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

2017 Annual Data Summary

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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Cover photograph: Hatching Least Bell's Vireo egg, by Angela Johnson

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EXECUTIVE SUMMARY

Surveys for the endangered Least Bell's Vireo (*Vireo bellii pusillus*) were conducted at Marine Corps Base Camp Pendleton (MCBCP or Base), California, between 3 April and 13 July 2017. Drainages containing riparian habitat suitable for vireos were surveyed two to four times. Six hundred and thirty-nine male vireos and 23 transient vireos were detected. Territorial vireos were detected on 19 out of the 23 drainages/sites surveyed. Ninety-two percent of all vireo territories occurred on the six most populated drainages, with the Santa Margarita River containing 65% of all territories on Base. Seventy-eight percent of male vireos were confirmed as paired.

The number of documented Least Bell's Vireo territories on MCBCP (639) decreased 10% from 2016 to 2017. The number of territories on 4% (1/23) of drainages surveyed increased by three or more territories from 2016, while 17% of drainages (4/23) decreased by three or more territories, and 78% of drainages (18/23) showed no change or increased/decreased by two or fewer territories.

The decrease in vireo numbers on MCBCP (10%) was inconsistent with population changes in surrounding areas, including the lower San Luis Rey River (increased by 19%), the middle San Luis Rey (increased by 3%), and Marine Corps Air Station, Camp Pendleton (MCAS) (remained constant). The local decrease in the vireo population on MCBCP corresponded with an increase off-Base. This discrepancy is likely a result of higher than average winter rains range-wide promoting vegetation growth in the lower canopy and mitigating the effects of drought in areas off-Base that had been heavily impacted by management activities, allowing those areas to be used by vireos.

The majority of vireo territories occurred in habitat characterized as willow (*Salix* spp.) riparian, with 73% of males in the study area found in this habitat. An additional 6% of birds occupied willow habitat co-dominated by sycamores (*Platanus racemosa*) or cottonwoods (*Populus fremontii*). Sixteen percent of territories were found in riparian scrub dominated by mule fat (*Baccharis salicifolia*) and/or sandbar willow (*S. exigua*). Two percent or fewer vireos used drier habitats characterized by a mix of sycamores and oaks (*Quercus agrifolia*), upland scrub, and non-native vegetation.

In October 2013, a wildfire burned 1,266 ha, including 355 ha of riparian vegetation that supported vireos during the breeding season. We collected data on vegetation structure and species composition in the burned riparian habitat (Above Hospital South and North sites) to document the recovery of this vegetation and the associated response of vireos to the habitat changes. The first year after the fire, 84% of the riparian vegetation was classified as high burn severity and 16% was classified as moderate burn severity. Live vegetation was mostly concentrated below 4 m and it increased significantly in the 0-1 m and 1-2 m height categories between 2016 and 2017 (7.8-15.1% increase). Vegetation volume increased slightly in the 5-6 m, 6-7 m, and 7-8 m height categories (1.4-1.6%). Live and overall canopy height did not change between 2016 and 2017. In 2017, 4 years post-fire, exotic and herbaceous species comprised 38% of the vegetation < 1 m, down from 1-3 years post-fire, with a corresponding increase in the cover of woody vegetation in this height category. During the first 3 years post-fire, the pattern of vegetation recovery at the Above Hospital sites differed from that at Las

Flores Creek (which burned in October 2007 and was sampled in 2008-2012), where the fire was less severe. However, by 2017 (4 years post-fire), vegetation cover in the lower height categories at the Above Hospital site approached or surpassed the cover in these height categories at Las Flores Creek. The proportion of vegetation in the lower canopy made up of herbaceous cover (exotic and native species) declined over 4 years at both sites. The main difference between the two sites appears to be the mid-canopy, which was less severely burned and changed little over time at Las Flores Creek, but has increased substantially over 4 years post-fire at the Above Hospital site.

In May 2014, a second wildfire event burned 8,906 ha on MCBCP, 837 ha of which was riparian vegetation that was occupied by vireos at the time of the fire. We evaluated vireo response to both the October 2013 and the May 2014 wildfires by calculating territory density within the wildfire perimeters (pre- and post-fire) and also by monitoring vireo nests within the area burned in October 2013 (Post-fire sites) compared to Reference sites that have not experienced significant disturbance in the past 16-18 years.

Vireo territory density at the October 2013 Post-fire sites did not differ from unburned Reference sites in 2017 and had increased to pre-fire levels by the third-year post-fire (2016). Vireo territory density in areas that burned in May 2014 remained at pre-fire levels achieved in 2016 after an initial 34% decrease the first year post-fire (2015). This suggests that riparian habitat can recover quickly from wildfires, regardless of the timing of the fire, to become adequate vireo habitat within 2 years of the burning.

We color-banded and resighted color-banded Least Bell's Vireos to evaluate adult site fidelity, natal dispersal, and the effect of wildfire on vireo site fidelity, dispersal, and survivorship. Two-hundred and twenty-nine Least Bell's Vireos were banded for the first time during the 2017 season. These included 28 adult vireos and 201 hatch-year vireos. All adult vireos and ten hatch-year birds were banded with unique color combinations. The remaining 191 hatch-year vireos (all nestlings) were banded with a single gold numbered federal band on the right leg.

Ninety-nine Least Bell's Vireos banded prior to the 2017 breeding season were resighted and identified on Base in 2017. Eighteen of these were originally banded on the San Luis Rey River, five were originally banded at MCAS, one was banded in Baja California Sur, and the remaining birds were banded at MCBCP. Adult birds of known age ranged from 1-8 years old. Adult survivorship, or the proportion of individuals known to survive from 2016 to 2017, was 54% (83/153). Survivorship of first-year birds that fledged from MCBCP in 2016 and were documented on Base or elsewhere in 2017 was 7% (8/116), based on the number of uniquely banded individuals detected. Assuming an equal sex ratio of banded juveniles, first-year survivorship of males was 10% and first-year survivorship of females was 3%.

The majority of returning adult vireos showed strong between-year site fidelity. Seventy-five percent of males (38/50) and 22% of females (2/9) present in 2016 and 2017 returned to within 100 m of their previous territory. The average between-year movement for returning adult vireos was 0.4 ± 1.5 km. The average movement of first-year vireos detected in 2017 that fledged from a known nest on MCBCP in 2016 was 17.9 ± 32.2 km.

Six vireos (four adults and two first-year birds) that originated at MCBCP moved off-Base and were detected elsewhere in 2017. The adult female and a first-year male were detected along the San Luis Rey River. The three adult males and one first-year male were found on the San Dieguito River, the Tijuana River, Zuma Canyon in the Santa Monica Mountains, and Whitewater Canyon in the San Bernardino Mountains.

We monitored Least Bell's Vireos to evaluate the effects of the October 2013 wildfire on survivorship, nest success, and breeding productivity. Vireos were monitored at two Post-fire sites and two Reference sites.

Adult survivorship of vireos at Post-fire sites and Reference sites was 44% and 69%, respectively. First-year survivorship was 4% and 9%, respectively. One hundred percent (11/11) of adults from Post-fire sites that were detected in both 2016 and 2017 returned in 2017 to the same territory occupied in 2016. Eighty-nine percent (16/18) of adult vireos detected in 2016 Reference sites returned to Reference sites in 2017. Two of 45 first-year vireos that were banded as nestlings at Post-fire sites in 2016 returned in 2017, one to a Post-fire site and one to areas outside of our monitoring sites. Six of 70 first-year vireos that were banded as nestlings at Reference sites in 2016 returned in 2017, one to a Post-fire site and five returned to areas outside of our monitoring sites.

Nesting activity was monitored between 24 March and 24 July in 51 territories within the Post-fire and Reference monitoring sites. All territories but one were occupied by pairs, and all nesting attempts were monitored. One hundred and fifteen nests (60 in Post-fire sites and 55 in Reference sites) were monitored during the monitoring period.

Completed nests at Post-fire sites were as likely to be successful as nests at Reference sites in 2017. Forty-one percent (22/54) of Post-fire nests and 57% (30/53) of Reference nests successfully fledged young. Predation was believed to be the primary source of nest failure at both sites. Predation accounted for 66% (21/32) and 70% (16/23) of nest failures at Post-fire and Reference sites, respectively. Of the remaining 18 nests that failed, failure was attributed to exposure to cold and wet weather, egg infertility, and other unknown reasons. No Least Bell’s Vireo nests were parasitized by Brown-headed Cowbirds (*Molothrus ater*) in 2017.

Breeding productivity was similar at Post-fire sites and at Reference sites (2.6 versus 3.4 young per pair), although Post-fire pairs were less likely than Reference pairs to successfully fledge at least one young in 2017 (76% versus 96%).

In 2017, successful nests at Reference sites were placed higher in the host plant than unsuccessful nests, but all other nest placement characteristics for successful and unsuccessful nests within Post-fire and Reference sites were similar. Vireo nests at Post-fire sites were placed lower in the host plants but in taller nest plants than nests in Reference sites. Twelve plant species were used as hosts for vireo nests in 2017. Seventy-five percent of all nests were placed in arroyo willow (*S. lasiolepis*), sandbar willow, wild grape (*Vitus* sp.), or mule fat.

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; Kus 1998, 1999; Kus et al. 2010), 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 (U. S. Geological Survey [USGS] unpubl. data), roughly a third of which occurred on Marine Corps Base Camp Pendleton (MCBCP or Base).

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, although double-brooding can be more common during some years when breeding conditions are favorable (early initiation, high early fledging success; Ferree and Kus 2008b, Ferree et al. 2010a, Lynn and Kus 2009, 2010a). 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.

Two large wildfire events occurred on MCBCP in 2013 and 2014. One occurred in October 2013, burning 1,266 ha, including 355 ha of riparian habitat, during the time of year when vireos were not present. The second wildfire event occurred in mid-May 2014 during the vireo breeding season, and burned 8,906 ha on MCBCP. Eight hundred and thirty-seven ha of riparian habitat burned, much of which was occupied by vireos prior to the fire. Many post-fire bird studies have addressed chaparral and forest habitat types but few studies have focused on riparian habitat, especially in fire-prone southern California. This report presents preliminary analysis of vireo and vegetation response to these wildfires to date, focusing in particular on the October 2013 fire.

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 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, (4) assess the effects of the wildfires on vireos by measuring vireo territory density, survivorship, inter-annual movement, nest success, and productivity by intensively monitoring vireos within established nest monitoring sites that burned in October 2013 (sections of the Santa Margarita River and De Luz Creek) compared to reference sites in which vegetation had experienced little, if any, anthropogenic alteration in the past 15 years, and (5) document the vegetation structure and plant composition during the fourth breeding season post-fire in the sites that burned in October 2013 and the subsequent recovery of the vegetation at these sites.

When combined with data from other years, these data will inform natural resource managers about the status of this endangered species at MCBCP, and guide modification of land use and management practices as appropriate to ensure the species' continued existence.

This work was funded by the Assistant Chief of Staff, Environmental Security, Resources Management Division, MCBCP, California. All activities were conducted under 10(a)1(A) Recovery Permit #TE-829554-17.4.

STUDY AREAS AND METHODS

Field Surveys

All of MCBCP's major drainages, and several minor ones supporting riparian habitat, were surveyed for vireos between 3 April and 13 July 2017 (Fig. 1). Field work was conducted by USGS biologists Katie Allen, Lisa Allen, Armand Amico, Annabelle Bernabe, Trevin Braun, Thane Carstens, Collin Farmer, Jonathan Gunther, Scarlett Howell, Angela Johnson, Barbara Kus, Michael Lester, Ryan Pottinger, Michelle Treadwell, Charlie Vettes, and Jill Wussow. The specific areas surveyed are as follows:

1. ***Santa Margarita River:***
   a. From 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, Fig. 15, Fig. 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 of the Santa Margarita River with the Base boundary (Appendix A, Fig. 15). In 2017, approximately 1 km of the upper section of this area was not surveyed because of access restrictions.

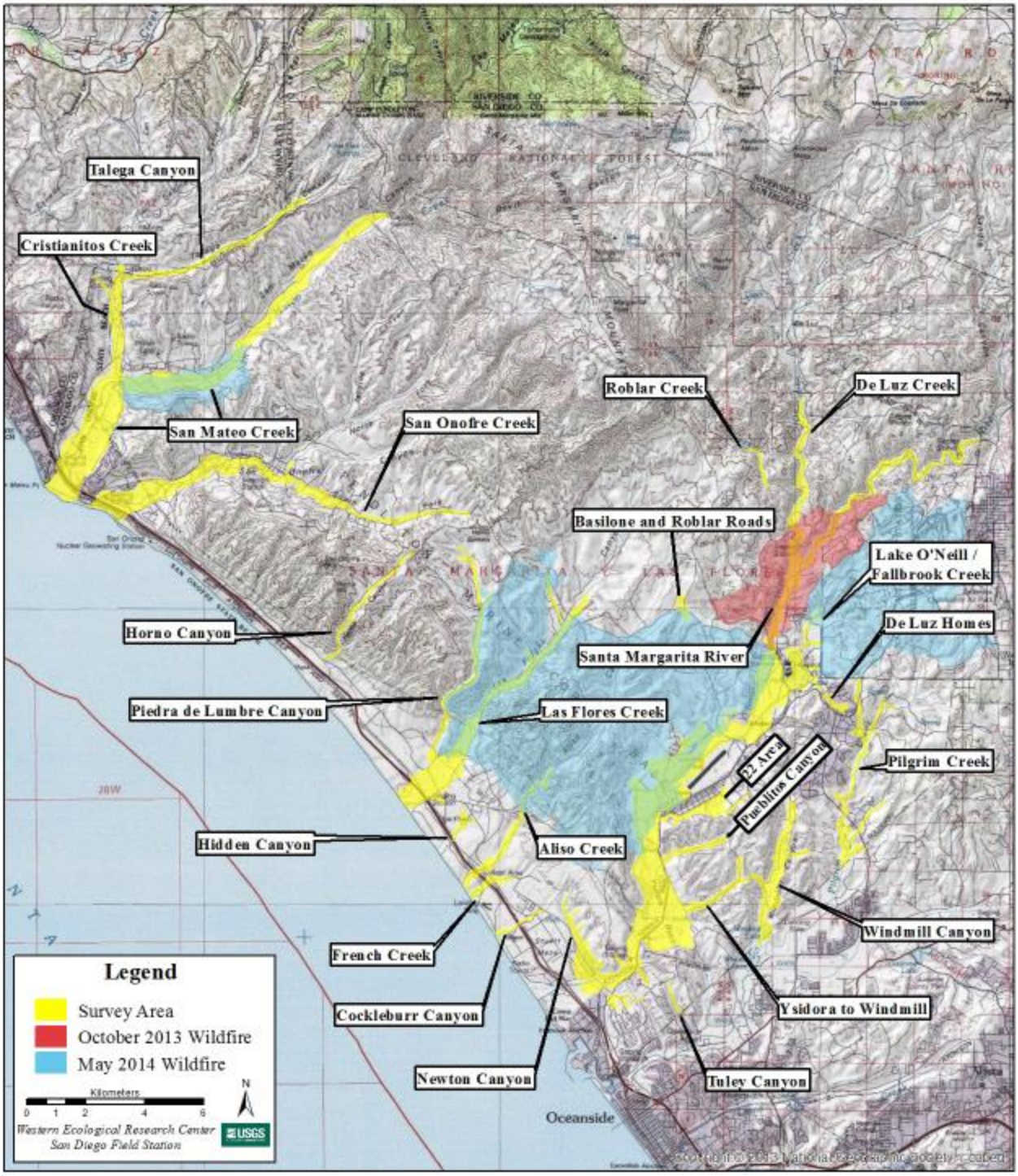

Fig. 1. Least Bell's Vireo survey areas at Marine Corps Base Camp Pendleton, 2017.

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 FNWS (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).

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, Fig. 17, Fig. 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 abandoned agricultural fields (Appendix A, Fig. 18).
b. From San Mateo Road upstream to the Base boundary (Appendix A, Fig. 18, Fig. 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 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 three to four times at least 10 days apart. Sites surveyed four times throughout the breeding season were: Santa Margarita River (1a), Lake O'Neill (4a), Fallbrook Creek (4b), Cockleburr Canyon, Aliso Creek, Las Flores Creek, San Onofre Creek (17a), San Mateo Creek (18a), Cristianitos Creek, and Pilgrim Creek (21a). Sites surveyed three times were: Basilone and Roblar Roads, 22 Area, Pueblitos Canyon, Tuley Canyon, Newton Canyon, French Creek, Hidden Canyon, Horno Canyon, San Onofre Creek (17b), San Mateo Creek (18b), Talega Canyon, Pilgrim Creek (21b), Windmill Canyon, Ysidora Basin to Windmill Canyon, De Luz Homes habitat, and De Luz Creek (limited access prevented a fourth survey of this site). The upper portion of the Santa Margarita River (1b) and Piedra de Lumbre Canyon (limited access prevented a third survey at this site) were surveyed twice for vireos. Surveys at Roblar Creek were limited by access restrictions and therefore this site was only surveyed once.

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 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 audibly through the detection of the "pair call", a unique call elicited between mated birds, visually when observed traveling quietly with the male, or was inferred by observing a nest, breeding behavior such as a food carry, or the presence of dependent fledglings. 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 Trimble Juno SB (Sunnyvale, CA) 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*).

Post-fire Vegetation Study Design

We sampled vegetation in vireo habitat that was burned in the October 2013 wildfire at two "Post-fire" study sites on the Santa Margarita River (Fig. 2) to examine the annual response of vireo habitat to fire. From 2014-2016, we collected species composition and vegetation structure data along 24 permanent linear transects (Fig. 3, Appendix B), but did not sample transect 24 in 2017 because it had been cleared for other purposes between 2016 and 2017 and no longer represented vegetation recovering from the wildfire. We did not collect vegetation data from two other quadrats in 2017 because they were covered by large piles of dead vegetation deposited by high water flow from winter rains.

Transects were spaced approximately 100 m apart, perpendicular to the river, beginning at De Luz Road and extending approximately 3 km downstream to the southern boundary of the wildfire. Sampling points consisted of 2- by 2-m quadrats located at 10-m intervals along each transect; the number of points sampled varied with the length of each transect.

We used a number of permanent and semi-permanent methods to ensure that quadrats could be re-sampled in each year. First, a metal 1.5-m rebar was driven into the ground, leaving at least 75 cm above ground to mark the start of each transect. We placed the rebar on the east end of each transect at the edge of burned vireo habitat. From the rebar, using a compass and tape measure, two field personnel measured the distances between sampling points. A numbered, wooden stake tied with fluorescent flagging was driven into the ground and colored plastic flagging was tied nearby to aid in locating the quadrats. We collected geographic coordinates for each rebar and quadrat using a GPS unit. Finally, photographs were taken from the rebar and facing along each transect in July or August each year to qualitatively assess the changes in vegetation (Appendix C).

Vegetation Sampling and Burn Severity

Foliage cover at 1-m height intervals was estimated using the "stacked cube" method, developed specifically to characterize canopy architecture in structurally diverse riparian habitat (Kus 1998). At each quadrat along a vegetation transect we recorded live canopy height, absolute canopy height (live or dead), and percent cover of vegetation, by species, at 1-m height intervals, using a modified Daubenmire (1959) scale with cover classes < 1, 1-10, 11-25, 26-50, 51-75, 76-90, and > 90%. The sampling units were 2- by 2- by 1-m high "cubes," which were "stacked" vertically between the ground and the top of the canopy. Four 2-m length PVC pipes were placed on the ground to define quadrat boundaries, and a 7.5-m tall fiberglass telescoping pole, demarcated in 1-m intervals, was used to determine height class and canopy height. Vegetation data were collected by USGS personnel.

For analysis, cover codes were converted to class midpoints, which were then used to quantify vegetation structure at each sampling point. We calculated means for nine height classes: 0-1, 1-2, 2-3, 3-4, 4-5, 5-6, 6-7, 7-8, and > 8 m, then averaged these quadrat measurements to obtain a mean for the entire site. We examined percent cover for all plant species (total cover), exotic plants (exotic cover), and native herbaceous plants (herbaceous cover).

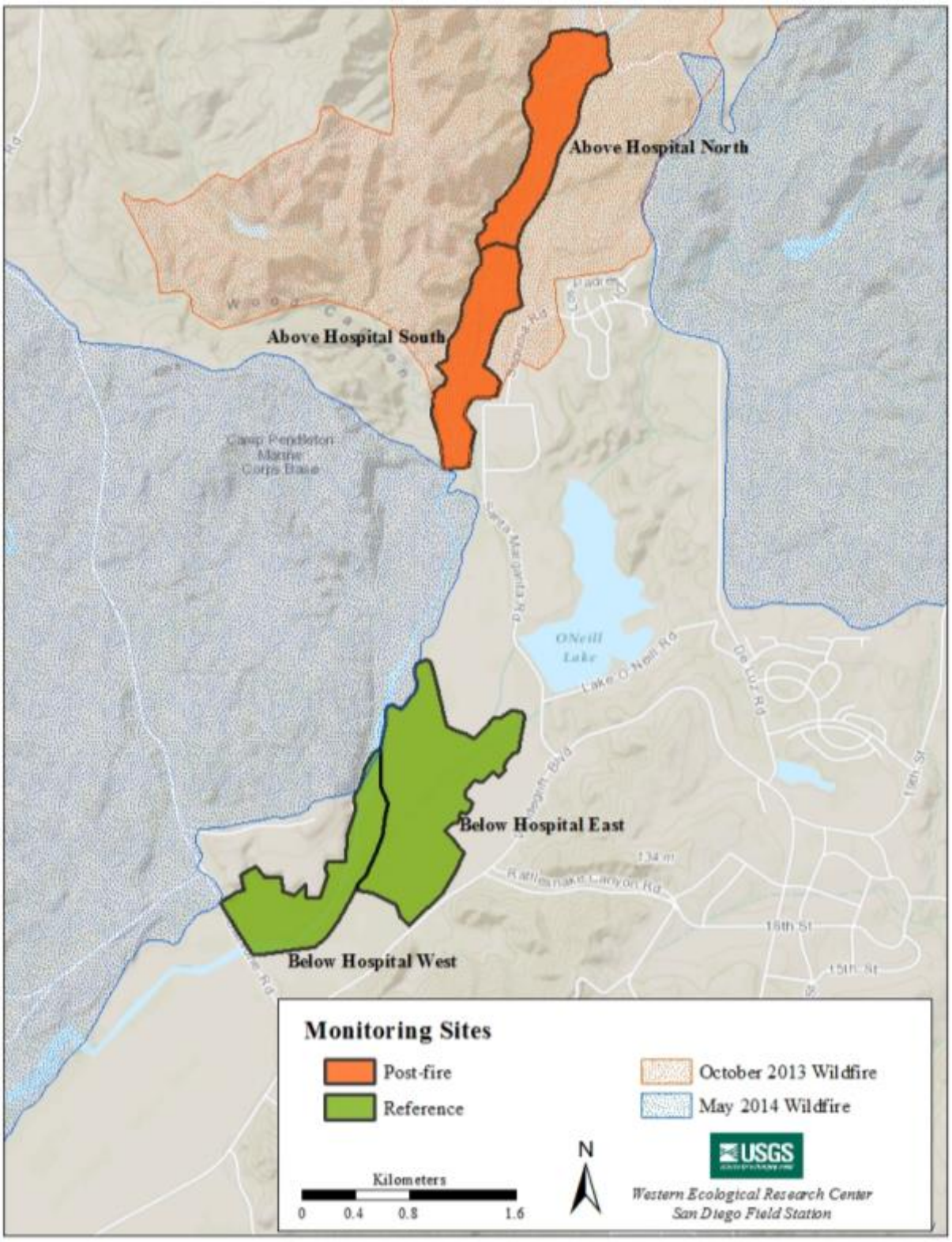

Fig. 2. Location of Least Bell's Vireo Post-fire and Reference study sites at Marine Corps Base Camp Pendleton, 2017.

