10% to 15% (Rourke and Kus 2007a) and 2007 from 10% to 22% (Rourke and Kus 2008), and increase the adult survivorship for 2007 from 63% to 66% (Rourke and Kus 2008). One other vireo with a metal gold numbered federal band was reported from the Sepulveda Basin on the Los Angeles River in 2007 (Griffith Wildlife Biology 2007). The identity of this vireo could not be verified

to obtain specific details of its origin, but it can be assumed that this bird was banded at Camp Pendleton or FNWS in 2005 or 2006.

Thirteen of the 117 hatch-year vireos banded in 2007 that survived to fledge (11 males and 2 females) were resighted with or captured and given unique color band combinations on Base in 2008 (Table 9). One other hatch-year male vireo banded on Base in 2007 was recaptured and given a unique color band combination at the Marine Corps Air Station in 2008 (Lynn and Kus 2009), yielding a conservative first year survivorship of 12%. Assuming an equal sex ratio of banded nestlings, first-year survivorship of males was 21% (12/58.5) and females was 3% (2/58.5). Another 16 vireos that were resighted in 2008 on Base with gold numbered federal bands on their right legs (two males and 14 females) may have been banded as nestlings in 2007 or in 2005. Assuming that these 16 vireos were banded as nestlings in 2007, the first year survivorship estimate increases to 26% (24% for males and 27% for females). Because female vireos are elusive and difficult to recapture, the first year survivorship estimate may be conservative.

Table 9. Number of least Bell's vireos banded as nestlings at giant reed (*Arundo donax*) Removal sites, Reference sites, and other areas on Marine Corps Base Camp Pendleton in 2007, and those that returned in 2008.

Year/Sex	Removal Sites	Reference Sites	Other Areas	Total
2007				
Unknown	52	63	2	117
2008				
Male	9[a]	3	0	12
Female	1	1	0	2

[a] One male vireo was banded at a Removal site and was recaptured at Marine Corps Air Station.

Survivorship at Removal and References Sites

Of the 26 banded adult vireos (five females and 21 males) that were detected within Removal sites in 2007, 13 (one female and 12 males) were resighted in 2008 for a 50% survival rate (20% for females, 57% for males) (Table 8). Of the 19 banded adult vireos (four females and 15 males) that were detected within Reference sites in 2007, 13 (one female and 12 males) were resighted in 2008 for a 68% survival rate (25% for females and 80% for males). Over-winter survival rate did not differ between Removal and Reference sites ($\chi^2_{0.05,1} = 0.15$, $P = 0.70$).

One-hundred and fifteen of the 117 banded nestlings that were known to fledge in 2007 were banded on a Removal or Reference site. Of these, 14 were recaptured and given unique color band combinations in 2008 (13 on Camp Pendleton and one at the Marine Corps Air Station) for an overall first-year survival rate of 12% for fledglings from Reference and Removal sites (Table 9). First-year survivorship at Removal sites was higher than at Reference sites (Fisher's Exact $P = 0.09$): ten (nine males and one female) nestlings from Removal sites and four

(three males and one female) nestlings from References sites survived into 2008, for a first-year survivorship rate of 19% (10/52) at Removal sites and 6% (4/63) at Reference sites.

Base-wide Site Fidelity and Movement

Resighting banded birds allowed us to identify individuals that either returned to the same site they used in a previous year (within 100 m) or moved to a different location (Table 10). Thirty-one adult vireos that were identified in 2007 were resighted in 2008, 30 of which occupied known territories both years. One vireo, banded in 2007 at the De Luz MAPS station, was excluded from the following analysis because his breeding territory was not identified in 2007. The majority of returning adult vireos showed strong between-year site fidelity. Twenty-four of the 30 returning adults (80%) occupied a breeding site in 2008 that they had defended in 2007 (within 100 m). Three additional vireos (10%) returned to sites adjacent to their previous territories (within 300 m). Two vireos (one female and one male) moved 1.5 and 2.9 km, respectively, from their 2007 breeding territories to their 2008 breeding territories, but remained within the same drainage. The average distance moved by returning adult vireos was 0.2 ± 0.6 km (SD).

Table 10 Between-year movement of adult least Bell's vireos at Marine Corps Base Camp Pendleton, 2008.

Year Last	Drainage[a] / Territory / Treatment		Distance Moved	Band Combination[b]		Age in	
Detected	2007	2008	(km)	Left Leg	Right Leg	2008	Sex[c]
2007	SMR / ARH / REM	SMR / ES09	2.9	Mgo	OROR/pupu	≥ 2 yr	M
2007	SMR / ODN / REF	SMR / HW33 / REF	1.5	Mgo	LPLP/pupu	≥ 2 yr	F
2007	SMR / VIC / REM	SMR / LND / REM	0.3	ORDG/Mgo	pupu	≥ 2 yr	F
2007	SMR / BIL / REF	SMR / HW40	0.2	DGOR	Mgo	≥ 3 yr	M
2007	SMR / DAT / REF	SMR / DRK / REF	0.2	pupu	LPBK/Mgo	≥ 3 yr	M
2007	SMR / SG07	SMR / SG06	0.1	pupu	WHWH/Mgo	≥ 3 yr	M
2007	SMR / ABB / REM	SMR / ATT / REM	0.1	Msi	DPDP/gogo	≥ 2 yr	M
2007	PC / PS01	PC / PS03	0.1	pupu	OROR/Mgo	≥ 2 yr	M
2007	SMR / MIK / REF	SMR / CED / REF	0.1	-	PUOR/Msi	≥ 2 yr	M
2007	SMR / UM30	SMR / UM41	0.0	BKLP/Mgo	pupu	2 yr	M
2007	SMR / ZPR / REF	SMR / ZPR / REF	0.0	ORPU/Mgo	pupu	2 yr	M
2007	SMR / HE17 / REF	SMR / HE22 / REF	0.0	gogo	LPBK/Msi	≥ 2 yr	M
2007	SMR / QIN / REF	SMR / QIN / REF	0.0	Mgo	WHWH/pupu	≥ 2 yr	M
2007	SMR / ANA / REM	SMR / ANA / REM	0.0	pupu	BKLP/Mgo	≥ 2 yr	M
2007	SMR / ANI / REM	SMR / ANI / REM	0.0	WHDP/Msi	gogo	≥ 2 yr	M
2007	SMR / BOW / REF	SMR / BOW / REF	0.0	WHDP/Mgo	pupu	≥ 2 yr	M
2007	SMR / HRP / REF	SMR / HRP / REF	0.0	Mgo	BYST/pupu	≥ 2 yr	M
2007	SMR / HOL / REF	SMR / HOL / REF	0.0	WHWH/Msi	gogo	≥ 2 yr	M
2007	SMR / LIF / REF	SMR / LIF / REF	0.0	YEYE/Msi	gogo	≥ 2 yr	M
2007	SMR / IND / REM	SMR / IND / REM	0.0	pupu	BKBK/Mgo	≥ 2 yr	M
2007	SMR / LAP / REM	SMR / LAP / REM	0.0	PUOR/Msi	gogo	≥ 2 yr	M
2007	SMR / VIC / REM	SMR / VIC / REM	0.0	pupu	PUPU/Mgo	≥ 2 yr	M
2007	SMR / AE05	SMR / AE16	0.0	Mgo	PUPU/pupu	≥ 3 yr	M
2007	SMR / ARS / REM	SMR / ARS / REM	0.0	-	YEPU/Mgo	≥ 3 yr	M

Table 5. Continued.

Year Last Detected	Drainage[a] / Territory / Treatment 2007	2008	Distance Moved (km)	Band Combination[b] Left Leg	Right Leg	Age in 2008	Sex[c]
2007	SMR / HTI / REF	SMR / HTI / REF	0.0	-	BWST/Mgo	≥ 3 yr	M
2007	SMR / ORN / REM	SMR / ORN / REM	0.0	-	OROR/Mgo	≥ 3 yr	M
2007	SMR / VEG / REM	SMR / VEG / REM	0.0	PUPU/pupu	Mgo	≥ 3 yr	M
2007	SMR / ALI / REM	SMR / ALI / REM	0.0	Mgo	PUWH/pupu	≥ 4 yr	M
2007	SMR / ATK / REM	SMR / ATK / REM	0.0	OROR/Msi	pupu	≥ 4 yr	M
2007	SMR / HLD / REF	SMR / HLD / REF	0.0	PUWH/Mgo	pupu	≥ 4 yr	M
2007	DL / DLMAPS	DL / DS11	0.8	gogo	OROR/Msi	≥ 1 yr	M
2006	SLR / PGH	SLR / HE33	13.2	ORDG/Mdb	pupu	2 yr	M
2006	SLR / CSAP	SLR / HW36	11.4	WHDP/Mdb	-	2 yr	M
2006	SMR / SMMAPS	SMR / HE31	7.3	DGOR/Msi	gogo	2 yr	M
2006	SLR / WOUT	SMR / AE25	7.2	-	-	2 yr	M
2006	SLR / WSTA	SLR / PON	5.9	Mdb	DPDP/sisi	2 yr	M
2006	SLR / BTHR	SMR / YB15	4.5	PUOR/Mdb	pupu	2 yr	M
2006	SMR / FAU	SMR / HW26	3.6	Mgo	LPBK/gogo	2 yr	F
2006	SMR / BEK	SMR / HE23	1.4	Mgo	ORPU/gogo	2 yr	M
2006	SMR / APO	SMR / HW33	1.2	Mgo	YEPU/pupu	2 yr	M
2005	SLR / RTL	SMR / JSP	14.1	-	WHDP/Mdb	3 yr	F
2005	SMR / AH07	SMR / AH04	1.7	pupu	PUOR/Mgo	3 yr	F
2005	SMR / ES05	SMR / ATT	1.1	ORPU/pupu	Mgo	3 yr	F
≤ 2006	SLR	SMR / HW28	8.2[d]	Mdb	-	≥ 2 yr	F
≤ 2006	SLR	SMR / OCM	8.8[d]	Mdb	-	≥ 2 yr	M
≤ 2007	SLR	LF / LN10	12.3[d]	-	Mdb	≥ 1 yr	M
≤ 2007	SLR	FR / FR01	8.0[d]	-	Mdb	≥ 1 yr	M
≤ 2007	SLR	NW / NC03	5.3[d]	-	Mdb	≥ 1 yr	M
≤ 2007	SLR	SMR / BN03	3.6[d]	-	Mdb	≥ 1 yr	M

[a] Drainage Codes: DL = De Luz Creek; FR = French Creek; LF = Las Flores Creek; NW = Newton Canyon; PC = Pilgrim Creek; SLR = San Luis Rey River; SMR = Santa Margarita River. Treatment Codes: REF = Reference; REM = Removal.

[b] Band colors: Mdb = dark blue numbered federal band; Mgo = gold numbered federal band; Msi = silver numbered federal band; gogo = metal gold; pupu = metal purple; sisi = metal silver; BKBK = plastic black; BKLP = plastic black-light pink split; BWST = plastic blue-white striped; BYST = plastic black-yellow striped; DGOR = plastic dark green-orange split; DPDP = plastic dark pink; DPWH = plastic dark pink-white split; LPLP = plastic light pink; LPBK = plastic light pink-black split; ORDG = plastic orange-dark green split; OROR = plastic orange; ORPU = plastic orange-purple split; PUOR = plastic purple-orange split; PUPU = plastic purple; PUWH = plastic purple-white split; WHDP = plastic white-dark pink split; WHPU = plastic white-purple split; WHWH = plastic white; YEPU = plastic yellow-purple split; YEYE = plastic yellow.

[c] Sex: F = female; M = male.

[d] Distance measured from 2008 territory to the closest location on the San Luis Rey River where banding has been conducted (i.e., approximately 400m northeast of College Boulevard) (USGS, unpublished data).

The 14 first year vireos from Camp Pendleton that were resighted in 2008 dispersed an average of 1.2 ± 0.8 km from their 2007 natal sites (range 0.4-2.6 km for males and 0.8-1.3 km for females) (Table 11). Four first year vireos that fledged from nests on the San Luis Rey River in 2007 were recaptured and banded with unique color combinations. One female dispersed 11.1 km to the Santa Margarita River drainage. Three males dispersed 4.7 to 12.2 km onto Camp Pendleton. Two of these occupied territories at Removal sites in 2008 and the third occupied a

territory in the Las Flores Creek drainage. Overall, the average distance first year vireos dispersed from both Camp Pendleton and the San Luis Rey River was 2.6 ± 3.9 km (SD) (*n* = 17).

Table 11. Between-year dispersal of least Bell's vireos banded as juveniles in 2007, at Marine Corps Base Camp Pendleton in 2008.

Year Last Detected	Drainage[a] / Territory / Treatment		Dispersal Distance (km)	Band Combination[b]		Sex[c]
	2007	2008		Left Leg	Right Leg	
2007	SLR / WSTA	SMR / HW08	11.1	-	WHPU/Mdb	F
2007	SMR / ZPR / REF	SMR / HE24 / REF	1.3	WHDP/pupu	Mgo	F
2007	SMR / ATT / REM	SMR / AE23 / REM	0.8	PUOR/pupu	Mgo	F
2007	SLR / WALY	LF / LL18	12.2	PUWH/pupu	Mdb	M
2007	SLR / FO7	SMR / BGL / REM	6.8	pupu	OROR/Mdb	M
2007	SLR / WTHE	SMR / ES07 / REM	4.7	YEYE/gogo	Mdb	M
2007	SMR / ABB / REM	SMR / SG18	2.6	-	ORDG/Mgo	M
2007	SMR / ZPR / REF	SMR / SG12	2.3	BKLP/pupu	Mgo	M
2007	SMR / ALI / REM	SMR / ES20 / REM	2.2	YEPU/gogo	Mgo	M
2007	SMR / VEG / REM	SMR / BN17	1.8	DPDP/sisi	Mgo	M
2007	SMR / ATK / REM	SMR / DON / REM	1.3	PUWH/sisi	Mgo	M
2007	SMR / HTI / REF	SMR / HE05 / REF	1.3	WHWH/sisi	Mgo	M
2007	SMR / CZN / REM	SMR / AE23 / REM	0.5	BKBK/gogo	Mgo	M
2007	SMR / FAU / REF	SMR / PEP / REF	0.5	DPWH/gogo	Mgo	M
2007	SMR / ORN / REM	SMR / ES19 / REM	0.5	PUWH/gogo	Mgo	M
2007	SMR / VIC / REM	SMR / PR25	0.5	OROR/gogo	Mgo	M
2007	SMR / ANI / REM	SMR / CZN / REM	0.4	WHPU/Mgo	-	M

[a] Drainage Codes: DL = De Luz Creek; FR = French Creek; LF = Las Flores Creek; NW = Newton Canyon; PC = Pilgrim Creek; SLR = San Luis Rey River; SMR = Santa Margarita River. Treatment Codes: REF = Reference; REM = Removal.

[b] Band colors: Mdb = dark blue numbered federal band; Mgo = gold numbered federal band; Msi = silver numbered federal band; gogo = metal gold; pupu = metal purple; sisi = metal silver; BKBK = plastic black; BKLP = plastic black-light pink split; BWST = plastic blue-white striped; BYST = plastic black-yellow striped; DGOR = plastic dark green-orange split; DPDP = plastic dark pink; DPWH = plastic dark pink-white split; LPLP = plastic light pink; LPBK = plastic light pink-black split; ORDG = plastic orange-dark green split; OROR = plastic orange; ORPU = plastic orange-purple split; PUOR = plastic purple-orange split; PUPU = plastic purple; PUWH = plastic purple-white split; WHDP = plastic white-dark pink split; WHPU = plastic white-purple split; WHWH = plastic white; YEPU = plastic yellow-purple split; YEYE = plastic yellow.

[c] Sex: F = female; M = male.

Six other vireos that had been banded off Base were resighted at Camp Pendleton in 2008. All carried a single blue numbered federal band indicating that they were originally banded as nestlings on the San Luis Rey River. One was female and five were males. One male was resighted at a Reference site. We estimated minimum dispersal distances for each bird by measuring the distance between its 2008 location and the closest monitored vireo population where banding has been conducted on the San Luis Rey River. The ages of the birds are unknown as banding has been conducted annually on the San Luis Rey River since 1989. Minimum dispersal distances ranged from 3.6 to 12.3 km (Table 10).

Site Fidelity and Movement – Removal and Reference Sites

Fidelity to treatment type was also very high and did not differ between treatments, as 100% (12/12) of vireos from Removal sites and 92% (12/13) of adult vireos from territories at Reference sites returned to the same treatment type they had defended previously (Table 10). The single bird (DGOR : Mgo, Table 5) that did not return to the Reference site in which it previously nested was documented defending a territory approximately 200 m west-northwest on the Santa Margarita River in 2008. Overall, 96% (24/25) of adult vireos that previously occupied a territory within a monitoring site/treatment type returned to the same site/treatment type in 2008.

One adult male was captured and banded early in 2007, and apparently attempted to breed at a Removal site in 2007. This male disappeared less than one month after banding when his first nest failed, and he was replaced by an unbanded male. The banded male was resighted in 2008 approximately 2.9 km south of his original 2007 breeding territory, and may have been the unidentified male that occupied that site in 2007 (resighting in 2007 was inconclusive). Because this male moved during the breeding season rather than between breeding seasons, we excluded his movements from this analysis.

Eleven of the thirteen first year vireos recaptured on Base were male and two were female (Table 11). All 13 originally fledged from either a Removal site or a Reference site, and dispersed to territories located within the Santa Margarita River drainage. Both females returned to within 1.3 km of their natal sites and to the same treatment type as their natal site, one a Removal site and the other a Reference site. Eight males fledged from Removal sites and five of these returned to Removal sites [three to the same site (within 600 m of their natal territories) and two to the other Removal site (1.3 km and 2.2 km from their natal territories)] and three dispersed to territories outside of the monitoring sites. Three males fledged from Reference sites and two of the three returned to the same site (within 1.3 km); the third dispersed to a territory outside of the monitoring sites. Males that dispersed from Removal and Reference sites moved 0.5–2.6 km from their natal territories.

Nest Monitoring

Nesting activity was monitored in a total of 60 territories within the Removal and Reference monitoring areas (Table 12, Figs. 5-8, Appendix D). Of these, 51 territories were "fully" monitored, meaning that all nests within the territory were found and documented during the breeding season. Pairs within the remaining nine territories were documented nesting; however, only a subset of nests by a pair was found and monitored ("partially monitored"). A total of 130 nests were monitored during the breeding season; 11 of these were not completed (coded as "INC" in Appendix D) and have been excluded from calculations of nest success and productivity. Of the remaining 119 nests, 110 were in fully monitored territories.

Table 12. Number of least Bell's vireo territories and nests monitored at giant reed (*Arundo donax*) Removal and Reference sites on Marine Corps Base Camp Pendleton, 2008.

	Nest Monitoring Area Type	
	Removal	**Reference**
Territories fully monitored	25	26
Nests in fully monitored territories	51	59
Completed nests per pair (fully monitored territories)	2.04 ± 0.5 (SD)	2.27 ± 0.9 (SD)
Territories partially monitored	5	4
Nests in partially monitored territories	5	4
Total # of nests monitored	56	63

Nesting Attempts

Within fully monitored territories, there was no difference in number of nesting attempts per pair at Removal sites (2.0 nests per pair) and at the Reference sites (2.3 nests per pair) (Mann-Whitney $U = 276.50$, $P = 0.36$) over the course of the 2008 breeding season. Fully monitored pairs at Removal sites were as likely to re-nest after their initial attempt as were pairs at Reference sites (Fisher's Exact $P = 0.72$), as 94% of Removal pairs and 92% of Reference pairs initiated a second attempt. Nest fate did not influence the likelihood that pairs would re-nest. At Removal sites, all pairs attempted a second nest after a failed first nesting attempt and 86% attempted to re-nest after a successful nesting attempt (Fisher's Exact $P > 0.99$). At Reference sites, 94% of pairs attempted second nests after a failed first nesting attempt, while 50% of pairs re-nested after a successful first attempt (Fisher's Exact $P = 0.36$). Overall, 95% (19/20) of vireo pairs attempted to re-nest after a failed first nesting attempt in 2008, similar to the proportion that attempted to re-nest after a failed first nesting attempt in previous years (Fig. 9). Conversely, in 2008, a higher number of vireo pairs (77%; 24/31) attempted to re-nest after a successful first nesting attempt than in previous years (Fig. 9). Four pairs at Removal sites and 10 pairs at Reference sites initiated three nesting attempts, and two pairs at Reference sites initiated four nesting attempts in 2008.

First nesting attempts in 2008 at Removal and Reference sites were initiated during the same week (5–12 April) and the median date of first nest initiation did not differ between treatment types (median at Removal sites = 15 April, median at Reference sites = 13 April; $t = 0.25$, $P = 0.80$). First nesting attempts were initiated significantly earlier in 2008 than in any other year (median for 2008 = 15 April; 2005 = 23 April; 2006 = 10 May; 2007 = 28 April; $F = 22.10$; $P < 0.001$; Fig. 10).

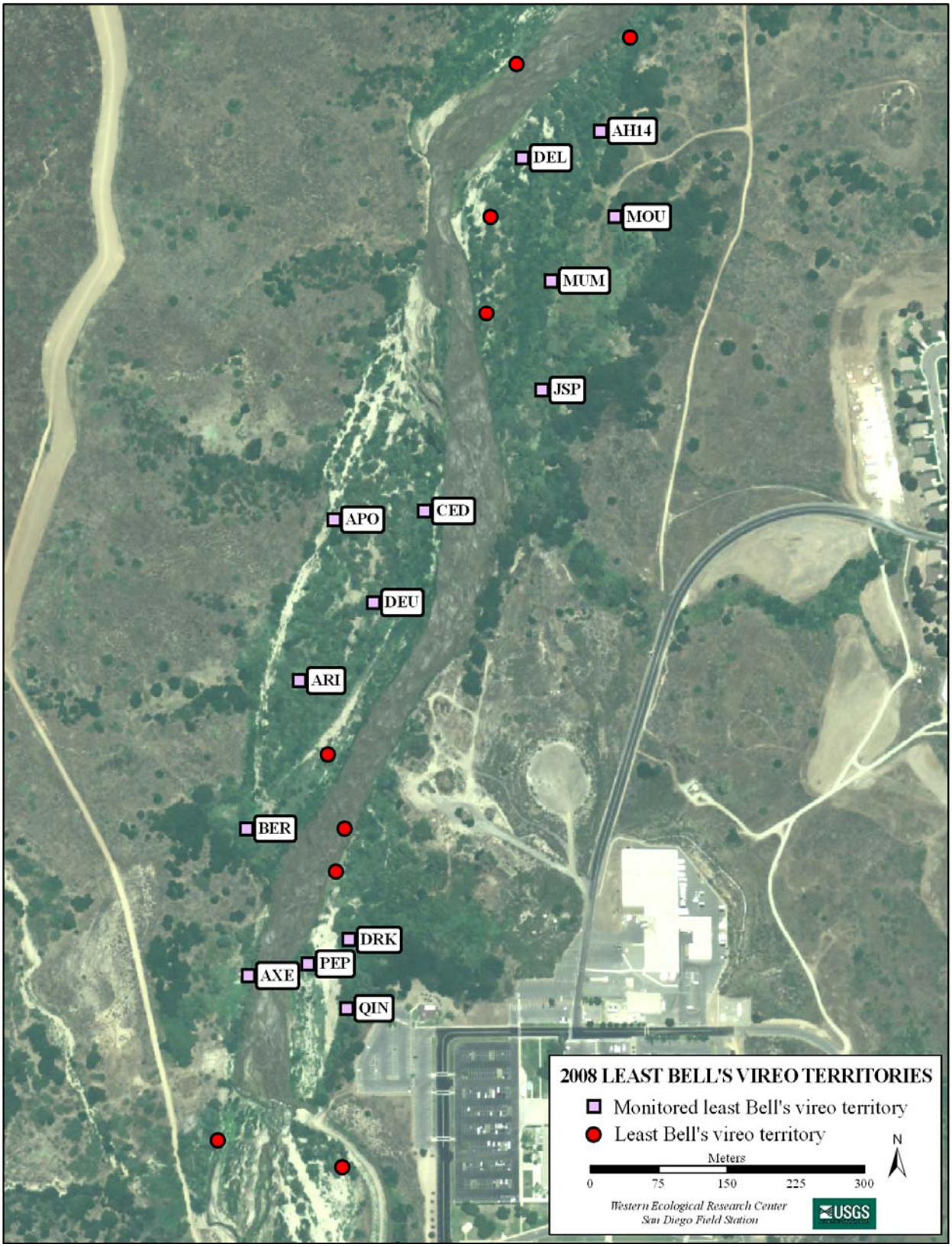

Fig. 5. Locations of monitored least Bell's vireo territories at the Above Hospital Reference site, Marine Corps Base Camp Pendleton, 2008.

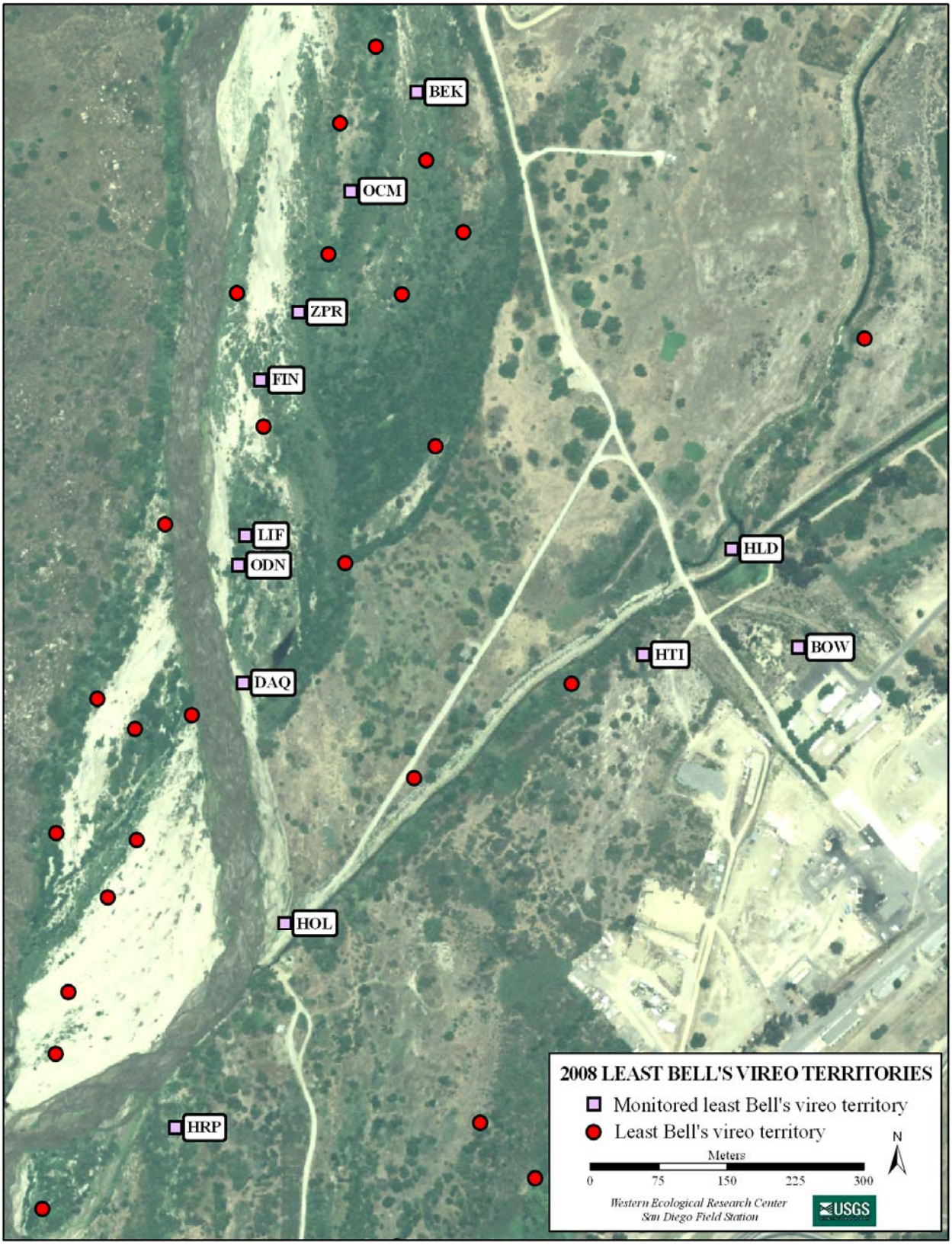

Fig. 6. Locations of monitored least Bell's vireo territories at the Below Hospital Reference site, Marine Corps Base Camp Pendleton, 2008.

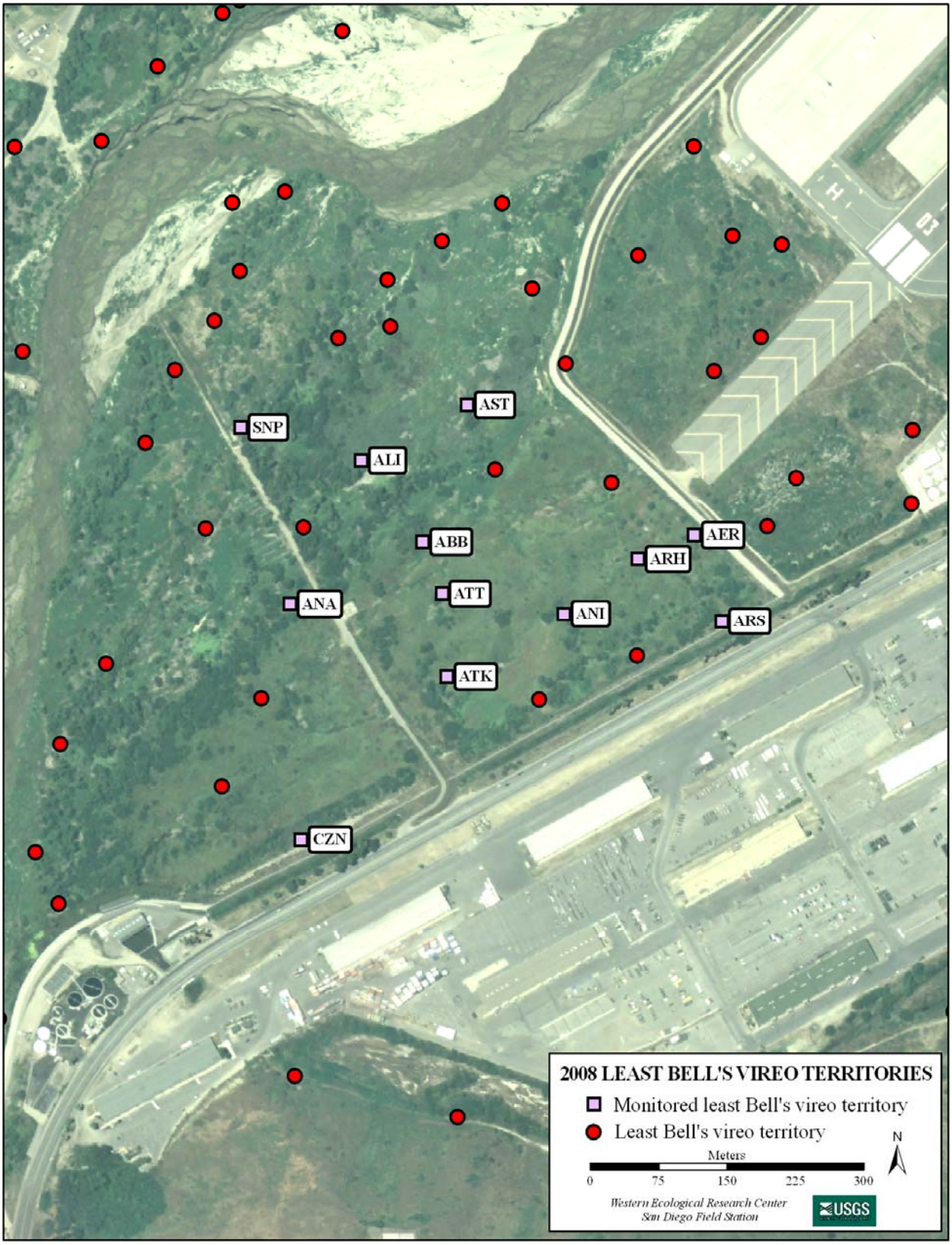

Fig. 7. Locations of monitored least Bell's vireo territories at the Air Station giant reed (*Arundo donax*) Removal site, Marine Corps Base Camp Pendleton, 2008 .

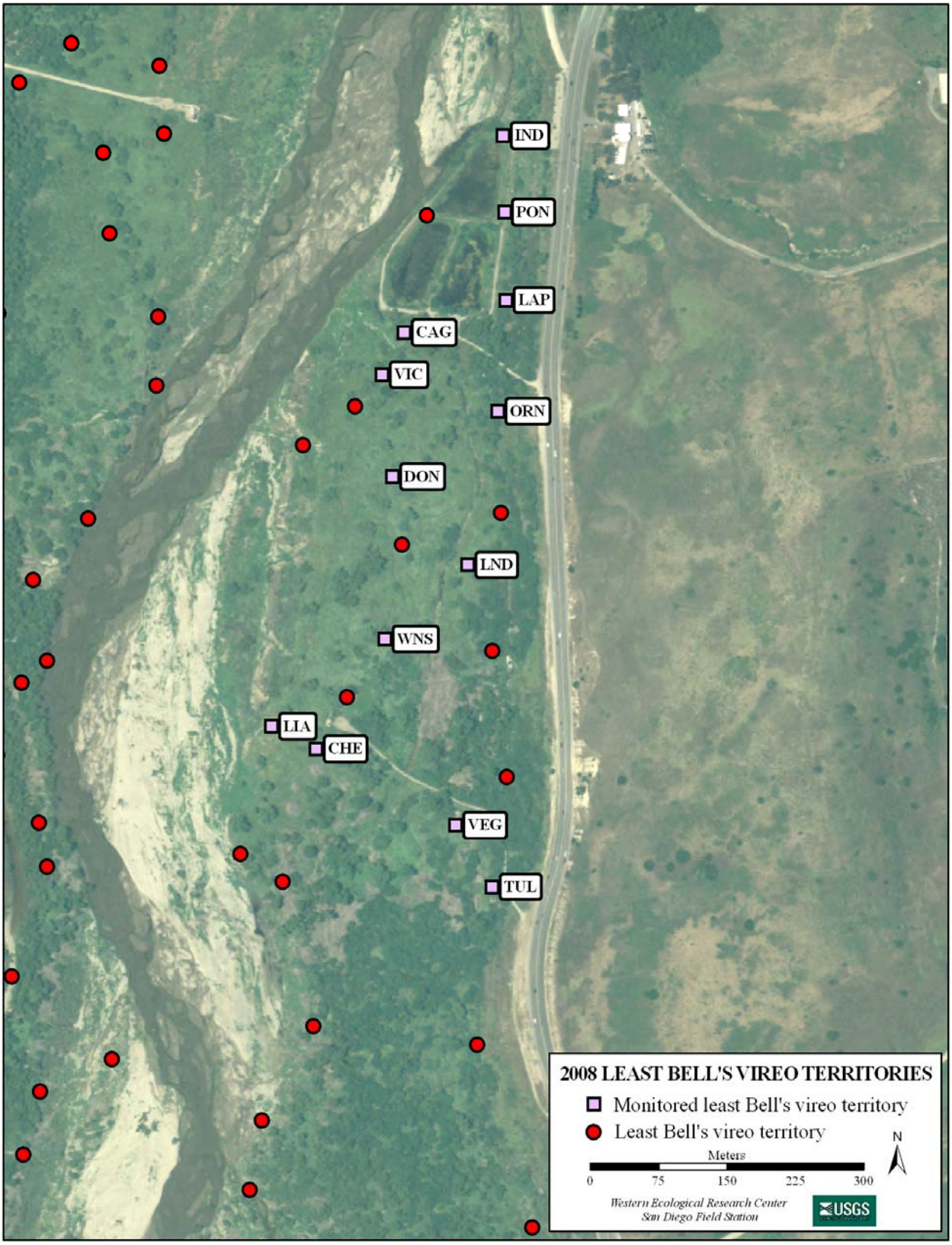

Fig. 8. Locations of monitored least Bell's vireo territories at the Seep giant reed (*Arundo donax*) Removal site, Marine Corps Base Camp Pendleton, 2008 .

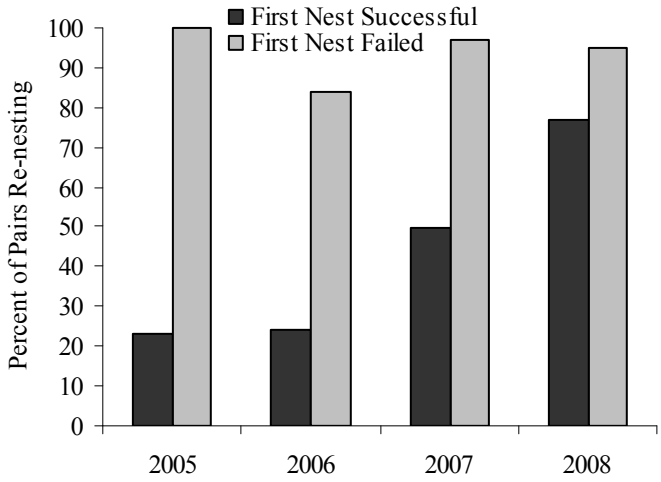

Fig. 9. Percent of vireo pairs that re-nested after a successful or failed first nesting attempt on Marine Corps Base Camp Pendleton, 2005-2008.

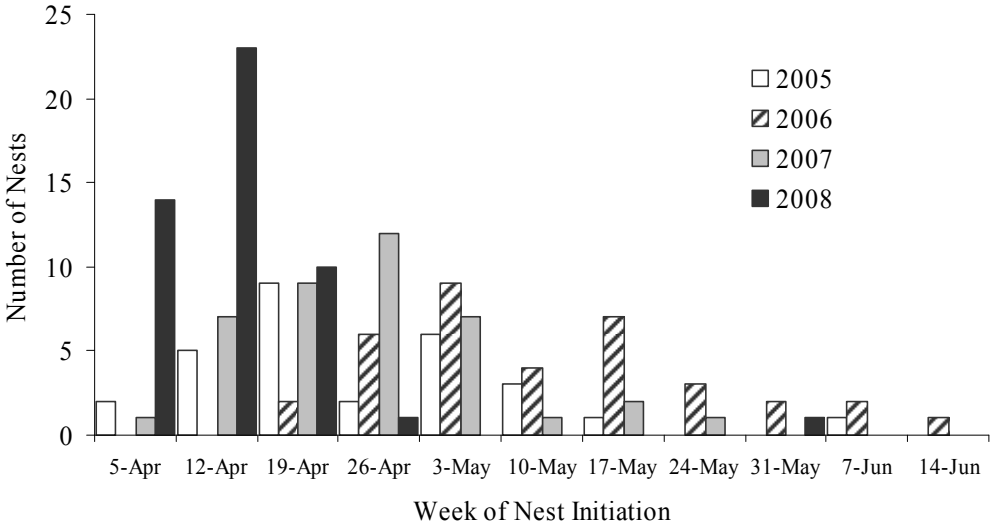

Fig. 10. Number of first least Bell's vireo nests initiated by week at Marine Corps Base Camp Pendleton, 2005-2008.

Nest Success

Nests in Removal sites were more likely to be successful than nests in Reference sites ($\chi^2_{0.05,1}$ = 6.63, P = 0.01), as 77% (43/56) of Removal nests successfully fledged young while

52% (33/63) of Reference nests successfully fledged young (Table 13). First nesting attempts were significantly more likely to be successful at Removal sites (84%) than at Reference sites (38%) (Fisher's Exact $P = 0.001$) in 2008 (Fig. 11A). Overall, 61% of first nesting attempts were successful in 2008, a significantly higher percentage of successful first nests than in previous years (2005 = 39%, 2006 = 40%, and 2007 = 26%) ($\chi^2_{0.05,3} = 12.25$, $P = 0.007$) (Fig. 11B).

Table 13. Fate of least Bell's vireo nests in fully and partially monitored territories, Marine Corps Base Camp Pendleton, 2008. Numbers in parentheses are proportions of total nests.

	Number of Nests		
Nest Fate	**Removal**	**Reference**	**Total**
Successful	43	33	76 (0.64)
Failed			
Predation	10	24	34 (0.28)
Parasitism	0	0	0 (0.00)
Other/Unknown	3	6	9 (0.08)
Total Completed Nests	56	63	119 (1.00)

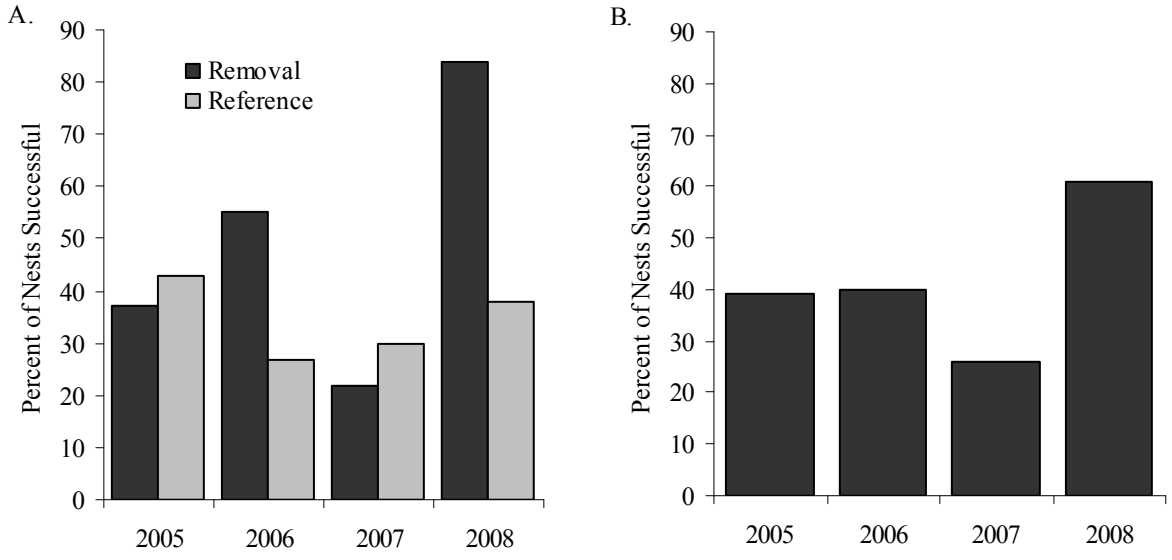

Fig. 11. Percent of successful least Bell's vireo nesting attempts (A) for first nests at Removal and Reference sites, and (B) for first overall, on Marine Corps Base Camp Pendleton, 2005-2008.

Causes of nest failure were similar between Removal and Reference sites. Predation was believed to be the primary source of nest failure at both sites, although no predation events were witnessed (Table 13). Predation accounted for 77% (10/13) and 80% (24/30) of nest failures at Removal and Reference sites, respectively. Overall, 18% and 38% of completed vireo nests, respectively, were lost to predation. Nests failed for known and unknown reasons in this study. One nest at a Removal site was found tipped with the eggs on the rim and likely failed because it

was attached to an unstable support. A second Removal site nest failed from unknown causes: one egg was missing and two 7-day-old nestlings were dead in the nest. One nest at a Removal site and one nest at a Reference site probably failed from Argentine ant (*Linepithema humile*) predation as the skeletons of nestlings were found in the nest and ants were present on and around the nest. One nest at a Reference site contained infertile eggs that showed no sign of development by the expected hatch date and one nest was abandoned during egg-laying. Three additional nests at Reference sites failed between nest-building and egg-laying from unknown causes.

Cowbird Parasitism

No nest parasitism of Bell's vireos by brown-headed cowbirds was documented in 2008.

Productivity

Clutch size did not differ between Removal and Reference sites (Table 14). Measures of hatching success were greater at Removal sites. A higher percentage of nests at Removal sites reached the nestling stage (93% vs. 73%; Fisher's Exact $P = 0.004$), translating into a greater percentage of eggs hatching at Removal sites than at Reference sites (84% vs. 66%; Fisher's Exact $P < 0.01$). Measures of fledging success were similar between Removal and Reference sites. Of the nests containing nestlings, a slightly higher percentage of Removal nests (83%) successfully fledged young than Reference nests (77%). However, overall productivity per pair was significantly higher at Removal sites (5.1 young per pair) than at Reference sites (3.6 young per pair). Ninety-six percent (24/25) of pairs at Removal sites and 92% (24/26) of pairs at Reference sites were ultimately successful in fledging young from at least one nest. Fifteen pairs at Removal (60%) and five pairs at Reference (19%) sites successfully double brooded, fledging young from two nests during the 2008 breeding season.

Overall, vireo pairs at monitored sites on Camp Pendleton fledged 4.4 vireo young per pair, and 94% (48/51) of all monitored pairs were successful in fledging at least one young in 2008.

Table 14. Reproductive success and productivity of nesting least Bell's vireos at giant reed (*Arundo donax*) Removal and Reference sites, Marine Corps Base Camp Pendleton, 2008 .

Parameter	Removal Sites	Reference Sites	Total
Nests with eggs	56	60	116
Eggs laid	196	204	400
Average clutch size[a]	3.6 ± 0.5 (SD)	3.7 ± 0.5 (SD)	3.7 ± 0.5 (SD)
Nests with hatchlings	52	43	95
Hatchlings	165	135	300
Hatching success:			
Eggs[b]	84%	66%	75%
Nests[c]	93%	72%	82%
Nests with fledglings	43	33	76
Fledglings	141	104	245
Fledging success:			
Hatchlings[d]	85%	77%	82%
Nests[e]	83%	77%	80%
Fledglings per egg	0.7	0.5	0.6
Fledglings per nest	2.5	1.7	2.1
Average number of young fledged per pair[f]	5.1 ± 1.9 (SD)	3.6 ± 2.0 (SD)	4.4 ± 2.1 (SD)
Pairs fledging ≥ one young[g]	24 (96%)	24 (92%)	48 (94%)

[a] Based on 50 Removal and 48 Reference non-parasitized nests with a full clutch (two-sample Mann-Whitney *U*-test; $U = 1078.5$, $P = 0.38$).
[b] Percent of all eggs that hatched.
[c] Percent of all nests with eggs in which at least one egg hatched.
[d] Percent of all nestlings that fledged.
[e] Percent of all nests with nestlings in which at least one young fledged.
[f] Based on 25 Removal and 26 Reference pairs who were fully monitored (two-sample Mann-Whitney *U*-test; $U = 184.5$, $P = 0.01$).
[g] Based on fully monitored pairs.

Four-Year Productivity Comparisons

From 2005 to 2007, there were no statistical differences documented in average clutch size or number of young fledged per pair between Removal and Reference sites when analyzed on an annual basis (Rourke and Kus 2006a, 2007a, 2008). This pattern persisted in 2008 for average clutch size, but the number of young fledged per pair was significantly greater at Removal sites than at Reference sites in 2008. When data from 2005 to 2008 were combined and analyzed using a two-way ANOVA, however, significant differences in average clutch size and total number of young fledged per pair between years became apparent. From 2005 to 2008, average clutch size was consistently smaller, although not statistically so, in nests at Removal sites than at Reference sites (Fig. 12A). When data from all four years were combined and analyzed, a significant year effect was found (Table 15, Fig. 12B), with the average clutch size in 2007 significantly lower than the average clutch size in 2005 and 2008 ($F_{0.05, 3, 189} = 4.83$, $P < 0.01$). No difference in clutch size was found between any other pairs of years. Mean clutch size was 3.6 eggs per nest in 2005, 3.5 eggs per nest in 2006, 3.3 eggs per nest in 2007, and 3.7 eggs per nest in 2008.

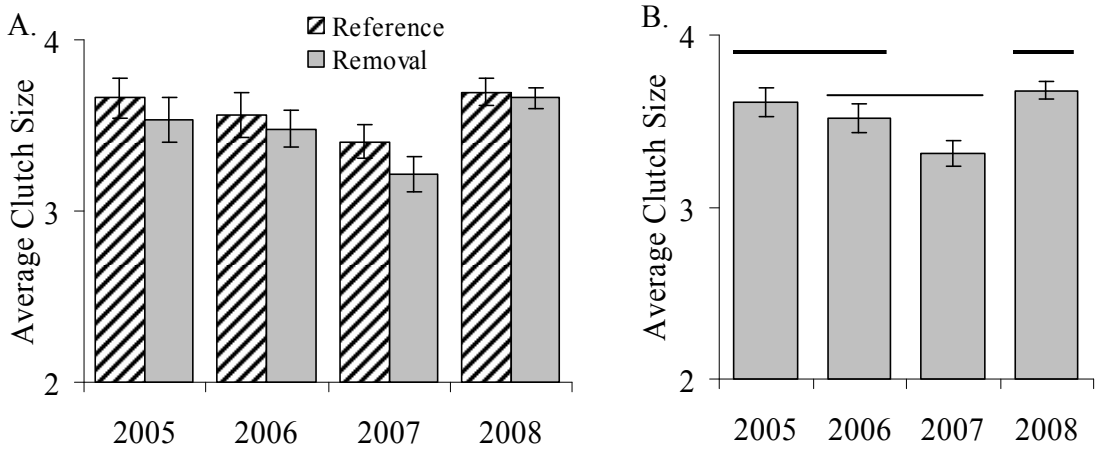

Fig. 12. Average annual least Bell's vireo clutch size (± SE) of nests (A) at giant reed (*Arundo donax*) Removal and Reference sites and (B) summarized by year across treatments (bars under different lines are statistically different) at Marine Corps Base Camp Pendleton, 2005-2008.

Table 15. Results from two-way ANOVA testing for differences in average clutch size of least Bell's vireos nesting at giant reed (*Arundo donax*) Removal and Reference sites at Marine Corps Base Camp Pendleton, 2005-2008.

Source	SS	df	MS	*F*	*P*
Treatment	0.55	1	0.55	2.13	0.15
Year	3.60	3	1.20	4.70	< 0.01
Treatment * Year	0.16	3	0.05	0.21	0.88
Error	47.29	185	0.26		

A similar trend to that shown for average clutch size of nests at Removal and Reference sites was documented for overall productivity of pairs nesting at those sites from 2005-2007, but not in 2008. From 2005-2007, pairs at Removal sites, on average, fledged fewer young each year compared to pairs at Reference sites (Fig. 13A), but this trend was reversed in 2008. These differences were not significant in 2005, 2006, and 2007 (Rourke and Kus 2006a, 2007a, 2008); however significantly more young fledged per pair at Removal sites in 2008 (Table 16, Fig. 13). When data were combined, results from a two-way ANOVA indicated a significant difference ($F_{0.10, 3, 164} = 14.81$, $P < 0.01$) in the average number of young fledged by pairs between years, with average number of young per pair significantly higher in 2008 than in all other years. There was also a significant interaction between year and treatment ($F_{0.10, 3, 164} = 4.39$, $P < 0.01$), with treatment influencing productivity in 2008 but not in other years.