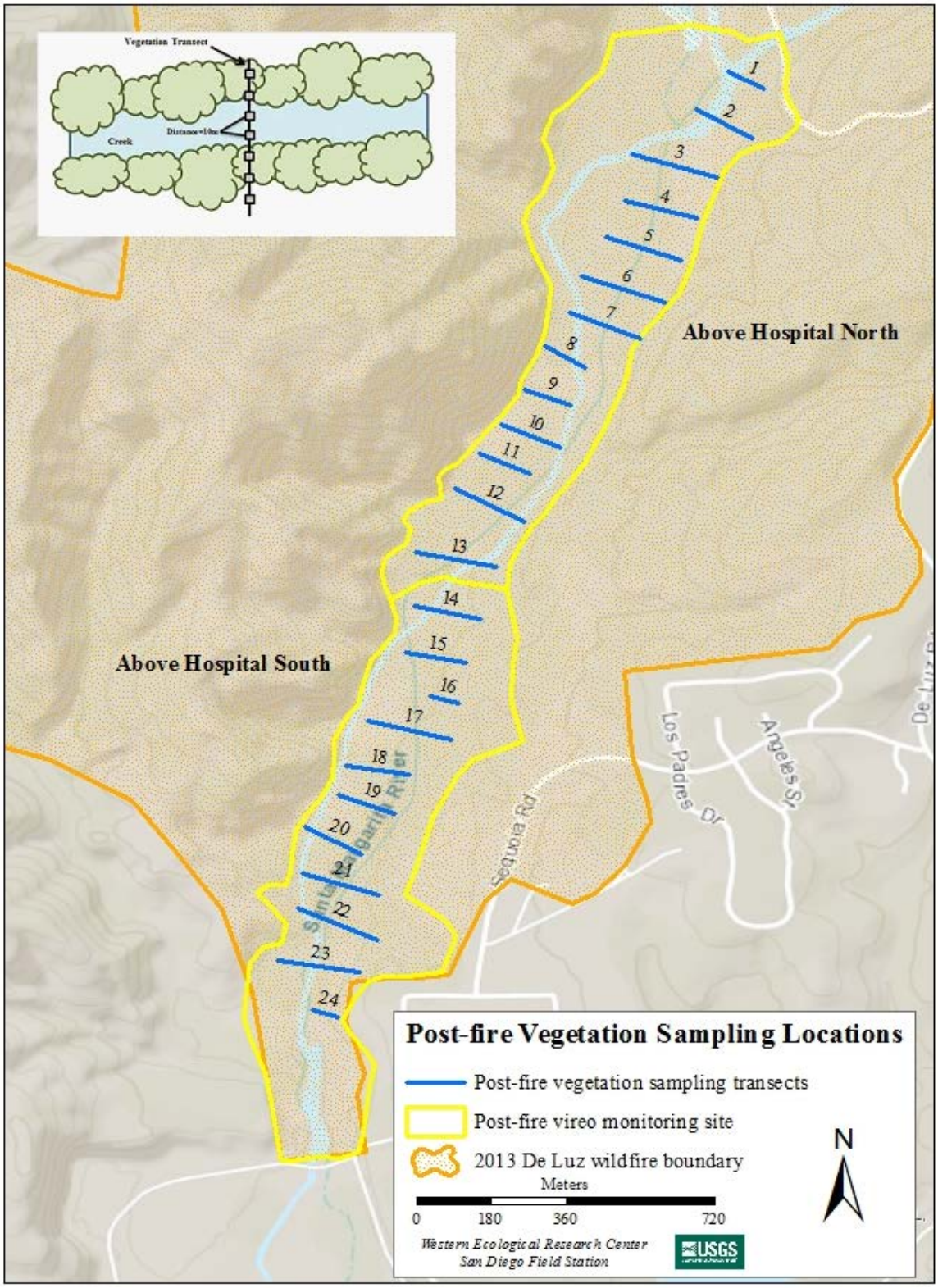

Fig. 3. Locations of Post-fire vegetation transects at Least Bell's Vireo nest monitoring sites. Insert is schematic diagram of a vegetation sampling transect.

We recorded burn severity within 5 m of each quadrat in August 2014 using a Burn Severity Index (BSI) (Table 1). We did not place any quadrats in unburned habitat. We collected BSI at 291 quadrats and sampled vegetation structure and species composition at 292 quadrats.

Table 1. Burn severity index (BSI) used in analyses of vegetation and avian responses to wildfire.

Burn Severity[1]	Rank	Description
Unburned	0	Not burned during 2013 wildfire.
Low	1	Herbaceous layer burned or singed. No major damage to trees or shrubs.
Moderate	2	Herb cover and detritus layer completely removed. Trees and shrubs partially burned. Some trees, but not all, scorched. Most trees and shrubs retain at least partial leaf cover, albeit singed. Some trees and shrubs with damaged trunk bark. If canopy was singed, at least 1/3 of dead leaves were still attached to branches.
High	3	Trees, shrubs, and herb cover completely scorched. Most trees burned from ground to canopy top removing > 2/3 of leaf cover and severely damaging the bark layer. Shrubs, including leaves and stems, reduced to small charred stumps at the ground/soil surface level. Tree snags, fallen trees, and detritus layer reduced to ash.

[1]Famolaro 2008.

We compared BSI and vegetative cover at the Post-fire site with vegetation data collected at Las Flores Creek in August 2011, following a wildfire that burned in October 2007 (Ferree et al. 2012b).

Post-fire Territory Density

In addition to vegetation characteristics, we compared the annual density of vireo territories within riparian vegetation in Post-fire sites and Reference sites to determine how vireos responded to recovery of riparian vegetation that burned in the October 2013 wildfires. We also compared vireo territory density in riparian areas that burned during wildfires in May 2014, before and after the fire, to determine whether the time of year that fires occurred had an effect on vegetation recovery and consequently on re-colonization by vireos.

Banding

The primary goals of banding Least Bell's Vireos on MCBCP were (1) to evaluate adult vireo site fidelity within a potential source population, (2) to investigate natal dispersal on Base, and the role MCBCP young play in potentially supporting vireo populations off-Base, and (3) to

evaluate how wildfire affected vireo site fidelity, dispersal, and survivorship. The regional Least Bell's Vireo color banding convention designates orange or gold as the color representing MCBCP. Therefore, nestlings from monitored nests were banded at 6-7 days of age with a single anodized gold numbered federal band on the right leg. Adult vireos within Post-fire 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 (or both, depending on the available color combinations) to designate MCBCP as the bird's site of origin. Returning adults previously banded as nestlings with a single numbered federal band were target netted to determine their identity, and their original band was supplemented with other bands to generate unique color combinations.

During surveys and nest monitoring activities, we attempted to resight all vireos to determine whether or not they were banded, and if so, to confirm their identity by reading their unique color band combination or by recapturing birds with single federal bands. We used resighting and recapture data to calculate minimum annual survivorship, or the fraction of all individuals known to be present on Base in one year that returned the following year (e.g., (# known to be present in 2017) / (# known to be present in 2016)). Individuals "known to be present" in a given year included birds observed directly as well as individuals not observed but whose presence was inferred retroactively by their detection in a subsequent year. Imperfect detectability of banded individuals is typical of mark-recapture studies and occurs for various reasons (e.g., females are more cryptic and may be missed on surveys, birds are detected as banded but their full color combinations [and thus identities] are not obtained; birds with single federal bands are not recaptured and thus their identities not determined). Our previous estimates of minimum annual survivorship therefore require adjustment upward each year to incorporate data for individuals not "seen" previously but now known to have been alive.

Survivorship from 2016-2017 was calculated for known individuals that were: (1) adults in 2016 on Base and were resighted anywhere on Base in 2017; (2) adult vireos that held territories in Post-fire or Reference sites in 2016 and were resighted anywhere on Base in 2017; (3) first-year vireos that were banded as nestlings or juveniles anywhere on Base in 2016 and were resighted anywhere in 2017 (including off-Base); and (4) first-year vireos that were banded as nestlings or juveniles in Post-fire or Reference sites in 2016 and were resighted anywhere in 2017. Unlike for estimates of overall survivorship of adults and juveniles (i.e., (1) and (3)), we did not adjust survivorship (see above) for analyses involving Post-fire and Reference sites because we could not confirm the presence of birds in those specific sites during years that they were not detected.

Site fidelity and movements of vireos were determined by measuring the distance between the center of a vireo's breeding or natal territory in 2016 and the center of the same vireo's breeding territory in 2017. Vireos exhibited site fidelity if they returned to within 100 m of their 2016 territory (Kus et al. 2010). Site fidelity and movement were calculated for the same four categories analyzed for survivorship (see above), except that only individuals with known territory locations during the last year they were detected prior to 2017 were included (e.g., juveniles banded after fledging were excluded because their natal territories could not be confirmed in light of their capacity for substantial movement; vireos captured at one of the two

Monitoring Avian Productivity and Survivorship (MAPS) stations on Base were excluded unless their territory locations were known from surveys).

Nest Monitoring

Our purposes for monitoring Least Bell's Vireo nests were to evaluate how vireo nest success and productivity were affected by alteration of vireo habitat by the October 2013 wildfires. Therefore, we monitored vireo nests at two Post-fire sites and two Reference sites to compare differences between the two groups. As a result of the 2013 and 2014 wildfires, some of our study sites changed categories between years (see below and Table 2). Unless otherwise noted, Reference site in this report refers to 2015-2017 Reference sites.

Table 2. Least Bell's Vireo study site categories from 2005 to 2017, Marine Corps Base Camp Pendleton.

	Study Years		
Site Location	**2005-2013**	**2014**	**2015-2017**
Below Hospital West (North)	-	Reference, burned in May 2014	-
Below Hospital West (South)	-	-	Reference
Below Hospital East	Reference	Reference	Reference
Above Hospital North	-	Post-fire	Post-fire
Above Hospital South	Reference	Post-fire	Post-fire

October 2013 Wildfire

In October 2013, wildfires burned approximately 1,266 ha encompassing the upper Santa Margarita River and the lower section of De Luz Creek on MCBCP (Fig. 2). Approximately 355 ha of riparian vegetation was completely burned, leaving standing burned willow, sycamore, and cottonwood trunks with no remaining understory or green foliage except a thin strip bordering the river. Almost all of the riparian area that burned was documented as breeding habitat for Least Bell's Vireo prior to the fire.

In 2014, we began monitoring vireos within two Post-fire sites. One of the Post-fire monitoring sites had been monitored as a Reference site in a previous study (the effect of giant reed removal on vireos) from 2005-2013 (Above Hospital South site) until it burned in the 2013 wildfire (Fig. 2). Therefore, we were able to present pre- and post-fire analyses for this site. The second Post-fire monitoring site occurred just upstream of the Above Hospital South site and encompassed riparian vegetation along the Santa Margarita River including the junction with De Luz Creek.

Reference Sites

Our vireo monitoring Reference sites for 2014-2017 included one site that has been used as a Reference site since 2005 (Below Hospital East, Table 2, Fig. 2). In 2014, we selected a second Reference site (Below Hospital West, northern section) (Fig. 2) to replace the Above Hospital South Reference site that burned in the October 2013 fire. However, approximately 90% of the new Below Hospital West Reference site burned in May 2014. Therefore, we

selected a new Reference site (Below Hospital West, southern section) in 2015 and used this as a Reference site again in 2016 and 2017 (Table 2).

We compared vireo breeding productivity between Post-fire and Reference sites in 2017 to determine whether wildfires influenced vireo productivity. We examined nest success and the proportion of nests that were depredated or parasitized by cowbirds, and the likelihood of re-nesting after a first nesting attempt (successful or failed), to associate the effects recovering habitat may have on the vulnerability of vireo nests to predators and brood parasites. We also examined clutch size (the maximum number of vireo eggs known to be laid in the nest), the proportion of eggs that hatched, the proportion of nestlings that fledged, the proportion of eggs that produced fledglings, the proportion of nests that successfully fledged young, the total number of fledglings per pair, and the proportion of pairs that had at least one successful nest. We examined vireo nest placement (nest height, height of the host plant, distance of the nest from the edge of the host plant, and distance of the nest from the edge of the vegetation clump that contained the host plant) to explore vireo response to potential differences in vegetation structure between Post-fire and Reference sites.

We also were interested in determining the effects of wildfire on adult and juvenile survivorship, site fidelity, and movements of adults and juveniles between years to determine patterns of attraction or avoidance of Post-fire and Reference sites. To this end, we attempted to band all adult and juvenile vireos at monitored sites and recapture or resight all banded vireos within Post-fire and Reference 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 Post-fire and Reference sites.

Finally, we calculated and compiled annual vireo density within the Post-fire and Reference sites by delineating the boundary surrounding all monitored territories at each site (Fig. 2), then counting the number of vireo territories that occurred within those boundaries each year from 2012 through 2017. We examined these data to look for trends in local population size and density, particularly in response to the recovery of native habitat following alteration by wildfire.

We monitored vireo nesting activity at 26 territories in Post-fire sites and 25 territories in Reference sites between 24 March and 24 July 2017. Territories were chosen based on their location within areas that were monitored in previous years or in order of their arrival at new sites. Vireos 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 (identified by the acronym 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.

Marine Corps Base Camp Pendleton implements an intensive annual cowbird control program on Base, and parasitism of Least Bell's Vireo nests is extremely rare. Nevertheless, when necessary we followed 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 7th 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.

Data Analyses

We examined annual differences in the dates vireos arrived and established breeding territories by compiling the total number of vireo territories established by the end of each month (April, May, June, and July) within a subset of survey areas that were surveyed at least four times annually for the past 12 years. We used Chi-square or Fisher's Exact tests to determine if there were differences between Post-fire and Reference sites in adult over-winter survivorship, likelihood of re-nesting after a first nesting attempt, likelihood of re-nesting if the first nesting attempt failed or was successful, nest success, the proportion of nests that were depredated, whether or not the first nest attempt was successful, the proportion of eggs that hatched, the proportion of nestlings that fledged, the proportion of eggs that produced fledglings, the proportion of nests that produced fledglings, and the number of pairs that had at least one successful nest. We also used Chi-square or Fisher's Exact tests to determine if there were annual differences in the fate of the first nesting attempt. 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 to determine if there were differences in canopy height and vegetation volume at each height category between 2016 and 2017 at Post-fire sites and between 2017 Post-fire sites and vegetation data collected in 2011 at Las Flores Creek, which burned in 2007. We also used *t*-tests to determine if there were differences in vireo territory density, in the number of nesting attempts, clutch size, number of fledglings per pair, nest height, host plant height, distance to the edge of the host plant, and distance to the edge of the vegetation clump in which the nest was located between Post-fire and Reference sites, to determine if there were differences in nest placement characteristics between successful and failed nests within Post-fire and Reference sites. 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, Chicago, IL). Two-tailed tests were considered significant if $P \leq 0.10$. Means are presented with standard deviations. All data from MCBCP from 2005-2016 used in comparisons with current data can be found in Rourke and Kus 2006a, 2007a, 2008, and Lynn and Kus 2009, 2010a, 2010b, 2011c, 2012b, and 2013, and Lynn et al. 2014, 2015, and 2016. See Griffith Wildlife Biology 2004 for data prior to 2005.

We used MARK (White and Burnham 1999) to model the effects of Post-fire habitat recovery and year on daily survival rate (DSR) of vireo nests (Dinsmore et al. 2002). Nest survival was calculated across a 30-day cycle length (4 days egg-laying, 14 days incubation, 12 days nestling period) in which incubation begins with the penultimate egg. Age of nests at the time they were discovered was calculated by forward- or backward-dating of nests in relation to known dates of nest-building, egg-laying, or hatching. We used an information-theoretic approach (Akaike's Information Criteria or AIC; Burnham and Anderson 2002) to evaluate support for models reflecting *a priori* hypotheses regarding the effect of treatment on DSR. We hypothesized that DSR would be lower in Post-fire sites than in Reference sites. We used logistic regression with a logit link to build models. First, we generated a constant survival model to serve as a reference for the effect of treatment and habitat variables on DSR. We then modeled the treatment covariate and evaluated support for the model in relation to the constant survival model.

RESULTS

Population Size and Distribution

A total of 662 male Least Bell's Vireos were detected during Base-wide surveys (Table 3; Appendix D, Figs. 21-39). Of these, 639 were territorial males, 78% of which were confirmed as paired, and 23 were transients. This represents a 10% decrease in territories from 2016 (713). Transient vireos were observed on 6 of the 23 (26%) drainages/sites surveyed. Ninety-two percent of all vireo territories occurred on the six most populated drainages/sites (Santa Margarita River, Las Flores Creek, San Onofre Creek, San Mateo Creek, Pilgrim Creek, and De Luz Creek), and the majority of vireo territories (65%) occurred along the Santa Margarita River, the largest expanse of riparian vegetation on Base (Table 3, Table 4). The remaining 17 drainages/sites each contained fewer than ten territories.

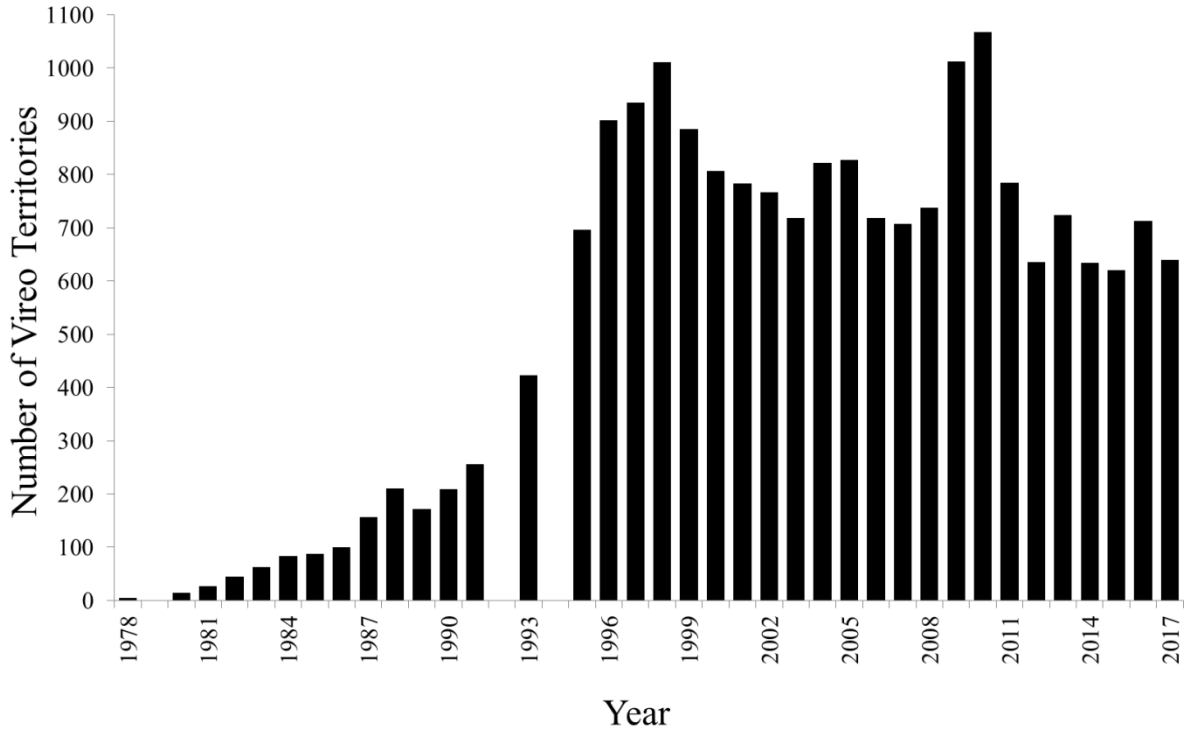

Fig. 4. Number of Least Bell's Vireo territories at Marine Corps Base Camp Pendleton, 1978–2017.

The distribution of Least Bell's Vireo territories documented on Base in 2017 appeared to shift compared to 2016 (Table 4). The Santa Margarita River lost 61 territories between 2016 and 2017, a 13% decrease, with losses spread throughout the drainage. Other sites with large numeric loss in vireo numbers were De Luz Creek, San Mateo Creek, and Cristianitos Creek, decreasing by 3-10 territories each (45%, 13%, and 50%, respectively). The upper section of De Luz Creek that was not surveyed in 2017 (approximately 1 km) had three vireo territories in 2016. Within this reduced survey area, the number of vireo territories in De Luz Creek declined by seven, a 37% decrease. The drainage with the largest numeric increase in vireo territories was San Onofre Creek (five territories, 11% increase). Nine survey areas continued to fluctuate between zero and five territories over the past 10 years. Two of these (Pueblitos Canyon and Ysidora Basin to Windmill Canyon) gained one or two territories between 2016 and 2017, three remained the same as in 2016 (Cockleburr Creek, Talega Canyon, and Tuley Canyon), and four lost one territory (Roblar Creek, Basilone and Roblar Roads, French Canyon, and Horno Canyon). Eighteen drainages (78%) showed no change or changed (increased or decreased) by two or fewer territories between 2016 and 2017.

Table 3. Number and distribution of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2017.

Drainage/Survey Site	Territories: Known Pairs	Territories: Single/Status Undetermined	Total Territories	Transients
Santa Margarita River:				
I-5 to De Luz Creek	317	52	369	16
De Luz Creek to Base Boundary	20	14	34	0
22 Area	2	8	10	0
De Luz Creek[1]	9	3	12	1
Roblar Creek	2	0	2	1
Lake O'Neill/Fallbrook Creek	5	0	5	2
Basilone-Roblar Roads	3	0	3	0
Pueblitos Canyon	1	1	2	0
Newton Canyon	3	0	3	0
Cockleburr Creek	0	0	0	0
French Canyon	1	1	2	0
Aliso Creek	5	0	5	0
Hidden Canyon	1	6	7	0
Las Flores Creek:				
Pacific Ocean to Stuart Mesa Rd	0	0	0	0
Stuart Mesa Rd to Power Lines	17	12	29	0
Power Lines to Zulu Impact Area	24	4	28	0
Piedra de Lumbre Canyon	1	7	8	0
Horno Canyon	0	0	0	0
San Onofre Creek:				
Pacific Ocean to Basilone Rd	24	17	41	1
Basilone Rd to Access Rd to Range 219	5	4	9	0
San Mateo Creek				
Pacific Ocean to San Mateo Road	25	3	28	0
San Mateo Road to Yankee Training Area	4	2	6	0
Cristianitos Creek	3	0	3	0
Talega Canyon	0	0	0	0
Tuley Canyon	0	0	0	0
Pilgrim Creek:				
Base Boundary upstream to Vandegrift Blvd	12	3	15	1
Vandegrift Blvd to upstream riparian limit	3	5	8	1
Windmill Canyon	6	0	6	0
Ysidora Basin to Windmill Canyon	1	1	2	0
De Luz Homes	2	0	2	0
Total	496	143	639	23

[1] Upper section of this survey area (approximately 1 km) not surveyed in 2017.

Table 4. Number of territorial male Least Bell's Vireos at Marine Corps Base Camp Pendleton, by drainage, 2004-2017. Number includes only singing males determined to hold territories. Numeric change is the positive or negative change in the number of vireo territories between 2016 and 2017.

	Number of Territorial Males														Numeric
Drainage	**2004**[1]	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**Change**
Santa Margarita River[2]	440	472	417	423	463	599	678	467	382	453	410	403	474	413	-61
De Luz Creek[3]	26	18	25	24	25	39	34	27	28	31	27	23	22	12	-10
Roblar Creek	1	0	0	0	0	2	1	1	1	2	2	2	3	2	-1
Lake O'Neill/Fallbrook Creek	16	20	10	9	11	11	15	6	5	5	7	3	3	5	2
Basilone-Roblar Roads	-	2	0	0	0	5	4	2	4	0	3	2	4	3	-1
Pueblitos Canyon	3	5	3	2	2	1	0	0	0	0	1	0	0	2	2
Newton Canyon	9	8	8	5	4	6	7	6	4	6	5	3	5	3	-2
Cockleburr Creek	0	2	2	2	1	2	0	0	1	0	0	0	0	0	0
French Canyon	5	6	4	2	2	2	2	2	2	3	3	1	3	2	-1
Aliso Creek	21	21	11	9	11	21	16	9	8	9	6	4	6	5	-1
Hidden Canyon	5	8	5	4	4	2	4	3	3	3	4	3	5	7	2
Las Flores Creek	84	85	76	81	70	107	124	92	61	65	43	47	56	57	1
Piedra de Lumbre Canyon	5	8	9	6	3	5	6	3	5	3	3	6	7	8	1
Horno Canyon	0	1	0	0	0	1	1	4	1	1	1	1	1	0	-1
San Onofre Creek	56	52	43	44	41	62	54	57	46	52	54	48	45	50	5
San Mateo Creek	68	56	59	46	53	83	71	56	45	41	26	40	39	34	-5
Cristianitos Creek	8	6	8	8	4	13	10	11	10	11	6	5	6	3	-3
Talega Canyon	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0
Tuley Canyon	2	-	0	0	0	0	0	0	0	0	0	0	0	0	0
Pilgrim Creek	37	36	23	26	26	27	24	25	20	30	23	21	23	23	0
Windmill Canyon	20	12	7	8	12	13	10	7	6	5	6	5	8	6	-2
Ysidora Basin to Windmill Canyon	8	4	6	5	4	5	2	1	1	1	2	1	1	2	1
De Luz Homes	5	4	2	3	2	6	5	5	3	3	2	3	2	2	0
Total	819	827	718	707	738	1,013	1,068	784	636	724	634	621	713	639	-74

[1] 2004 sites not listed: Vandegrift Hills (1), Kilo 1/ Kilo 2 Hills (2); 2004 total = 822 territories.
[2] Includes vireo territories detected within the 22 Area.
[3] Upper approximately 1 km of this area not surveyed in 2017.

Least Bell's Vireos began arriving on Base during the last week of March 2017, with 76% established by the end of April (Fig. 5). This represented a higher proportion of territories established by the end of April than all years except 2008, 2009, and 2010. By the end of May, 95% of territories had been established. The first vireo detected on MCBCP in 2017 was found on 24 March. This is one day later than in 2015 and 2016, but the fourth earliest documented arrival date for vireos, after 21 March 2013 and 22 March 2012 (earliest arrival dates for other years: 4 April 2005; 31 March 2006; 2 April 2007; 31 March 2008; 23 March 2009; 29 March 2010; 4 April 2011; 27 March 2014). Note that these dates represent anecdotal observations; standardized vireo surveys began 3 April in 2017 but vireo presence prior to surveys was noted when observed.