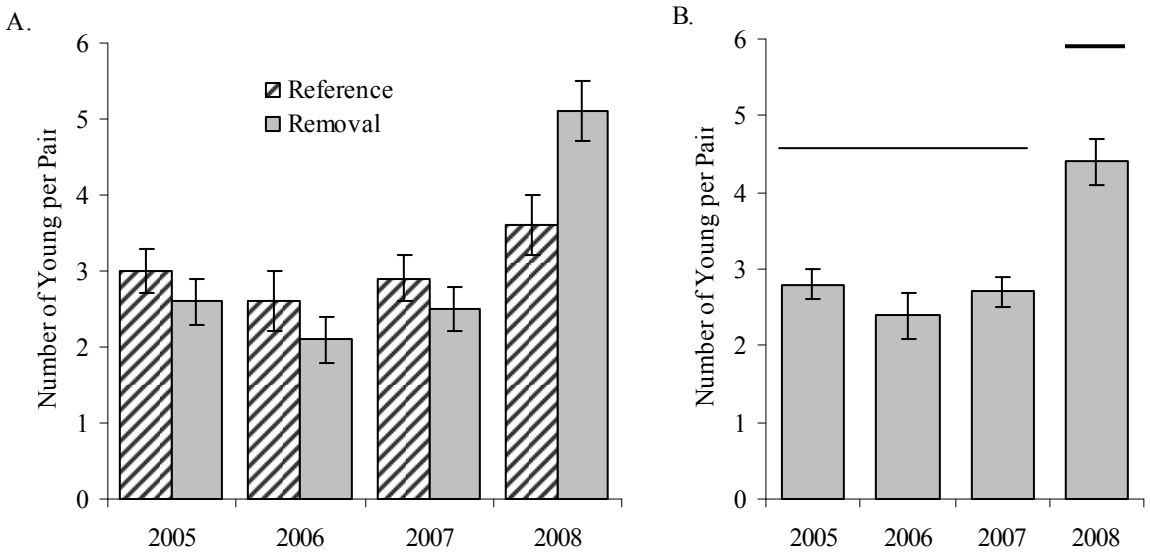

Fig. 13. Average number of least Bell's vireo young fledged per pair (± SE) at (A) giant reed (*Arundo donax*) Removal and Reference sites per year, and (B) summarized by year across treatments (bars under different lines are statistically different) at Marine Corps Base Camp Pendleton, 2005-2008.

Table 16. Results from two-way ANOVA testing for differences in the average number of young fledged per pair of least Bell's vireos nesting at giant reed (*Arundo donax*) Removal and Reference sites at Marine Corps Base Camp Pendleton, 2005-2008.

Source	SS	df	MS	*F*	*P*
Year	116.45	3	38.82	14.81	< 0.01
Treatment	0.06	1	0.06	0.02	0.88
Year * Treatment	34.53	3	11.51	4.39	< 0.01
Error	429.81	164	2.62		

Population Density

The density of the vireo population increased in 2008 at both Removal and Reference sites, and was the highest observed in both sites since 1997 (Fig. 14). Vireo density at Removal sites averaged higher than at Reference sites in 2008, although this difference was not statistically significant (χ^2= 0.39, P = 0.73, df = 1). Vireo density at Removal sites was consistently higher than or comparable to that at Reference sites prior to 2001 (when giant reed removal began at our treatment sites). Vireo density at Removal sites was reduced during the two years following treatment, but increased to match that of Reference sites by the third post-treatment year (Griffith Wildlife Biology 2004; Rourke and Kus 2006a, 2007a, 2008).

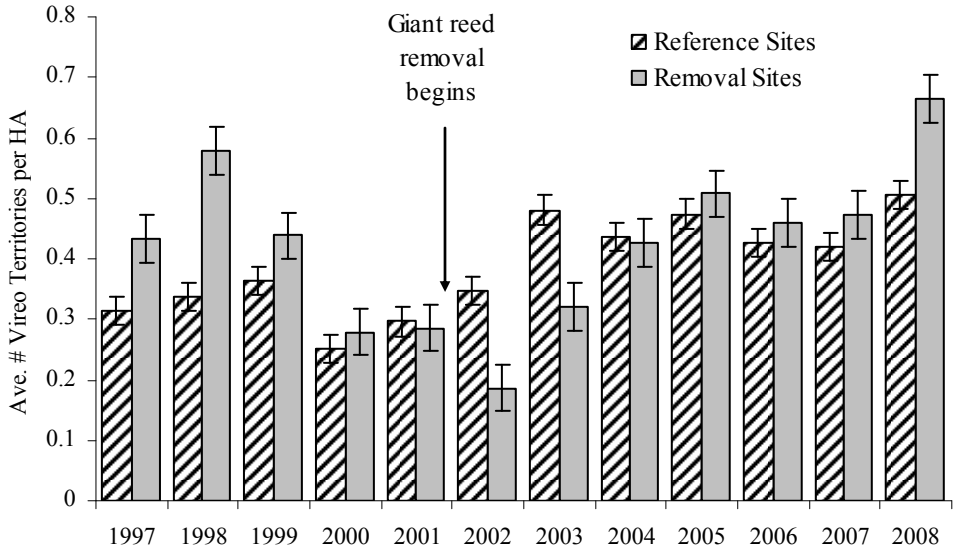

Fig. 14. Annual density of least Bell's vireo territories (± SE) at Reference and giant reed (*Arundo donax*) Removal sites by year, averaged across sites. (Source: Griffith Wildlife Biology 2004, Rourke and Kus 2006a, 2007a, 2008).

Annual Precipitation Effects on Vireo Productivity and Population Size

Although there were some indications that annual precipitation may be related to vireo productivity (Fig. 15), especially during years with low annual precipitation, we did not find any significant relationships between vireo clutch size (r = 0.68, P = 0.32) or young/pair (r = -0.03, P = 0.97) and annual precipitation. However, we found that the total number of vireo territories on Camp Pendleton, going back to 1997, was positively correlated with annual precipitation (r = 0.53; P = 0.07; Fig. 16).

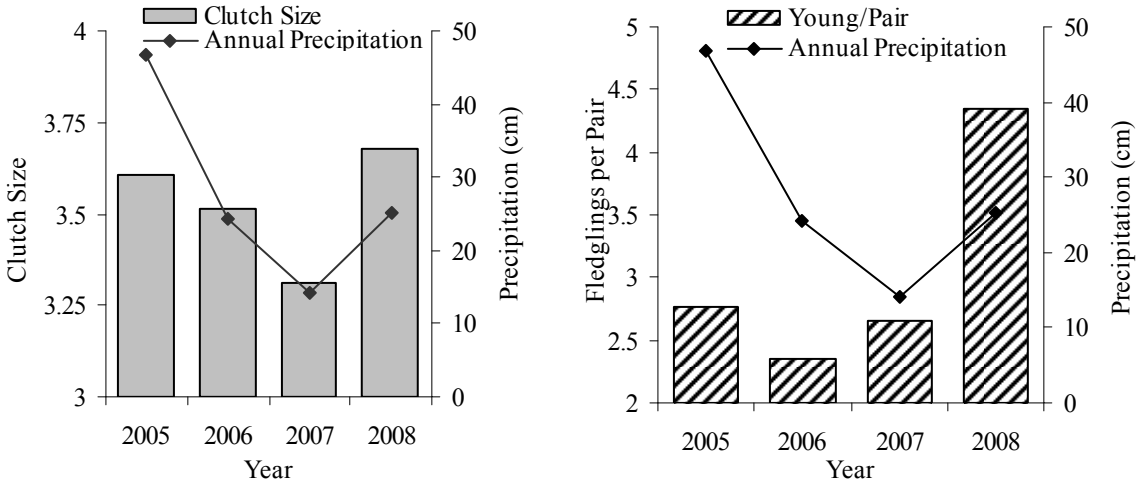

Fig. 15. Average least Bell's vireo clutch size and number of young fledged per pair in relation to total precipitation in the preceding bioyear (July – June), 2005-2008.

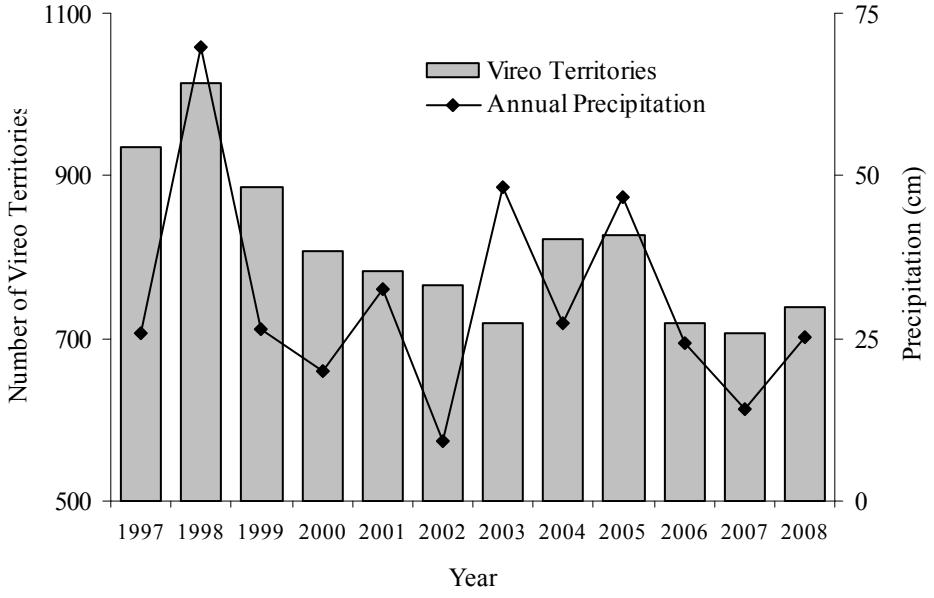

Fig. 16. Relationship between number of least Bell's vireo territories on Marine Corps Base Camp Pendleton and total precipitation in the preceding bioyear (July – June), 1997-2008 ($r = 0.53$, $P = 0.07$).

Nest Characteristics

A total of 15 plants (14 species and one "dead" category, which included all dead woody species) were used as hosts for vireo nests at Removal and Reference sites in 2008, although not all were used within each treatment (Table 17). Vireos used nine of the 15 species at Removal

sites and 14 of the 15 species at Reference sites. Despite this difference, vireos at Removal and Reference sites were comparable in their selection of host species, as 58-90% of nests were placed in arroyo willow, sandbar willow, and mule fat (Table 17). Four vireo nests were built in exotic plant species, three in poison hemlock (one at Removal sites and two at Reference sites) and one in black mustard (at a Reference site). The remaining 21% of nests were placed in ten plant species. Nine of the remaining ten plant species were used as host plants at Reference sites while only four were used as hosts at Removal sites.

In 2008, successful and unsuccessful nests within Removal and Reference sites were generally similar in placement. However, at Reference sites, successful nests were placed significantly closer to the edge of the host plant than unsuccessful nests and at Removal sites, unsuccessful nests were placed in significantly taller host plants than successful nests (Table 18). This placement may be explained by higher proportion of larger trees (arroyo willows typically are larger than mule fat and sandbar willows) at Removal sites than at Reference sites. It is possible that vireos may be using host species in proportion to their availability at each site, although we did not collect host plant availability data to verify this. The tendency to use larger trees at Removal sites was confirmed by examining the nest placement characteristics of all nests at Removal sites compared to all nests at Reference sites (Table 18). Vireo nests at Removal sites were placed significantly higher above ground, in taller host plants, further from the edge of the plant in which they were placed, further from the edge of the vegetation clump in which they were placed, and further from the edge of riparian vegetation than nests at Reference sites (Table 18).

Table 17. Host plant species used by least Bell's vireos at giant reed (*Arundo donax*) Removal and Reference sites, Marine Corps Base Camp Pendleton, 2008. Numbers in parentheses are proportions of total nests.

	Number of Nests	
Host Species	**Removal**	**Reference**
Arroyo willow	37 (0.64)	16 (0.25)
Mule fat	5 (0.09)	14 (0.22)
Sandbar willow	9 (0.16)	7 (0.11)
California wild grape (*Vitis californica*)	0 (0.00)	6 (0.09)
Black willow	1 (0.02)	4 (0.06)
Dead species	2 (0.03)	3 (0.05)
Coast live oak	0 (0.00)	3 (0.05)
Mexican elderberry (*Sambucus nigra*)	1 (0.02)	3 (0.05)
Poison hemlock	1 (0.02)	2 (0.03)
California blackberry (*Rubus ursinus*)	0 (0.00)	2 (0.03)
Alder	0 (0.00)	1 (0.02)
Coyote brush (*Baccharis pilularis*)	0 (0.00)	1 (0.02)
Black mustard	0 (0.00)	1 (0.02)
Poison oak (*Toxicodendron diversilobum*)	1 (0.02)	1 (0.02)
Mugwort	1 (0.02)	0 (0.00)

Table 18. Least Bell's vireo nest characteristics and results of Mann-Whitney *U*-tests of successful vs. unsuccessful nesting attempts at giant reed (*Arundo donax*) Removal and Reference sites, Marine Corps Base Camp Pendleton, 2008.

	Nest Fate				
Nest Characteristic	**Successful**	**Unsuccessful**	***n*[a]**	***U*[b]**	***P*[c]**
Removal Site					
Average nest height (m)	0.96	0.86	(39, 18)	411.5	0.30
Average host height (m)	5.32	7.86	(39, 19)	240.0	0.03
Average distance to edge of host (m)	1.09	1.02	(39, 18)	327.5	0.69
Average distance to edge of clump (m)	5.94	5.49	(39, 19)	335.5	0.56
Average distance to edge of riparian vegetation (m)	102.73	104.44	(39, 18)	358.5	0.90
Reference Site					
Average nest height (m)	0.69	0.65	(28, 32)	497.5	0.46
Average host height (m)	3.39	3.77	(28, 35)	486.0	0.96
Average distance to edge of host (m)	0.55	0.97	(28, 33)	251.5	< 0.01
Average distance to edge of clump (m)	4.23	3.62	(29, 32)	523.5	0.39
Average distance to edge of riparian vegetation (m)	34.33	39.53	(29, 32)	433.0	0.65
Overall	**Removal**	**Reference**			
Average nest height (m)	0.93	0.67	(57, 60)	925.0	< 0.01
Average host height (m)	6.15	3.60	(58, 63)	905.5	< 0.01
Average distance to edge of host (m)[d]	1.07	0.78	(57, 61)	1353.5	0.04
Average distance to edge of clump (m)	5.79	3.91	(58, 61)	1339.0	0.02
Average distance to edge of riparian vegetation (m)	103.27	37.06	(57, 61)	787.0	< 0.01

[a] *n* = number of nests in sample (Successful, Unsuccessful)
[b] *U* = Mann-Whitney *U* statistic
[c] *P* = P-value

DISCUSSION

In 2008, the number of documented least Bell's vireo territories (738) remained within the low end of the range of approximately 700-1000 territories observed on Marine Corps Base Camp Pendleton over the past 13 years. The vireo population has fluctuated between a low of 696 territories in 1995 and a high of 1,011 territories in 1998 (Griffith Wildlife Biology 2004) (Fig. 3). From 1998 to 2003, the vireo population steadily declined to 718 territories. In 2004 and 2005, the vireo population increased to 823 and 827 territories, respectively. In 2006, the population decreased to its 2003 estimate of 718 territories, in 2007 it lost 11 territories, and in 2008, the vireo population increased by 31 territories to 738 territories. The vireo population on Camp Pendleton has not fluctuated substantially in the past three years and distribution of birds has also changed little. With the exception of the Santa Margarita River, which gained 40 territories (10%), and Las Flores Creek, which lost 11 territories (14%), the total change in territory numbers within the remaining 21 drainages/sites ranged from 0 to 7 territories and averaged 1.5 ± 1.9 (SD) territories per drainage/site. The stability in vireo numbers across drainages/sites is further evident as 67% (14/21) of those drainages differed by zero to one territory compared to their 2007 totals.

Fluctuations in the vireo population on Camp Pendleton generally reflect similar population trends along the lower San Luis Rey River, where a gradually increasing population peaked in 2003, and since then has remained relatively stable (Ferree and Kus 2007, 2008, 2009). The vireo population in the middle San Luis Rey River, between South Mission Road and Interstate 15, has also demonstrated a gradual increase since the mid-1980s and has fluctuated between 60 and 80 pairs since 2002 (Jones 1985; Kus 1988, 1989, 1991a, 1991b, 1994, 1995; Kus and Beck 1998; Peterson *et al.* 2002; Rourke and Kus 2006b, 2007b; USGS unpublished data).

The general stability in the Camp Pendleton vireo population from 2006 to 2008 is reflected in the relatively balanced gains and losses of vireo territories from different drainages. In some drainages/sites (Pueblitos Canyon, Newton Canyon, Cockleburr Canyon, French Creek, Hidden Canyon, Piedra de Lumbre Canyon, and the canyon between Ysidora Basin and Windmill Canyon) vireo populations have failed to increase in numbers since 2005. In other drainages/sites (Santa Margarita, Pilgrim Creek, Windmill Canyon), vireo populations have increased or remained the same each year since 2005. Such redistribution of the vireo population may reflect changing conditions at different sites, where habitat suitability changes, either by catastrophic changes such as fire or flood scouring, or by gradual changes in floristic structure or composition. This was manifested by the decrease in number of vireo territories between 2007 and 2008 in drainages that burned in October and November 2007. The Fall 2007 fires, while encompassing a large area, did not burn all vegetation within each drainage. Therefore, it was possible for vireos to continue to hold territories in isolated, unburned clumps of vegetation surrounded by burned landscape. We also saw an increase in number of vireo territories outside of the burn perimeter but within the same drainages, indicating that some vireos may have moved from territories that burned in 2007 to nearby, unburned suitable habitat.

Redistribution of the vireo population may also be driven by demographic parameters, particularly site fidelity. Male vireos have a strong tendency to return to or near to the same breeding sites each year (between-year movement average 0.1 ± 0.5 km); however, first year male vireos tend to disperse from their natal territories (2.7 ± 3.3 km). Therefore, younger vireos are more likely to move to colonize new or recovering habitat that recently became suitable, while older vireos occupying their traditional territories may gradually die off and not be replaced if habitat becomes less suitable.

Since 2005, the banding of least Bell's vireos with unique color combinations has allowed us to estimate both adult and juvenile survival rates as well as investigate annual dispersal of adult and first year adult vireos. In 2006, 2007, and 2008, 12-22% of vireos that fledged the previous year survived and were detected holding territories on Base. This first-year survivorship is likely an underestimate because 1) the number is skewed toward male vireos because females are cryptic, and thus more difficult to detect, and so it likely under-represents female survivorship; and 2) the number does not include vireos with single gold numbered bands that may have been banded as nestlings the previous year but could not be confirmed. Regardless, first-year survivorship was higher at Removal sites than at Reference sites for vireos that hatched in 2007. This suggests that recent giant reed removal may be benefitting vireo populations, but should be viewed with caution in case 2008 was an unusual year.

Annual survivorship estimates for adult and/or second-year least Bell's vireos may be further underestimated because of their potential dispersal/emigration off Base. One of the largest off Base drainages containing suitable vireo habitat and thus a potential destination for migrating vireos is the San Luis Rey River running along the southern border of Camp Pendleton. In 2008, a female vireo that had been banded as a nestling on Camp Pendleton was detected breeding along the San Luis Rey River. She had not been detected since 2005. During the 2006, 2007, and 2008 breeding seasons, 27 vireos originally banded on the San Luis Rey River were resighted on Base, demonstrating that dispersal between the drainages is occurring. One additional female vireo that had been banded as a nestling on Camp Pendleton was detected breeding along the San Diego River (Wellik *et al*. 2009). Finally, one unconfirmed male vireo banded along the Santa Margarita River on Camp Pendleton or FNWS in 2005 or 2006 was resighted near Burbank, California (Griffith Wildlife Biology 2007; USGS, unpublished data). These movements demonstrate the ability of vireos to disperse far beyond their natal drainages. Further banding and resighting of vireos within southern California will allow a better determination of the extent of movement between populations and the role such movements play in maintaining genetic diversity and persistence in these populations. Continued monitoring of cohorts banded as nestlings provides the opportunity to collect life-time reproductive data for a segment of the population, facilitating identification of age-and possibly sex-related patterns in life history characteristics that influence population size, productivity, and genetic structure.

Productivity in general was higher in 2008 than in the preceding years. The proportion of pairs that fledged at least one young overall was high in 2008 (94%) relative to the proportion of successful pairs in 2005 (89%), 2006 (79%), and 2007 (89%)(Rourke and Kus 2006a, 2007a, 2008), and echoed the trend in average clutch size. Moreover, the number of young fledged per pair was significantly higher in Removal sites than in Reference sites in 2008, unlike in previous years when pair productivity did not differ significantly between sites. Higher productivity in

general in 2008, measured by the high number of young fledged per pair, can be attributed to a higher number of pairs that successfully fledged two broods (20/51 [39%]; compared to 1/33 [3%] in 2005, 2/42 [5%] in 2006, and 4/46 [9%] in 2007). The unusually high number of double broods in 2008 may be explained by earlier initiation of nesting than in previous years, which extended the breeding season and allowed time for multiple successful nesting attempts. Successful nesting attempts take longer than failed attempts, and it is possible that in previous years, vireos with successful early nest attempts may have been less likely to attempt a second brood because what remained of the breeding season was not sufficient to successfully fledge a second nest. Not only did nesting commence earlier in 2008 than in recent years, but the success rate of first nests was higher, enhancing the potential for pairs to double brood. Two pairs in 2008 had successful first nesting attempts, failed second attempts, and then successful third nesting attempts.

This increase in productivity was also evident in the lower San Luis Rey vireo population where 33% (32/96) of pairs successfully fledged two broods in 2008 (Ferree and Kus 2009). Possible explanations for this increase in productivity are likely related to environmental factors that we did not measure, such as changes in predator populations, changes in abundance and availability of prey, and/or changes in habitat structure and floristic development that might affect nest concealment. It is also likely that factors currently unknown influenced the timing of migration and arrival on the breeding grounds, resulting in an exceptionally early and long breeding season in 2008.

While the proportion of pairs that successfully fledged young was similar between Removal and Reference sites (96% and 92%, respectively), the number of pairs that successfully fledged two broods in 2008 was higher at Removal sites (60%) than at Reference sites (19%). We did not measure general habitat, prey, or predator-related variables at Removal and Reference sites to determine what factors may explain this discrepancy. However, assuming that Removal and Reference sites were equal in all characteristics except for our test variable (the timing of giant reed removal), it may be concluded that at least in 2008, Removal sites were superior to Reference sites with respect to vireo breeding habitat. We did not see significant differences in vireo nesting parameters between giant reed Removal sites and Reference sites, indicating that the process of removing giant reed did not have a negative effect on vireo breeding productivity. We did not measure vireo productivity before or during giant reed removal activities; however, the increase in number of fledglings produced per pair in 2008 may indicate that recent giant reed Removal sites are providing better nesting habitat for vireos than the Reference plots. Given the varied results from previous years, the endangered status of the species, low annual sample sizes, and therefore reduced power to detect effects within a single year, the potential that 2008 represented an unusual year for vireo productivity, and that a primary objective of this research is to determine whether giant reed removal has an effect(s) on vireo productivity, we believe the accumulation of data in the future, and potentially increasing the number of sample plots, is warranted.

Vireo territory density did not differ between Removal and Reference sites in 2008. However, we observed a trend in vireo density at Removal sites associated with the timing of giant reed removal. Vireo density was consistently higher at Removal sites than at Reference sites from 1997 through 2000, before giant reed removal began. From 2000 through 2002,

during the non-breeding season when vireos were absent, giant reed was manually removed and chemically treated at Removal sites (J. Giessow, pers. comm.). Vireo density increased at Reference sites during this period while density decreased at Removal sites to its lowest point in 2002. Giant reed typically grows in thick stands that crowd out the native plant understory and also frequently the canopy species. Removal of this thick vegetation necessarily entails clearing of vegetation in the area, leaving a somewhat sparse understory and therefore little breeding habitat for vireos. As the native understory and canopy plant species recover, we would expect to see a corresponding recovery in vireo numbers. In 2003, vireo density began increasing at Removal sites, presumably in response to recovery of understory vegetation, and surpassed Reference sites by 2005. Since 2005, vireo density at Removal sites has been similar to that at Reference sites, and reached a high point of 1.5 vireos per ha in 2008.

Annual precipitation for the bioyear preceding the 2008 breeding season was higher than for 2006 and 2007, though still below the average for the past 12 years (30.8 cm). We saw an increase in vireo breeding productivity (clutch size and number of young fledged per pair) in 2008 over 2006 and 2007, loosely associated with annual precipitation. Although annual differences in the amount and timing of precipitation may affect vireo productivity by increasing primary productivity and prey numbers, we were not able to detect strong associations between annual precipitation and our measures of vireo productivity. Greater precipitation was associated with higher productivity in song sparrows (*Melospiza melodia*) in a long-term study and also Darwin's finches (*Geospiza* spp.) in extreme conditions (Boag and Grant 1984, Grant and Grant 1987, Chase *et al.* 2005). Conversely, Paxton et al. (2007) found very low productivity in southwestern willow flycatchers associated with a year of extreme drought. Our four-year time frame may not be sufficient to detect these annual differences. We did detect a positive association between annual precipitation and total number of vireo territories detected on Base. However, because vireos do not winter on Base and the bulk of the annual precipitation occurs when vireos are not present, a direct connection between vireo numbers and precipitation is not clear.

Nest site characteristics did not differ greatly between successful and unsuccessful nests, either at Reference sites or at Removal sites. Similarly, Kus *et al*. (2008) found that fine-scale and intermediate-scale nest placement factors were not significantly related to nest survival along the San Luis Rey River, just south of Camp Pendleton. However, we found that nest placement in 2008 was significantly different between Removal and References sites, and may have contributed to the higher productivity of vireo pairs at Removal sites. At Removal sites, nests were placed higher and further from the edge of the host plant, the nest vegetation clump, and the riparian vegetation than at Reference sites. Nests at Removal sites were also placed in taller host species. Excluding vines and dead woody plants, 71% of nests at Removal sites were placed in relatively large trees (e.g., arroyo willow, black willow, Mexican elderberry) while only 52% of nests at Reference sites were placed in relatively large trees, which may explain the characteristics of nest placement at Removal sites (higher and further from the host edge). We did not measure available habitat characteristics, but it is possible that the selection of host plants reflects the presence of more large trees at Removal sites. Further investigation into habitat variables at these sites may explain whether or not nest placement is a factor of what is available or if vireos are selecting particular nest sites out of proportion to their availability.

CONCLUSIONS

Generally, the vireo population on Camp Pendleton has tracked the overall increase in least Bell's vireos in southern California since the late 1970s (USFWS 2006). This population increase can be attributed, at least partially, to management actions, including control of brown-headed cowbirds and protection and restoration of riparian habitat. On Camp Pendleton, brown-headed cowbird control has reduced cowbird parasitism to a negligible level since the mid-1990s, releasing a major limit on vireo breeding productivity. There was no cowbird parasitism documented on Camp Pendleton during 2008. Cowbird control has a demonstrably positive effect on vireo productivity (Kus 1999, Kus and Whitfield 2005), but must be constantly practiced to maintain the pressure on cowbird populations.

Control of giant reed and other invasive riparian plant species has increased vireo breeding habitat, also contributing to increases in the vireo population. Such habitat restoration has a delayed effect, however, as demonstrated within our giant reed Removal and Reference sites, where vireo productivity at Removal sites was consistently lower than at Reference sites until 2008. Results from 2008 should be evaluated cautiously, however, as vireo productivity was higher overall, and cannot be separated from the effect of unique conditions in 2008. Further investigation into habitat, prey, and predation pressures as associated with vireo breeding productivity would likely help to tease out the variables that directly affect vireo productivity and may be subject to management actions to help augment vireo populations.

LITERATURE CITED

Boag, P. T., and P. R. Grant. 1984. Darwin's finches (*Geospiza*) on Isla Daphne Major, Galapagos: Breeding and feeding ecology in a climatically variable environment. Ecological Monographs 54: 463-489.

Brown, B. T. 1993. Bell's Vireo (*Vireo bellii*). In The Birds of North America, No. 35 (A. Poole, P. Stettenheim, and F. Gill, Eds.). Philadelphia: The Academy of Natural Sciences; Washington, DC: The American Ornithologists' Union.

Chase, M. K., N. Nur, and G. R. Geupel. 2005. Effects of weather and population density on reproductive success and population dynamics in a song sparrow (*Melospiza melodia*) population: a long-term study. Auk 122:571-592.

Cody, M. L. 1981. Habitat selection in birds: The roles of vegetation structure, competitors, and productivity. BioScience 31:107-113.

Ferree, K. and B. E. Kus. 2007. Least Bell's vireos and southwestern willow flycatchers at the San Luis Rey River Flood Control Project area in San Diego County, California: breeding activities and habitat use. 2006 Data Summary. Prepared for RECON Environmental, Inc., San Diego, California.

Ferree, K. and B. E. Kus. 2008. Least Bell's vireos and southwestern willow flycatchers at the San Luis Rey River Flood Control Project area in San Diego County, California: breeding activities and habitat use. 2007 Data Summary. Prepared for RECON Environmental, Inc., San Diego, California.

Ferree, K. and B. E. Kus. 2009. Least Bell's vireos and southwestern willow flycatchers at the San Luis Rey River Flood Control Project area in San Diego County, California: breeding activities and habitat use. 2008 Annual Report. Prepared for RECON Environmental, Inc., San Diego, California.

Franzreb, K. E. 1989. Ecology and conservation of the endangered least Bell's vireo. Biological Report 89(1). U.S. Fish and Wildlife Service, Department of Interior. March 1989.

Grant, P. R., and B. R. Grant. 1987. The extraordinary El Nino event of 1982-83: Effects on Darwin's finches on Isla Genovesa, Galapagos. Oikos 49:55-66.

Griffith Wildlife Biology. 2004. The status of the least Bell's vireo at Marine Corps Base Camp Pendleton in 2004. Unpublished draft report for Assistant Chief of Staff, Environmental Security, Camp Pendleton, California, by Jane C. Griffith and John T. Griffith, Griffith Wildlife Biology, Calumet, Michigan.

Griffith Wildlife Biology. 2007. The status of the least Bell's vireo and southwestern willow flycatcher at Los Angeles County drainage area detention basins and flood control channels in 2007. Unpublished final report for United States Army Corps of Engineers, Los Angeles

District Operations Branch, Los Angeles California, by Griffith Wildlife Biology, Calumet, Michigan.

Howell, S. L. and B. E. Kus. 2009. Distribution, abundance and breeding activities of the southwestern willow flycatcher at Marine Corps Base Camp Pendleton, California. 2008 Annual Data Summary. Prepared for Assistant Chief of Staff, Environmental Security, Marine Corps Base Camp Pendleton.

Jones, B. L. 1985. A report on the status of the least Bell's vireo on the San Diego, Sweetwater and San Luis Rey rivers, San Diego County, California. Unpublished report for U.S. Fish and Wildlife Service, Portland, Oregon.

Kus, B. E. 1988. Status and management of the least Bell's vireo at the San Luis Rey River, San Diego County, California 1988. Unpublished report for the State of California Department of Transportation, District 11, San Diego, California.

Kus, B. E. 1989. Status of the least Bell's vireo at the San Luis Rey River, San Diego County, California 1989. Unpublished report for the State of California Department of Transportation, District 11, San Diego, California.

Kus, B. E. 1991a. Status of the least Bell's vireo at the San Luis Rey River, San Diego County, California 1990. Unpublished report for the State of California Department of Transportation, District 11, San Diego, California.

Kus, B. E. 1991b. Distribution and breeding status of the least Bell's vireo at the San Luis Rey River, San Diego County, California 1991. Unpublished report for the State of California Department of Transportation, District 11, San Diego, California.

Kus, B. E. 1994. Distribution and breeding status of the least Bell's vireo at the San Luis Rey River, San Diego County, California 1992-1993. Unpublished report for the State of California Department of Transportation, District 11, San Diego, California.

Kus, B. E. 1995. Distribution and breeding status of the least Bell's vireo at the San Luis Rey River, San Diego County, California 1994. Unpublished report for the State of California Department of Transportation, District 11, San Diego, California.

Kus, B. E. 1998. Use of restored riparian habitat by the endangered least Bell's vireo (*Vireo bellii pusillus*). Restoration Ecology 6:75-81.

Kus, B. E. 1999. Impacts of brown-headed cowbird parasitism on the productivity of the endangered least Bell's vireo. Studies in Avian Biology 18:160-166.

Kus, B. E. and P. P. Beck. 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. Unpublished report for the California Department of Fish and Game, Sacramento, California.

Kus, B. E., B. L. Peterson, and D. H. Deutschman. 2008. A multiscale analysis of nest predation on least Bell's vireos (*Vireo bellii pusillus*). Auk 125:277-284.

Kus, B. E. and M. J. Whitfield. 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. Ornithological Monographs 57:16-27.

Lynn, S. and B. Kus. 2009. Least Bell's vireo and southwestern willow flycatcher surveys at Marine Corps Air Station, Camp Pendleton, California. 2008 data summary. Unpublished report for Naval Facilities Engineering Command Southwest, San Diego, California.

Paxton, E. H. M. K. Sogge, S. L. Durst, T. C. Theimer, and J. R. Hatten. 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.

Peterson, B. L., B. E. Kus, and M. J. Wellik. 2002. Surveys for the least Bell's vireo and southwestern willow flycatcher at the San Luis Rey River. 2002 annual summary. Unpublished report for the State of California Department of Transportation, District 11, San Diego, California.

RHJV (Riparian Habitat Joint Venture). 2004. Version 2.0. The riparian bird conservation plan: a strategy for reversing the decline of riparian associated birds in California. California Partners in Flight. [Online.] Available at www.prbo.org/calpif/pdfs/riparian_v-2.pdf.

Rotenberry, J. T., and J. A. Wiens. 1989. Reproductive biology of shrubsteppe passerine birds: Geographical and temporal variation in clutch size, brood size, and fledging success. Condor 91:1-14.

Rotenberry, J. T., and J. A. Wiens. 1991. Weather and reproductive variation in shrubsteppe sparrows: A hierarchical analysis. Ecology 72:1325-1335.

Rourke, J. W. and B. E. Kus. 2006a. Distribution, abundance and breeding activities of the least Bell's vireo at Marine Corps Base Camp Pendleton, California. 2005 Annual Report. Prepared for Assistant Chief of Staff, Environmental Security, Marine Corps Base Camp Pendleton.

Rourke, J. W. and B. E. Kus. 2006b. Distribution and breeding activities of the least Bell's vireo and southwestern willow flycatcher at the San Luis Rey River, San Diego, California. 2005 annual report. Unpublished report for the State of California Department of Transportation, District 11, San Diego, California.

Rourke, J. W. and B. E. Kus. 2007a. Distribution, abundance and breeding activities of the least Bell's vireo at Marine Corps Base Camp Pendleton, California. 2006 Annual Data

Summary. Prepared for Assistant Chief of Staff, Environmental Security, Marine Corps Base Camp Pendleton.

Rourke, J. W. and B. E. Kus. 2007b. Distribution and breeding activities of the least Bell's vireo and southwestern willow flycatcher at the San Luis Rey River, San Diego, California. 2006 annual report. Unpublished report for the State of California Department of Transportation, District 11, San Diego, California.

Rourke, J. W. and B. E. Kus. 2008. Distribution, abundance and breeding activities of the least Bell's vireo at Marine Corps Base Camp Pendleton, California. 2007 Annual Data Summary. Prepared for Assistant Chief of Staff, Environmental Security, Marine Corps Base Camp Pendleton.

SYSTAT Software, Inc. 2005. Systat user's guide. Version 11 for Windows, SYSTAT Software, Inc., Point Richmond, CA.

USFWS (U.S. Fish and Wildlife Service). 1986. Final rule determining endangered status for the least Bell's vireo. Federal Register 51(85):16474-16482.

USFWS (U.S. Fish and Wildlife Service). 1998. Draft recovery plan for the least Bell's vireo. U.S. Fish and Wildlife Service, Portland, OR.

USFWS (U.S. Fish and Wildlife Service). 2001. Least Bell's vireo survey guidelines. Unpublished document prepared by the USFWS Carlsbad Office, Carlsbad, California. January 19, 2001.

USFWS (U.S. Fish and Wildlife Service). 2006. Least Bell's vireo (*Vireo bellii pusillus*) 5-year review summary and evaluation. Carlsbad Fish and Wildlife Office, Carlsbad, California. 26 pp.

Wellik, M. J., S. Lynn, and B. Kus. 2009. Distribution, abundance, and breeding activities of the least Bell's vireo along the San Diego River, California. 2008 Annual Data Summary. Prepared for the San Diego River Conservancy, San Diego, California.

WRCC (Western Regional Climate Center). 2008. California Climate Data Archive, a Collaboration among Western Regional Climate Center, Scripps Institution of Oceanography and California Energy Commission. [Online.] Available at www.calclim.dri.edu/scaall.html.

APPENDIX A

LEAST BELL'S VIREO SURVEY AREAS AT MARINE CORPS BASE CAMP PENDLETON, 2008

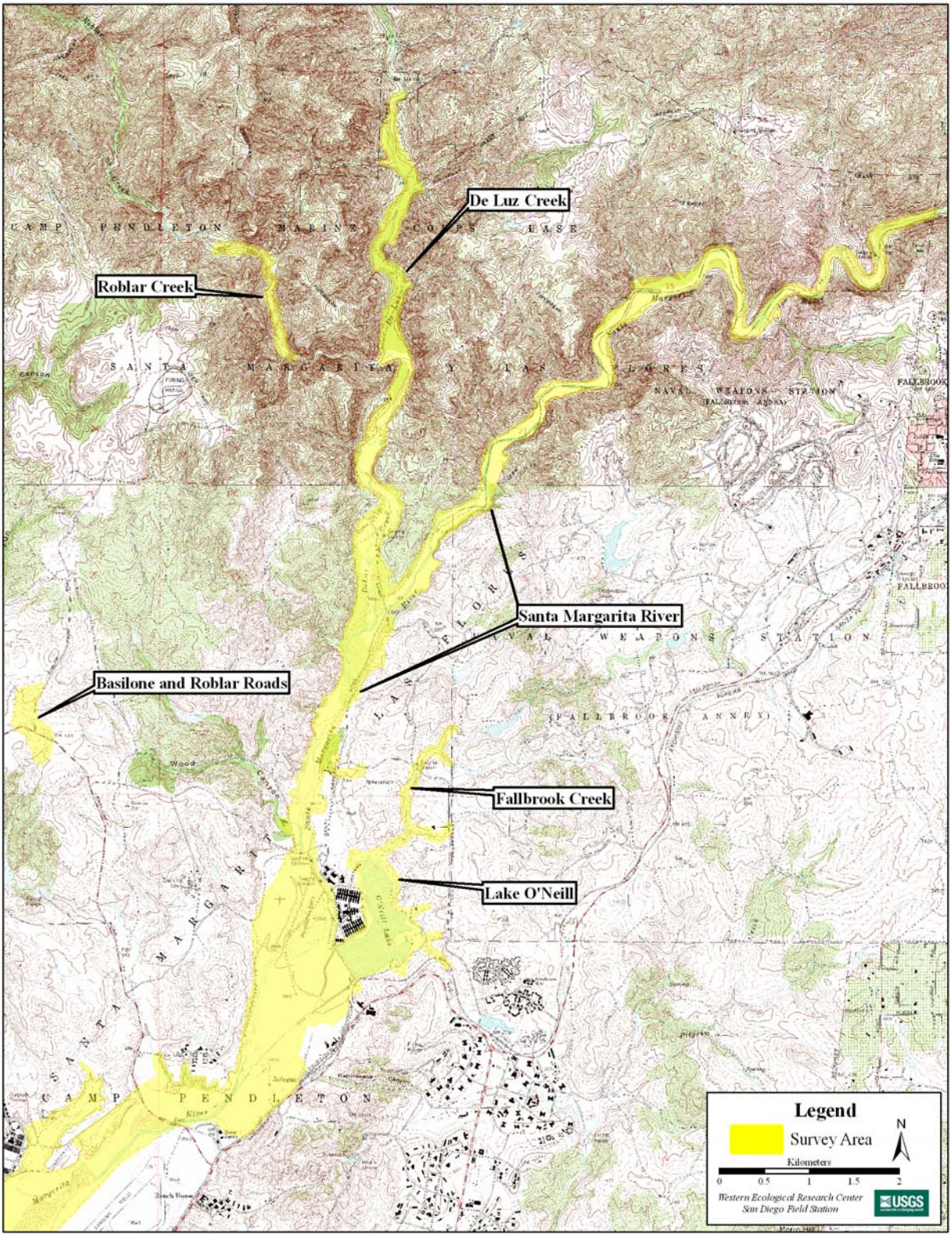

Fig. 15. Least Bell's vireo survey areas at Marine Corps Base Camp Pendleton, 2008: Upper Santa Margarita River, Fallbrook Creek, Lake O'Neill, De Luz Creek, Roblar Creek, and Basilone and Roblar Roads.

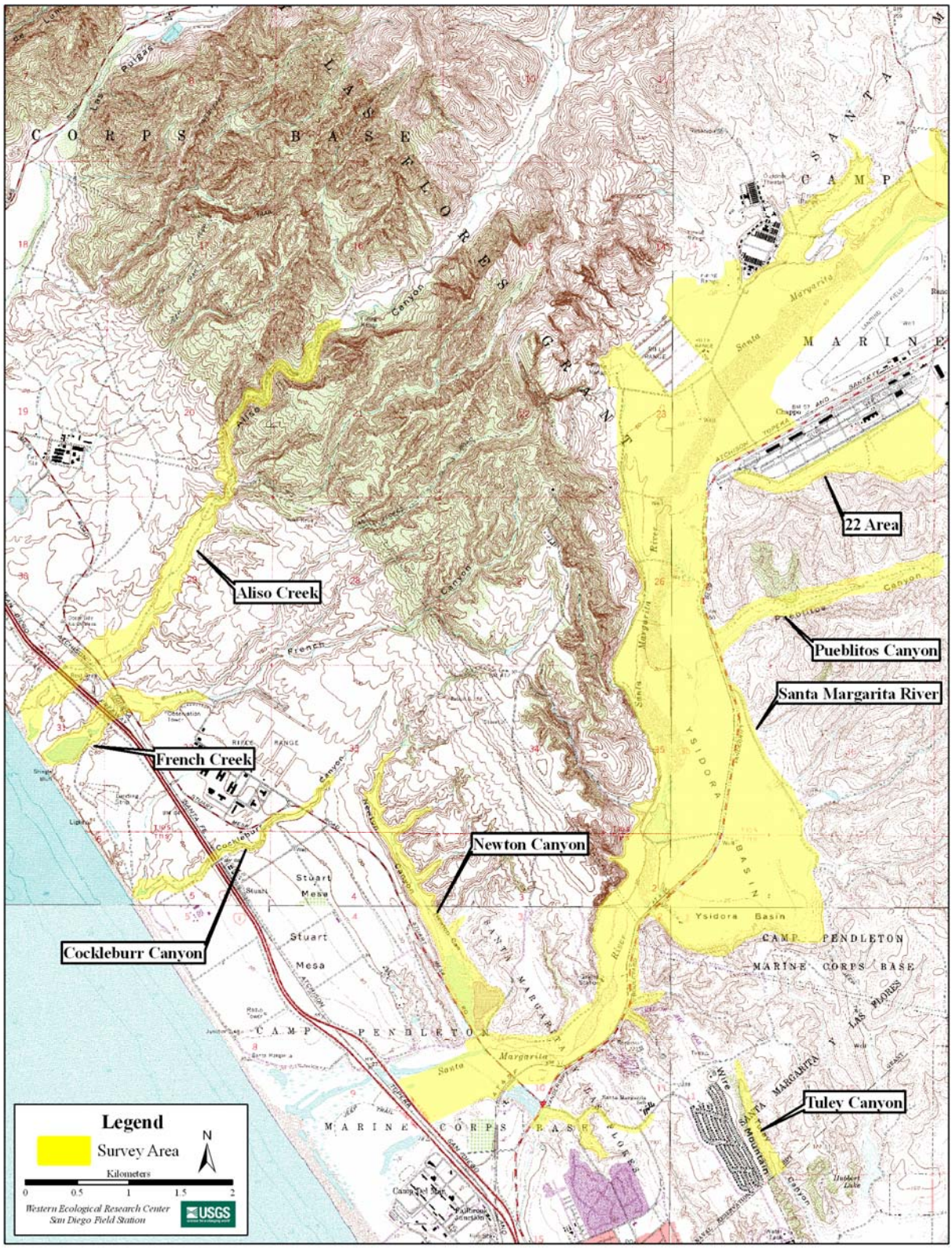

Fig. 16. Least Bell's vireo survey areas at Marine Corps Base Camp Pendleton, 2008: Lower Santa Margarita River, 22 Area, Pueblitos Canyon, Tuley Canyon, Newton Canyon, Cockleburr Canyon, French Creek, and Aliso Creek.

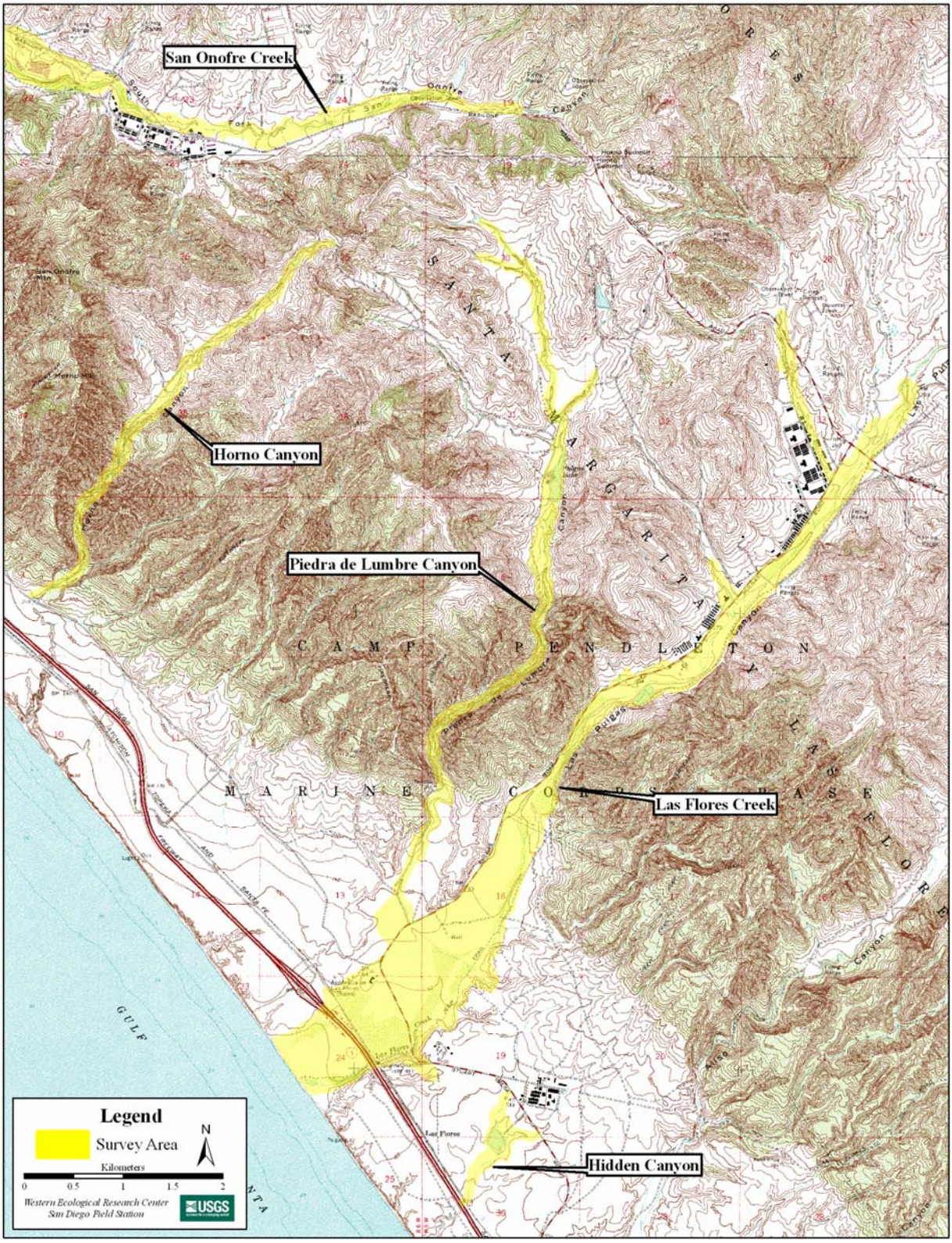

Fig. 17. Least Bell's vireo survey areas at Marine Corps Base Camp Pendleton, 2008: San Onofre Creek South Fork, Horno Canyon, Piedra de Lumbre Canyon, Las Flores Creek, and Hidden Canyon.

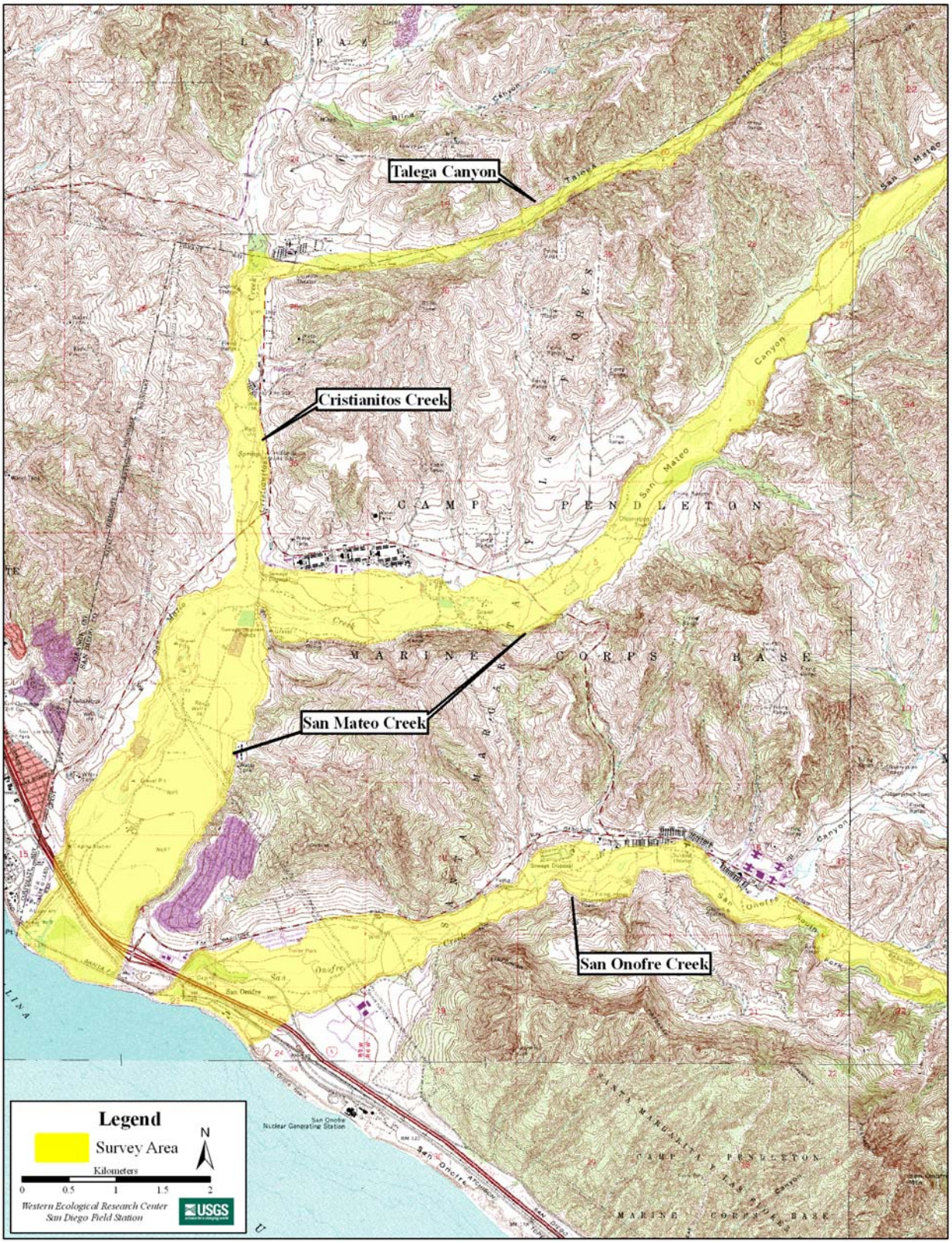

Fig. 18. Least Bell's vireo survey areas at Marine Corps Base Camp Pendleton, 2008: Talega Canyon, Cristianitos Creek, San Mateo Creek, and San Onofre Creek.