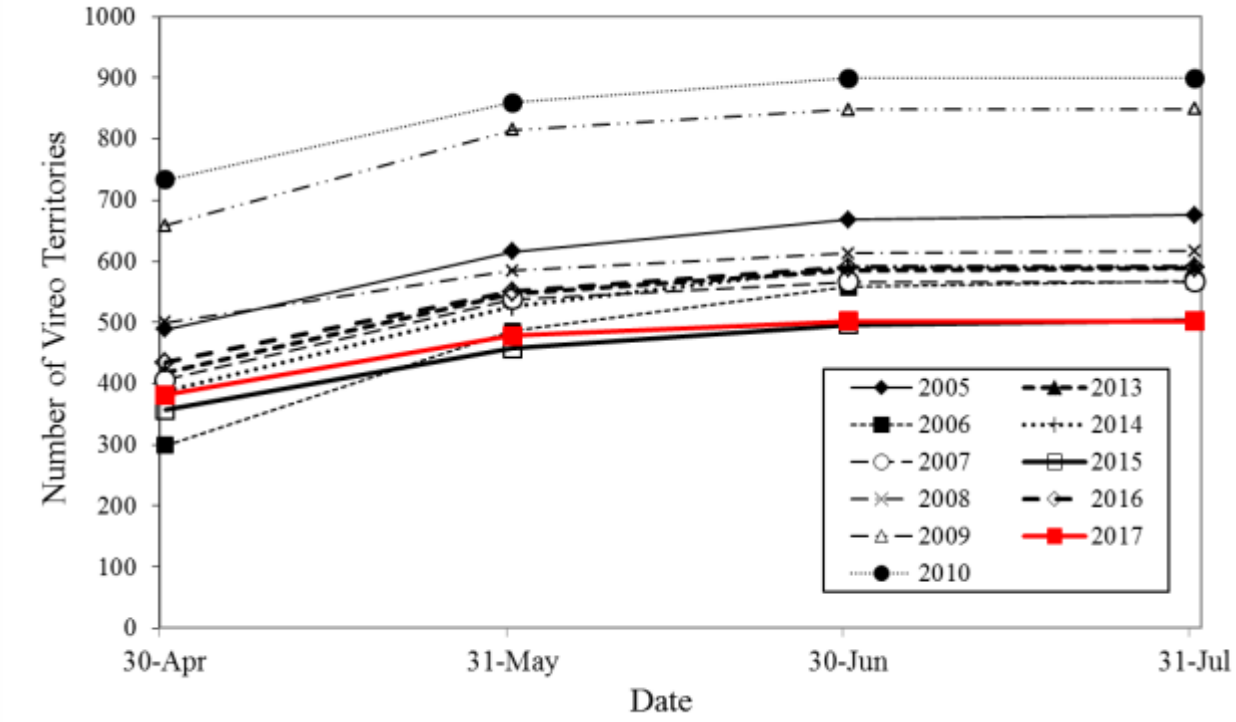

Fig. 5. Territory establishment of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2005-2017. Numbers include only vireos in areas that were surveyed at least four times per year. Dates represent period end-points. Surveys began late in 2011 and 2012; therefore, arrival dates for these years are not included.

Habitat Characteristics

Vireos used a number of different habitat types ranging from willow-dominated thickets along stream courses to areas primarily dominated by non-native annual vegetation (Table 5). The majority of vireo locations occurred in habitat characterized as mixed willow riparian, with 73% of males in the study area found in this habitat. An additional 6% of birds occupied willow habitat co-dominated by cottonwoods or sycamores. Seventeen percent of territories were found in riparian scrub, dominated by mule fat and/or sandbar willow. Two percent of vireos occupied

non-native vegetation, 1% of territories occurred in drier habitats characterized by a mix of sycamore and oaks, and < 1% of territories occurred in upland scrub.

Table 5. Habitat types used by Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2017.

	Number of Locations			
Habitat Type	**>50% Native**	**>50% Exotic**	**Total**	**Percent of Total**
Mixed Willow	450	36	486	73%
Riparian Scrub	92	20	112	17%
Willow/Sycamore	28	0	28	4%
Willow/Cottonwood	12	2	14	2%
Non-native	1	10	11	2%
Oak/Sycamore	9	0	9	1%
Upland Scrub	2	0	2	< 1%
Grand Total	594	68	662	100%

The proportion of vireo territories documented in exotic vegetation increased by over 200% from 2016 to 2017 (Table 6). Ten percent (67/639) of vireo territories in 2017 were in areas where exotic species comprised at least 50% of the habitat. Eighty-five percent of territories dominated by non-native vegetation contained black mustard (*Brassica nigra*), 38% contained poison hemlock (*Conium maculatum*), and 21% contained milk thistle (*Silybum marianum*). Vireo territories dominated by exotic vegetation were often co-dominated by more than one non-native species. Ten drainages contained territories dominated by non-native vegetation in 2017 compared to four in 2016. Three of these drainages (the Santa Margarita River, De Luz Creek, and Las Flores Creek) also contained territories dominated by non-native vegetation in 2015 and 2016. The proportion of vireo territories dominated by exotic vegetation increased in 2017 after a 1-year decrease in 2016. Overall, 2005 remained the year with the highest number of drainages (13) containing at least one vireo territory dominated by exotic vegetation.

Table 6. Proportion of Least Bell's Vireo territories dominated or co-dominated by exotic vegetation, by drainage, 2005-2017.

	Proportion of Territories (Number of Territories within the Drainage)												
Drainage	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Pueblitos Canyon	0 (5)	0 (3)	0 (2)	**0.50 (2)**	0 (1)	- -	- -	- -	- -	0 (1)	- -	- -	**1.00 (2)**
Windmill Creek	**0.67 (12)**	**0.14 (7)**	**0.13 (8)**	**0.67 (12)**	**0.92 (13)**	**0.60 (10)**	**0.71 (7)**	**0.33 (6)**	0 (5)	0 (6)	0 (5)	0 (8)	**0.67 (6)**
Piedra de Lumbre Canyon	**1.00 (8)**	0 (9)	0 (6)	**0.67 (3)**	**0.20 (5)**	0 (6)	**0.33 (3)**	**0.20 (5)**	0 (3)	0 (3)	0 (6)	0 (7)	**0.50 (8)**
De Luz Creek	**0.06 (18)**	**0.04 (25)**	0 (24)	0 (25)	0 (39)	0 (34)	0 (28)	**0.04 (28)**	0 (31)	**0.19 (27)**	**0.13 (23)**	**0.09 (22)**	**0.42 (12)**
San Mateo Creek	**0.66 (56)**	**0.12 (59)**	0 (46)	**0.14 (53)**	**0.10 (83)**	**0.25 (68)**	**0.04 (56)**	0 (45)	0 (41)	0 (26)	**0.18 (40)**	0 (39)	**0.38 (34)**
Aliso Creek	**0.05 (21)**	0 (11)	**0.11 (9)**	0 (11)	0 (21)	**0.06 (16)**	0 (9)	**0.25 (8)**	0 (9)	0 (6)	0 (4)	0 (6)	**0.20 (5)**
Las Flores Creek	**0.02 (85)**	**0.14 (76)**	0 (81)	**0.29 (70)**	**0.22 (107)**	**0.21 (124)**	**0.20 (92)**	**0.16 (61)**	**0.11 (65)**	0 (43)	**0.13 (47)**	**0.09 (56)**	**0.14 (57)**
San Onofre Creek	**0.23 (52)**	0 (43)	0 (44)	**0.13 (41)**	**0.21 (62)**	**0.11 (54)**	**0.07 (57)**	0 (46)	**0.04 (52)**	0 (54)	**0.11 (47)**	0 (45)	**0.10 (50)**
Pilgrim Creek	0 (36)	0 (23)	0 (26)	0 (26)	**0.15 (27)**	**0.04 (24)**	**0.04 (25)**	0 (20)	0 (30)	0 (23)	0 (21)	0 (23)	**0.09 (23)**
Santa Margarita River[1]	**0.17 (472)**	**0.05 (417)**	**0.04 (423)**	**0.03 (463)**	**0.06 (599)**	**0.06 (676)**	**0.13 (467)**	**0.06 (382)**	**0.04 (451)**	**0 (410)**	**0.07 (399)**	**0.03 (472)**	**0.06 (413)**
Cristianitos Creek	**0.50 (6)**	**0.13 (8)**	**0.25 (8)**	0 (4)	**0.08 (13)**	**0.10 (10)**	**0.09 (11)**	0 (10)	0 (11)	0 (6)	0 (5)	**0.50 (6)**	0 (3)
Hidden Canyon	0 (8)	0 (5)	0 (4)	0 (4)	**0.50 (2)**	0 (4)	0 (3)	0 (3)	0 (3)	0 (4)	**0.33 (3)**	0 (5)	0 (7)
Basilone-Roblar Roads	0 (2)	- -	- -	- -	0 (5)	0 (3)	0 (2)	**0.25 (4)**	- -	**0.33 (3)**	0 (2)	0 (4)	0 (3)
Newton Canyon	**0.63 (8)**	**0.13 (8)**	0 (5)	**0.50 (4)**	**0.20 (6)**	0 (4)	**0.17 (6)**	**0.25 (4)**	0 (6)	**0.20 (5)**	0 (3)	0 (5)	0 (3)
French Canyon	0 (6)	0 (4)	0 (2)	0 (2)	0 (2)	0 (2)	0 (2)	**0.50 (2)**	0 (3)	0 (3)	0 (1)	0 (3)	0 (2)
Ysidora Basin to Windmill Cyn	**0.25 (4)**	**0.50 (6)**	0 (5)	**0.25 (4)**	**0.20 (5)**	**0.50 (2)**	0 (1)	0 (1)	0 (1)	0 (2)	0 (1)	0 (1)	0 (2)
Lake O'Neill/ Fallbrook Crk	**0.15 (20)**	0 (10)	**0.11 (9)**	0 (11)	0 (11)	0 (15)	0 (6)	0 (5)	0 (5)	0 (7)	0 (3)	0 (3)	0 (5)
De Luz Homes	0 (4)	0 (2)	0 (3)	0 (2)	0 (6)	0 (5)	0 (5)	0 (3)	0 (3)	0 (2)	0 (3)	0 (2)	0 (2)
Horno Canyon	**1.00 (1)**	- -	- -	- -	0 (1)	0 (1)	0 (4)	0 (1)	0 (1)	0 (1)	0 (1)	0 (1)	- -
Roblar Creek	- -	- -	- -	- -	0 (2)	0 (1)	0 (1)	0 (1)	0 (2)	0 (2)	0 (2)	0 (3)	0 (2)
Cockleburr Canyon	0 (2)	0 (2)	0 (2)	0 (1)	0 (2)	- -	- -	0 (1)	- -	- -	- -	- -	- -
Talega Canyon	0 (1)	- -	- -	- -	0 (1)	- -	- -	- -	- -	- -	- -	- -	- -
Total	0.19 (827)	0.06 (718)	0.03 (707)	0.09 (703)[2]	0.10 (1009)[2]	0.10 (1059)[2]	0.12 (784)	0.07 (636)	0.04 (722)[2]	0.04 (634)	0.08 (616)[2]	0.03 (711)[2]	0.10 (639)

[1] Includes vireo territories detected within the 22 Area.
[2] Data not recorded in all territories.

Post-fire Vegetation Characteristics

The October 2013 wildfire burned most of the Post-fire sites at high intensity; 84% of quadrats (245/291) were classified as high burn severity and 16% (47/291) were classified as moderate burn severity. No quadrats were classified as low burn severity. In 2017, we sampled 285 quadrats, 84% (238/285) of which were classified as high burn severity, and 16% (47/285) of which were classified as moderate burn severity.

The average live canopy height and maximum canopy height (including live and dead vegetation) did not change from 2016 to 2017. Vegetation cover increased significantly from 2016 to 2017 in the lowest height categories (Fig. 6A, 0-1 m, $t = 8.2$, $P < 0.01$; 1-2 m, $t = 5.1$, $P < 0.01$). The proportion of vegetation cover < 1 m and between 1 and 2 m that was comprised of herbaceous species (exotic and native combined) declined over 4 years at Above Hospital (from 52% 1 year post-fire to 38% 4 years post-fire and from 34% 1 year post-fire to 23% 4 years post-fire, respectively; Fig. 6A). The remaining cover < 2 m each year consisted mostly of woody vegetation represented by stump-sprouted red and arroyo willow, dead/burned branches, mule fat, and sandbar willow. While vegetation cover in height categories over 4 m continued to be low (< 8%; Fig. 6A), vegetation cover increased in the upper height categories from 2016 to 2017 (5-6 m, $t = 2.0$, $P = 0.04$; 6-7 m, $t = 2.7$, $P = 0.01$, 7-8 m, $t = 3.0$, $P < 0.01$).

Average burn severity for the October 2007 wildfire at Las Flores Creek was lower than at the Above Hospital site: 46% of the riparian habitat was classified as high burn severity, 29% as moderate burn severity, 9% as low burn severity, and 16% as unburned during the first year after the fire (Ferree et al. 2012b). The overall structure of vegetation at the Above Hospital site was similar to that at Las Flores Creek, with cover decreasing with increasing canopy height (Fig. 6A and B). Cover in the low canopy at Las Flores Creek was substantially higher than at the Above Hospital site from 1 to 3 years post-fire, but by 4 years post-fire, vegetation cover in the lower canopy at the Above Hospital site approached and surpassed the cover in these height categories at Las Flores Creek (0-1 m: $t = 2.0$, $P = 0.04$; 1-2 m: $t = 1.5$, $P = 0.14$). Similar to at the Above Hospital site, the proportion of vegetation in the low canopy made up by herbaceous species (exotic and native combined) declined over time (at < 1 m, from 60% 1 year post-fire to 38% 4 years post-fire; between 1 and 2 m, from 52% 1 year post-fire to 28% 4 years post-fire). Cover in the mid-canopy at Las Flores Creek, which was less severely burned, changed little over the 4 years post-fire, in contrast to at the Above Hospital site, where mid-canopy vegetation has been re-establishing over the last 4 years.

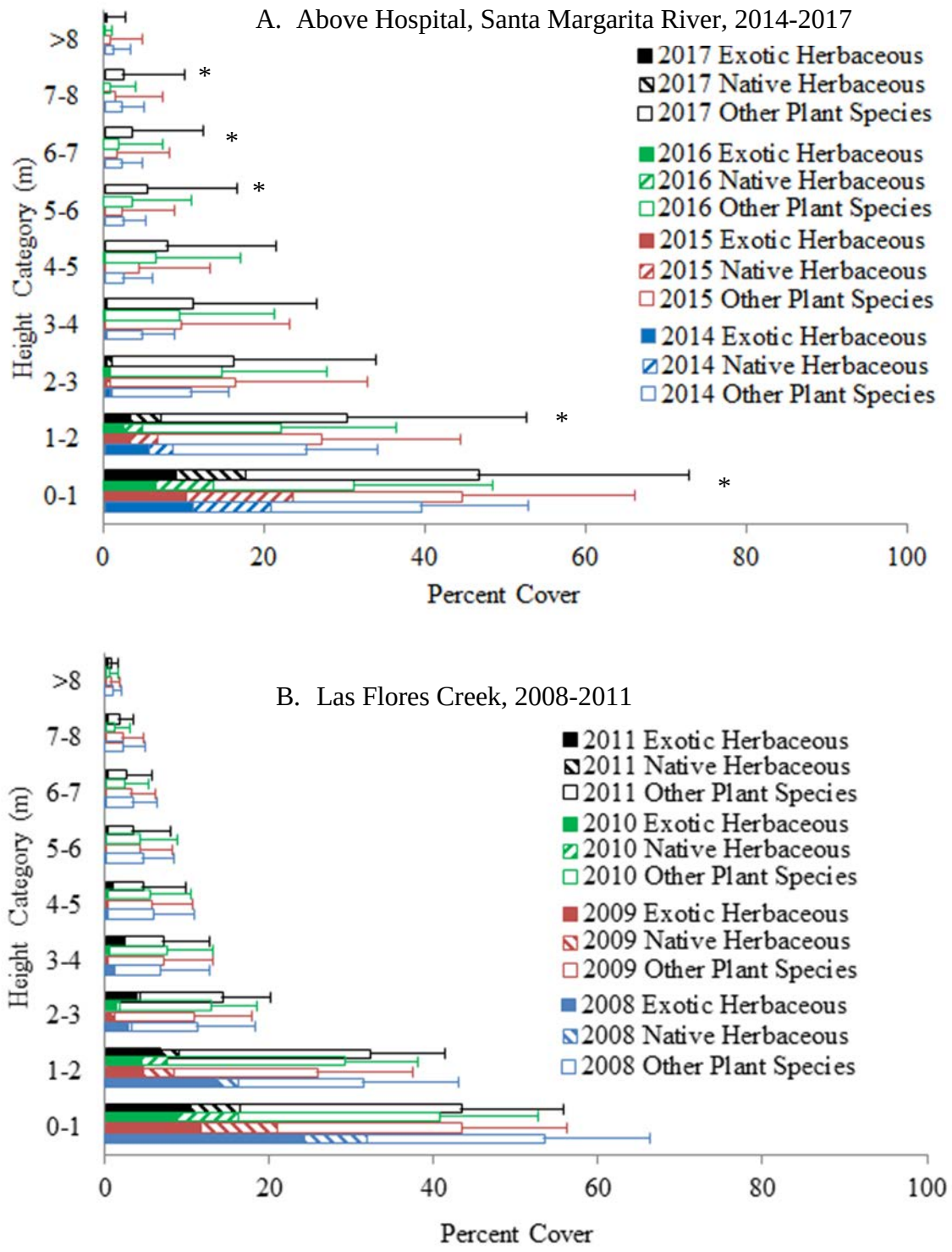

Fig. 6. Average total percent cover by height class (m) and plant type at A. Above Hospital, Santa Margarita River, 2014-2017, 1-4 years after the October 2013 wildfire and B. Las Flores Creek, 2008-2011, 1-4 years after the October 2007 wildfire (Ferree et al. 2012b), Marine Corps Base Camp Pendleton. Error bars represent 1 standard deviation. Asterisks (*) indicate statistically significant differences between 2016 and 2017 ($P \leq 0.10$, Student's *t*-tests).

Population Density

Of the 639 vireo territories documented in 2017, 39 (6%) were located within the October 2013 wildfire perimeter (0.11 territories/ha of burned riparian habitat). Sixty vireo territories (8%) were located in the same area in 2016 (0.17 territories/ha), 54 vireo territories (9%) were located in the same area in 2015 (0.15 territories/ha), and 48 territories (8%) were recorded in the same area in 2014 (0.14 territories/ha), the year after the fire. In 2013, the year just prior to the fire, 59 territories (8%) were recorded within the same area (0.17 territories/ha). Vireo territory density did not differ significantly between Post-fire and Reference sites in 2012, 2013, 2015, and 2017 but did differ in 2014 and 2016 (Fig. 7).

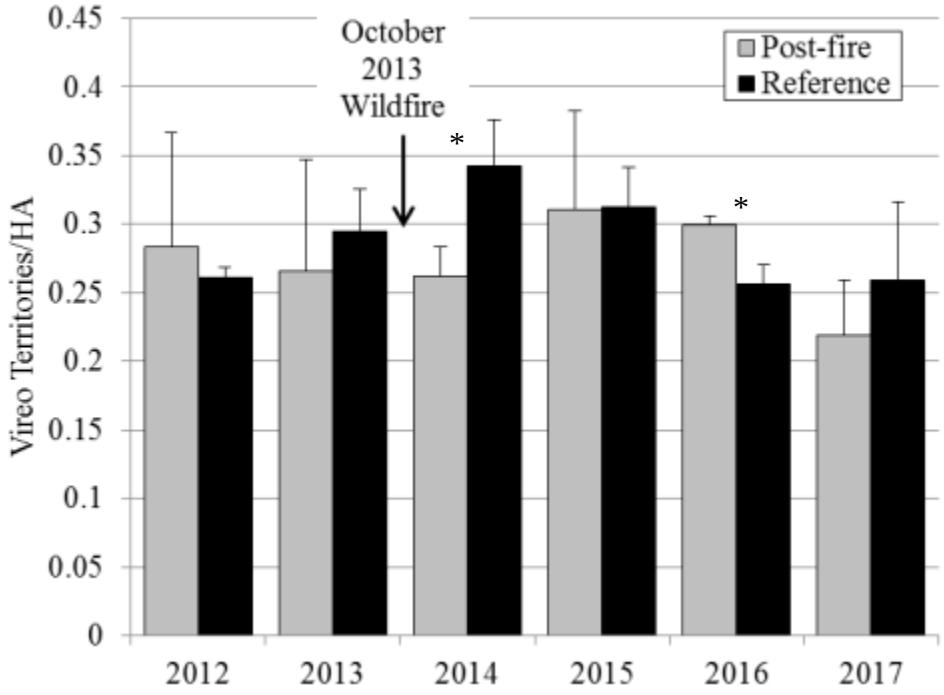

Fig. 7. Annual density of Least Bell's Vireo territories at Post-fire and Reference sites by year, averaged across sites, Marine Corps Base Camp Pendleton, 2012-2017. Error bars represent 1 standard deviation. Asterisks (*) indicate statistically significant differences ($P \leq 0.10$, Student's *t*-tests).

The density of vireo territories in the area that burned in May 2014 remained relatively stable between 2012 and 2014 prior to the wildfire (0.19-0.21 territories/ha; annual decline of 3-7%), then declined sharply (by 34%) in 2015 to 0.12 territories/ha, the year after the fire, and increased back to 2012-2014 density in 2016 and 2017 (0.19 territories/ha; Fig. 8). In 2017, 157 of 639 vireo territories (25%) were located within the May 2014 wildfire perimeter, almost identical to 2014 immediately before the fire, when 156 of 634 (25%) vireo territories were located within the same area.

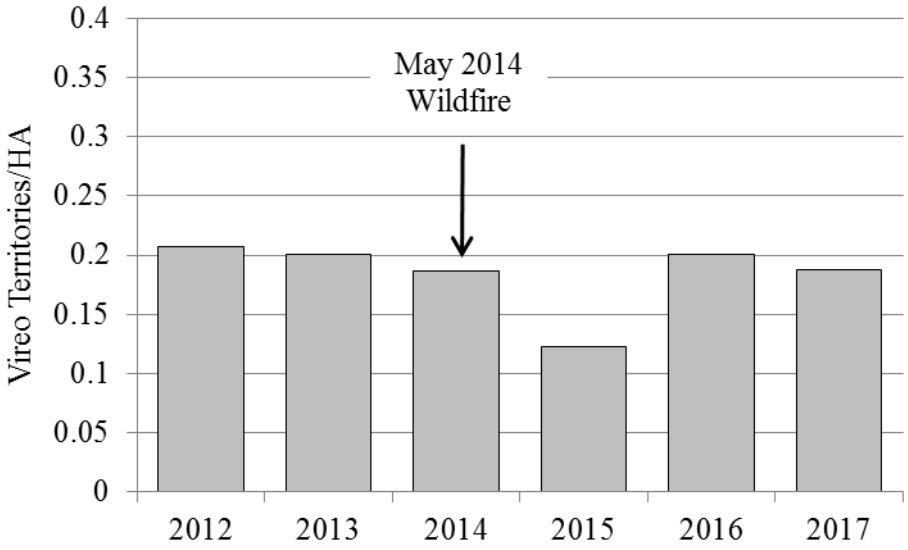

Fig. 8. Annual density of Least Bell's Vireo territories in riparian vegetation within the perimeter of the May 2014 wildfires, Marine Corps Base Camp Pendleton, 2012-2017. The 2014 number includes territories that were established prior to the May 2014 wildfire.

Banded Birds

Returning Banded Birds

We were able to observe 1,016 adult Least Bell's Vireos (644 males, 97% of all males, and 371 females, 75% of all females, and 2 (100%) of unknown sex) on Base well enough to determine banding status in 2017, although not all banded vireos were observed well enough to conclusively identify the individual. Ninety-nine of these had been banded prior to the 2017 breeding season, three of which we could not identify because band combinations were not confirmed (one) or because the vireos were banded with only a single numbered metal federal band as nestlings and not recaptured ("natal"; two total; Table 7). Therefore, we were able to identify 95 vireos on Base that had unique color band combinations in 2017 (Table 7, Appendix E). Of these, 71 vireos had been banded on Base and 24 vireos were originally banded off-Base (18 on the San Luis Rey River, Ferree et al. 2012, 2013, 2015, Houston et al. 2015 and 2016; five on MCAS, Howell and Kus 2015; and one in Baja California Sur, USGS unpubl. data, Table 8). Adult birds of known age ranged from 1-8 years old.

Table 7. Banding status of Least Bell's Vireos detected on Marine Corps Base Camp Pendleton and those that emigrated off-Base in 2017.

	Detected on Base[1]			Emigrants		
Banding Status	**Male**	**Female**	**Total on Base**	**Male**	**Female**	**Total**
Uniquely banded prior to 2017	60	18	78	3	1	82
Natal[2] recaptured in 2017	10	8	18	3	0	21
Subtotal of known identity vireos	69	26	95	6	1	102
Unidentified (Partial resights)	1	-	1	-	-	1
Natal[2], not recaptured	-	2	2	-	-	2
Grand total	71	28	99	6	1	106

[1] Includes immigrants.
[2] Natal vireos were originally banded as nestlings with a single numbered metal federal band.

Two natal vireos (both females) were resighted on Base in 2017 (Table 7). Based on the color of the metal leg bands, one was banded as a nestling on Base or at MCAS and the other was banded as a nestling on the San Luis Rey River. Efforts to recapture and identify these vireos were unsuccessful.

Seven vireos that were originally banded on Base (with gold numbered metal federal bands) were detected off-Base in in 2017 (Table 7). Two males and one female were observed on the San Luis Rey River, all three of which were banded on Base as nestlings in 2016 (Houston et al. 2017, Allen et al. 2017); one of the two males was also resighted in Baja California Sur in February 2017 (USGS unpubl. data). One male was observed on the San Dieguito River and was last detected in 2012 when it was banded as a nestling on Base. One male was observed on the Tijuana River in 2017 and was last detected breeding on Base in 2012. One male was observed in the Santa Monica Mountains in Zuma Canyon, northwest of Malibu, and was last detected breeding on Base in 2015 (W. Sakai pers. comm. 2017). The final male was detected in the San Bernardino Mountains in Whitewater Canyon Preserve, east of Los Angeles (USGS unpubl. data), and was banded as a nestling on Base in 2016.