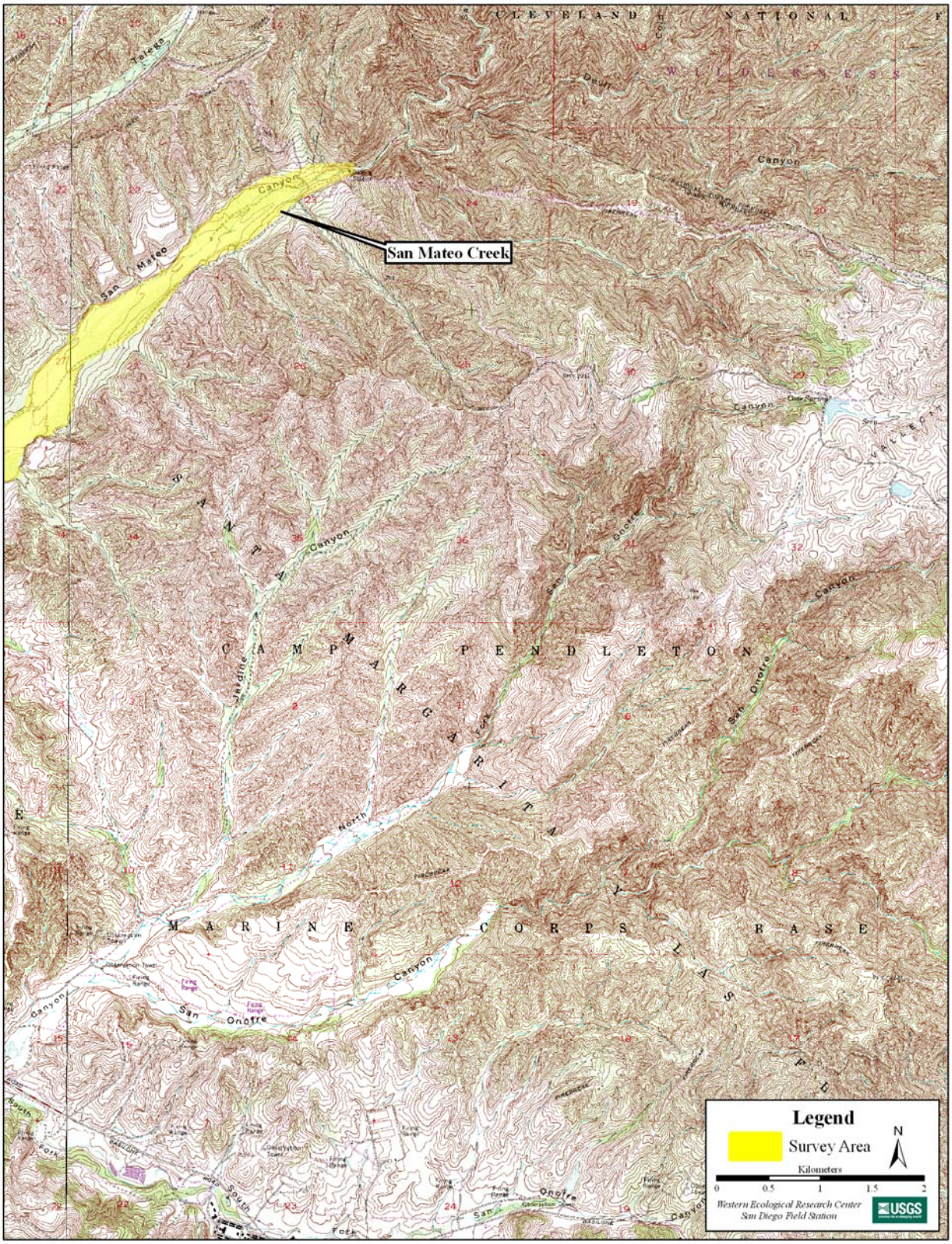

Fig. 19. Least Bell's vireo survey areas at Marine Corps Base Camp Pendleton, 2008: Upper San Mateo Creek.

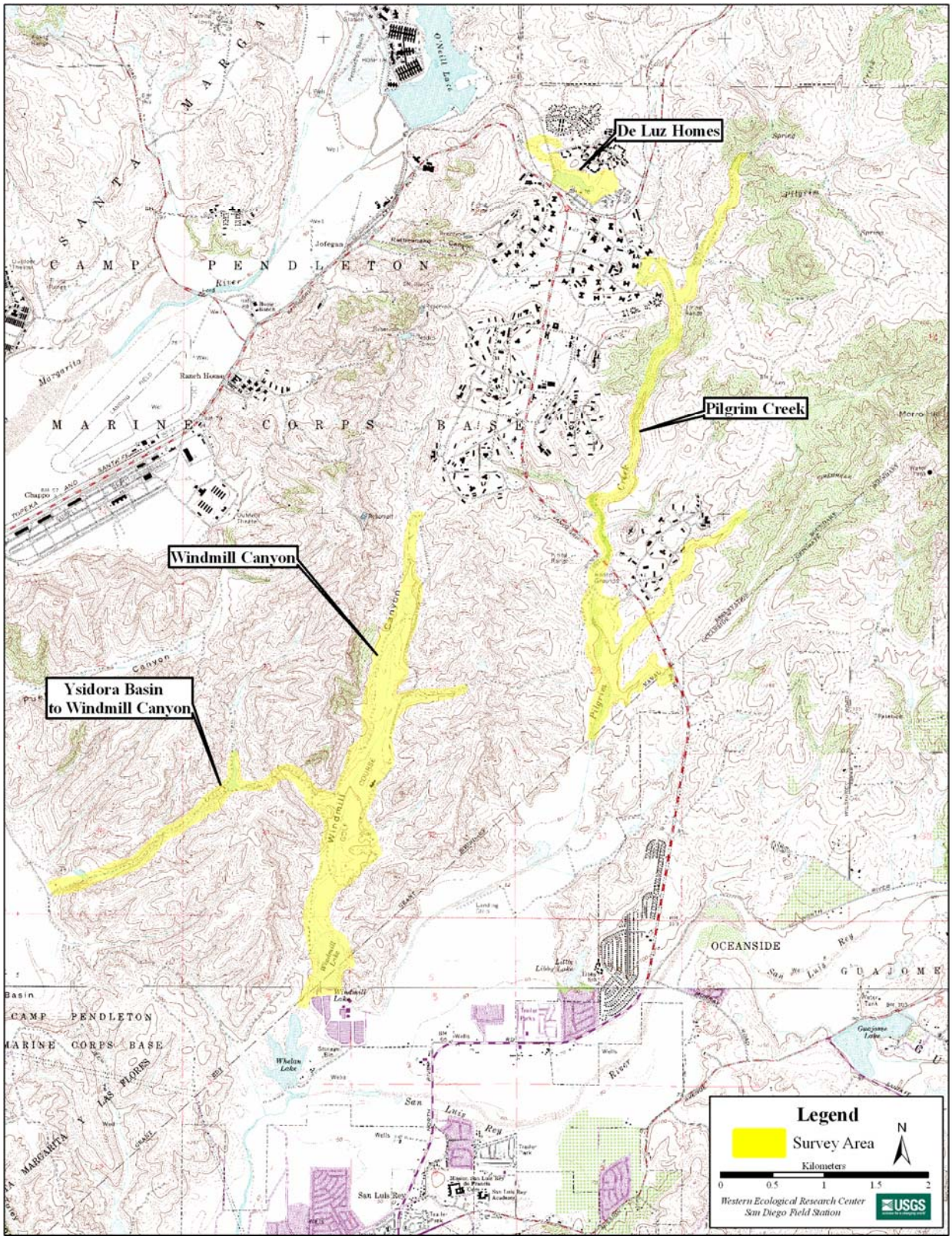

Fig. 20. Least Bell's vireo survey areas at Marine Corps Base Camp Pendleton, 2008: Windmill Canyon, Ysidora Basin to Windmill Canyon, Pilgrim Creek, and De Luz Homes Habitat.

APPENDIX B

LOCATIONS OF LEAST BELL'S VIREOS AT MARINE CORPS BASE CAMP PENDLETON, 2008

Fig. 21. Locations of least Bell's vireos at Marine Corps Base Camp Pendleton, 2008: Upper Santa Margarita River.

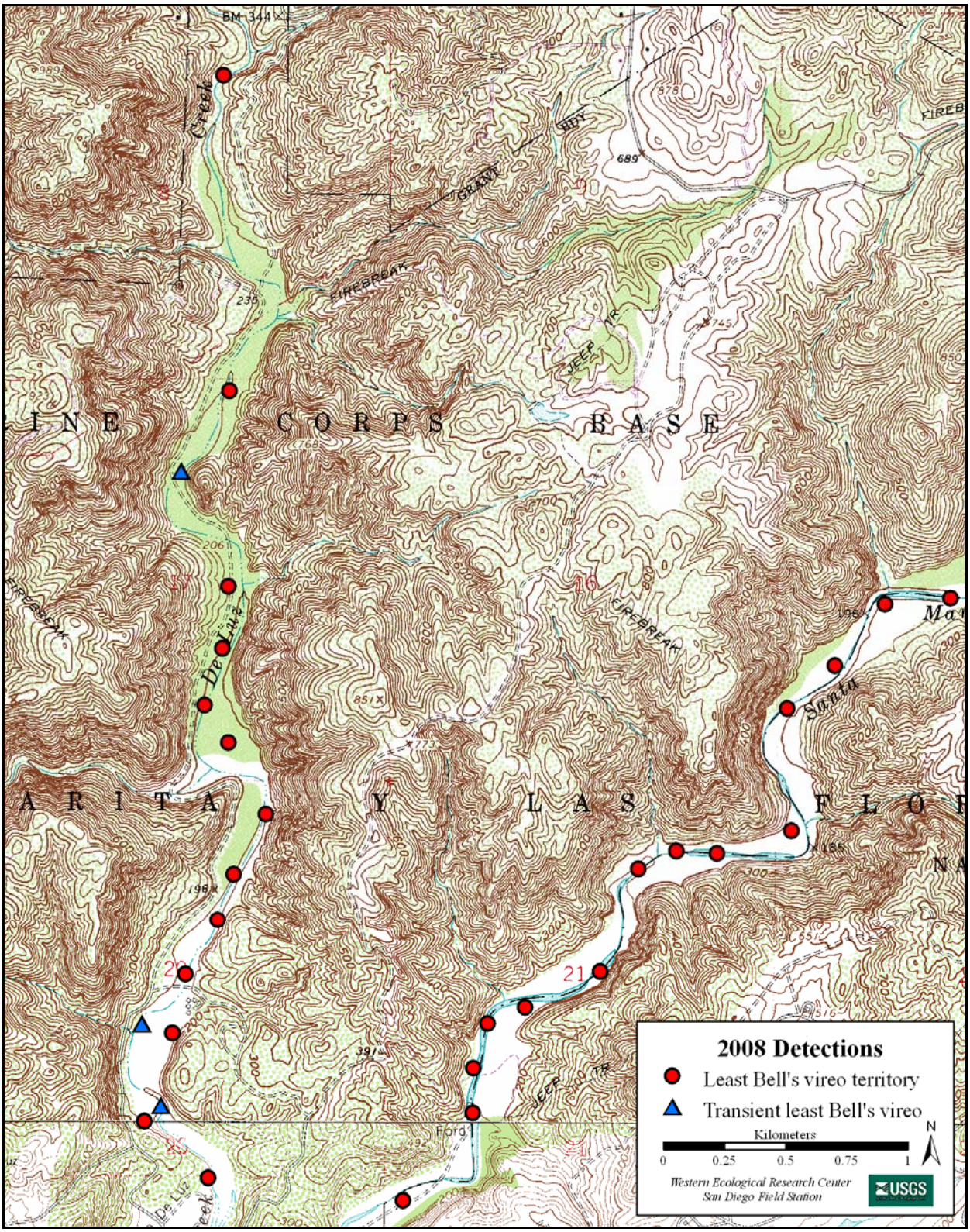

Fig. 22. Locations of least Bell's vireos at Marine Corps Base Camp Pendleton, 2008: Upper Santa Margarita River, De Luz Creek, and Roblar Creek.

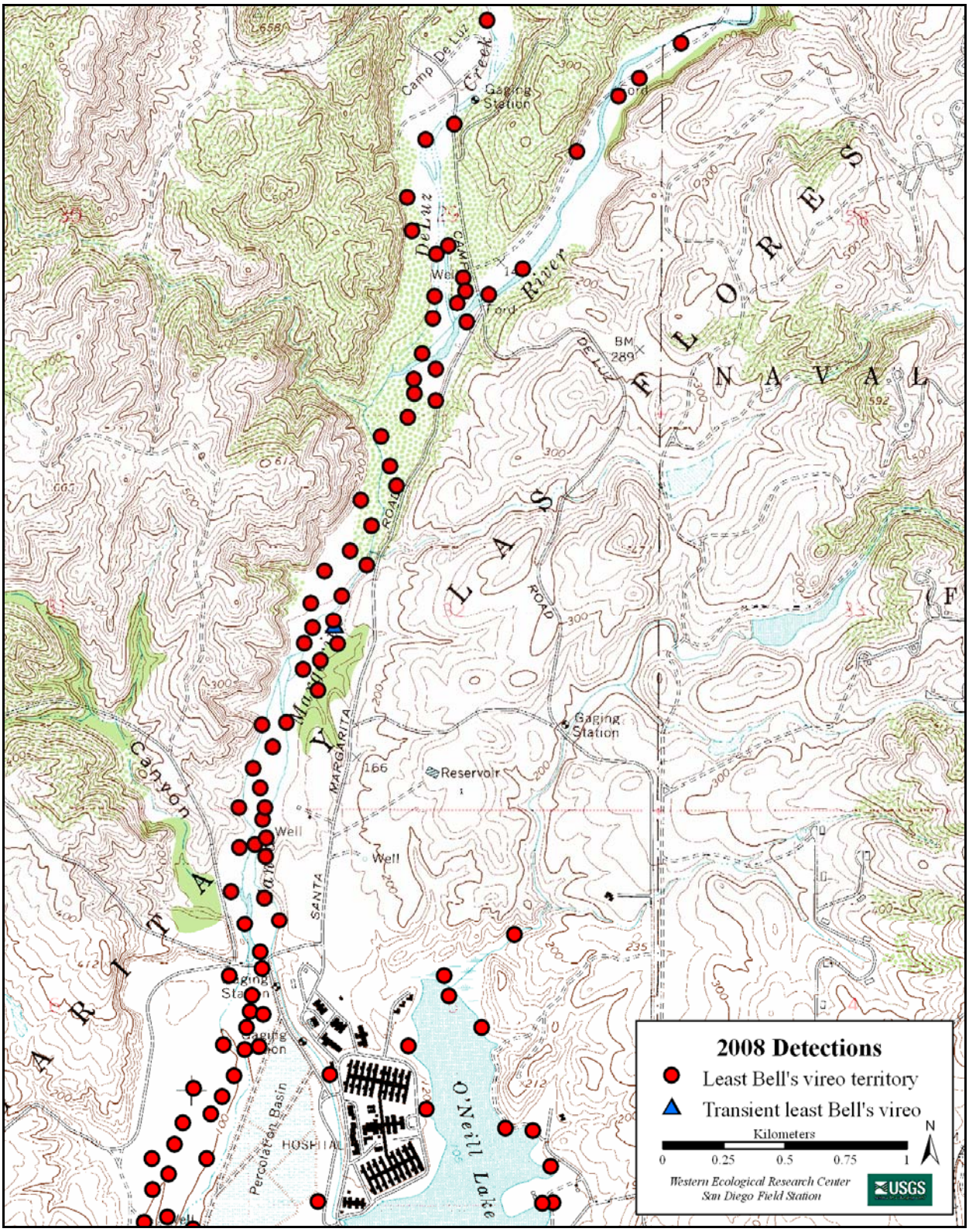

Fig. 23. Locations of least Bell's vireos at Marine Corps Base Camp Pendleton, 2008: Santa Margarita River, Lake O'Neill, and Fallbrook Creek.

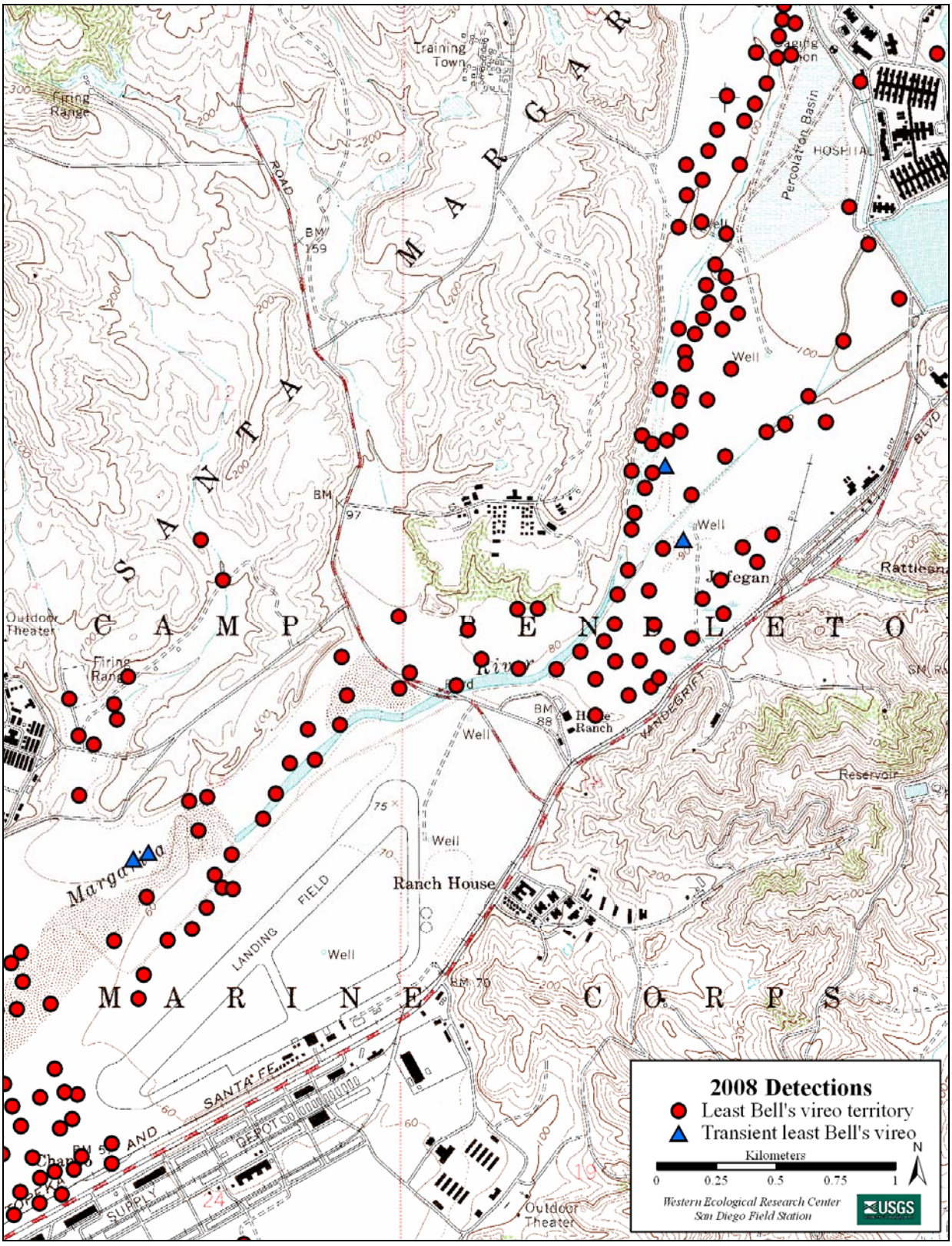

Fig. 24. Locations of least Bell's vireos at Marine Corps Base Camp Pendleton, 2008: Santa Margarita River.

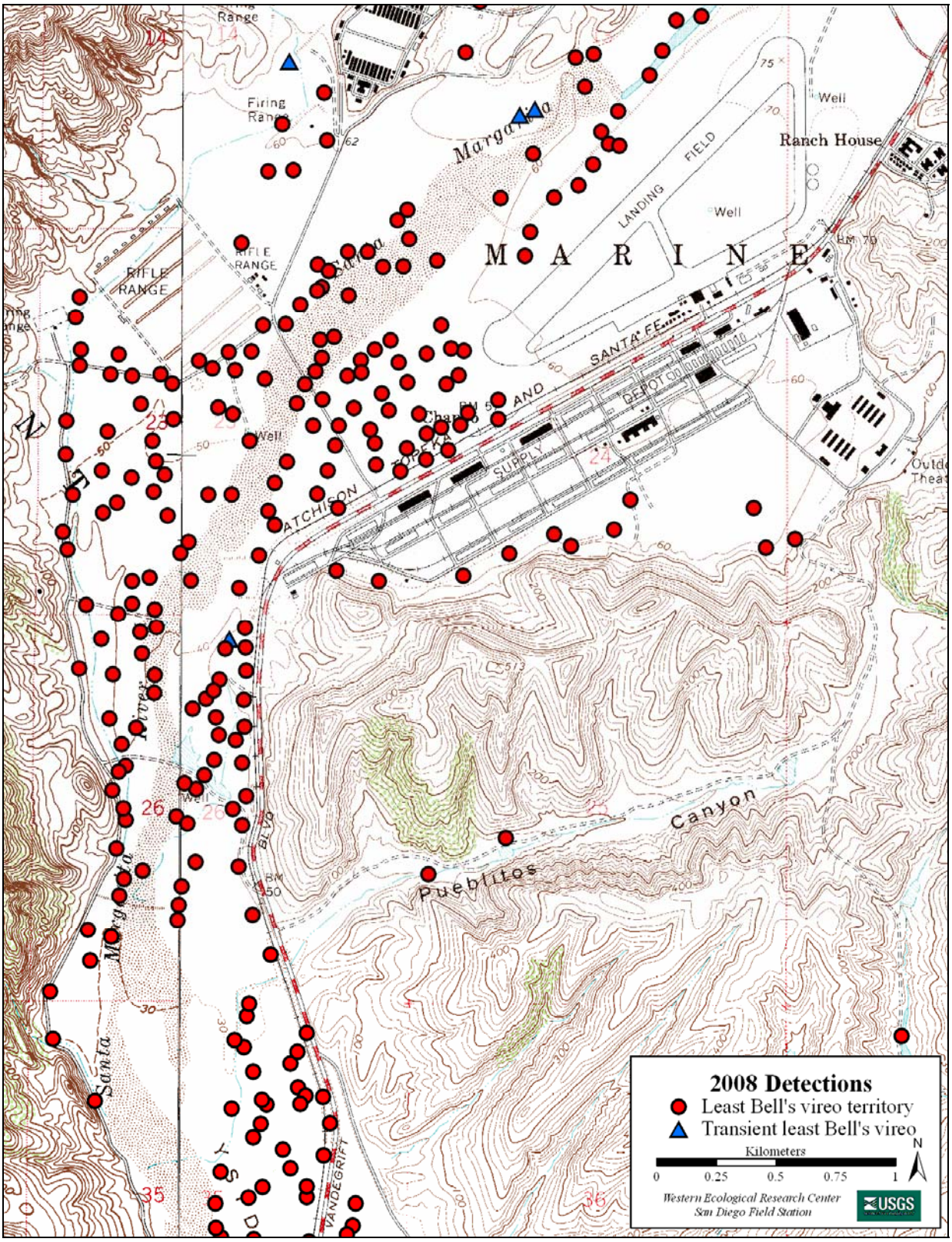

Fig. 25. Locations of least Bell's vireos at Marine Corps Base Camp Pendleton, 2008: Santa Margarita River, 22 Area, and Pueblitos Canyon.