Two vireos that were detected on Base in 2017 were also observed in Baja California Sur during the previous winter. A female vireo banded at the Santa Margarita MAPS station as an adult in 2016 was seen in Baja California Sur in October 2016 and February 2017, then was observed breeding near the Santa Margarita MAPS station in 2017. The male was originally banded in Baja California Sur in 2015, was resighted breeding on Base in 2016, and was resighted again in Baja California Sur in October 2016 and February 2017 before returning to breed on Base in 2017 (USGS unpubl. data).

Table 8. Number of banded adult Least Bell's Vireos at Marine Corps Base Camp Pendleton in 2017, by original year banded, age, original banding location, and sex.

		Number of Vireos Observed by Origin						
		Marine Corps Base Camp Pendleton		San Luis Rey River		Marine Corps Air Station, Camp Pendleton	Other Site[1]	
Year Originally Banded	Age in 2017	Male	Female	Male	Female	Male	Male	Total
2009	8 yrs.	1	-	-	-	-	-	1
2010	≥ 8 yrs.	2	-	-	-	-	-	2
	≥ 7 yrs.	-	1	-	-	-	-	1
2011	6 yrs.	1	-	-	-	-	-	1
2012	≥ 6 yrs.	3	-	-	-	-	-	3
	5 yrs.	1	-	1	1	-	-	3
2013	≥ 5 yrs.	3	-	-	-	-	-	3
	4 yrs.	3	5	1	-	-	-	9
2014	≥ 4 yrs.	7	2	-	-	-	-	9
	≥ 3 yrs.	1	-	-	-	-	-	1
	3 yrs.	-	1	2	-	-	-	3
2015	≥ 3 yrs.	8	3	-	-	-	-	11
	2 yrs.	12	3	6	1	5	1	28
2016	≥ 2 yrs.	5	3	-	-	-	-	8
	2 yrs.	-	1	-	-	-	-	1
	≥ 1 yr.	-	1	-	-	-	-	1
	1 yr.	3	2	4	2	-	-	11
Subtotal		50	22	14	4	5	1	96
Unknown[2]	≥ 1 yr.	1	1	-	1	-	-	3
Total		51	23	14	5	5	1	99

[1] Banded on the wintering grounds in Baja California Sur so natal territories are unknown.

[2] Natal vireos banded with single numbered metal federal band or identity unknown because of inadequate resight, so natal year is not known. Two vireos were seen with a metal gold numbered band, indicating that they were originally banded at Marine Corps Base Camp Pendleton or Marine Corps Air Station, Camp Pendleton. One vireo was seen with a metal dark blue numbered band, indicating that it was originally banded on the San Luis Rey River.

New Banded Birds

A total of 229 Least Bell's Vireos were captured and banded for the first time during 2017 (Table 9). These included 28 adult vireos caught for the first time and banded with a

unique color combination and 201 hatch-year birds (191 of which were banded as nestlings with a single gold numbered federal band and 10 of which were incidentally caught at one of the two MAPS stations on Base and given a unique color combination). One 2017 banded nestling was recaptured after fledging and given a unique color combination; this bird is included in the nestling total). These newly banded vireos are not included in survivorship, fidelity, or movement analyses.

Table 9. Summary of new Least Bell's Vireos captured and banded on Marine Corps Base Camp Pendleton in 2017.

Age Banded	Males	Females	Unknown Sex	Total
Adult	22	4	2	28
Juvenile			10[1]	10
Nestling			191	191
Total	22	4	203	229

[1] Incidentally captured post-fledging and given unique color band combination. Does not include one 2017 banded nestling that was recaptured after fledging and given a unique color band combination.

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 (e.g., transients or individuals captured as non-territorial birds) in 2017. 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. However, this baseline number can be used to calculate minimum annual survivorship for the vireo population on Base and is adjusted annually to add in individuals that were not identified in a particular year but were detected in subsequent years (see Methods: Banding).

Adult Survivorship from 2016-2017

Of 135 uniquely color banded adult vireos detected on Base during the 2016 breeding season, 48% (65/135) returned in 2017 (Table 10). Eighteen additional adult vireos identified in 2017 but not detected on Base in 2016 were added to the calculations to yield an adjusted annual survivorship of 54% (83/153; Table 10). Sixty-three of the 107 adult male vireos known to be alive in 2016 were resighted in 2017, an over-winter survivorship rate of 59%. Twenty of the 45 adult female vireos known to be alive in 2016 were resighted in 2017, an over-winter survivorship rate of 44%. The remaining 44 males, 25 females, and 1 vireo of unknown sex were not resighted in 2017.

Table 10. Number of banded adult Least Bell's Vireos detected in 2016 at Post-fire sites, Reference sites, and other areas on Marine Corps Base Camp Pendleton, and where those that returned were detected in 2017. Numbers in parentheses include the adjustments resulting from vireos that were identified in 2017 but not in 2016.

	Study Site Name and Type for each Year			
Year / Sex	**Post-fire**	**Reference**	**Other[1]**	**Total**
2016				
Male	18	21	57	96 (107)
Female	7	4	27	38 (45)
Unknown			1	1 (1)
Total	25	25	85	135 (153)
2017				
Male	10[2]	14[3]	28[4]	52 (63)
Female	2[5]	2[3]	9[6]	13 (20)
Total	12	16	37	65 (83)

[1] Includes all areas outside of study sites.
[2] Nine vireos occupied territories in Post-fire sites in 2016, one vireo occupied a territory outside of monitoring sites in 2016.
[3] All vireos occupied Reference sites in 2016.
[4] One vireo occupied a territory at a Reference site and the remaining 27 occupied territories outside of the monitoring sites in 2016.
[5] Both vireos occupied territories at Post-fire sites in 2016.
[6] One vireo occupied a territory at a Reference site and the remaining occupied territories outside of the monitoring sites in 2016.

First-year Survivorship from 2016-2017

Of the 116 hatch-year vireos banded in 2016 that survived to fledge, eight (six males and two females) were resighted with or captured and given unique color band combinations in 2017 (Table 11). This yields a conservative first-year survivorship of 7% (8/116) (Table 11, Table 12). Assuming an equal sex ratio of banded juveniles, first-year survivorship of males was 10% (6/58) and females was 3% (2/58).

Table 11. Number of Least Bell's Vireos banded as nestlings or fledglings at Post-fire sites, Reference sites, and other areas on Marine Corps Base Camp Pendleton in 2016, and where those that returned were detected in 2017.

	Study Site Name and Type for each Year			
Year/Sex	**Post-fire**	**Reference**	**Other[1]**	**Total**
2016				
Unknown	45	70	1	116
2017				
Male	1[2]	0	5[3]	6
Female	1[4]	0	1[4]	2
Total	2	0	6	8

[1] Includes all areas outside of study sites.
[2] Banded as a nestling at a Post-fire site in 2016.
[3] One banded as a nestling at a Post-fire site and four banded as nestlings at Reference sites in 2016.
[4] Banded as a nestling at a Reference site in 2016.

Adjusted Annual Survivorship

Eighteen adult banded vireos (11 males and 7 females) that were detected in 2017 were not observed in 2016 (Table 10; Appendix F). These detections were used to adjust estimates of annual survivorship for previous years (see Methods: Banding). Incorporating these detections into calculations increased first-year and adult survivorship estimates for 2013, 2014, 2015, and 2016 (Table 12).

Table 12. Adjustments to first-year and adult Least Bell's Vireo survivorship on Marine Corps Base Camp Pendleton, 2017. These numbers update survivorship estimates presented in Lynn and Kus 2011c, 2012b, and 2013, Lynn et al. 2014, 2015, and 2016.

	First-year Survivorship			Adult Survivorship		
Years	**Original**	**Previous Estimate**	**New**	**Original**	**Previous Estimate**	**New**
2005-2006	10%	16%	-	30%	41%	-
2006-2007	10%	27%	-	60%	76%	-
2007-2008	11%	24%	-	40%	63%	-
2008-2009	9%	16%	-	45%	61%	-
2009-2010	7%	11%	-	44%	57%	-
2010-2011	4%	14%	-	25%	42%	-
2011-2012	10%	15%	-	38%	69%	-
2012-2013	16%	18%	19%	76%	86%	87%
2013-2014	8%	16%	-	51%	59%	61%
2014-2015	2%	2%	3%	46%	59%	62%
2015-2016	20%	20%	22%	42%	51%	58%
2016-2017	7%	-	7%	48%	-	54%

Survivorship at Post-fire and References Sites

Of the 25 banded adult vireos of known sex (18 males and 7 females) that were detected within Post-fire sites in 2016, 11 (nine males and two females) were resighted in 2017 for a 44% survival rate (50% for males and 29% for females; Table 10, Table 13, and Appendix F). Of the 25 banded adult vireos of known sex (21 males and 4 females) that were detected within the Reference sites in 2017, 17 (14 males and 3 females) were resighted in 2017 for a 68% survival rate (67% for males and 75% for females). Over-winter survival rate was slightly but not significantly lower for vireos that occupied Post-fire than for vireos that occupied Reference sites in 2016 (Fisher's Exact $P = 0.15$). Percent survivorship for adults from 2016-2017 was lower than during the previous two winters at Post-fire sites, but at Reference sites, percent survivorship for adults was higher than 2015-2016 and lower than 2014-2015.

One hundred and fifteen of the 116 banded juveniles that were known to fledge in 2016 were banded on a Post-fire or Reference site (45 at Post-fire sites and 70 at Reference sites; Table 11, Table 13). Of these, two males from Post-fire sites and four males and two females from Reference sites were recaptured on MCBCP and given unique color band combinations in 2017 for a first-year survival rate of 4% for fledglings from Post-fire sites (9% for males and 0% for females, assuming equal sex ratio of banded nestlings) and 7% for fledglings from Reference sites (11% for males and 6% for females, assuming equal sex ratio for banded nestlings). There was no difference in over-winter survival rate between nestlings from Post-fire sites and nestlings from Reference sites in 2016 (Fisher's Exact $P = 0.48$). Juvenile survivorship at both Post-fire and Reference sites was lower in 2016-2017 than 2015-2016, but equal to or higher than survivorship in 2014-2105.

Table 13. Between-year survivorship of adult and juvenile Least Bell's Vireos from Post-fire and Reference sites, 2014-2015, 2015-2016, and 2016-2017, at Marine Corps Base Camp Pendleton.

	Percent Survival		
	2014-2015	**2015-2016**	**2016-2017**
Post-fire Sites			
Adult Males	81%	59%	50%
Adult Females	40%	40%	29%
Total Adults	73%	56%	44%
Juvenile Males	7%	22%	9%
Juvenile Females	0%	4%	0%
Total Juveniles	4%	13%	4%
Reference Sites			
Adult Males	83%	45%	67%
Adult Females	0%	60%	75%
Total Adults	79%	44%	68%
Juvenile Males	0%	29%	11%
Juvenile Females	0%	15%	6%
Total Juveniles	0%	22%	7%

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 (Appendix F). Sixty adult vireos (51 males and 9 females) that were identified at MCBCP in 2016 were resighted in 2017, all of which occupied known territories both years. The majority of returning adult vireos showed strong between-year site fidelity. Of the 60 returning territorial adults, 40 (67% of territorial adults; 38 males, 75% of males; two females, 22% of females) occupied a breeding site in 2017 that they had defended in 2016 (within 100 m). Eleven additional vireos (19% of all vireos; seven males, 14% of males; four females, 44% of females) returned to sites adjacent to their previous territories (within 300 m). The average distance moved by returning adult vireos was 0.4 ± 1.5 km (range 0.0-11.0 km; 0.2 ± 0.6 km, range 0.0-3.4 km for males; 1.4 ± 3.0 km, range 0.0-11.1 km for females).

Four adult vireos that originated on MCBCP were detected off-Base for the first time in 2017. One female that was last detected on Base in 2016 moved 11.1 km to the lower San Luis Rey River. One male, banded as a nestling on Base in 2012, was recaptured along the San Dieguito River, 35.8 km from his natal site. One male that was detected breeding on Base in 2012 moved 84.4 km to the Tijuana River. The fourth vireo, a male, was last detected breeding on Base in 2015 and moved 158.2 km to Zuma Canyon in the Santa Monica Mountains. One adult male vireo that was detected along the San Luis Rey River in 2016 was redetected on MCBCP in 2017 having moved 3.8 km between years.

Eight first-year vireos that were banded as nestlings in 2016 on MCBCP were resighted in 2017 and occupied known territories (six males and two females; Table 14). The average distance that first-year vireos moved from their natal territories was 17.9 ± 32.2 km (range 0.2-97.0 km; males moved 22.7 ± 36.6 km, range 0.2-97.0 km; females moved 3.7 ± 2.3 km, range 2.1-5.3 km). Three first-year male vireos that were banded as nestlings on MCBCP in 2016 were redetected off-Base, two along the San Luis Rey River, 10.8-13.4 km away from their natal sites, and one in Whitewater Canyon in the San Bernardino Mountains, 97.0 km from its natal site. Six other first-year vireos that were originally banded as nestlings along the San Luis Rey River (four males and two females) in 2016 dispersed 6.7 ± 4.0 km to MCBCP.

Site Fidelity and Movement – Post-fire and Reference Sites

Adult fidelity to Post-fire and Reference sites was high. Of vireos detected in both 2016 and 2017, all 11 of the vireos that held territories at Post-fire sites in 2016 returned to Post-fire sites in 2017 (100%), although not necessarily to the same Post-fire site. Sixteen of the 18 vireos that held territories at Reference sites in 2016 returned to Reference sites in 2017 (89%; Appendix F). The remaining two vireos that held territories at Reference sites in 2016 were redetected in 2017 outside of the monitoring sites. Two first-year vireos that fledged from Post-fire sites in 2016 were redetected in 2017. One of these returned to a Post-fire site (50%) and one returned to areas outside of the monitoring sites (50%). Six first-year vireos that fledged from Reference sites in 2016 were redetected in 2017. One returned to a Post-fire site (17%) and five returned to areas outside of the monitoring sites (83%).

Table 14. Between-year dispersal into or out of Marine Corps Base Camp Pendleton by Least Bell's Vireos banded as juveniles in 2016 and detected in 2017.

Drainage / Territory / Monitoring Site Type[1]		Dispersal	Band Combination[2]		
2016	2017	Distance (km)	Left Leg	Right Leg	Sex[3]
SMR / SNO / REF	WW / LBV10	97.0	ORDG/Mgo	PUPU	M
SMR / REM / REF	SLR / DT06	13.4	WHDP/Mgo	DPWH	M
SMR / WSP / REF	SLR / BO13	10.8	YEYE/Mgo	BKBK	M
SMR / SNO / REF	SMR / BN28	7.8	PUPU/Mgo	DPWH	M
SMR / HTI / REF	SMR / RR27	5.3	DPDP/Mgo	DPDP	F
SMR / ARL / PF	RO / DN07	5.2	OROR/Mgo	YEYE	M
SMR / REM / REF	SMR / QIN / PF	2.1	OROR/Mgo	BYST	F
SMR / UNI / PF	SMR / SCO / PF	1.8	DPWH/Mgo	DGOR	M
SLR / BGOO	LF / FS03	13.8[4]	BWST/Mdb	BKBK	F
SLR / WSHA	SMR / HDX / REF	9.0[4]	DPDB/Mdb	YEYE	M
SLR / BALM	SMR / BN25	5.3[4]	YEYE/Mdb	PUPU	M
SLR / DBOW	SMR / BN28	4.7[4]	-	DPWH/Mdb	F
SLR / SLR156	YW / YW03	4.0[4]	WHWH/Mdb	BYST	M
SLR / BRAT	SMR / SE13	3.5[4]	PUWH/Mdb	BYST	M

[1] Drainage Codes: LF = Las Flores Creek; SLR = San Luis Rey River; SMR = Santa Margarita River, WW = Whitewater Canyon, San Bernardino Mountains, YW = Between Ysidora and Windmill Canyons. Monitoring Site Type Codes: PF = Post-fire site; REF = Reference site.

[2] Band colors: Mdb = dark blue numbered federal band; Mgo = gold numbered federal band; BKBK = plastic black; BWST = plastic blue-white striped; BYST = plastic black-yellow striped; DGOR = plastic dark green-orange split; DPDB = plastic dark pink-dark blue split; DPDP = plastic dark pink; DPWH = plastic dark pink-white split; ORDG = plastic orange-dark green split; OROR = plastic orange; PUPU = plastic purple; PUWH = plastic purple-white split; WHDP = plastic white-dark pink split; WHWH = plastic white; YEYE = plastic yellow.

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

[4] Immigrant to MCBCP from the San Luis Rey River.

Nest Monitoring

Nesting activity was monitored in a total of 51 territories within the Post-fire and Reference monitoring areas (Table 15, Fig. 9-12, Appendix G). All of the territories were considered fully monitored, meaning that all nests within the territory were found and documented during the breeding season. One Post-fire territory was held by a single male and no nests were found; therefore, this territory was excluded from nest analyses. A total of 115 nests were monitored during the breeding season; eight of these were not completed (coded as "INC" in Appendix G) and have been excluded from calculations of nest success and productivity.

Table 15. Number of Least Bell's Vireo territories and nests monitored at Post-fire and Reference sites on Marine Corps Base Camp Pendleton, 2017.

	Nest Monitoring Area Type	
	Post-fire	**Reference**
Territories	26[1]	25
Nests (# complete)	60 (54)	55 (53)
Completed nests per pair	2.2 ± 0.9	2.1 ± 0.8
Total number of nests per pair (includes incomplete nests)	2.4 ± 1.1	2.2 ± 0.8
Total # of nests monitored	60	55

[1] One territory occupied by a single male not included in nesting calculations.

Post-fire versus Reference Sites

Nesting Attempts

Pairs at Post-fire sites and Reference sites had a similar number of nesting attempts (including incomplete nests) over the course of the 2017 breeding season (Table 15; $t = 0.7$, $P = 0.46$). Post-fire pairs (20/25; 80%) were equally likely to re-nest after an initial attempt as Reference pairs (21/25; 84%; Fisher's Exact $P > 0.99$). The incidence of re-nesting after a failed first nesting attempt did not differ between Post-fire pairs (17/18; 94%) and Reference pairs (13/13; 100%; Fisher's Exact $P > 0.99$). Similarly, pairs at Post-fire sites (3/7; 43%) were as likely to renest after a successful first nesting attempt as were pairs at Reference sites (8/12; 67%; Fisher's Exact $P = 0.38$). Pairs at both monitoring site types were more likely to re-nest after a failed first nesting attempt than after a successful first nesting attempt in 2017 (Fisher's Exact $P < 0.01$). This difference was consistent within Post-fire sites (94% vs. 42%, Fisher's Exact $P = 0.01$) and Reference sites (100% vs. 67%, Fisher's Exact $P = 0.04$). Overall, 97% (30/31) of vireo pairs attempted to re-nest after a failed first nesting attempt, similar to 2014-2016 (Fig. 13). However, 58% (11/19) of pairs attempted to re-nest after a successful first nesting attempt in 2017, similar to 2016 - a smaller proportion than in 2015 but a larger proportion than in 2014. Ten pairs at Post-fire sites and seven pairs at Reference sites attempted three or more nests. Four pairs at Post-fire sites and two pairs at Reference sites initiated four nesting attempts in 2017. One pair at a Post-fire site initiated five nesting attempts in 2017.

Fig. 9. Locations of monitored Least Bell's Vireo territories at the Below Hospital West Reference site, Marine Corps Base Camp Pendleton, 2017.

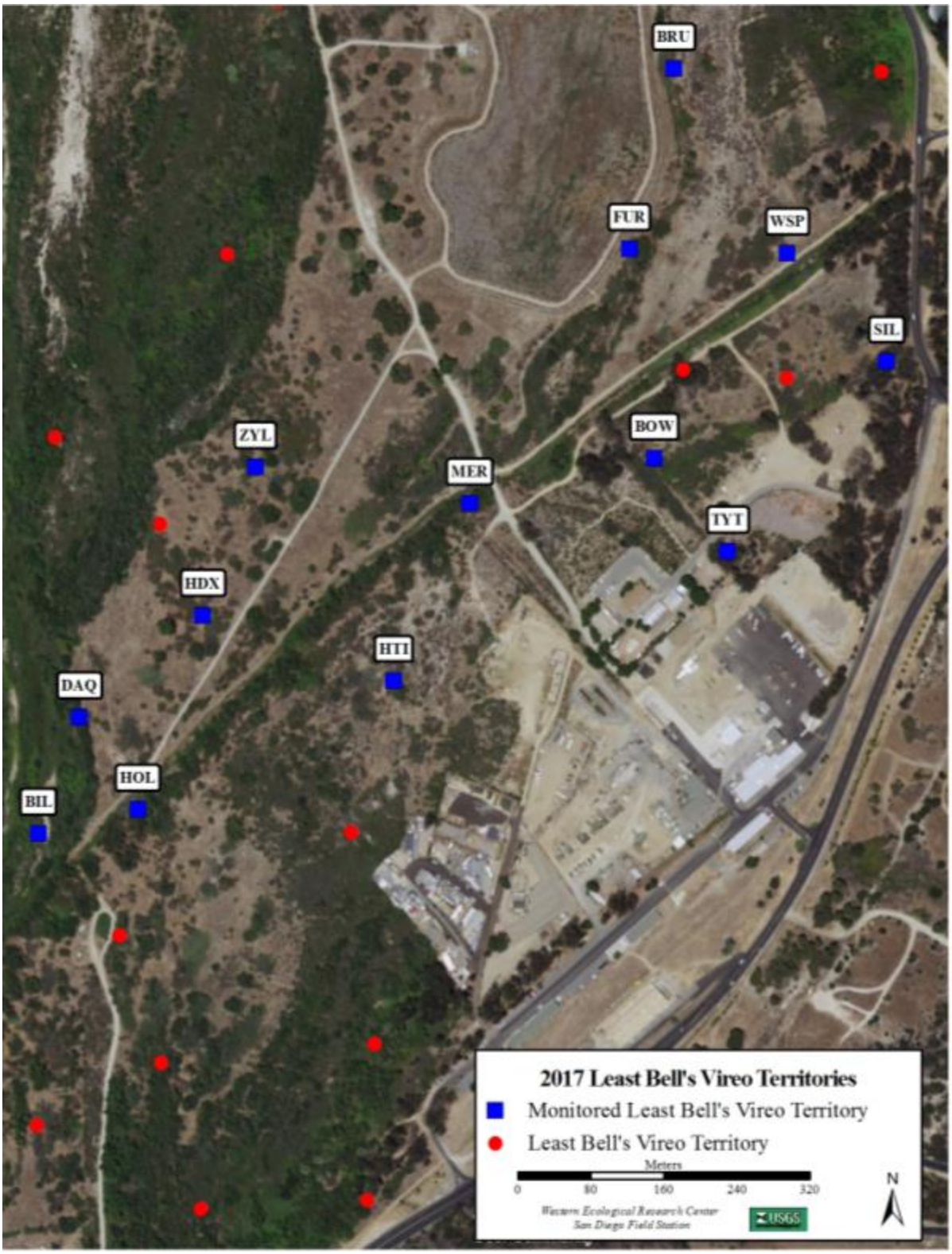

Fig. 10. Locations of monitored Least Bell's Vireo territories at the Below Hospital East Reference site, Marine Corps Base Camp Pendleton, 2017.

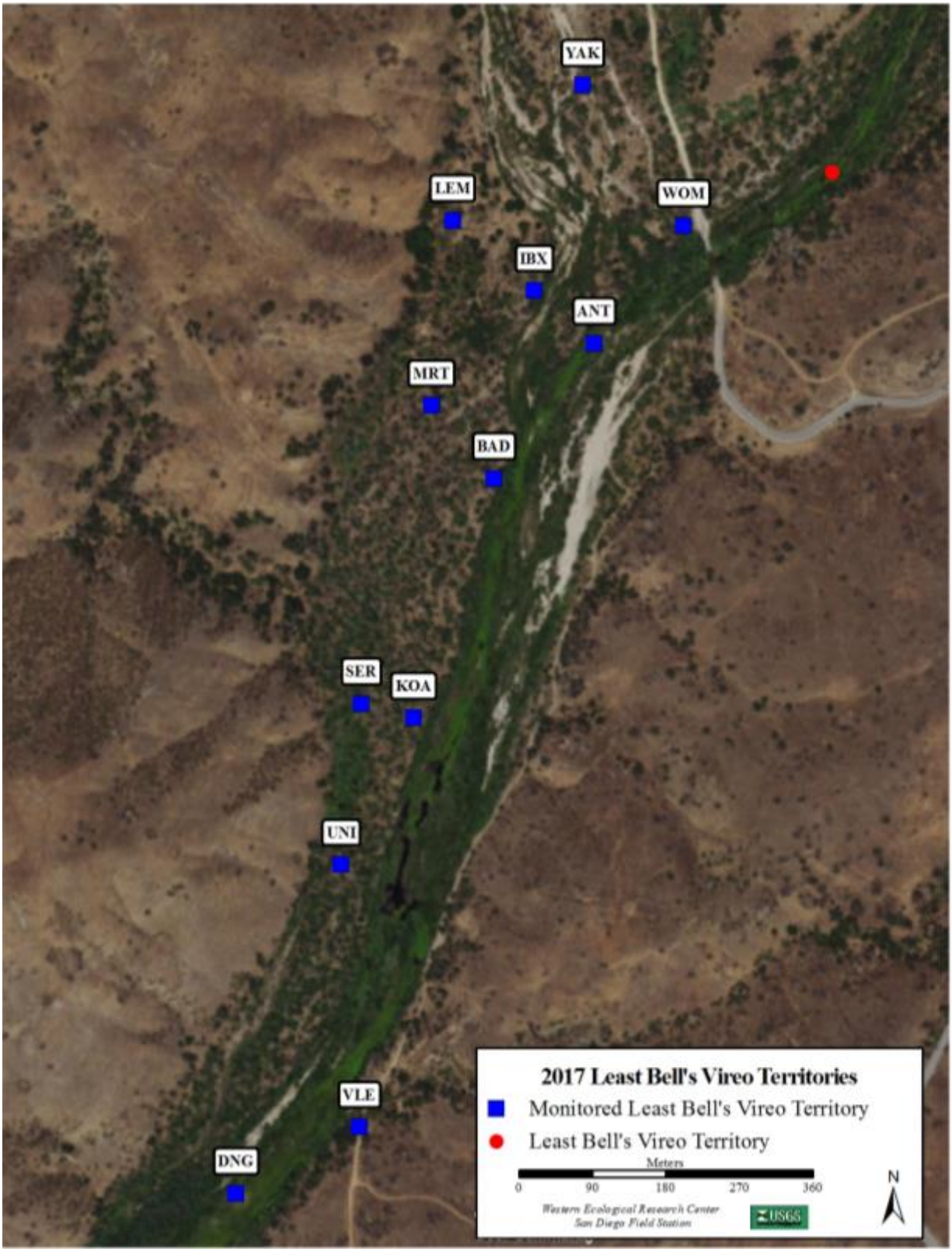

Fig. 11. Locations of monitored Least Bell's Vireo territories at the Above Hospital North Post-fire site, Marine Corps Base Camp Pendleton, 2017.

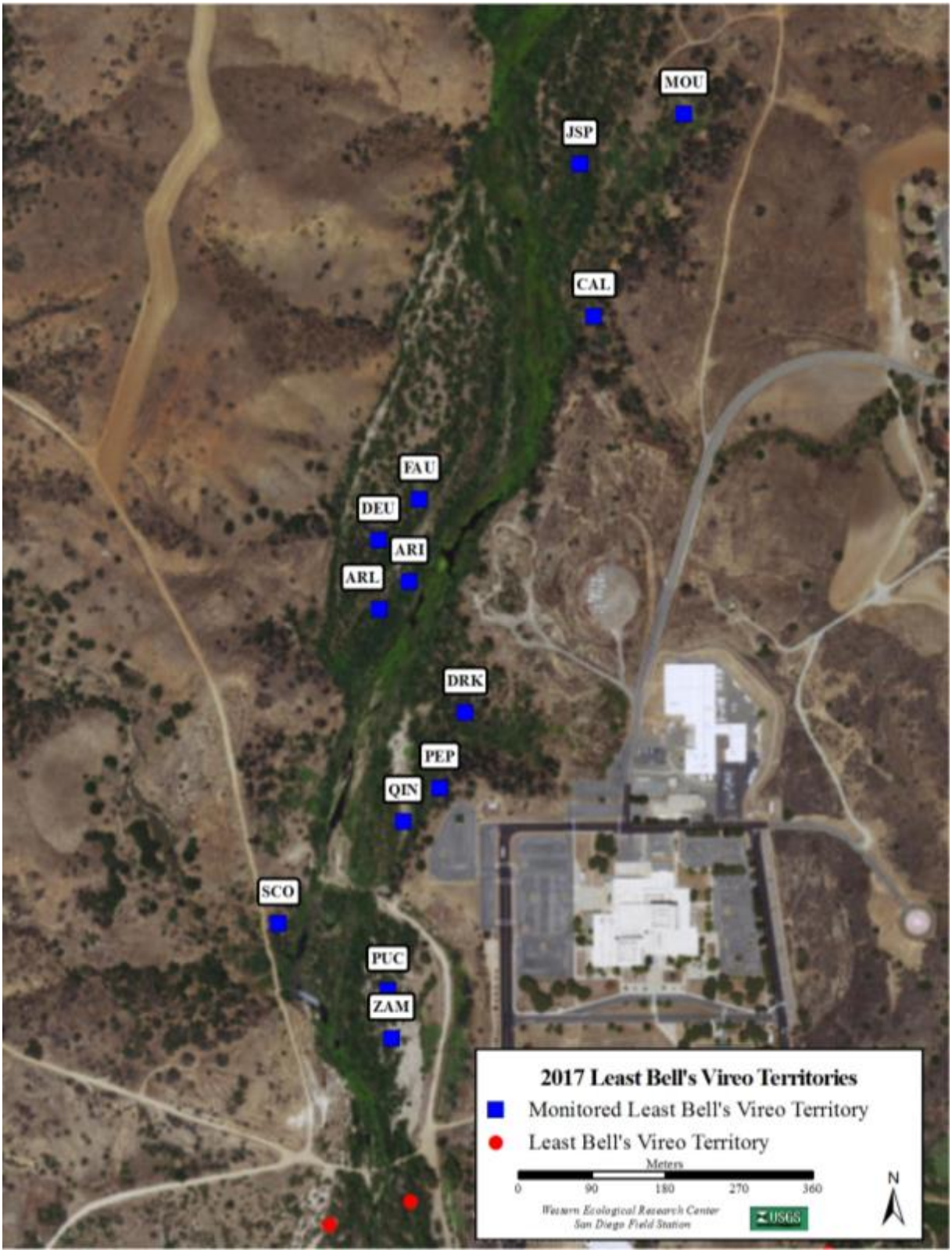

Fig. 12. Locations of monitored Least Bell's Vireo territories at the Above Hospital South Post-fire site, Marine Corps Base Camp Pendleton, 2017.

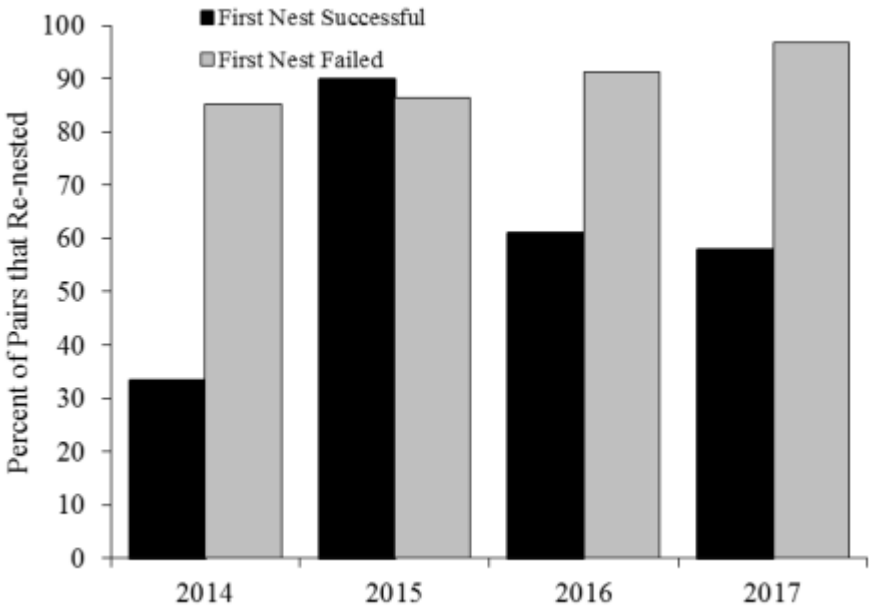

Fig. 13. Percent of Least Bell's Vireo pairs that re-nested after a successful or failed first nesting attempt by year, Post-fire and Reference sites combined, Marine Corps Base Camp Pendleton, 2014-2017.

Nest Success

Completed nests in Post-fire sites were as likely to be successful as completed nests in Reference sites ($\chi^2 = 2.1$, $P = 0.30$), as 41% (22/54) of nests in Post-fire sites successfully fledged young and 57% (30/53) of those in Reference sites successfully fledged young (Table 16). First nesting attempts were also as likely to be successful at Post-fire sites (28%) as at Reference sites (48%; $\chi^2 = 1.4$, $P = 0.24$) in 2017. Overall, 49% of all nesting attempts were successful and 38% of first nesting attempts were successful in 2017.

Table 16. Fate of completed Least Bell's Vireo nests in fully monitored territories at Post-fire and Reference sites, Marine Corps Base Camp Pendleton, 2017. Numbers in parentheses are proportions of total nests.

	Number of Nests		
Nest Fate	**Post-fire**	**Reference**	**Total**
Successful	22	30	52 (0.49)
Failed			
Predation	21	16	37 (0.35)
Parasitism	0	0	0 (0.00)
Other/Unknown	11	7	18 (0.17)
Total Completed Nests	54	53	107 (1.00)

Causes of failure were similar at Post-fire and Reference sites. The majority of nest failures at both Post-fire and Reference sites were caused by predation, although no confirmed predation events were witnessed (Table 16). Predation accounted for 66% (21/32) of nest failures at Post-fire sites and 70% (16/23) of nest failures at Reference sites. We documented 18 nests that failed for other reasons, known and unknown, at our monitoring sites (Appendix G). Six nests were abandoned with cold, wet eggs or nestlings after a storm. Nestlings died at one nest after the female disappeared. Nine nests failed between nest-building and egg-laying from unknown causes. At one other nest, eggs were likely infertile and did not hatch. One nest was abandoned with eggs for unknown reasons. Overall, 59% and 43% of completed vireo nests at Post-fire and Reference sites, respectively, were lost to predation or other causes.

Cowbird Parasitism

No Least Bell's Vireo nests were parasitized by Brown-headed Cowbirds in 2017.

Productivity

Clutch size did not differ between Post-fire sites and Reference sites (Table 17). However, the proportion of eggs that hatched and the proportion of nests that had hatchlings were higher at Reference sites than at Post-fire sites. Measures of fledging success were similar at Post-fire and Reference sites, but pairs at Post-fire sites appeared to produce fewer fledglings than pairs at Reference sites (this difference was not quite statistically significant). Pairs at Post-fire sites (76%) were less likely to successfully fledge young than pairs at Reference sites (96%). Three pairs at Post-fire sites and six pairs at Reference sites successfully double-brooded during the 2017 breeding season. Vireo pairs at Post-fire and Reference sites combined fledged three vireo young per pair, and 86% of monitored pairs were successful in fledging at least one young in 2017.

Table 17. Reproductive success and productivity of nesting Least Bell's Vireos at Post-fire and Reference sites, Marine Corps Base Camp Pendleton, 2017.

Parameter	Post-fire Sites	Reference Sites	Total
Nests with eggs	46	49	95
Eggs laid	154	171	325
Average clutch size[1]	3.6 ± 0.6	3.5 ± 0.6	3.5 ± 0.6
Hatchlings	99	134	233
Nests with hatchlings	33	44	77
Hatching success:			
Eggs[2]	64%	78%	72%
Nests[3]	72%	90%	81%
Fledglings	64	86	150
Nests with fledglings	22	30	52
Fledging success:			
Hatchlings[4]	65%	64%	64%
Nests[5]	67%	68%	68%
Fledglings per egg	0.4	0.5	0.5
Average number of young fledged per pair[6]	2.6 ± 1.9	3.4 ± 2.0	3.0 ± 2.0
Pairs fledging ≥ 1 young[7]	19 (76%)	24 (96%)	43 (86%)

[1] Based on 38 Post-fire and 46 Reference non-parasitized nests with a full clutch (t = -0.3; P = 0.81).
[2] Percent of all eggs that hatched (Chi-squared = 7.2, P < 0.01).
[3] Percent of all nests with eggs in which at least one egg hatched (Chi-squared = 3.9, P = 0.05).
[4] Percent of all hatchlings that fledged (Chi-squared < 0.1, P = 0.94).
[5] Percent of all nests with hatchlings in which at least one young fledged (Chi-squared < 0.1, P = 0.88).
[6] Based on 25 Post-fire and 25 Reference pairs (t = -1.6, P = 0.12).
[7] Based on 25 Post-fire and 25 Reference pairs (Fisher's Exact P = 0.10).

Daily Nest Survival

Analysis of DSR showed that the model that included year was the best supported model for predicting vireo nest survival (Table 18). According to this model, nests in 2017 had higher daily survival rates than nests in 2015 or 2016 (Fig. 14, Table 19). Although models that included treatment received some support, the odds ratios for the type of monitoring site in these less-supported models had confidence intervals that included 1, which indicates that they were not significant contributing factors to the models (Table 19).

Table 18. Logistic regression models for the effect of Treatment (whether a nest was in a Post-fire or Reference site) and Year on nest survival of Least Bell's Vireos on Marine Corps Base Camp Pendleton, 2015-2017. Models are ranked from best to worst based on Akaike's Information Criteria for small samples (AIC_C), ΔAIC_C, and Akaike weights (w). AIC_C is based on -2 x $\log_e$ likelihood (L) and the number of parameters (K) in the model.

Model	Deviance	# Parameters	AIC_C	ΔAIC_C	AIC_C Weight
Year	1018.2	3	1024.2	0	0.50
Treatment + Year	1017.1	4	1025.1	0.92	0.31
Treatment + Year + Treatment x Year	1016.4	6	1028.4	4.18	0.06
Constant	1026.7	1	1028.6	4.45	0.05
Treatment x Year	1023.4	3	1029.4	5.19	0.04
Treatment	1025.5	2	1029.5	5.28	0.04

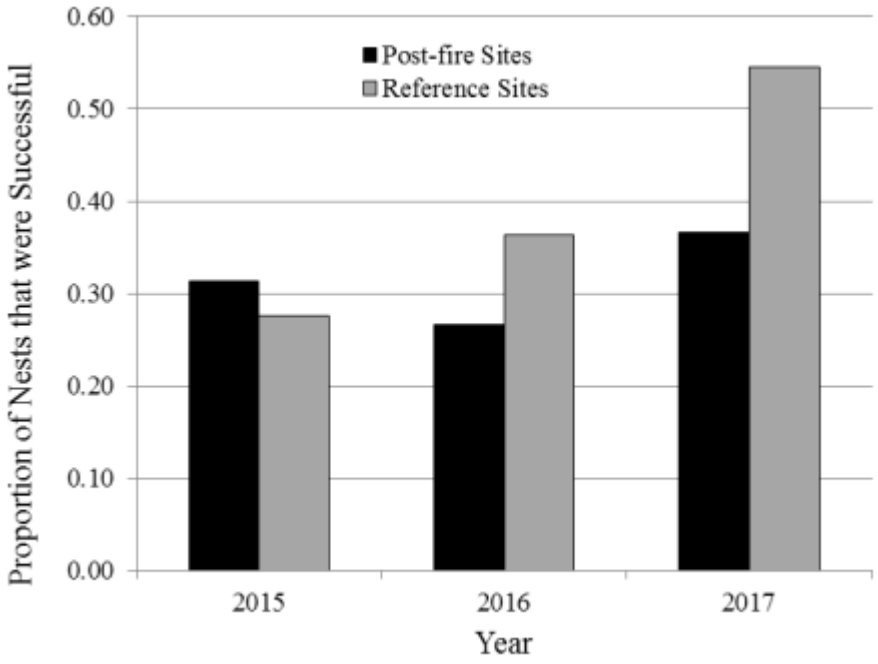

Fig. 14. Proportion of nests that survived to fledge young at Post-fire and Reference sites, Marine Corps Base Camp Pendleton, 2015-2017.

Table 19. Parameter estimate (β), standard error (SE), odds ratios and 95% confidence intervals (CI) for models explaining daily survival rate of Least Bell's Vireos at Post-fire and Reference sites on Marine Corps Base Camp Pendleton, 2015-2017. Models are in order of best-supported to least-supported.

Model	Effect	β	SE	Odds Ratio	95% CI
Year	2015 vs. 2017	-0.05	0.20	0.95	0.64-1.40
	2016 vs. 2017	-0.52	0.20	0.60	0.40-0.88
	Constant	3.85	0.15		
Treatment + Year	Treatment	-0.16	0.15	0.85	0.63-1.15
	2015 vs. 2017	-0.46	0.20	0.63	0.43-0.92
	2016 vs. 2017	-0.52	0.20	0.59	0.40-0.88
	Constant	3.92	0.17		
Treatment + Year	2015 vs. 2017	-0.63	0.29	0.53	0.30-0.94
+ Treatment x	2016 vs. 2017	-0.67	0.29	0.51	0.29-0.90
Year	Treatment	-0.39	0.31	0.68	0.37-1.24
	Treatment x 2015 vs. Treatment x 2017	0.32	0.39	1.37	0.63-2.97
	Treatment x 2016 vs. Treatment x 2017	0.30	0.40	1.34	0.62-2.93
	Constant	1.05	0.23		
Constant	Constant	3.50	0.08		
Treatment x Year	Treatment x 2015 vs. Treatment x 2017	-0.25	0.19	0.76	0.53-1.13
	Treatment x 2016 vs. Treatment x 2017	-0.32	0.20	0.73	0.49-1.09
	Constant	3.59	0.10		
Treatment	Treatment	-0.16	0.15	0.85	0.63-1.14
	Constant	3.58	0.11		

Nest Characteristics

Least Bell's Vireos used 12 plant species for nesting at Post-fire and Reference sites in 2017, although not all were used within each treatment (Table 20). Vireos used 11 species at Post-fire sites and eight species at Reference sites. Seventy-five percent of all nests (65% at Post-fire sites and 85% at Reference sites) were placed in arroyo willow, sandbar willow, wild grape (*Vitus* sp.), or mule fat. At Post-fire sites, three vireo nests (5%) were placed in herbaceous vegetation and 54 nests (95%) were placed in woody vegetation. At Reference sites, one vireo nest (2%) was placed in herbaceous vegetation and 53 nests (98%) were placed in woody vegetation. Four vireo nests were built in an exotic plant species (two in poison hemlock and two in black mustard); three of these nests were located in the Post-fire sites.

In 2017, successful nests were placed significantly higher in the host plant than unsuccessful nests at Reference sites (Table 21). Vireo nests at Post-fire sites were placed lower in the host plant but in taller host plants than those at Reference sites. There were no other differences in nest placement characteristics between successful and unsuccessful nests at Post-fire sites or at Reference sites.

Table 20. Host plant species used by Least Bell's Vireos at Post-fire and Reference sites, Marine Corps Base Camp Pendleton, 2017. Numbers in parentheses are proportions of total nests within treatment types.

	Number of Nests		
Host Species	**Post-fire**	**Reference**	**Total**
Arroyo or red willow	17 (0.30)	11 (0.20)	28 (0.25)
Sandbar willow	2 (0.04)	23 (0.43)	25 (0.23)
Wild grape	12 (0.21)	4 (0.07)	16 (0.14)
Mule fat	6 (0.11)	8 (0.15)	14 (0.13)
Coast live oak	6 (0.11)	0 (0.00)	6 (0.05)
Poison oak (*Toxicodendron diversilobum*)	3 (0.05)	3 (0.06)	6 (0.05)
Blue elderberry (*Sambucus nigra ssp. caerulea*)	5 (0.09)	0 (0.00)	5 (0.05)
California blackberry (*Rubus ursinus*)	1 (0.02)	3 (0.06)	4 (0.04)
California sycamore	2 (0.04)	0 (0.00)	2 (0.02)
Poison hemlock	2 (0.04)	0 (0.00)	2 (0.02)
Black mustard	1 (0.02)	1 (0.02)	2 (0.02)
Coyote brush (*Baccharis pilularis*)	0 (0.00)	1 (0.02)	1 (0.01)

Table 21. Least Bell's Vireo nest characteristics and results of Student's *t*-tests of successful versus unsuccessful nesting attempts at Post-fire and Reference sites, Marine Corps Base Camp Pendleton, 2017.

	Nest Fate				
Nest Characteristic	**Successful**	**Unsuccessful**	***n*[1]**	***t*[2]**	***P*[3]**
Post-fire Site					
Average nest height (m)	0.7	0.7	19, 38	-0.5	0.66
Average host height (m)	4.0	4.1	19, 38	-0.2	0.87
Average distance to edge of host (m)	0.8	0.7	19, 38	0.8	0.45
Average distance to edge of clump (m)	1.5	1.3	19, 38	0.6	0.53
Reference Site					
Average nest height (m)	0.8	0.7	29, 25	2.2	**0.03**
Average host height (m)	2.6	2.7	29, 25	-0.5	0.64
Average distance to edge of host (m)	0.5	0.6	29, 25	-0.9	0.41
Average distance to edge of clump (m)	1.5	1.4	29, 25	0.3	0.78
Post-fire and Reference Sites	**Post-fire**	**Reference**	***n*[4]**	***t*[2]**	***P*[3]**
Average nest height (m)	0.7	0.8	57, 54	-1.9	**0.06**
Average host height (m)	4.1	2.6	57, 54	3.4	< **0.01**
Average distance to edge of host (m)	0.7	0.6	57, 54	1.2	0.22
Average distance to edge of clump (m)	1.4	1.4	57, 54	-0.2	0.88

[1] *n* = number of nests in sample (Successful, Unsuccessful).
[2] *t* = Student's *t* statistic.
[3] *P* = *P*-value.
[4] *n* = number of nests in sample (Post-fire, Reference).

DISCUSSION

Least Bell's Vireo numbers have fluctuated over the past several years, manifested relatively consistently across several study areas in San Diego County including MCBCP, the San Luis Rey River, the San Diego River, MCAS, and the Sweetwater Reservoir until 2016 and 2017. The range-wide vireo population gradually increased through the 1980's and 1990's, reaching a peak in 2009-2010 before declining through 2012, then fluctuating between 60% and 70% of peak numbers through 2017 (Allen and Kus 2013, 2014; Allen et al. 2016, 2017; Ferree and Kus 2007, 2008a, 2008b, Ferree et al. 2010a, 2010b, 2011, 2012a, 2013, 2015; Hall and Kus 2016, 2017; Houston et al. 2015, 2016, 2017; Howell and Kus 2015; Jones 1985; Kus 1988, 1989, 1991a, 1991b, 1994, 1995; Kus and Beck 1998; Lynn and Kus 2008, 2010b, 2010c, 2011a, 2011b, 2012a, Lynn et al. 2010, 2012, 2014, 2015, 2016; Peterson et al. 2002; Pottinger and Kus 2013; Rourke and Kus 2006b, 2007b; USGS unpubl. data). In 2016, the population trends at different study areas within the vireo's range diverged, with vireos increasing on MCBCP from 2015 to 2016, but decreasing on MCAS and on the lower San Luis Rey and remaining stable on the middle San Luis Rey River. In 2017, there was also a discrepancy between sites, although in the opposite direction. Vireos decreased on MCBCP from 2016 to 2017, but increased on the lower San Luis Rey and the middle San Luis Rey and remained stable at MCAS.

The areas that showed the largest decrease in vireo numbers on MCBCP were the Santa Margarita River and De Luz Creek, both of which were heavily impacted by high water flow during the previous winter. Flood waters scoured these drainages, impacting vegetation along the river banks and leaving substantial piles of woody debris. While heavy rains contributed to thicker annual vegetation growth which should benefit vireos, it may be that the vegetated area was reduced as a result of the flood impact, providing less habitat for vireos in these areas. Other areas on MCBCP where vireo numbers decreased (San Mateo Creek and Cristianitos Creek) are typically drier and were not scoured by flood waters over the preceding winter. These drier areas have been adversely affected by prolonged drought, with riparian vegetation appearing degraded, particularly from dying woody vegetation being replaced by weedy herbaceous species. These drought-affected areas did not produce the lush annual growth as typically wetter areas (e.g., the Santa Margarita River) did in 2017. Recovery from drought in these drier areas will likely take more than 1 year of normal or above average rainfall. Habitat management in riparian areas adjacent to MCBCP (mowing and clearing for flood control along the lower San Luis Rey, Houston et al. 2016; tree trimming at MCAS, Hall and Kus 2016) may have adversely affected vireo numbers in those areas in 2016, but the heavy rainfall this past winter may have allowed for substantial habitat recovery in 2017, providing an increase in usable habitat by the breeding season. In 2016, we observed exceptionally high immigration of first-year breeders to MCBCP (15; Lynn et al. 2016), potentially in response to the habitat management that affected areas off-Base. In 2017, the number of known first-year vireos from natal territories off-Base that moved to MCBCP dropped to six, within the range observed in previous years. A minor contribution to the decrease in vireo numbers on MCBCP may be attributed to areas that did not get surveyed in 2017. Dirt roads to some areas were impassable because of standing water and mud for much of the early season, and access to one training area (Foxtrot) was denied altogether. This probably only resulted in three fewer territories detected in 2017, however.

The general decrease in vireo numbers region-wide since 2010 is likely largely attributable to drought conditions that have persisted on the breeding grounds in the recent past. San Diego County experienced a drought from 2012-2016, with precipitation for each bio-year (1 July–30 June) from July 2012 to June 2015 totaling < 65% of average precipitation between 2002 and 2011 (The Weather Company 2017). Low precipitation compromises primary productivity resulting in decreased annual plant and foliage growth. Consequently, foraging substrate and nesting cover for vireos was likely compromised, reducing arthropod abundance and the wildlife (i.e., vireos) that depend on them. Rainfall during the 2015-2016 bio-year was near the 2002-2011 average and for the 2016-2017 bio-year, rainfall was 60% above the 2002-2011 average. These recent years of average to above average rainfall may be contributing to increased breeding productivity in 2016 and 2017, although the long-term effects of drought are likely to continue for several years as habitat continues to recover.

Vireo territory density within the perimeters of the October 2013 and May 2014 wildfires appeared to be increasing relative to areas that did not burn during the first 3 years post-fire. However, in 2017, vireo territory density in the perimeter of the October 2013 fire dropped to below the lowest density observed (1 year post-fire). The decreased density was most evident in the Post-fire study sites, where territory density decreased, whereas the territory density in the Reference sites remained similar to 2016. This may have been a local response to the heavy rainfall in the winter of 2016-2017, which caused high floodwaters along the Santa Margarita River, scouring vegetation on the river banks and leaving large deposits of vegetative debris where vireos have nested in past years.