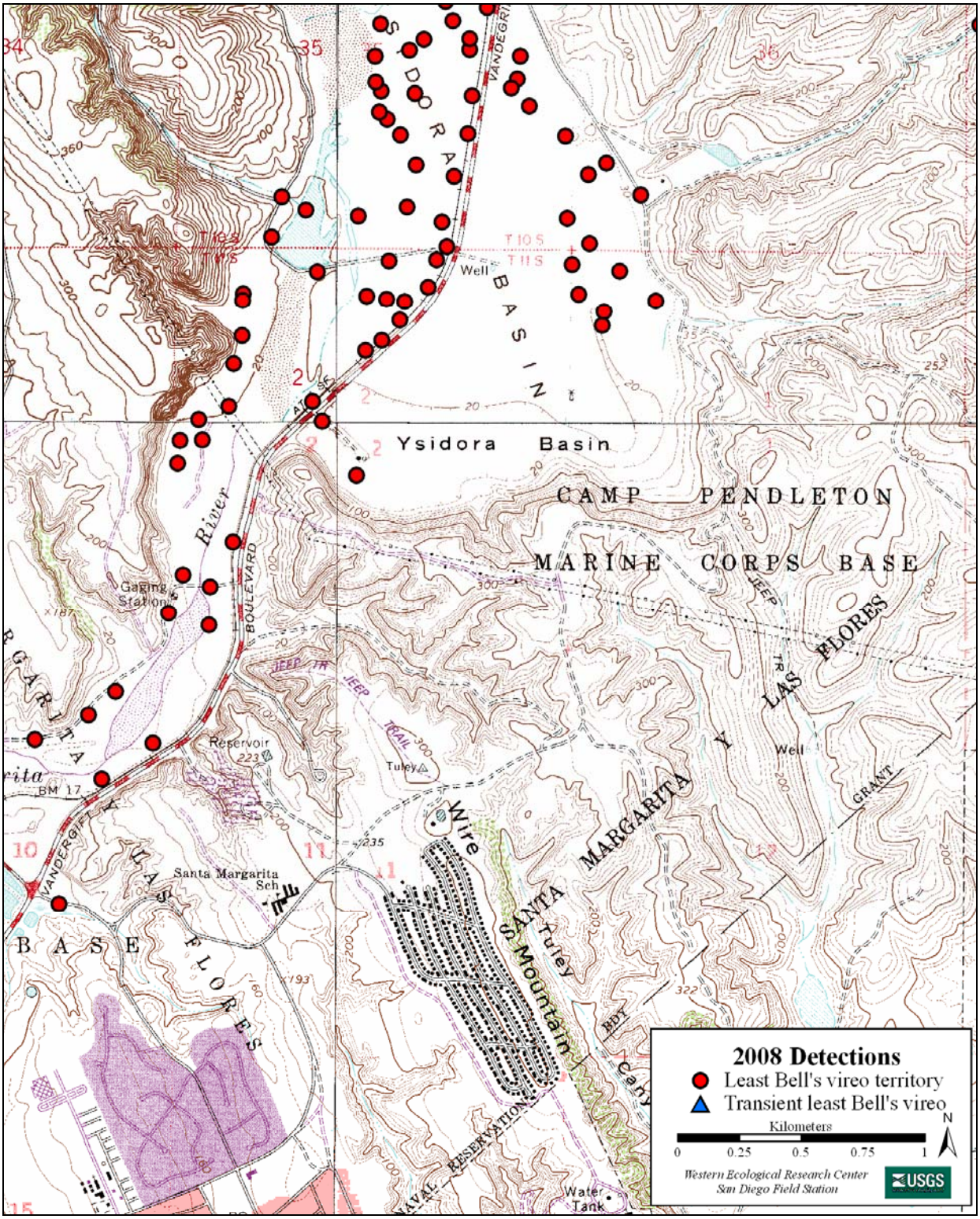

Fig. 26. Locations of least Bell's vireos at Marine Corps Base Camp Pendleton, 2008: Santa Margarita River, Ysidora Basin, and Ysidora Basin to Windmill Canyon.

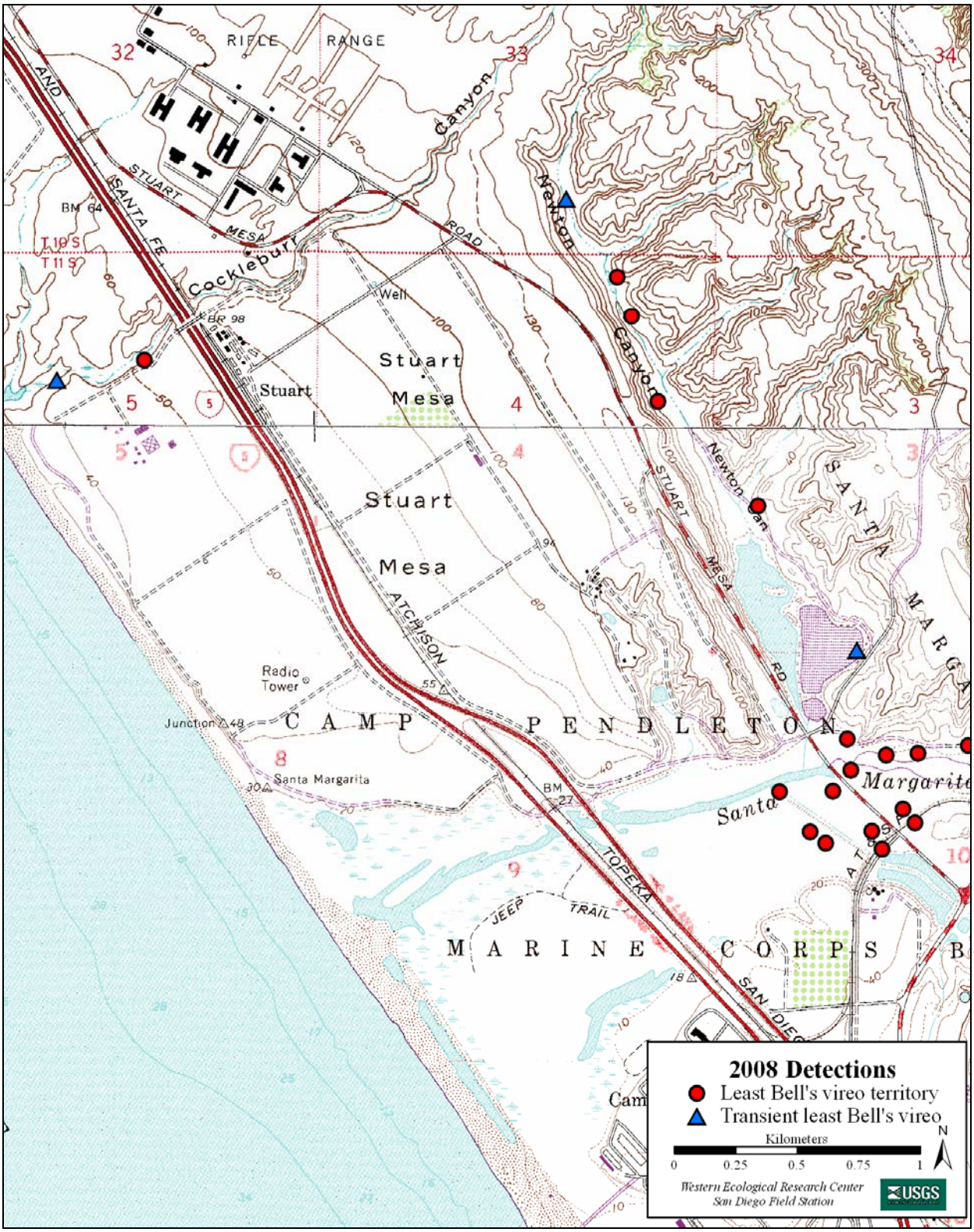

Fig. 27. Locations of least Bell's vireos at Marine Corps Base Camp Pendleton, 2008: Lower Santa Margarita River, Newton Canyon, and Cockleburr Canyon..

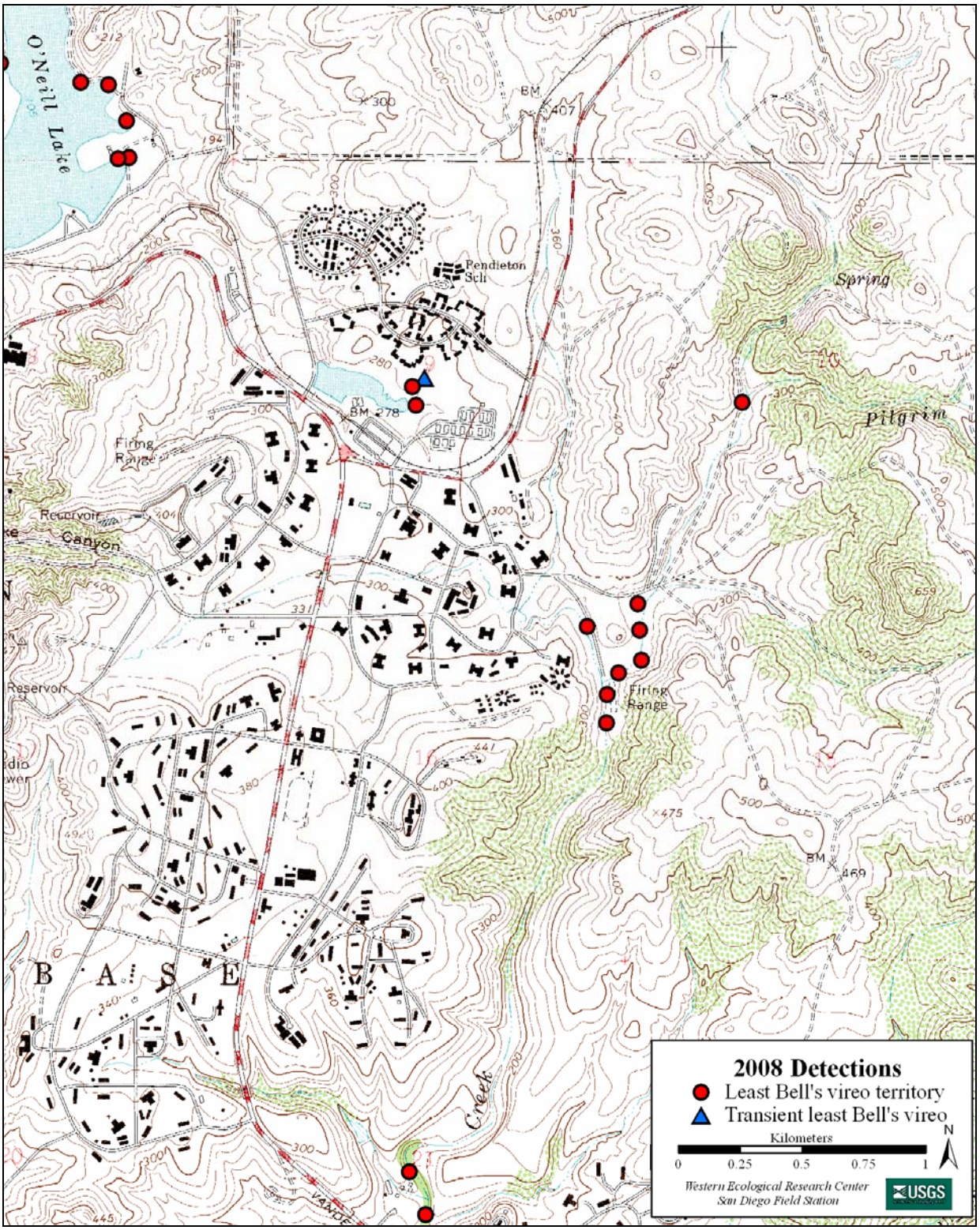

Fig. 28. Locations of least Bell's vireos at Marine Corps Base Camp Pendleton, 2008: Upper Pilgrim Creek, De Luz Homes Habitat, and Lake O'Neill.

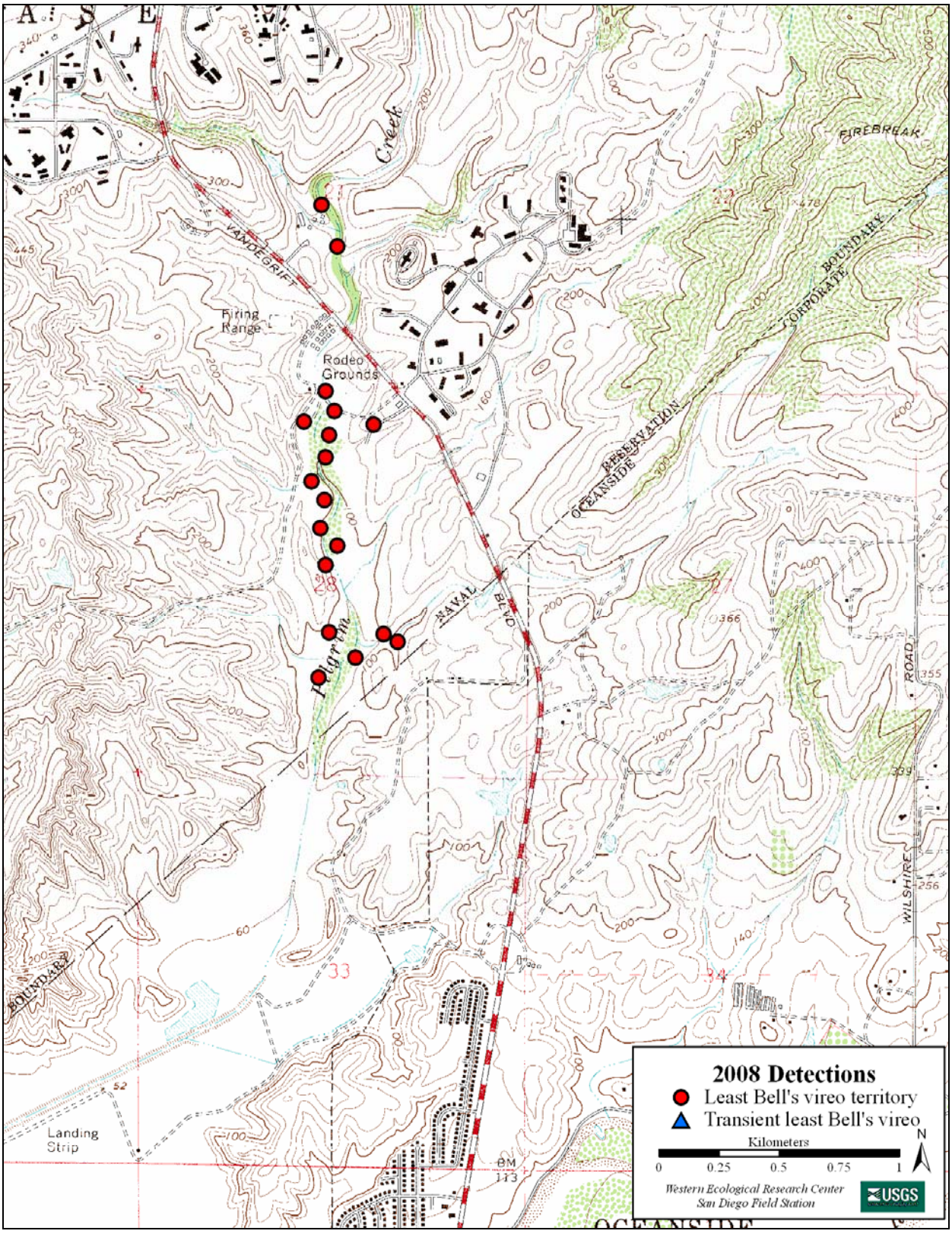

Fig. 29. Locations of least Bell's vireos at Marine Corps Base Camp Pendleton, 2008: Upper and Lower Pilgrim Creek.

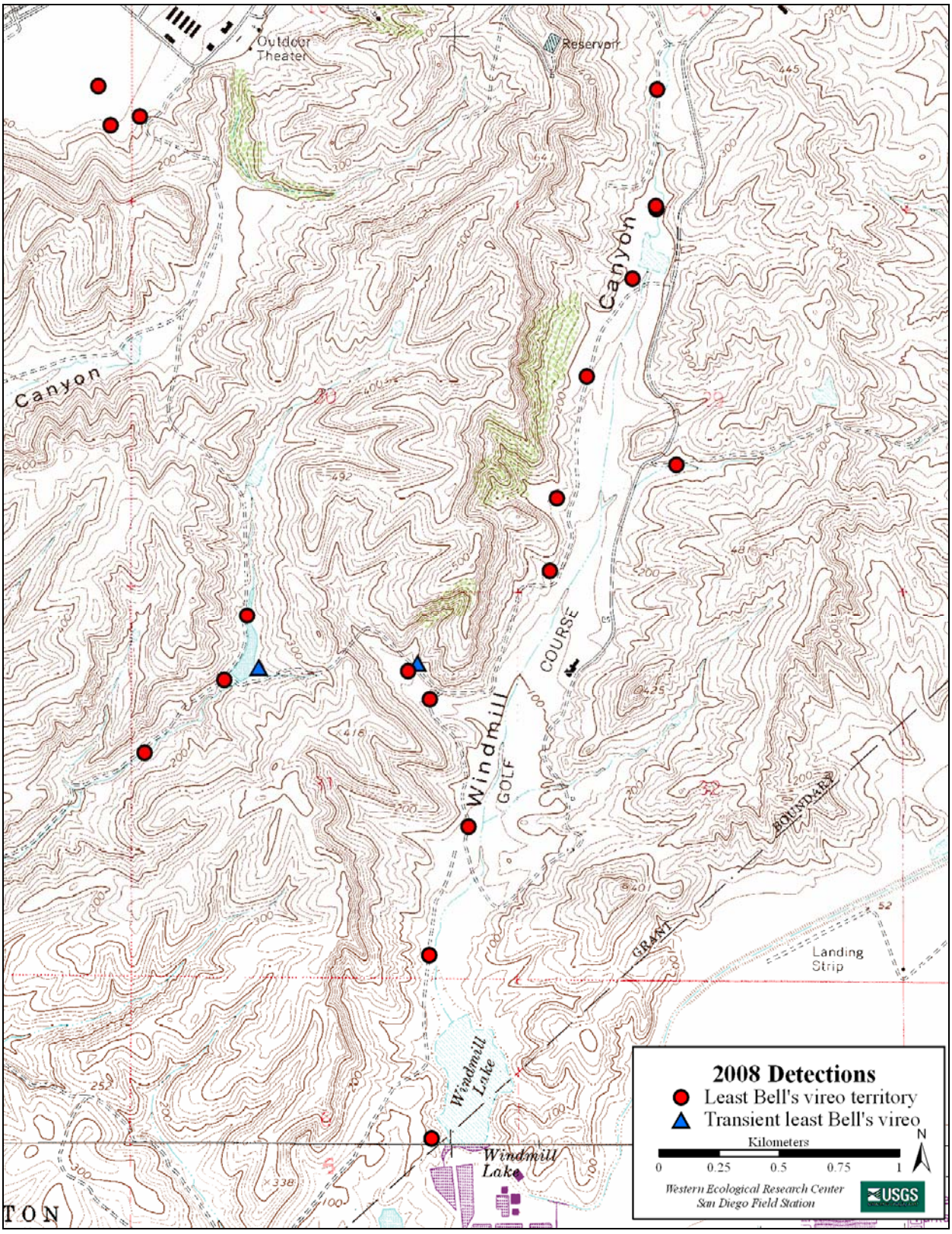

Fig. 30. Locations of least Bell's vireos at Marine Corps Base Camp Pendleton, 2008: Windmill Canyon and Ysidora Basin to Windmill Canyon.

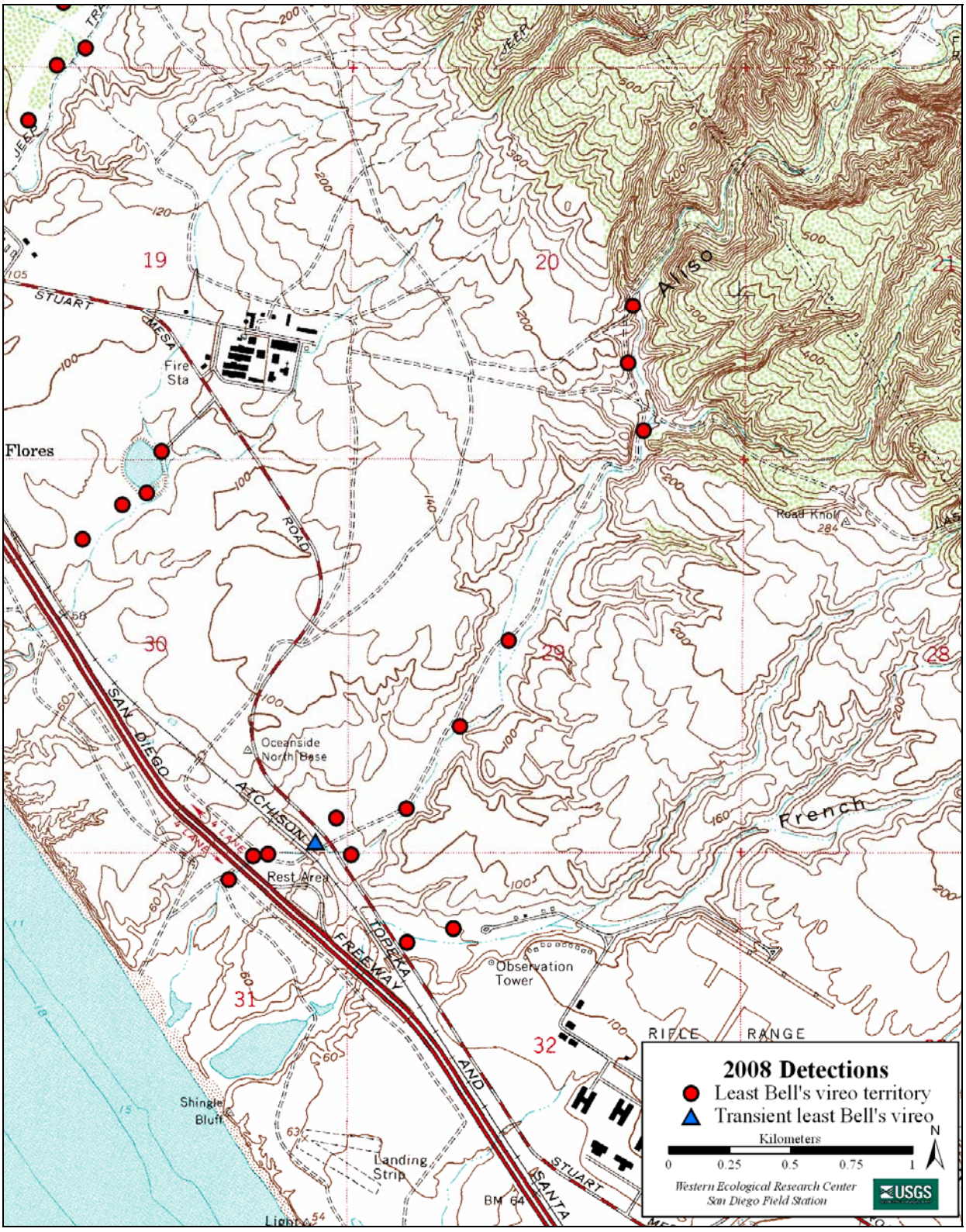

Fig. 31. Locations of least Bell's vireos at Marine Corps Base Camp Pendleton, 2008: French Creek, Aliso Creek, and Hidden Canyon.

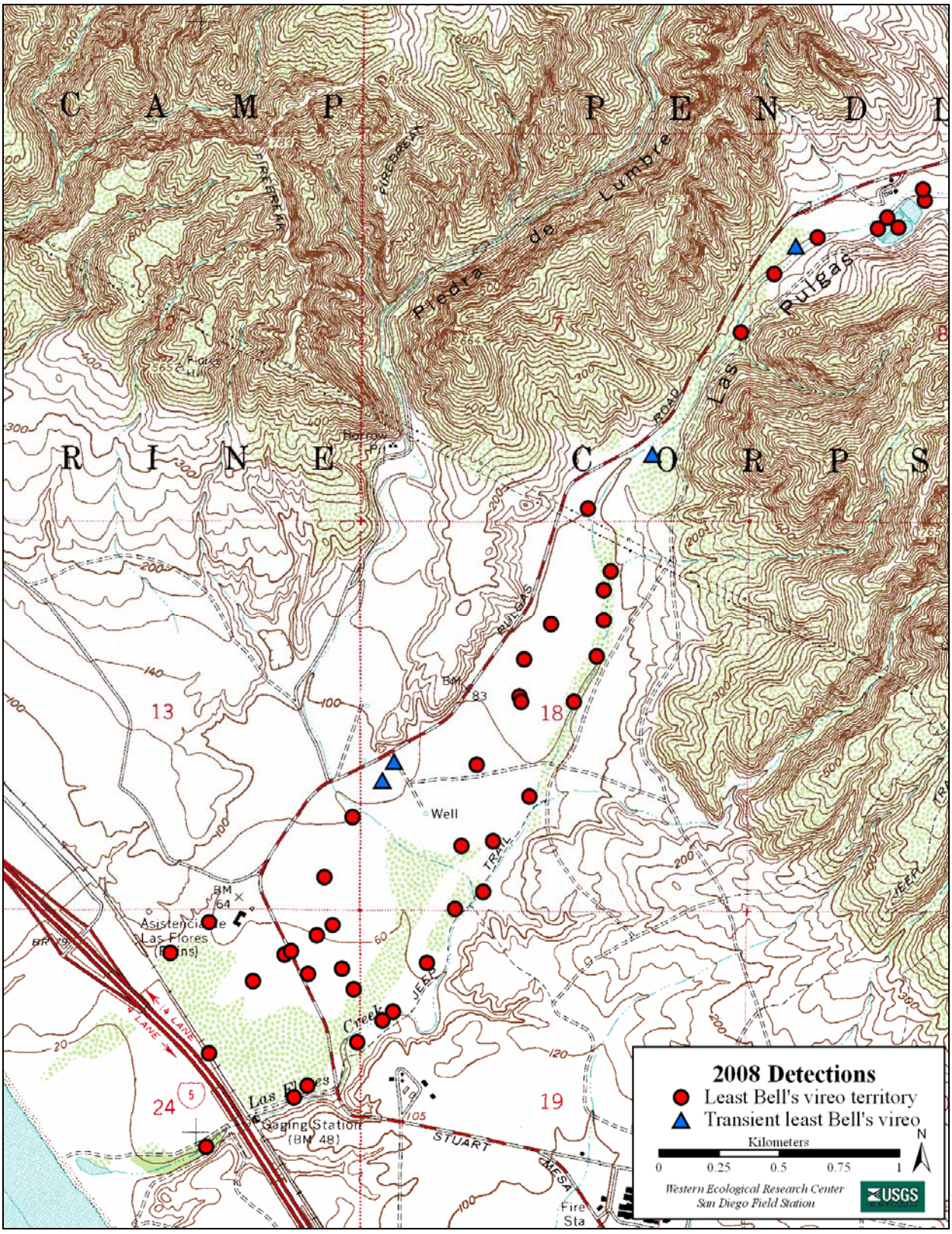

Fig. 32. Locations of least Bell's vireos at Marine Corps Base Camp Pendleton, 2008: Lower Las Flores Creek.