Vegetation cover at the Post-fire sites increased at the lower levels while the proportion of that cover comprised of herbaceous vegetation decreased. This suggests that the early successional herbaceous growth that typically follows wildfires is being replaced by more substantial, woody native trees and shrubs. This was also evident as the vegetation recovered after the Las Flores Creek fire. Concurrent with this shift at the Above Hospital site, vireos continued to place a greater proportion of their nests in woody vegetation than in herbaceous vegetation each year since 2014. At our Post-fire study sites, the natural succession of initial annual herbaceous growth to native willows and mule fat has progressed adequately to allow vireos to transition to placing their nests in more reliable, sturdy vegetation as these native plants grow to sufficient size, reducing the risk of nest failure as a result of host collapse. Supporting this, vireos at Reference sites, which have had relatively unchanged vegetation since before the wildfire, have consistently placed a greater proportion of their nests in woody vegetation than vireos at Post-fire sites.

Until 2017, vegetation recovery at the Post-fire sites at Above Hospital was slower than that at Las Flores Creek at the lowest height categories. However, by the fourth year post-fire, the lower canopy at Above Hospital had filled out and equaled or exceeded the vegetative cover in the lower canopy at Las Flores Creek. Also, at Above Hospital, the shift of vegetation cover in the lowest height categories from mostly herbaceous cover to mostly woody cover was less dramatic and more gradual than the shift at Las Flores during the 4 years post-fire. This is likely partly a factor of burn severity, which was higher at Above Hospital than at Las Flores. At Las Flores, vegetation that was not as severely burned was able to re-sprout, allowing for thicker cover and quicker recovery of woody vegetation than at the Above Hospital Post-fire sites.

Additionally, the recovery of burned vegetation at Las Flores coincided with normal rainfall, while the first 3 years post-fire at Above Hospital coincided with an extended drought, potentially inhibiting new growth.

Breeding productivity at MCBCP was higher in 2017 than in 2016, manifested by more fledglings produced per pair and also by the higher proportion of pairs that successfully produced fledglings. This higher breeding productivity was likely influenced by higher than average rainfall in the winter of 2016-2017, which produced dense cover in the lower canopy where vireos place their nests. Such thick cover may have helped obscure nests from predators, increased the availability of more stable nesting substrates, and provided habitat for the arthropod prey that vireos require.

In 2017, we continued to see vireos that originated outside of MCBCP moving on to Base and holding territories. Six first-year vireos moved to MCBCP from the San Luis Rey River, where they hatched in 2016. Conversely, three vireos that hatched on MCBCP in 2016 moved off-Base. Additionally, we documented three older vireos, one in the Santa Monica Mountains, one at the Tijuana River, and one at the San Dieguito River that had not been seen on Base since 2010-2015. Two of these three adult vireos that were detected off Base in 2017 had last been detected as adults breeding on MCBCP. It is highly unusual for adults with established territories to move so far between breeding seasons, and in particular to move to different drainages. Both of these vireos moved further between detections than any other adults in the past 10 years. In 2017, we also resighted two vireos on MCBCP that were last seen in Baja California Sur, on the wintering grounds. These movements demonstrate the ability of vireos to disperse well beyond their natal drainages. Incidental observations of vireos in areas that have not typically been thoroughly surveyed is helping to enhance our understanding of movements of both adult and dispersing juvenile vireos. Further banding and resighting of vireos within southern California and Baja California Sur continues to increase our understanding of the extent of movement between populations and during migration, 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 lifetime 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.

CONCLUSIONS

Until 2011, the vireo population on MCBCP tracked the overall increase in Least Bell's Vireos in southern California since the late 1970s (USFWS 2006). Since its peak in 2010, the vireo population on Camp Pendleton has decreased 33%, reaching a 21-year low in 2015, rebounding in 2016, and then dropping again in 2017. In 2016, an unusually high number of immigrant vireos were detected on MCBCP, although this trend did not manifest in 2017 where emigration and immigration of first-year vireos was more proportional to the number banded in each area. Additionally, the population decrease on MCBCP in 2017 was not reflected in other parts of the vireos' range. This suggests that vireo habitat on MCBCP was not significantly better than surrounding natal area, likely because of higher than average winter rains region-wide that promoted the growth of early successional vegetation that vireos readily use. When winter

rains were below average, vireos responded to the protection and restoration of high quality vireo habitat on MCBCP relative to vireo habitat off-Base that was less closely managed, or managed for potentially conflicting goals (e.g., habitat protection and flood control on the lower San Luis Rey River). Continuing the management strategy of habitat protection and restoration on MCBCP is likely to provide long-term benefits to the vireo population as well as other riparian-obligate wildlife.

The increasing trend in the vireo population in the 1980s and 1990s can largely be attributed to management actions, including control of Brown-headed Cowbirds and protection and restoration of riparian habitat. On MCBCP, Brown-headed Cowbird control has reduced cowbird parasitism to a negligible level since the mid-1990s, releasing a major limit on vireo breeding productivity. No cowbird parasitism was documented on MCBCP during 2017. Cowbird control has a demonstrably positive effect on vireo productivity (Kus 1999, Kus and Whitfield 2005), but must be consistently practiced to maintain the desired reduction in parasitism.

The recent fluctuations in the vireo population may be a consequence of a variety of interacting factors including wildfire (affecting apparent population size, distribution, and habitat-related nesting productivity and predation), drought (affecting breeding productivity and survival), high floodwaters, and the inherent carrying capacity of the current habitat (whether breeding, migratory, or wintering). These three factors are difficult to parse and are subject to change as a result of natural (e.g. weather) and anthropogenic (e.g. habitat alteration or restoration) processes, making future population trends difficult to predict.

The growth of exotic annual vegetation in burned or disturbed areas can provide short-term nesting substrate for vireos, as long as precipitation is sufficient throughout the breeding season to keep the herbaceous vegetation from drying out and collapsing. With higher than average rainfall in 2017, vegetative cover in the lower canopy, where vireos typically build their nests, increased significantly while the proportion of that cover made up of herbaceous vegetation decreased. As the proportion of woody vegetation has increased in the 4 years post-fire, vireos have responded by placing more of their nests in woody vegetation at the Post-fire sites. Reproducing or enhancing this natural succession by restoring woody vegetation in stages may be a viable approach when burned or disturbed areas are overwhelmed by exotic annuals that out-compete the native vegetation. However, care must be taken to retain small branches and leafy vegetation within 1 m of the ground to maintain sufficient habitat for nesting vireos. For example, in the first stage, replace a portion of the exotic annual cover with native woody vegetation. In subsequent stages, replace another portion of exotic annuals as the initial planting of woody and herbaceous natives become usable to native wildlife. This staging approach would also retain the potentially important food source for insect prey and also short-term nesting substrate for vireos provided by exotic annual vegetation that vireos may rely on to persist at burned sites in the absence of adequate native alternatives. Our results indicate that exotic herbaceous vegetation declines under unmanaged conditions within 3-5 years at recovering Post-fire sites, suggesting that the need for management intervention to reduce exotic cover may be minimal.

The wildfires that occurred in October 2013 and May 2014 were sparked by a combination of circumstances, including the on-going drought, strong east winds that carried dry, hot air from the deserts, human activity (e.g., vehicles with hot engines park on dry grass), and electrical infrastructure failure as a result of strong winds. Other, smaller fires on Base have also been ignited by military training involving the use of materials that can ignite fires (e.g., gunfire, vehicles with hot engines parked on dry grass). While most of these circumstances were beyond immediate human control, catastrophic events like wildfires highlight the delicate tipping point that can easily be upset by normally innocuous human actions. These impacts can adversely impact vireo populations in the short-term, causing direct mortality during the breeding season and destroying habitat during any time of the year. Given time and proper management, vireo habitat can recover from events such as wildfire; however, repeated, or unnaturally frequent wildfires have the potential to cause long-term degradation of habitat. Direct human impacts to vireo habitat were not documented in 2017, although continued attention to potential impacts (weed control, off-road vehicle traffic) is warranted. While some human impacts can only be mitigated by extreme action (e.g., closing high-speed roads in vireo habitat during vireo breeding season, prohibiting the use of firearms during dry, windy weather), other impacts may be mitigated by continued education and adjustments to schedules. Communication among personnel may reduce the instances of human-related impacts to vireos and occupied vireo habitat by allowing all participants to understand needs and flexibilities and adjust their activities accordingly. Our findings and experience indicate that impacts to vireos can be minimized when military training exercises and maintenance activities, such as continuing to clear vegetation outside the vireo breeding season or limiting these activities to areas not occupied by vireos, are coordinated among personnel. This coordination and cooperation among various departments could help maintain a balance between the sometimes competing land uses on Base, including military activities, recreation, habitat protection, and endangered species management.

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APPENDICES

Appendix A. Least Bell's Vireo Survey Areas at Marine Corps Base Camp Pendleton, 2017.

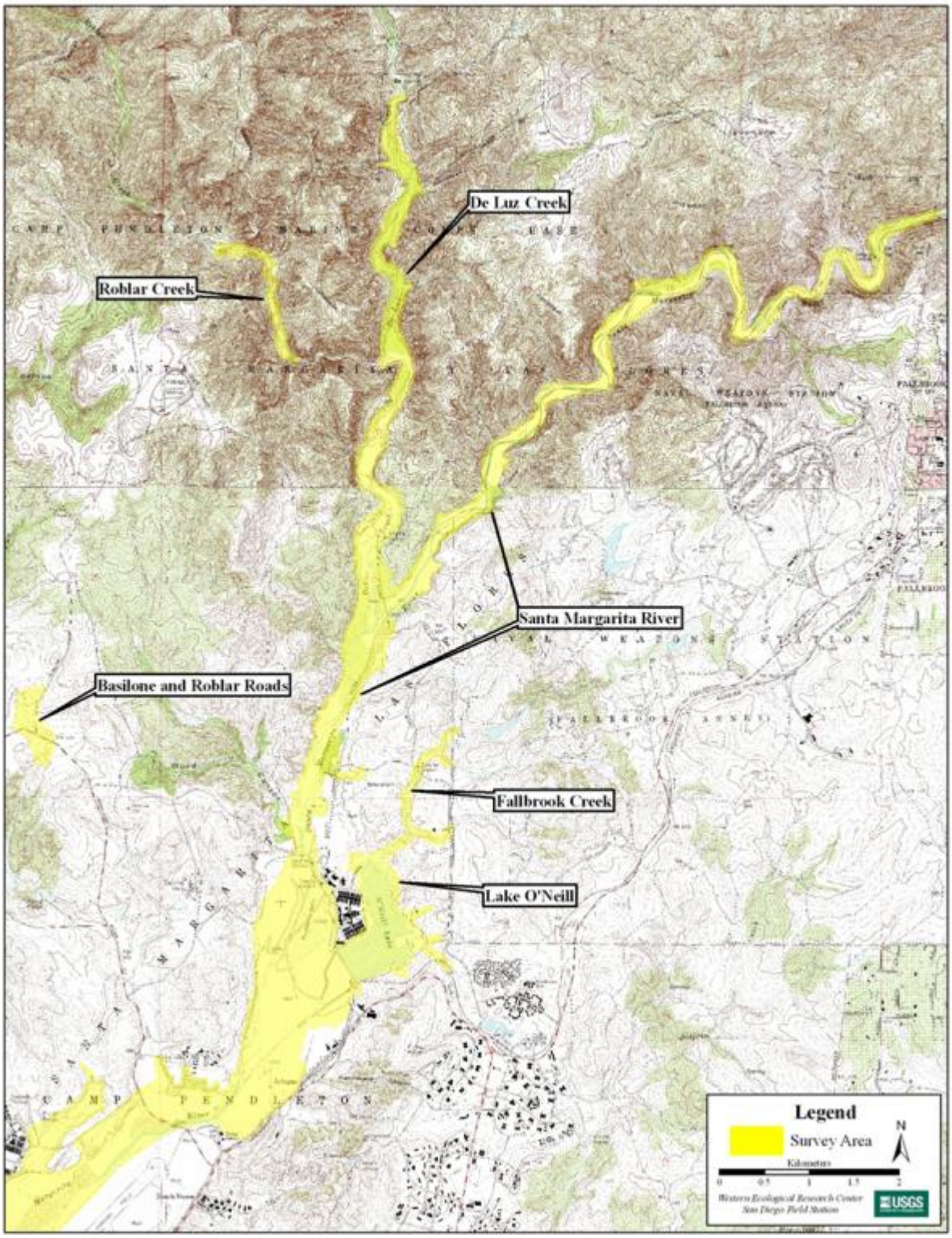

Fig. 15. Least Bell's Vireo survey areas at Marine Corps Base Camp Pendleton, 2017: Upper Santa Margarita River, Fallbrook Creek, Lake O'Neill, De Luz Creek, Roblar Creek, and Basilone and Roblar Roads.

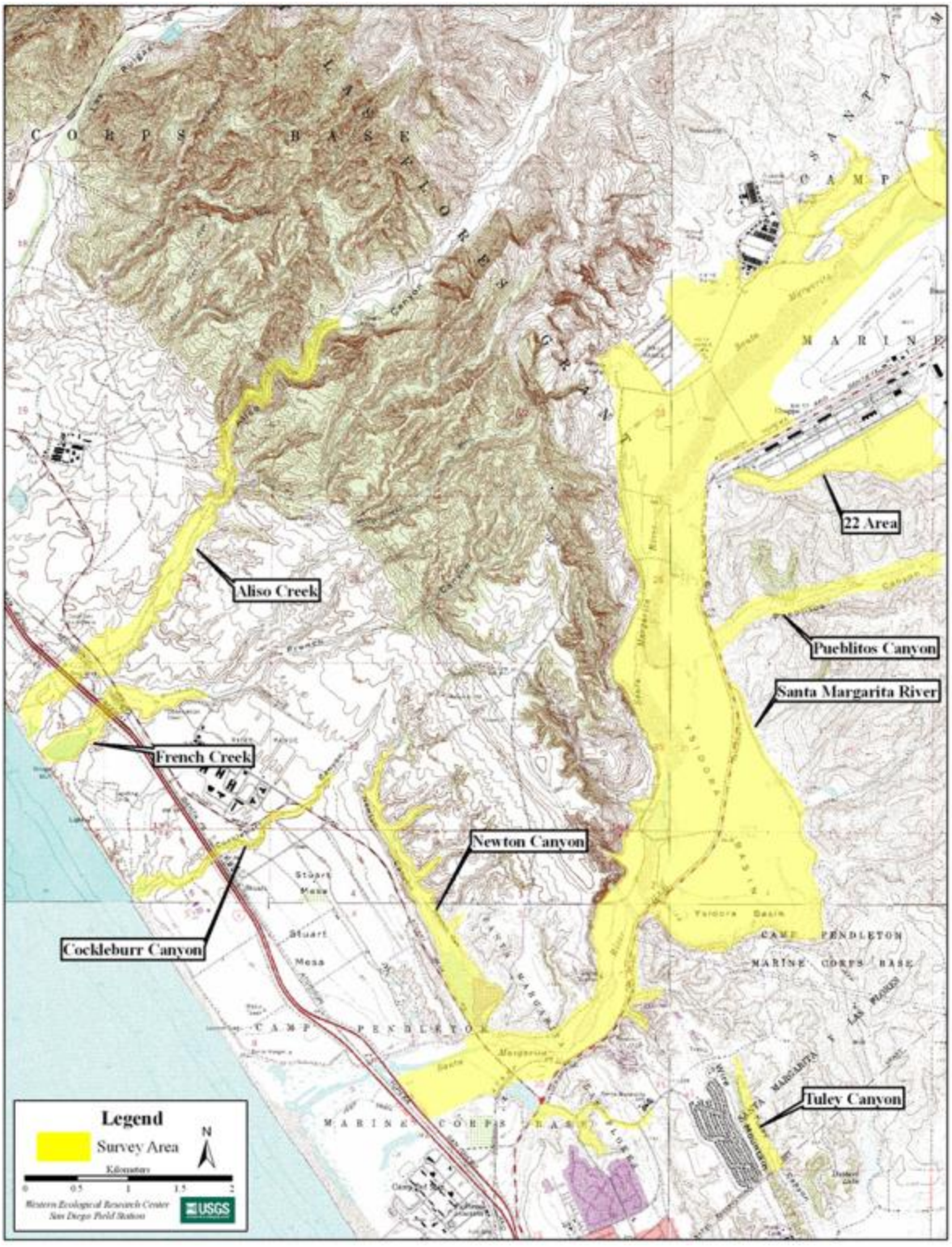

Fig. 16. Least Bell's Vireo survey areas at Marine Corps Base Camp Pendleton, 2017: Lower Santa Margarita River, 22 Area, Pueblitos Canyon, Tuley Canyon, Newton Canyon, Cockleburr Canyon, French Creek, and Aliso Creek.

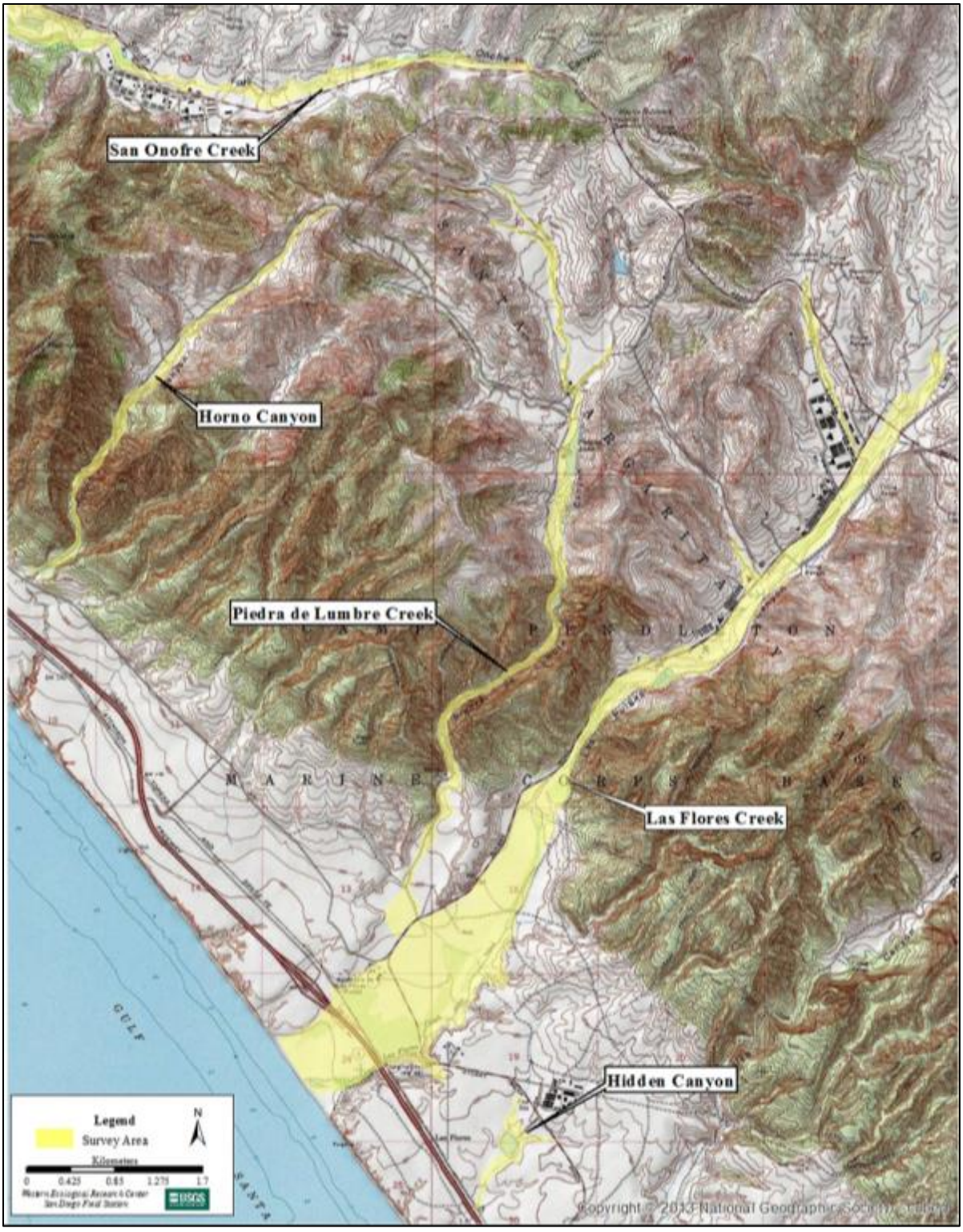

Fig. 17. Least Bell's Vireo survey areas at Marine Corps Base Camp Pendleton, 2017: San Onofre Creek South Fork, Ammunition Supply Point, Horno Canyon, Piedra de Lumbre Creek, Las Flores Creek, and Hidden Canyon.

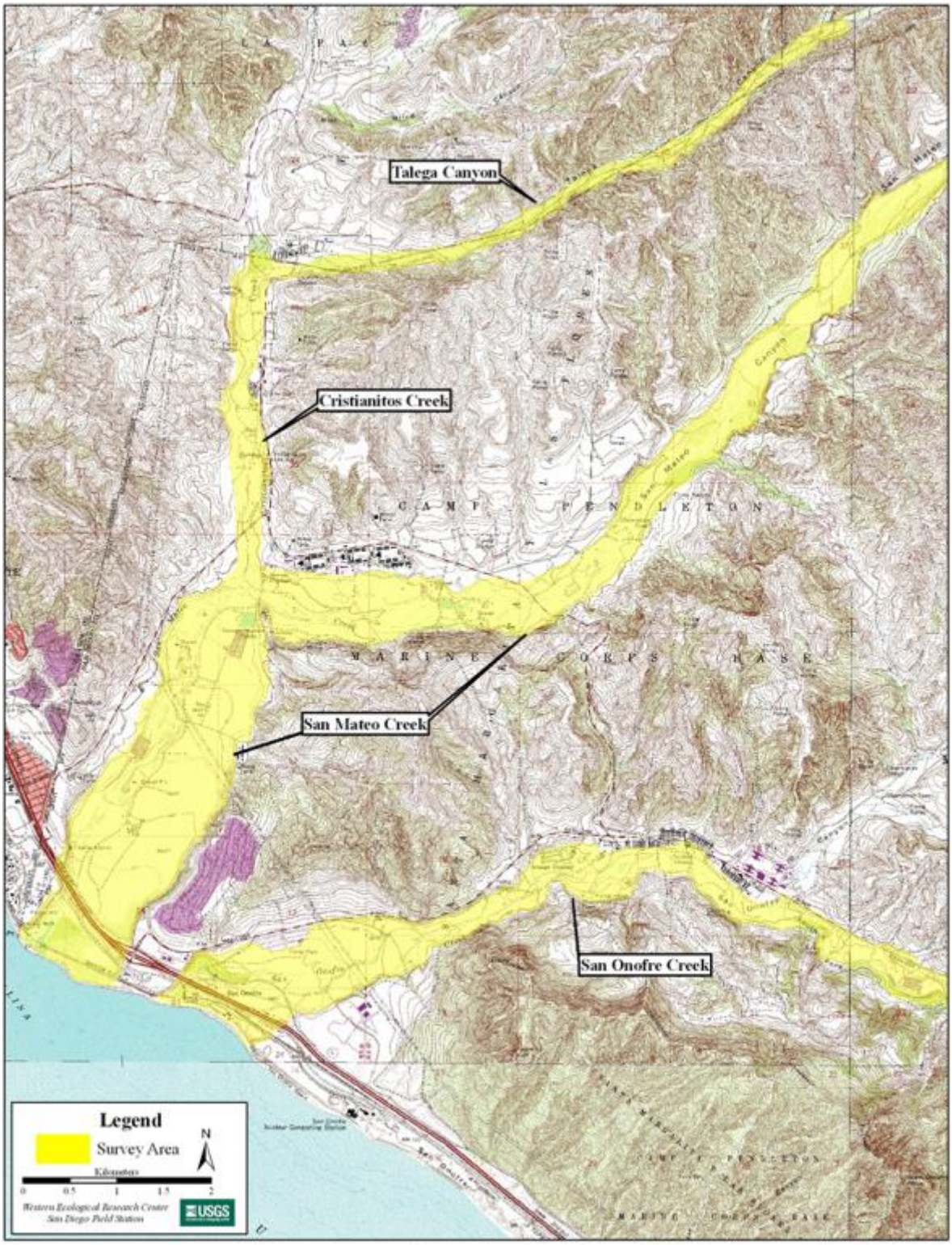

Fig. 18. Least Bell's Vireo survey areas at Marine Corps Base Camp Pendleton, 2017: Talega Canyon, Cristianitos Creek, San Mateo Creek, and San Onofre Creek.

Fig. 19. Least Bell's Vireo survey areas at Marine Corps Base Camp Pendleton, 2017: Upper San Mateo Creek.

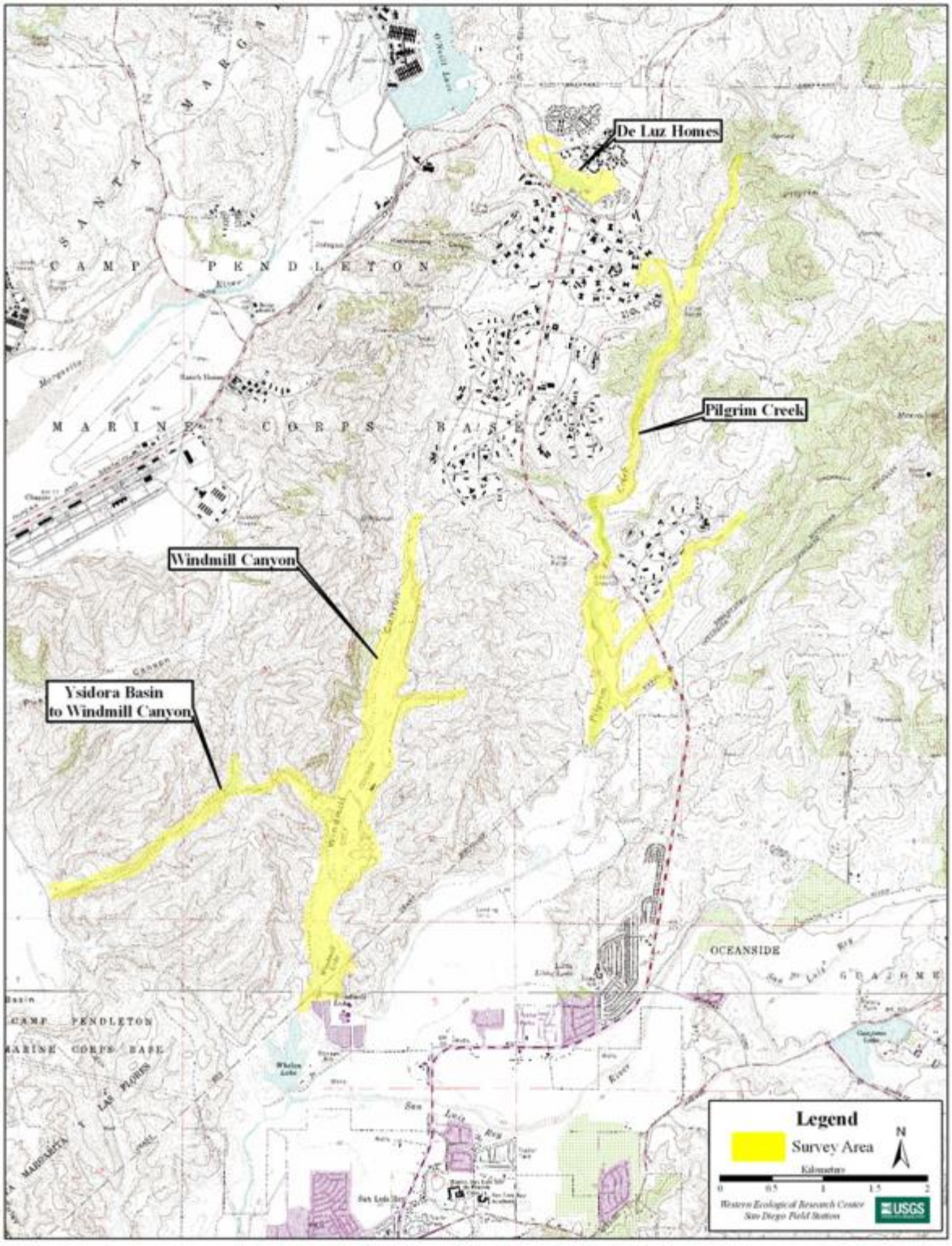

Fig. 20. Least Bell's Vireo survey areas at Marine Corps Base Camp Pendleton, 2017: Windmill Canyon, Ysidora Basin to Windmill Canyon, Pilgrim Creek, and De Luz Homes Habitat.

Appendix B. Coordinates of eastern ends of Post-fire vegetation transects. Datum is WGS84.

Transect ID	Latitude (Y)	Longitude (X)	Bearing (degrees)
1	33.36149	-117.32195	300
2	33.36043	-117.32222	302
3	33.35956	-117.32296	292
4	33.35868	-117.32341	288
5	33.35776	-117.32377	290
6	33.35683	-117.32411	290
7	33.35605	-117.32464	294
8	33.35544	-117.32585	294
9	33.35461	-117.32616	294
10	33.35369	-117.32640	294
11	33.35313	-117.32705	298
12	33.35207	-117.32718	300
13	33.35108	-117.32779	282
14	33.34996	-117.32814	282
15	33.34901	-117.32843	280
16	33.34813	-117.32859	286
17	33.34734	-117.32876	284
18	33.34656	-117.32968	280
19	33.34570	-117.33000	292
20	33.34483	-117.33072	294
21	33.34393	-117.33035	296
22	33.34297	-117.33037	296
23	33.34216	-117.33081	284
24	33.34128	-117.33122	292

Appendix C. Photographs of Post-fire vegetation transects taken from the beginning of each transect and oriented along the bearing of the transect, July 2014 and July/August 2017, Marine Corps Base Camp Pendleton. All photographs in 2014 were taken by L. Allen. Photographs from 2017 were taken by Lisa Allen, Armand Amico, Annabelle Bernabe, Angela Johnson, Michael Lester, Nevada Trager, and Michelle Treadwell.

Photographs Taken July 2014	Photographs Taken July 2017
	
Transect 1	
	
Transect 2	

Photographs Taken July 2014	Photographs Taken July 2017
	
Transect 3	
	
Transect 4	

Photographs Taken July 2014	**Photographs Taken July 2017**
	
Transect 5	
	
Transect 6	

Photographs Taken July 2014	Photographs Taken July 2017
	
Transect 7	
	
Transect 8	

Photographs Taken July 2014	Photographs Taken July 2017
	
Transect 9	
	
Transect 10	

Photographs Taken July 2014	Photographs Taken July 2017
	
Transect 11	
	
Transect 12	

Photographs Taken July 2014	Photographs Taken July 2017
	
Transect 13	
	
Transect 14	

Photographs Taken July 2014	Photographs Taken July 2017
	
Transect 15	
	
Transect 16	

Photographs Taken July 2014	Photographs Taken July 2017
	
Transect 17	
	
Transect 18	

Photographs Taken July 2014	Photographs Taken July 2017
	
Transect 19	
	
Transect 20	
	
Transect 21	

Photographs Taken July 2014	Photographs Taken July 2017
	
Transect 22	
	
Transect 23	

Appendix D. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2017.

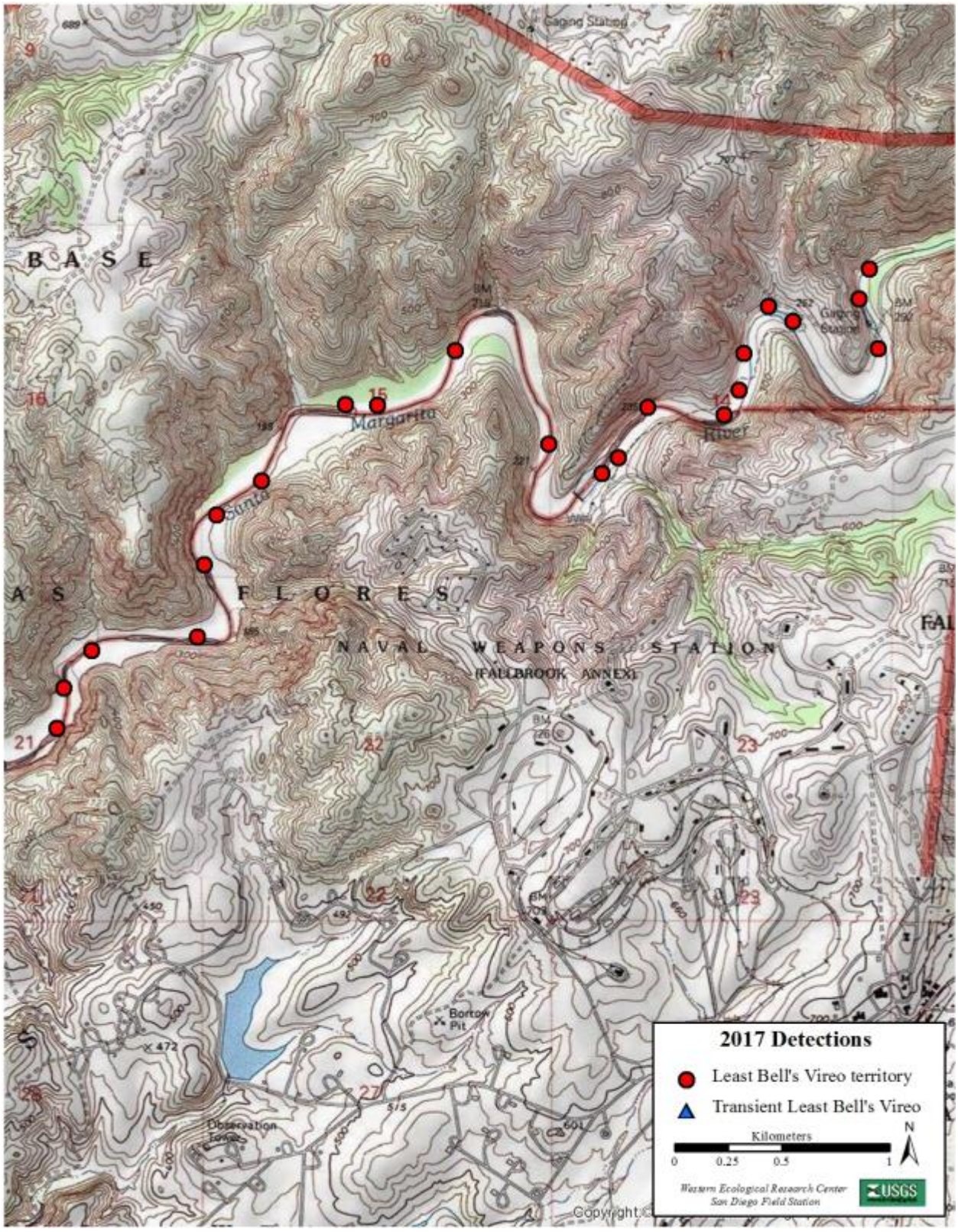

Fig. 21. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2017: Upper Santa Margarita River.

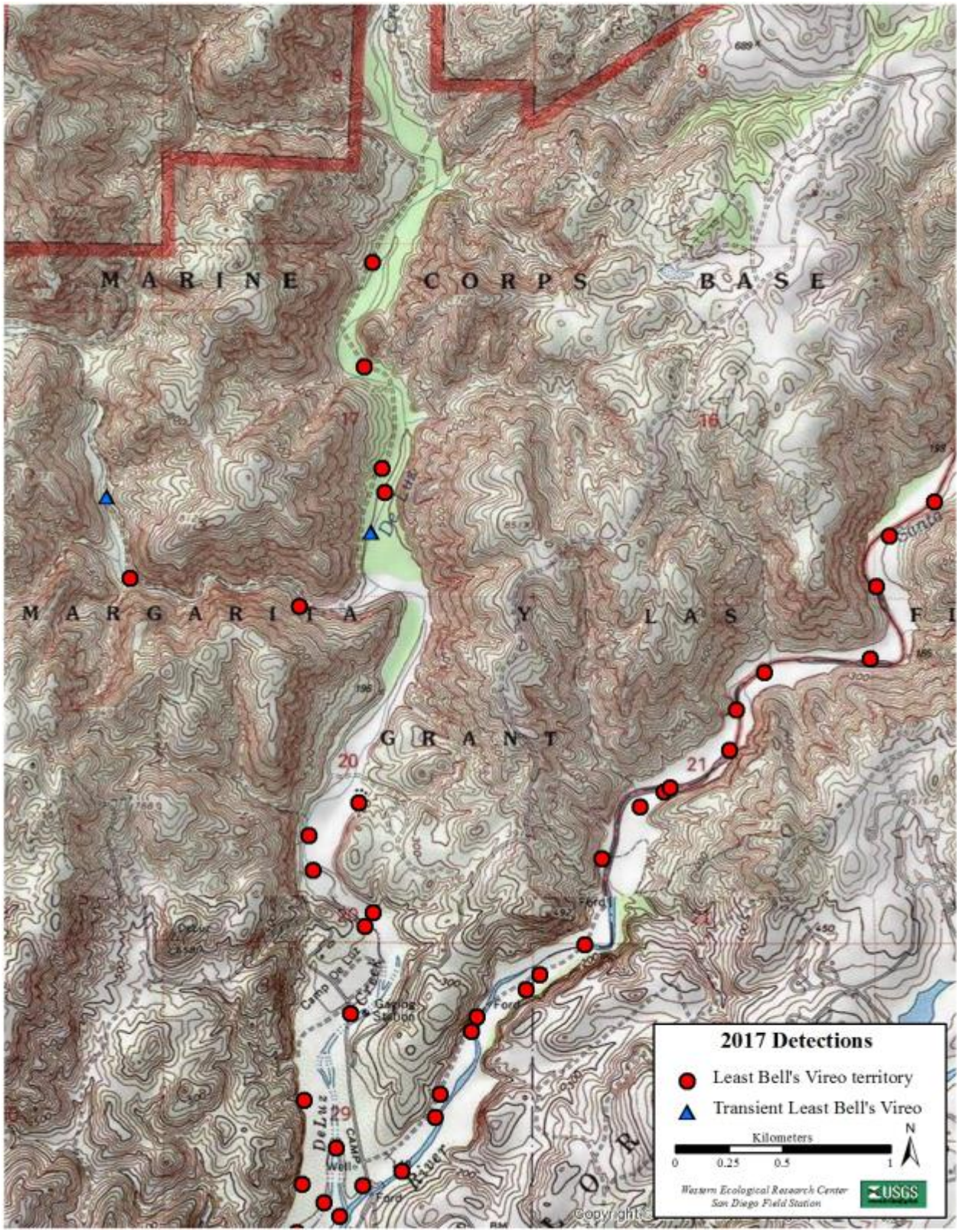

Fig. 22. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2017: Upper Santa Margarita River, De Luz Creek, and Roblar Creek.

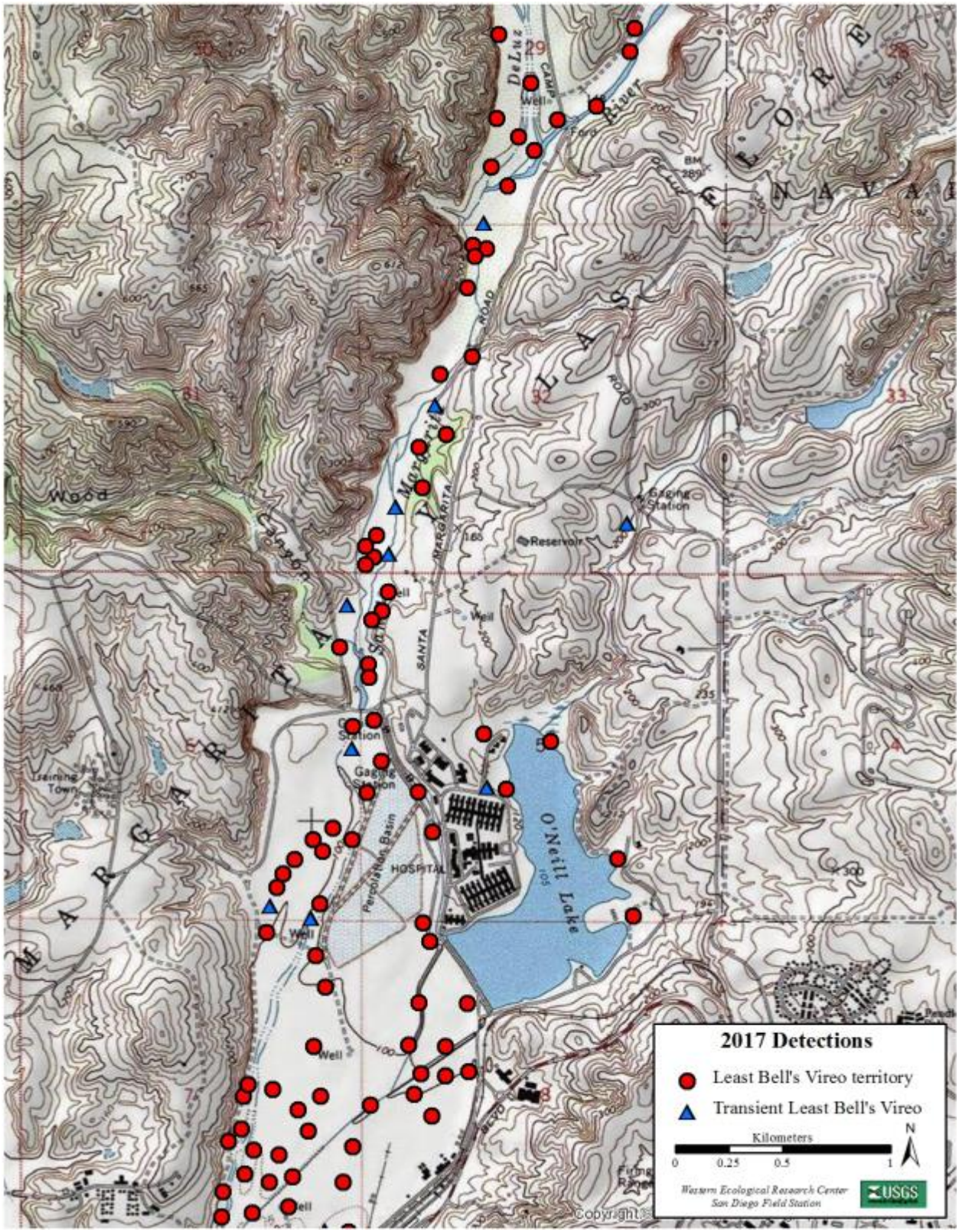

Fig. 23. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2017 Santa Margarita River, Lake O'Neill, and Fallbrook Creek.

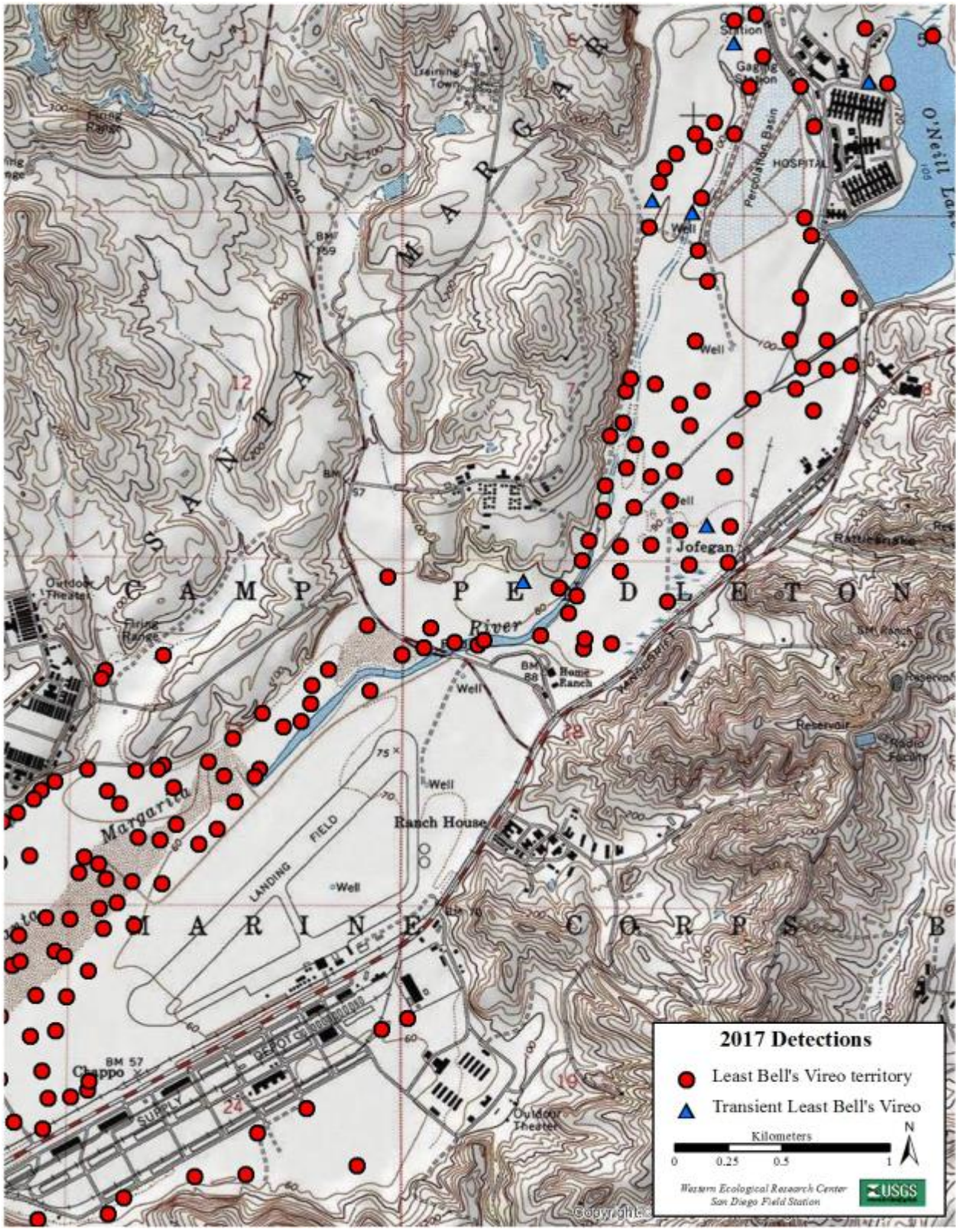

Fig. 24. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2017: Santa Margarita River.

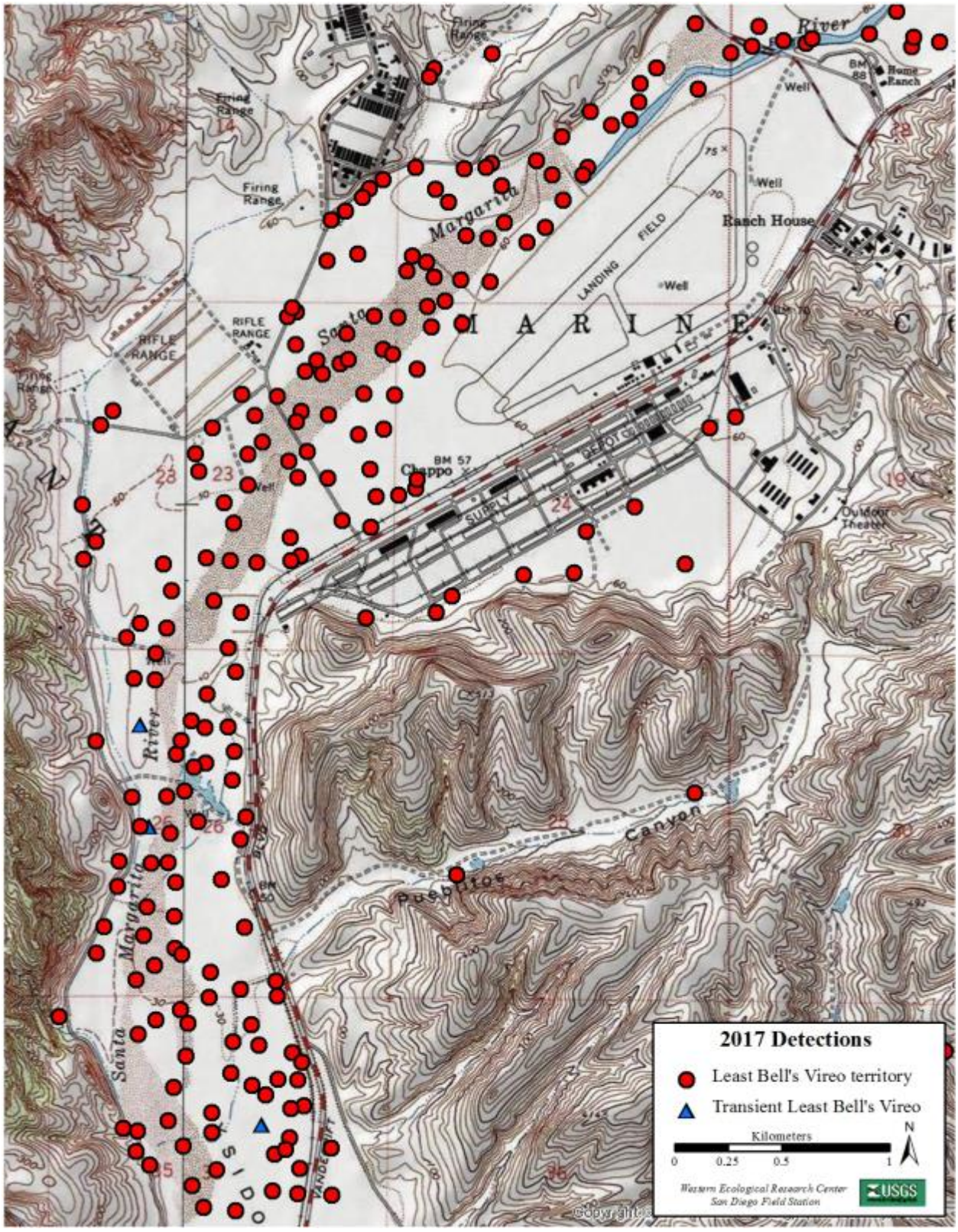

Fig. 25. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2017: Santa Margarita River, 22 Area, and Pueblitos Canyon.