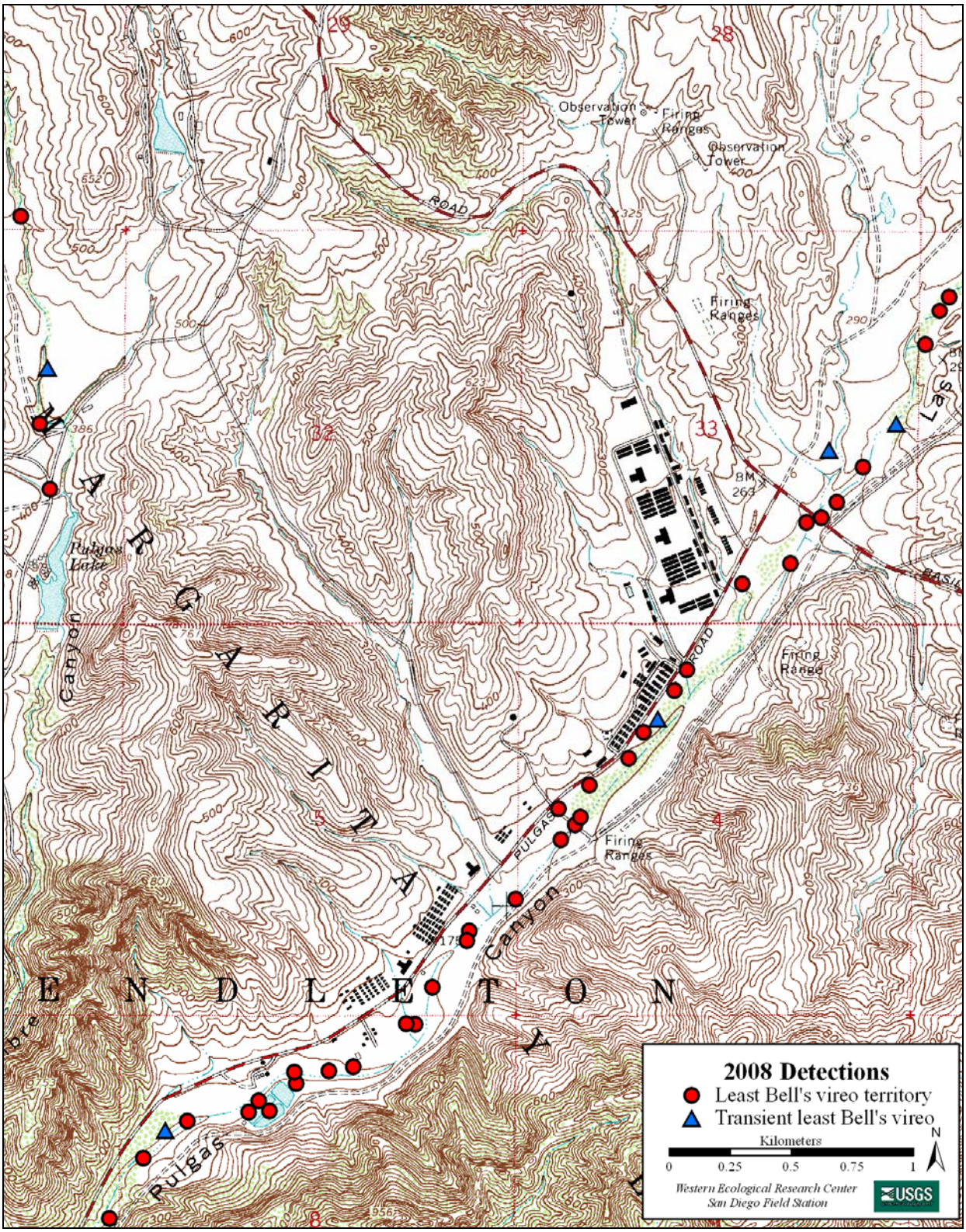

Fig. 33. Locations of least Bell's vireos at Marine Corps Base Camp Pendleton, 2008: Piedra de Lumbre Canyon and Upper Las Flores Creek.

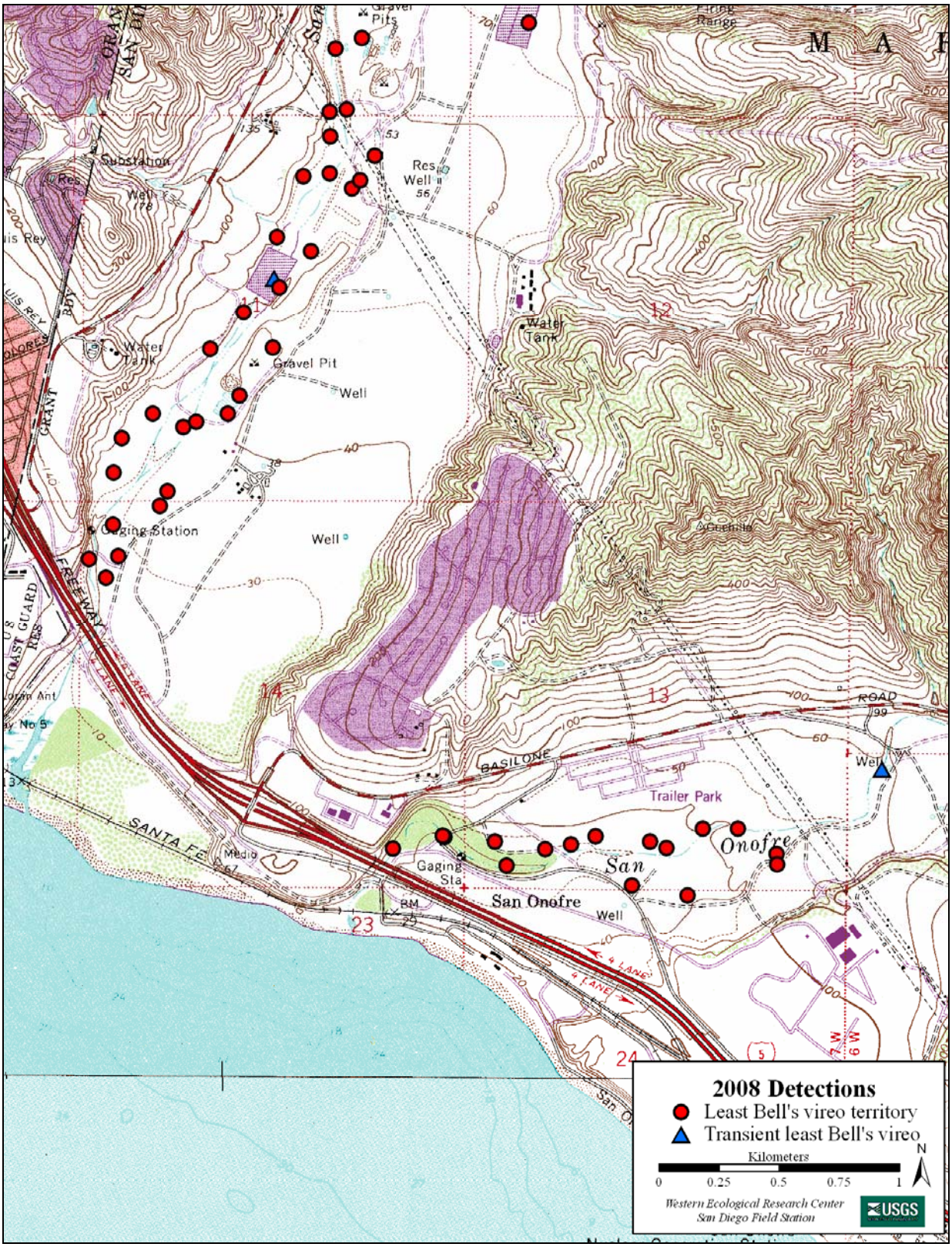

Fig. 34. Locations of least Bell's vireos at Marine Corps Base Camp Pendleton, 2008: Lower San Onofre Creek and Lower San Mateo Creek.

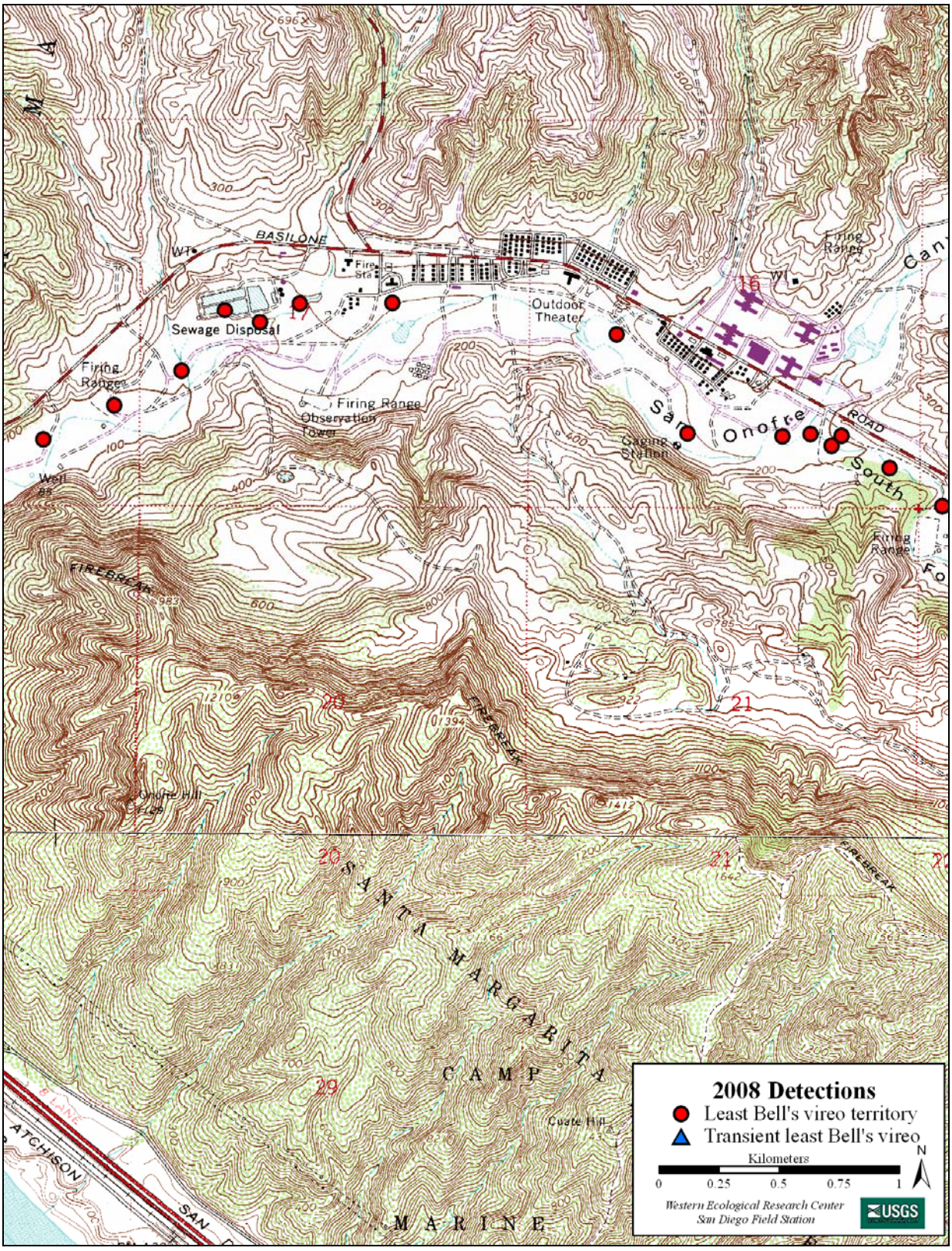

Fig. 35. Locations of least Bell's vireos at Marine Corps Base Camp Pendleton, 2008: San Onofre Creek.

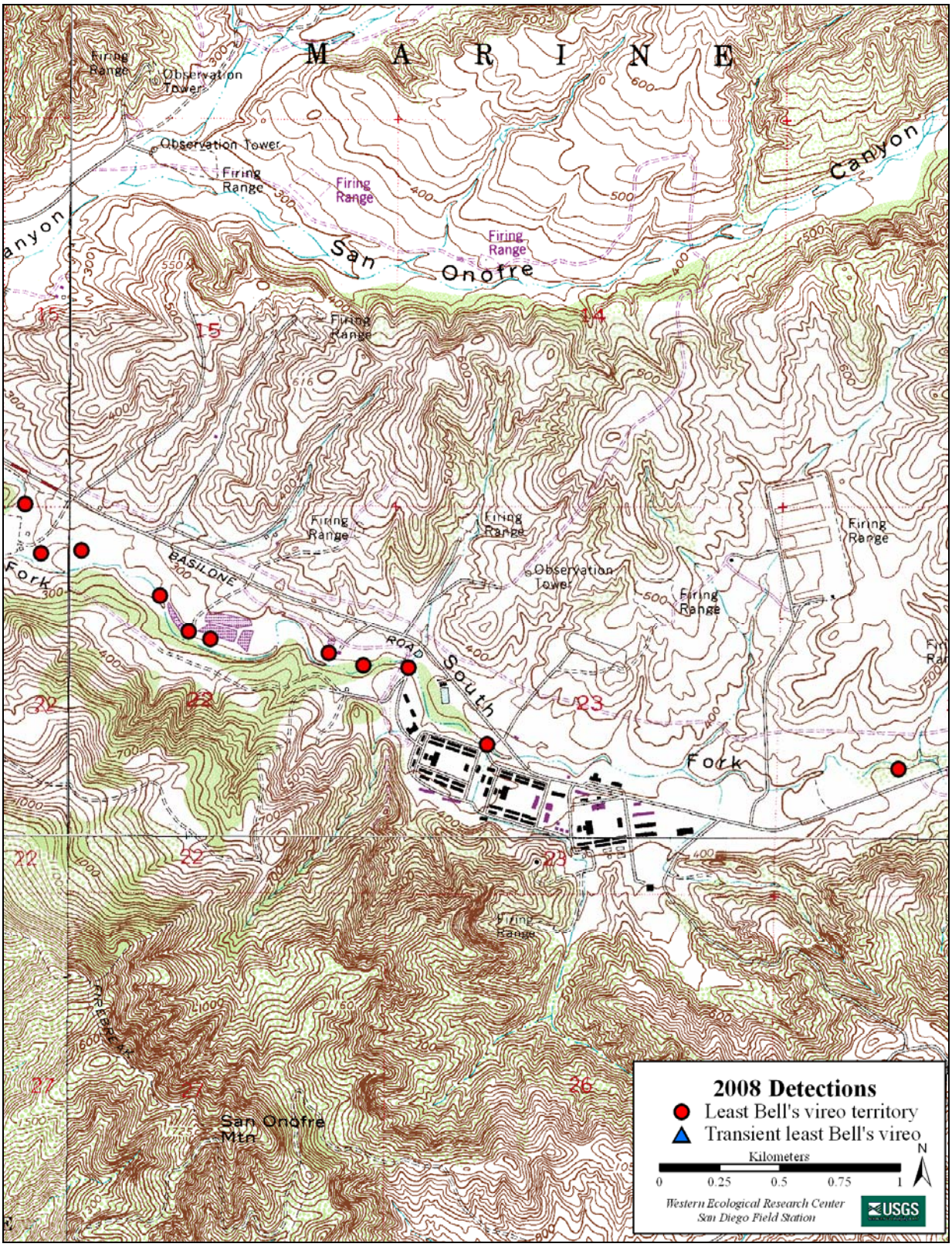

Fig. 36. Locations of least Bell's vireos at Marine Corps Base Camp Pendleton, 2008: San Onofre Creek.

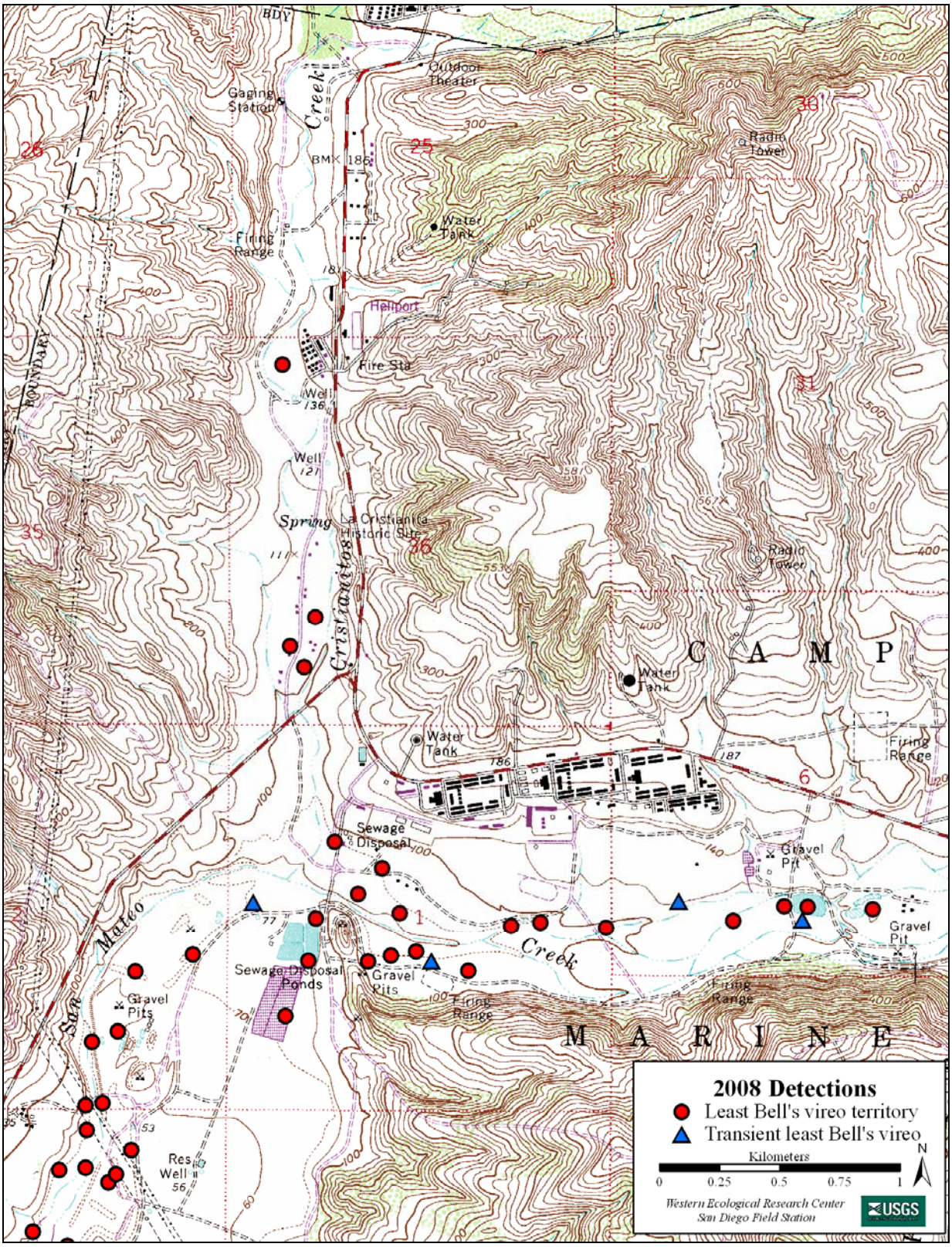

Fig. 37. Locations of least Bell's vireos at Marine Corps Base Camp Pendleton, 2008: San Mateo Creek and Cristianitos Creek.

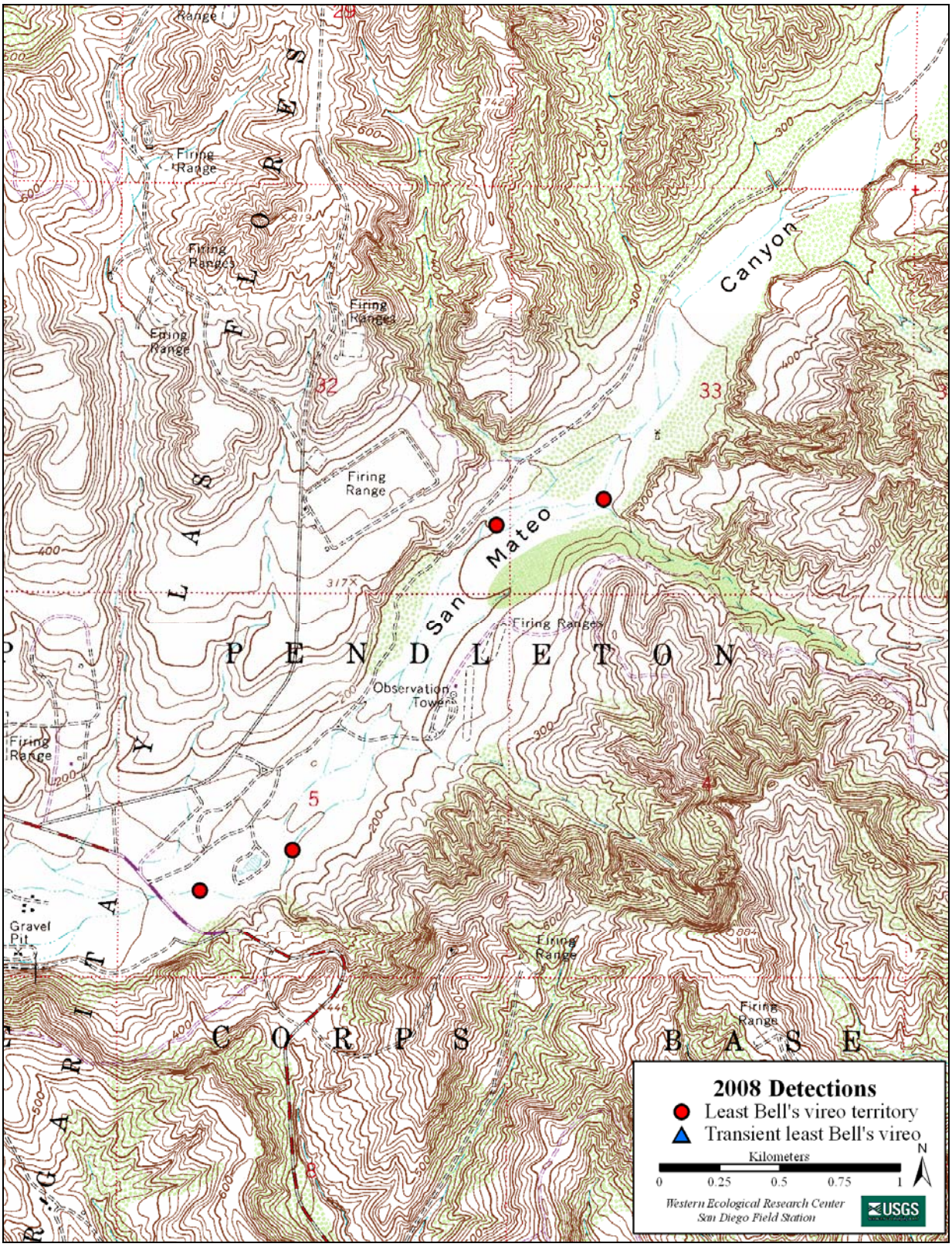

Fig. 38. Locations of least Bell's vireos at Marine Corps Base Camp Pendleton, 2008: Upper San Mateo Creek.

APPENDIX C

BANDED LEAST BELL'S VIREOS AT CAMP PENDLETON, 2008

Drainage / Sex	Band Combination[a] Left Leg	Right Leg	Age[b]	Comments
De Luz Creek				
Female	Mgo	-	≥ 2 yr	Banded as a nestling in or before 2006 at Camp Pendleton.
Female	Mgo	-	≥ 2 yr	Banded as a nestling in or before 2006 at Camp Pendleton.
Female	-	Msi	AHY	Resighted close to De Luz MAPS Station.
Male	gogo	DGOR/Msi	2 yr	Banded at the De Luz Creek MAPS Station in 2007 as an adult
Male	gogo	ORORMsi	≥ 2 yr	Banded at the De Luz Creek MAPS Station in 2007 with unknown age.
Male	-	Mgo	AHY	Banded as a nestling in or before 2007 at Camp Pendleton.
Male	-	Msi	AHY	Resighted close to De Luz MAPS Station.
Male	Mgo	WHDP/gogo	AHY	Banded as an adult in 2008 at De Luz Creek.
Unknown	DPDP/Mgo	pupu	AHY	Banded as an adult in 2008 at De Luz Creek.
Unknown	Mgo	WHWH/gogo	HY	Banded as a nestling in 2008 - QIN territory.
Unknown	Msi	ORPU/pupu	HY	Banded at the De Luz Creek MAPS Station in 2008 as a juvenile.
Unknown	ORDG/gogo	Msi	HY	Banded at the De Luz Creek MAPS Station in 2008 as a juvenile.
Unknown	ORPU/pupu	Msi	HY	Banded at the De Luz Creek MAPS Station in 2008 as a juvenile.
Unknown	WHPU/gogo	Mgo	HY	Banded as a juvenile in 2008 at De Luz Creek.
Lake O'Neill/Fallbrook Creek				
Female	-	Mgo	AHY	Banded as a nestling in or before 2007 at Camp Pendleton.
French Creek				
Male	-	Mdb	AHY	Banded off Base on the San Luis Rey River as a nestling in or before 2007.
Las Flores Creek				
Female	-	Mgo	AHY	Banded as a nestling in or before 2007 at Camp Pendleton.
Male	PUWH/pupu	Mdb	1 yr	Banded off Base at the San Luis Rey River as a nestling in 2007.
Male	-	Mdb	AHY	Banded off Base on the San Luis Rey River as a nestling in or before 2007.
Male	Mdb	-	HY	Banded off Base on the San Luis Rey River as a nestling in 2008.
Newton Creek				
Male	-	Mdb	AHY	Banded off Base on the San Luis Rey River as a nestling in or before 2007.
Pilgrim Creek				
Male	pupu	ORORMgo	≥ 2 yr	Banded as an adult in 2007 at Pilgrim Creek.
Santa Margarita River				
Female	Mdb	-	≥ 2 yr	Banded off Base on the San Luis Rey River as a nestling in or before 2006.
Female	Mgo	-	≥ 2 yr	Banded as a nestling in or before 2006 at Camp Pendleton.

Drainage Sex	Band Combination[a] Left Leg	Right Leg	Age[b]	Comments
Santa Margarita River continued				
Female	Mgo	-	≥ 2 yr	Banded as a nestling in or before 2006 at Camp Pendleton.
Female	Mgo	LPLP/pupu	≥ 2 yr	Banded as an adult in 2007 at the Santa Margarita River.
Female	ORDG/Mgo	pupu	≥ 2 yr	Banded as an adult in 2007 at the Santa Margarita River.
Female	-	WHPU/Mdb	1 yr	Banded off Base at the San Luis Rey River as a nestling in 2007.
Female	PUOR/pupu	Mgo	1 yr	Banded as a nestling in 2007 at the Santa Margarita River.
Female	WHDP/pupu	Mgo	1 yr	Banded as a nestling in 2007 at the Santa Margarita River.
Female	Mgo	LPBK/gogo	2 yr	Banded as a nestling in 2006 at the Santa Margarita River.
Female	-	WHDP/Mdb	3 yr	Banded off Base at the San Luis Rey River as a nestling in 2005.
Female	ORPU/pupu	Mgo	3 yr	Banded as a nestling in 2005 at the Santa Margarita River.
Female	pupu	PUOR/Mgo	3 yr	Banded as a nestling in 2005 at the Santa Margarita River.
Female	-	Mgo	AHY	Banded as a nestling in or before 2007 at Camp Pendleton.
Female	-	Mgo	AHY	Banded as a nestling in or before 2007 at Camp Pendleton.
Female	-	Mgo	AHY	Banded as a nestling in or before 2007 at Camp Pendleton.
Female	-	Mgo	AHY	Banded as a nestling in or before 2007 at Camp Pendleton.
Female	-	Mgo	AHY	Banded as a nestling in or before 2007 at Camp Pendleton.
Female	-	Mgo	AHY	Banded as a nestling in or before 2007 at Camp Pendleton.
Female	-	Mgo	AHY	Banded as a nestling in or before 2007 at Camp Pendleton.
Female	-	Mgo	AHY	Banded as a nestling in or before 2007 at Camp Pendleton.
Female	-	Mgo	AHY	Banded as a nestling in or before 2007 at Camp Pendleton.
Female	-	Mgo	AHY	Banded as a nestling in or before 2007 at Camp Pendleton.
Female	-	Mgo	AHY	Banded as a nestling in or before 2007 at Camp Pendleton.
Female	-	Mgo	AHY	Banded as a nestling in or before 2007 at Camp Pendleton.
Female	-	Msi	AHY	Resighted at the Santa Margarita River.
Female	-	WHDP/Mgo	AHY	Banded as an adult in 2008 - AER territory.
Female	DGOR/Msi	-	AHY	Banded as an adult in 2008 - HE23 territory.
Female	Mgo	DPDP/gogo	AHY	Banded as an adult in 2008 - CED territory.
Female	Mgo	DPWH/gogo	AHY	Banded as an adult in 2008 - AST territory.
Female	Mgo	PUWH/gogo	AHY	Banded as an adult in 2008 - OVM territory.
Female	Msi	BKLP/gogo	AHY	Banded at the Santa Margarita River MAPS Station in 2008 as an adult.

Drainage / Sex	Band Combination[a] Left Leg	Right Leg	Age[b]	Comments
Santa Margarita River continued				
Female	Msi	ORPU/gogo	AHY	Banded at the Santa Margarita River MAPS Station in 2008 as an adult.
Female	Msi	PUYE/gogo	AHY	Banded as an adult in 2008 - FIN territory.
Female	ORPU/Msi	-	AHY	Banded as an adult in 2008 - YB15 territory.
Female	PUOR/gogo	Msi	AHY	Banded at the Santa Margarita River MAPS Station in 2008 as an adult.
Female	pupu	ORDG/Mgo	AHY	Banded as an adult in 2008 - AH14 territory.
Female	pupu	PUOR/Msi	AHY	Banded at the Santa Margarita River MAPS Station in 2008 as an adult.
Male	-	PUOR/Msi	≥ 2 yr	Banded as an adult in 2007 at the Santa Margarita River.
Male	BKLP/gogo	Msi	≥ 2 yr	Banded at the Santa Margarita River MAPS Station as an adult in 2007.
Male	gogo	LPBK/Msi	≥ 2 yr	Banded as an adult in 2007 at the Santa Margarita River.
Male	Mdb	-	≥ 2 yr	Banded off Base on the San Luis Rey River as a nestling in or before 2006.
Male	Mgo	BYST/pupu	≥ 2 yr	Banded as an adult in 2007 at the Santa Margarita River.
Male	Mgo	ORORO/pupu	≥ 2 yr	Banded as an adult in 2007 at the Santa Margarita River.
Male	Mgo	WHWH/pupu	≥ 2 yr	Banded as an adult in 2007 at the Santa Margarita River.
Male	Msi	DPDP/gogo	≥ 2 yr	Banded as an adult in 2007 at the Santa Margarita River.
Male	PUOR/Msi	gogo	≥ 2 yr	Banded as an adult in 2007 at the Santa Margarita River.
Male	pupu	BKBK/Mgo	≥ 2 yr	Banded as an adult in 2007 at the Santa Margarita River.
Male	pupu	BKLP/Mgo	≥ 2 yr	Banded as an adult in 2007 at the Santa Margarita River.
Male	pupu	PUPU/Mgo	≥ 2 yr	Banded as an adult in 2007 at the Santa Margarita River.
Male	WHDP/Mgo	pupu	≥ 2 yr	Banded as an adult in 2007 at the Santa Margarita River.
Male	WHDP/Msi	gogo	≥ 2 yr	Banded as an adult in 2007 at the Santa Margarita River.
Male	WHWH/Msi	gogo	≥ 2 yr	Banded as an adult in 2007 at the Santa Margarita River.
Male	YEYE/Msi	gogo	≥ 2 yr	Banded as an adult in 2007 at the Santa Margarita River.
Male	-	BWST/Mgo	≥ 3 yr	Banded as an adult in 2006 at the Santa Margarita River.
Male	-	ORORO/Mgo	≥ 3 yr	Banded as an adult in 2006 at the Santa Margarita River.
Male	-	YEPU/Mgo	≥ 3 yr	Banded as an adult in 2006 at the Santa Margarita River.
Male	DGOR	Mgo	≥ 3 yr	Banded as an adult in 2006 at the Santa Margarita River.
Male	Mgo	PUPU/pupu	≥ 3 yr	Banded as an adult in 2006 at the Santa Margarita River.
Male	pupu	LPBK/Mgo	≥ 3 yr	Banded as an adult in 2006 at the Santa Margarita River.
Male	pupu	WHWH/Mgo	≥ 3 yr	Banded as an adult in 2006 at the Santa Margarita River.
Male	PUPU/pupu	Mgo	≥ 3 yr	Banded as an adult in 2006 at the Santa Margarita River.
Male	Mgo	PUWH/pupu	≥ 4 yr	Banded as an adult in 2005 at the Santa Margarita River.
Male	ORORO/Msi	pupu	≥ 4 yr	Banded as an adult in 2005 at the Santa Margarita River.
Male	PUWH/Mgo	pupu	≥ 4 yr	Banded as an adult in 2005 at the Santa Margarita River.
Male	-	ORDG/Mgo	1 yr	Banded as a nestling in 2007 at the Santa Margarita River.
Male	BKBK/gogo	Mgo	1 yr	Banded as a nestling in 2007 at the Santa Margarita River.
Male	BKLP/pupu	Mgo	1 yr	Banded as a nestling in 2007 at the Santa Margarita River.
Male	DPDP/sisi	Mgo	1 yr	Banded as a nestling in 2007 at the Santa Margarita River.
Male	DPWH/gogo	Mgo	1 yr	Banded as a nestling in 2007 at the Santa Margarita River.

Drainage / Sex	Band Combination[a] Left Leg	Right Leg	Age[b]	Comments
Santa Margarita River continued				
Male	OROR/gogo	Mgo	1 yr	Banded as a nestling in 2007 at the Santa Margarita River.
Male	pupu	OROR/Mdb	1 yr	Banded off Base at the San Luis Rey River as a nestling in 2007.
Male	PUWH/gogo	Mgo	1 yr	Banded as a nestling in 2007 at the Santa Margarita River.
Male	PUWH/sisi	Mgo	1 yr	Banded as a nestling in 2007 at the Santa Margarita River.
Male	WHPU/Mgo	-	1 yr	Banded as a juvenile in 2007 at the Santa Margarita River.
Male	WHWH/sisi	Mgo	1 yr	Banded as a nestling in 2007 at the Santa Margarita River.
Male	YEPU/gogo	Mgo	1 yr	Banded as a nestling in 2007 at the Santa Margarita River.
Male	YEYE/gogo	Mdb	1 yr	Banded off Base at the San Luis Rey River as a nestling in 2007.
Male	-	-	2 yr	Banded off Base at the San Luis Rey River as a nestling in 2006. Band removed.
Male	BKLP/Mgo	pupu	2 yr	Banded as a nestling in 2006 at the Santa Margarita River.
Male	DGOR/Msi	gogo	2 yr	Banded at the Santa Margarita River MAPS Station in 2006 as a juvenile.
Male	Mdb	DPDP/sisi	2 yr	Banded off Base at the San Luis Rey River as a nestling in 2006.
Male	Mgo	ORPU/gogo	2 yr	Banded as a nestling in 2006 at the Santa Margarita River.
Male	Mgo	YEPU/pupu	2 yr	Banded as a nestling in 2006 at the Santa Margarita River.
Male	ORDG/Mdb	pupu	2 yr	Banded off Base at the San Luis Rey River as a nestling in 2006.
Male	ORPU/Mgo	pupu	2 yr	Banded as a nestling in 2006 at the Santa Margarita River.
Male	PUOR/Mdb	pupu	2 yr	Banded off Base at the San Luis Rey River as a nestling in 2006.
Male	WHDP/Mdb	-	2 yr	Banded off Base at the San Luis Rey River as a nestling in 2006.
Male	-	DGOR/Msi	AHY	Banded as an adult in 2008 - FIN territory.
Male	-	Mdb	AHY	Banded off Base on the San Luis Rey River as a nestling in or before 2007.
Male	-	Msi	AHY	Resighted at the Santa Margarita River.
Male	DGOR/Mgo	-	AHY	Banded as an adult in 2008 - BEK territory.
Male	DPDP/Msi	gogo	AHY	Banded as an adult in 2008 - AST territory.
Male	DPWH/sisi	Mgo	AHY	Banded as an adult in 2008 - RR26 territory.
Male	DPWH/Msi	gogo	AHY	Banded as an adult in 2008 - ES33 territory.
Male	DPWH/pupu	Mgo	AHY	Banded as an adult in 2008 - SNP territory.
Male	LPBK/gogo	Mgo	AHY	Banded as an adult in 2008 - DAQ territory.
Male	LPBK/sisi	Mgo	AHY	Banded as an adult in 2008 - DEU territory.
Male	Mgo	BKLP/sisi	AHY	Banded as an adult in 2008 - MUM territory.
Male	Mgo	BYST/gogo	AHY	Banded as an adult in 2008 - MOU territory.
Male	Mgo	OROR/gogo	AHY	Banded as an adult in 2008 - PR28 territory.

Drainage / Sex	Band Combination[a] Left Leg	Right Leg	Age[b]	Comments
Male	Mgo	PUPU/sisi	AHY	Banded as an adult in 2008 - ABB territory.
Male	Mgo	WHPU/pupu	AHY	Banded as an adult in 2008 - BN17 territory.
Male	Mgo	YEPU/gogo	AHY	Banded as an adult in 2008 - LIA territory.
Male	ORDG/pupu	Mgo	AHY	Banded as an adult in 2008 - CHE territory.
Male	pupu	DGOR/Mgo	AHY	Banded as an adult in 2008 - AER territory.
Male	pupu	ORPU/Msi	AHY	Banded at the Santa Margarita River MAPS Station in 2008 as an adult.
Male	PUYE/Mgo	pupu	AHY	Banded as an adult in 2008 - JSP territory.
Male	WHPU/gogo	Msi	AHY	Banded as an adult in 2008 - AE10 territory.
Male	WHPU/pupu	Mgo	AHY	Banded as an adult in 2008 - HW28 territory.
Male	YEPU/pupu	Mgo	AHY	Banded as an adult in 2008 - ARH territory.
Unknown	BYST/gogo	Mgo	AHY	Banded as an adult in 2008 - CAG territory.
Unknown	DGOR/gogo	Msi	AHY	Banded as an adult in 2008 - HW45 territory.
Unknown	DGOR/pupu	Msi	HY	Banded at the Santa Margarita River MAPS Station in 2008 as a juvenile.
Unknown	gogo	BKLP/Msi	AHY	Banded at the Santa Margarita River MAPS Station in 2008 as an adult.
Unknown	gogo	ORPU/Msi	AHY	Banded at the Santa Margarita River MAPS Station in 2008 as an adult.
Unknown	Mgo	BKLP/pupu	AHY	Banded as a juvenile in 2008 - HW04 territory.
Unknown	Mgo	DGOR/gogo	AHY	Banded as an adult in 2008 - HW04 territory.
Unknown	Mgo	WHWH/sisi	AHY	Banded as an adult in 2008 - BER territory.
Unknown	Msi	PUOR/gogo	AHY	Banded at the Santa Margarita River MAPS Station in 2008 as an adult.
Unknown	Msi	PUWH/gogo	AHY	Banded at the Santa Margarita River MAPS Station in 2008 as an adult.
Unknown	Msi	WHWH/gogo	AHY	Banded at the Santa Margarita River MAPS Station in 2008 as an adult.
Unknown	ORPU/pupu	Msi	AHY	Banded at the Santa Margarita River MAPS Station in 2008 as an adult.
Unknown	ORPU/gogo	Msi	AHY	Banded as an adult in 2008 - HW45 territory.
Unknown	PUOR/pupu	Msi	AHY	Banded at the Santa Margarita River MAPS Station in 2008 as an adult.
Unknown	PUYE/Msi	gogo	AHY	Banded as an adult in 2008 - HW28 territory.
Unknown	PUYE/pupu	Mgo	AHY	Banded as an adult in 2008 - HE33 territory.
Unknown	WHDP/gogo	Msi	AHY	Banded as an adult in 2008 - HW45 territory.
Unknown	Mgo	WHDP/pupu	HY	Banded as a juvenile in 2008 - AE24 territory.
Unknown	Msi	DGOR/pupu	HY	Banded at the Santa Margarita River MAPS Station in 2008 as a juvenile.
Unknown	Msi	LPLP/gogo	HY	Banded as a juvenile in 2008 - HW28 territory.
Unknown	Msi	ORPU/pupu	HY	Banded at the Santa Margarita River MAPS Station in 2008 as a juvenile.
Unknown	ORDG/Msi	gogo	HY	Banded as a juvenile in 2008 - ODN territory.
Unknown	pupu	ORPU/Msi	HY	Banded at the Santa Margarita River MAPS Station in 2008 as a juvenile.
Unknown	PUPU/Msi	gogo	HY	Banded as a juvenile in 2008 - ES20 territory.
Unknown	PUYE/gogo	Msi	HY	Banded at the Santa Margarita River MAPS Station in 2008 as a juvenile.

Drainage / Sex	Band Combination[a] Left Leg	Right Leg	Age[b]	Comments
San Mateo Creek				
Female	DGOR/pupu	Mgo	AHY	Banded as an adult in 2008 at San Mateo Creek.
Male	-	Mgo	AHY	Banded as a nestling in or before 2007 at Camp Pendleton.
Unknown	Mgo	PUOR/sisi	AHY	Banded as an adult in 2008 at San Mateo Creek.
Unknown	PUPU/sisi	Mgo	AHY	Banded as an adult in 2008 at San Mateo Creek.

[a] Band colors: Mdb = dark blue numbered federal band; Mgo = gold numbered federal band; Msi = silver numbered federal band; gogo = metal gold; pupu = metal purple; sisi = metal silver; BKBK = plastic black; BKLP = plastic black-light pink split; BWST = plastic blue-white striped; BYST = plastic black-yellow striped; DGOR = plastic dark green-orange split; DPDP = plastic dark pink; DPWH = plastic dark pink-white split; LPBK = plastic light pink-black split; LPLP = plastic light pink; ORDG = plastic orange-dark green split; OROR = plastic orange; ORPU = plastic orange-purple split; PUOR = plastic purple-orange split; PUPU = plastic purple; PUWH = plastic purple-white split; PUYE = plastic purple-yellow split; WHDP = plastic white-dark pink split; WHPU = plastic white-purple split; WHWH = plastic white; YEPU = plastic yellow-purple split; YEYE = plastic yellow.

[b] Age: AHY = after hatch-year, HY = hatch-year.

APPENDIX D

STATUS AND NESTING ACTIVITIES OF LEAST BELL'S VIREOS AT MARINE CORPS BASE CAMP PENDLETON, 2008

Reference Site Territories					
Territory	**Nest**	**Monitoring[a]**	**Nest Fate[b]**	**# Fledged**	**Comments**
AH14	1	F	SUC	4	
AH14	2	F	SUC	3	
APO	1	F	PRE	0	
APO	2	F	PRE	0	
APO	3	F	PRE	0	
APO	4	F	SUC	3	
ARI	1	F	PRE	0	
ARI	2	F	SUC	3	
ARI	3	F	UNK	0	Cause of failure unknown.
AXE	1	F	INC	0	Nest building was initiated, but the nest was never completed.
AXE	2	F	PRE	0	
AXE	3	F	SUC	3	
BEK	1	F	PRE	0	
BEK	2	F	SUC	1	
BER	1	F	SUC	4	
BOW	1	F	SUC	4	
BOW	2	F	SUC	3	
CED	1	F	PRE	0	
CED	2	F	PRE	0	
CED	3	F	SUC	1	
DAN	2	P	SUC	1	
DAQ	1	F	SUC	4	
DAQ	2	F	PRE	0	
DAQ	3	F	PRE	0	
MUM	1	F	INC	0	Nest building was initiated, but the nest was never completed.
MUM	2	F	PRE	0	
MUM	3	F	SUC	4	
DEU	1	F	PRE	0	
DEU	2	F	PRE	0	
DEU	3	F	SUC	2	
DRK	1	F	SUC	4	
DRK	2	F	PRE	0	
DRK	3	F	PRE	0	
FIN	1	F	SUC	4	
FIN	2	F	SUC	3	
HE17	1	P	SUC	3	
HLD	1	F	PRE	0	
HLD	2	F	SUC	4	
HOL	1	F	OTH	0	Nest failed at end of nest building or during egg laying.
HOL	2	F	SUC	4	
HOL	3	F	PRE	0	

Reference Site Territories (*continued*)					
Territory	**Nest**	**Monitoring[a]**	**Nest Fate[b]**	**# Fledged**	**Comments**
HRP	1	F	PRE	0	
HRP	2	F	OTH	0	Nest failed at end of nest building or during egg laying.
HRP	3	F	PRE	0	
HRP	4	F	PRE	0	
HTI	1	F	PRE	0	
HTI	2	F	PRE	0	
HTI	3	F	SUC	4	
HW24	1	P	SUC	2	
HW33	1	P	SUC	4	
JSP	1	F	UNK	0	Cause of failure unknown, nestling carcasses were eaten by ants.
JSP	2	F	SUC	3	
LIF	1	F	INC	0	Nest building was initiated, but the nest was never completed.
LIF	2	F	PRE	0	
LIF	3	F	SUC	3	
MOU	1	F	PRE	0	
MOU	2	F	SUC	2	
MOU	3	F	SUC	3	
OCM	1	F	SUC	2	
ODN	1	F	FAL	0	Nest built by male alone, no female present.
ODN	2	F	UNK	0	Probable cause of nest failure was infertile eggs.
PEP	1	F	OTH	0	Nest failed at end of nest building or during egg laying.
PEP	2	F	SUC	4	
QIN	1	F	SUC	4	
QIN	2	F	SUC	3	
TDE	1	F	SUC	4	
ZPR	1	F	INC	0	Nest building was initiated, but the nest was never completed.
ZPR	2	F	SUC	4	
Giant Reed (*Arundo donax*) Removal Site Territories					
ABB	1	F	PRE	0	
ABB	2	F	PRE	0	
ABB	3	F	OTH	0	Nest was poorly constructed and detached from the host plant, eggs were found on nest rim.
AE06	1	P	SUC	3	
AE07	1	P	SUC	3	
AE22	1	P	SUC	4	
AE26	1	P	SUC	0	
AER	1	F	SUC	4	
AER	2	F	INC	0	Nest building was initiated, but the nest was never completed.
AER	3	F	SUC	4	
ALI	1	F	SUC	4	
ALI	2	F	SUC	3	

Giant Reed (*Arundo donax*) Removal Territories (*continued*)					
Territory	**Nest**	**Monitoring[a]**	**Nest Fate[b]**	**# Fledged**	**Comments**
ANA	1	F	PRE	0	
ANA	2	F	SUC	4	
ANI	1	F	SUC	4	
ANI	2	F	UNK	0	Cause of failure unknown.
ARH	1	F	SUC	2	
ARH	2	F	INC	0	Nest building was initiated, but the nest was never completed.
ARH	3	F	SUC	3	
ARS	1	F	PRE	0	
ARS	2	F	SUC	4	
AST	1	F	SUC	4	
AST	2	F	SUC	3	
ATK	1	F	SUC	4	
ATK	2	F	SUC	3	
ATT	1	F	SUC	3	
CAG	1	F	PRE	0	
CAG	2	F	SUC	2	
CHE	1	F	SUC	2	
CHE	2	F	SUC	4	
CZN	1	F	INC	0	Nest building was initiated, but the nest was never completed.
CZN	2	F	SUC	4	
DON	1	F	SUC	4	
DON	2	F	SUC	1	
FNR	1	P	PRE	0	
IND	1	F	SUC	4	
IND	2	F	PRE	0	
LAP	1	F	SUC	4	
LIA	1	F	SUC	4	
LIA	2	F	SUC	3	
LND	1	F	SUC	4	
LND	2	F	SUC	2	
ORN	1	F	SUC	4	
ORN	2	F	SUC	3	
PON	1	F	SUC	3	
PON	2	F	PRE	0	
PON	3	F	UNK	0	Cause of failure unknown, nestling carcasses were eaten by ants.
SNP	1	F	INC	0	Nest building was initiated, but the nest was never completed.
SNP	2	F	SUC	4	
SNP	3	F	PRE	0	
SNP	4	F	SUC	2	
TUL	1	F	SUC	3	
TUL	2	F	SUC	4	

Giant Reed (*Arundo donax*) Removal Territories (*continued*)					
Territory	**Nest**	**Monitoring[a]**	**Nest Fate[b]**	**# Fledged**	**Comments**
VEG	1	F	SUC	3	
VEG	2	F	PRE	0	
VEG	3	F	INC	0	Nest building was initiated, but the nest was never completed.
VEG	4	F	SUC	2	
VIC	1	F	SUC	3	
VIC	2	F	INC	0	Nest building was initiated, but the nest was never completed.
VIC	3	F	SUC	3	
WNS	1	F	SUC	4	
WNS	2	F	SUC	3	

[a] Monitoring: F = fully monitored territory; P = partially monitored territory.

[b] Nest Fate: INC = nest never completed; SUC = fledged at least one least Bell's vireo young; PRE = nest failure caused by predation; OTH = reason for nest failure known, such as substrate failure; UNK = reason for nest failure/abandonment unknown; FAL = false/bachelor nest built by unpaired male.