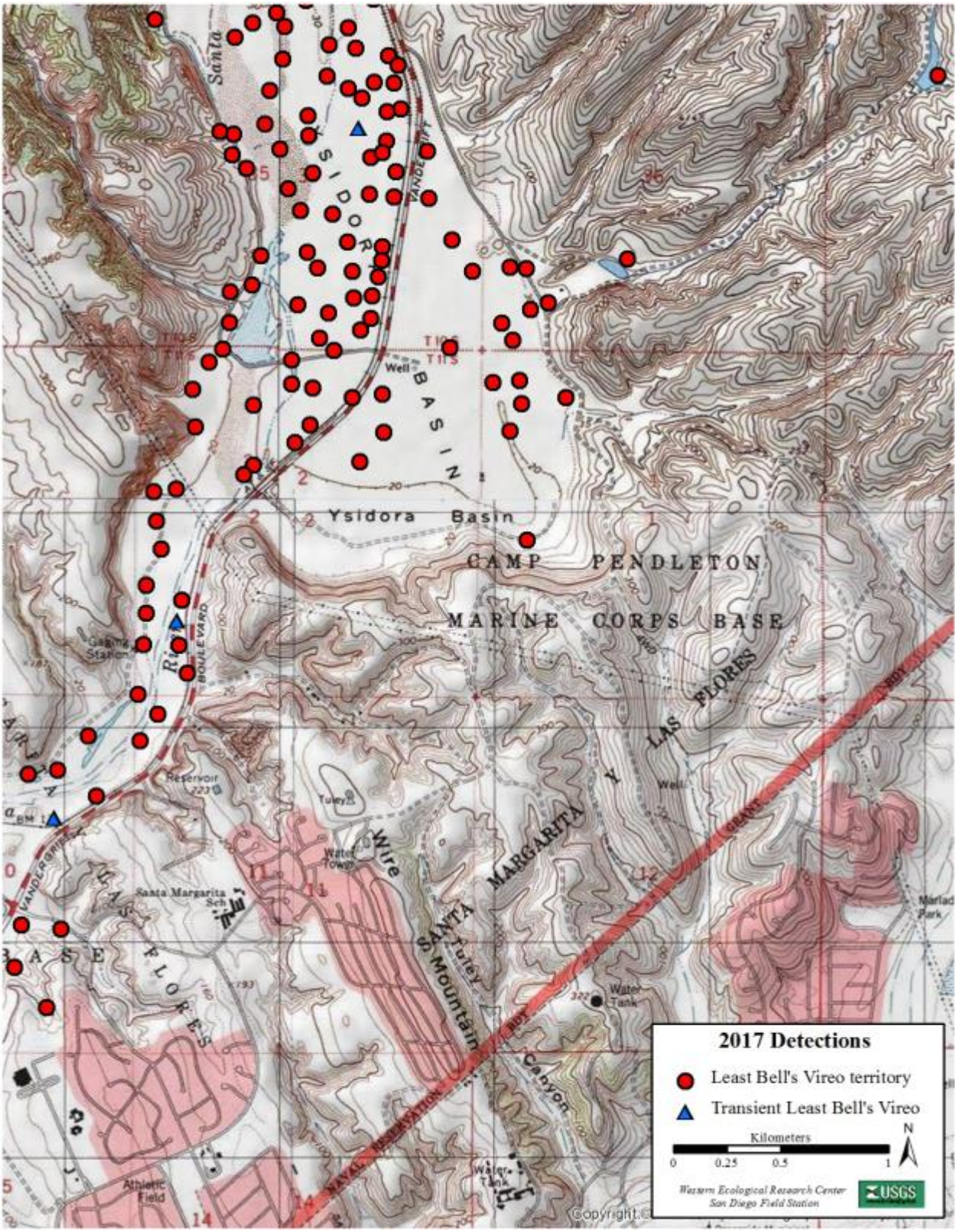

Fig. 26. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2017: Santa Margarita River, Ysidora Basin, and Ysidora Basin to Windmill Canyon.

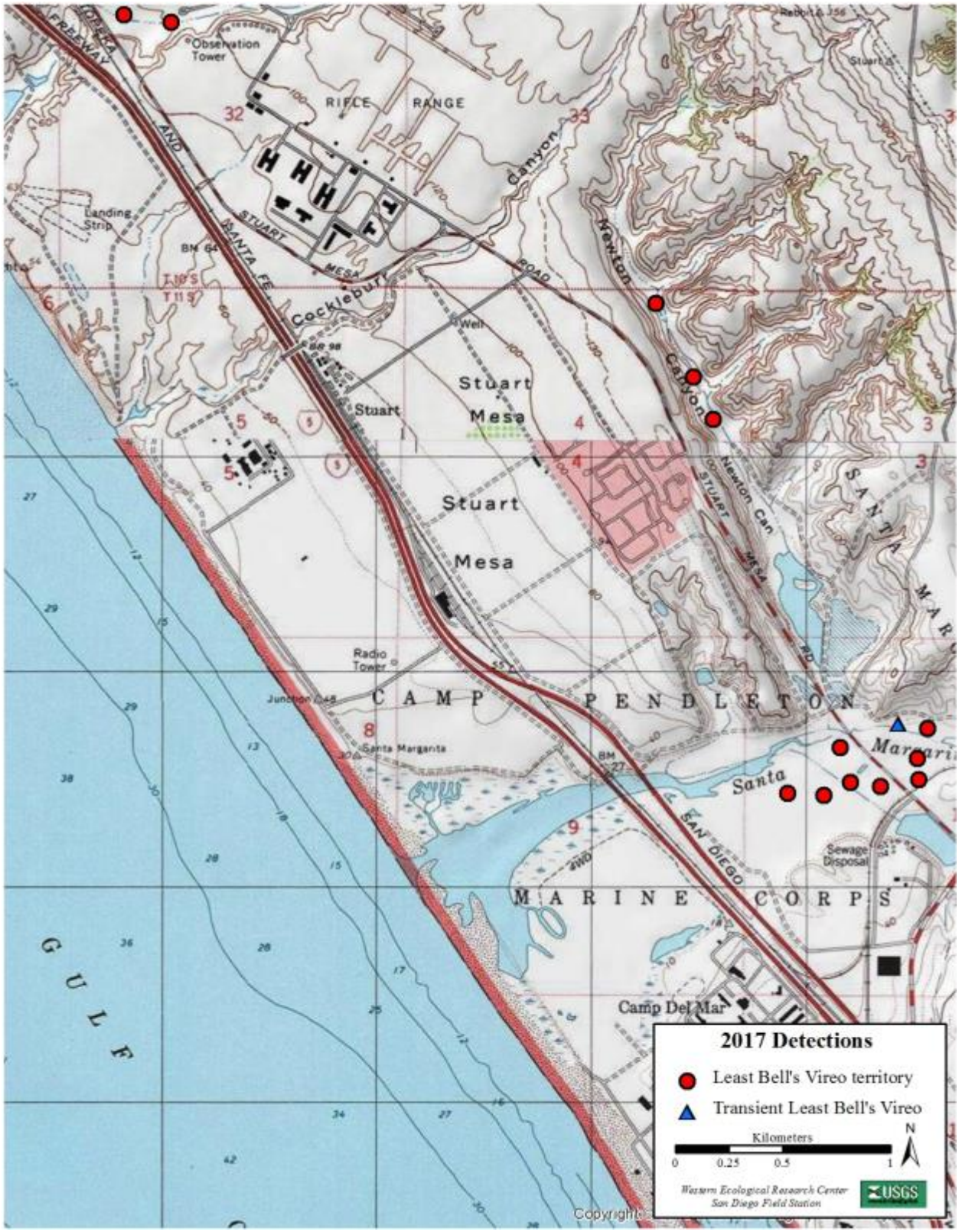

Fig. 27. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2017: Lower Santa Margarita River, Newton Canyon, and Cockleburr Canyon.

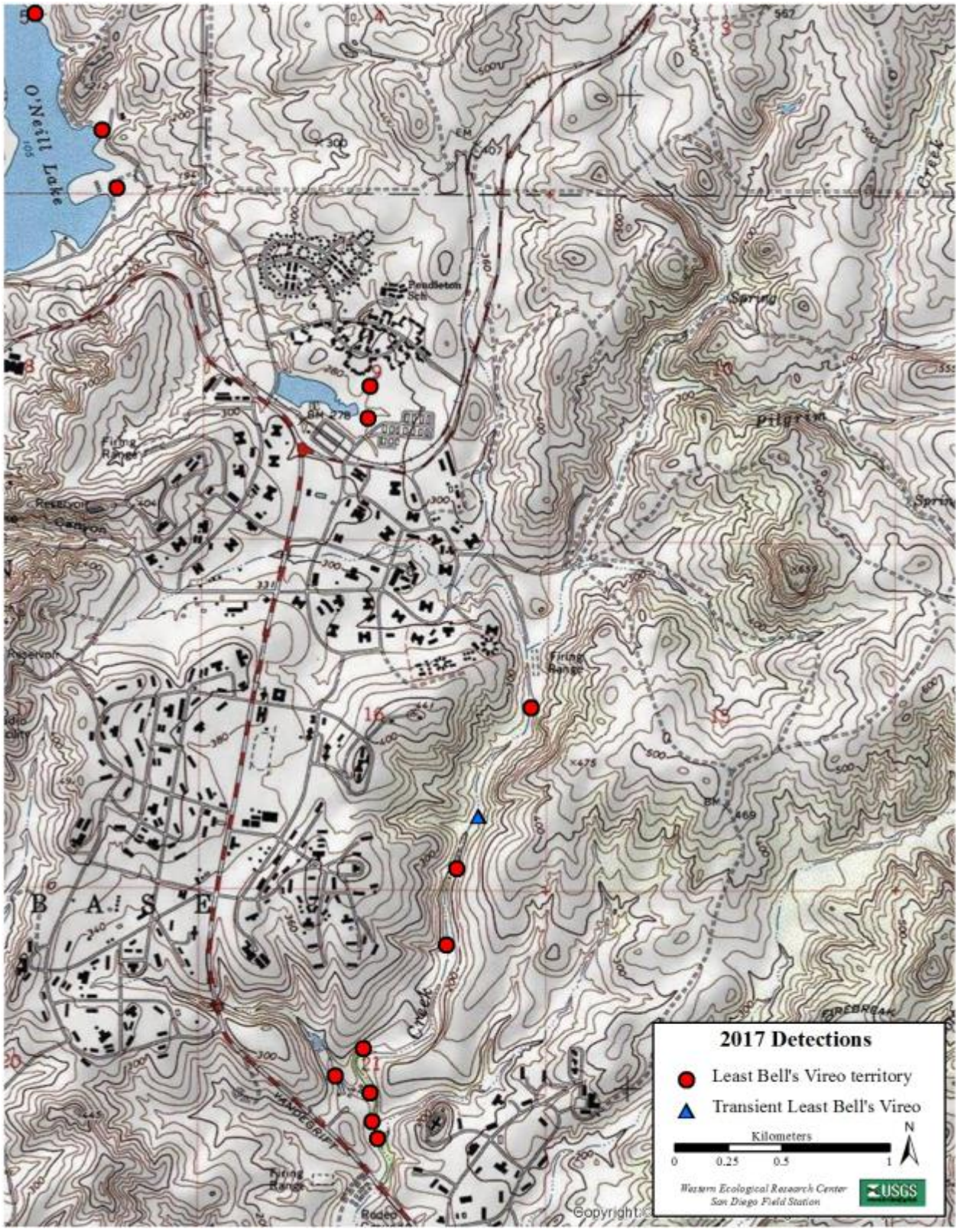

Fig. 28. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2017: Upper Pilgrim Creek, De Luz Homes Habitat, and Lake O'Neill.

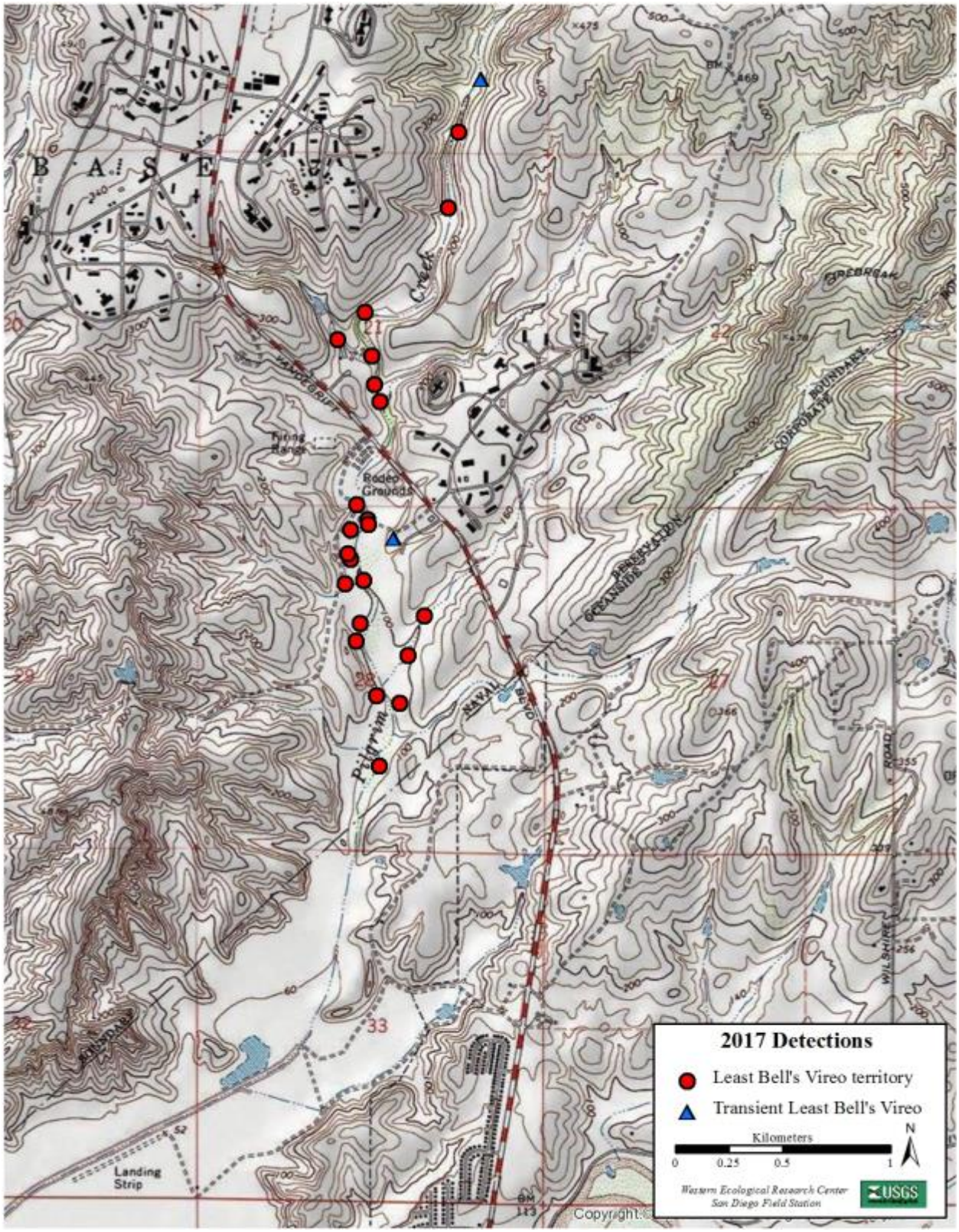

Fig. 29. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2017: Upper and Lower Pilgrim Creek.

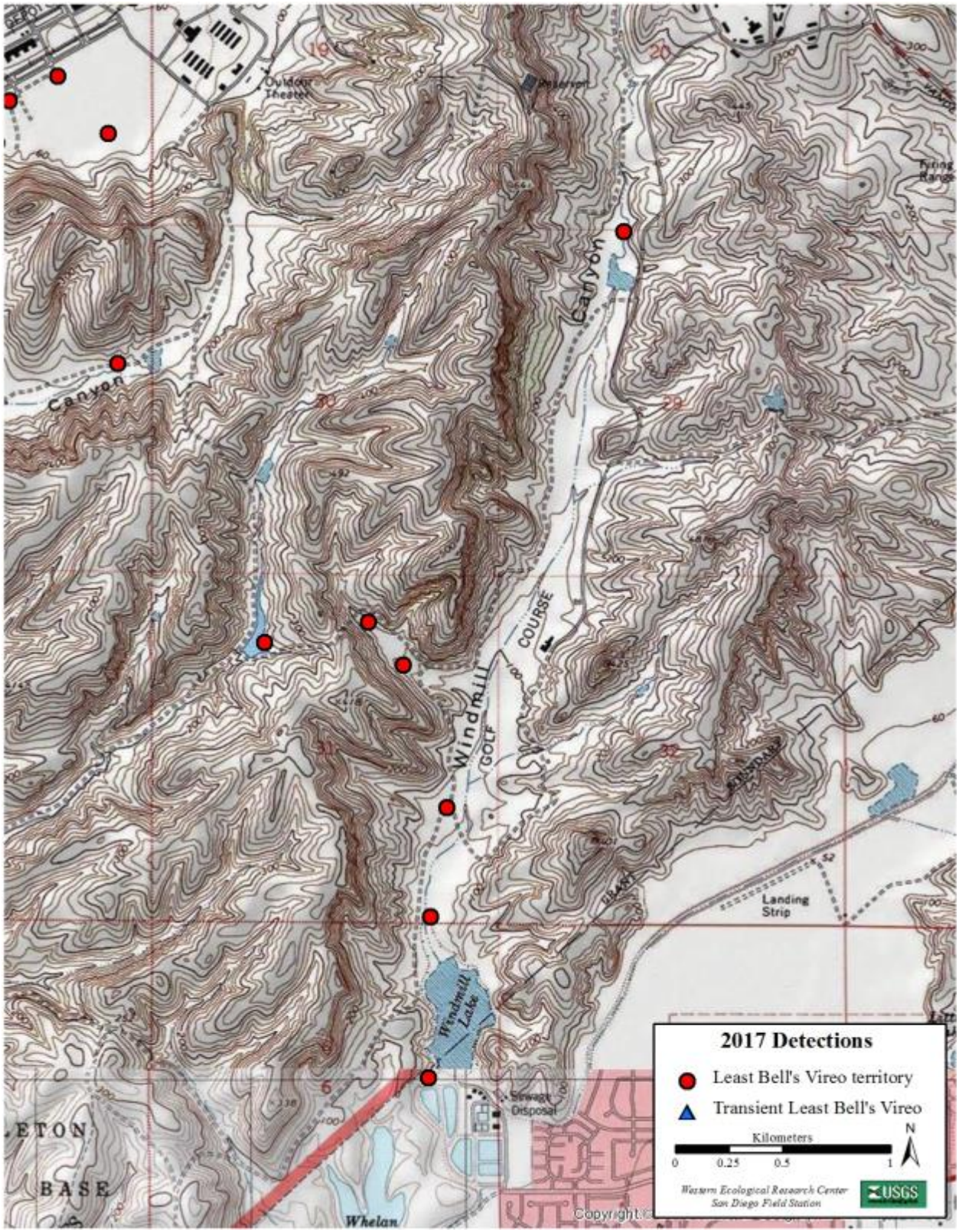

Fig. 30. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2017: Windmill Canyon and Ysidora Basin to Windmill Canyon.

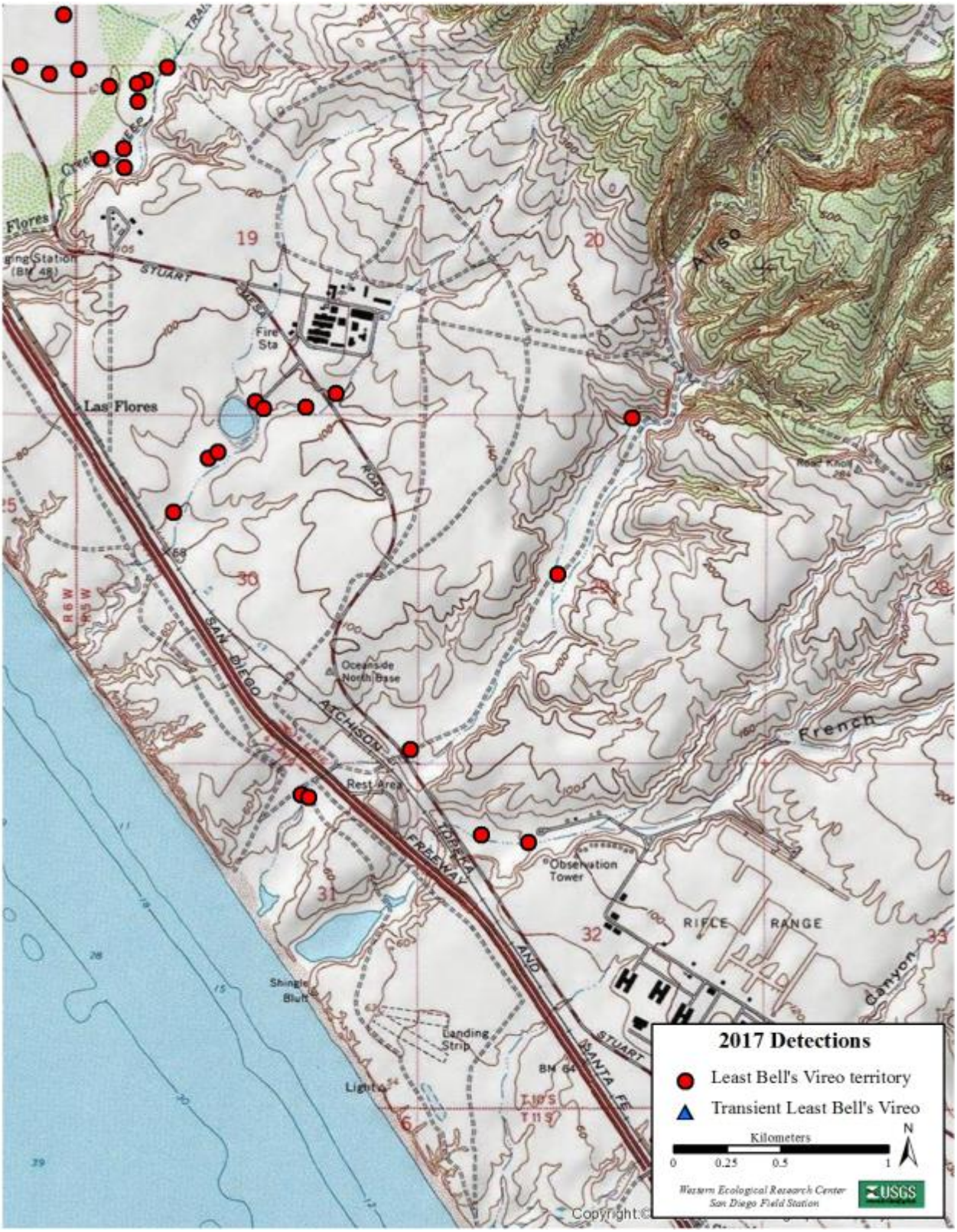

Fig. 31. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2017: French Creek, Aliso Creek, and Hidden Canyon.

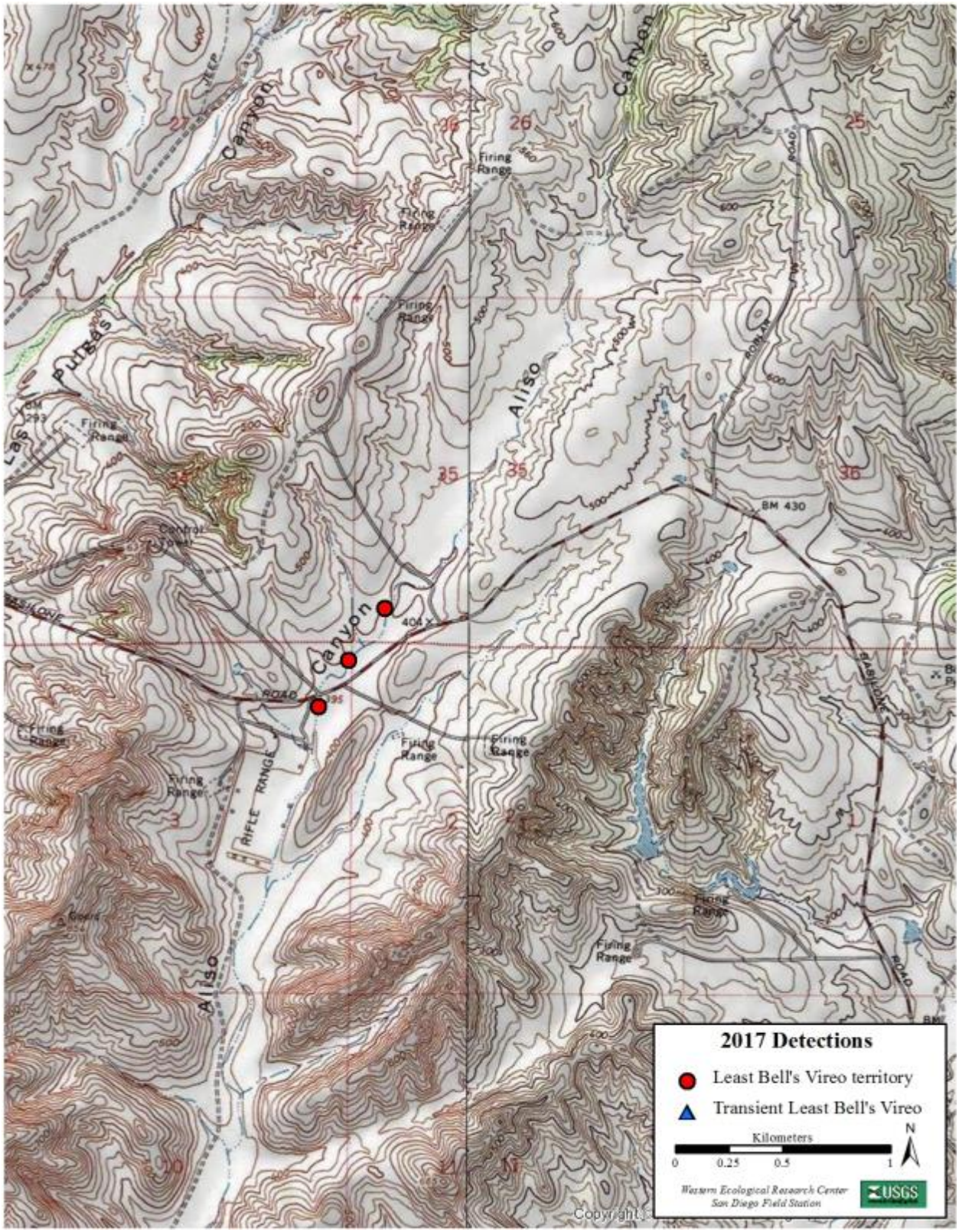

Fig. 32. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2017: Basilone and Roblar Roads.

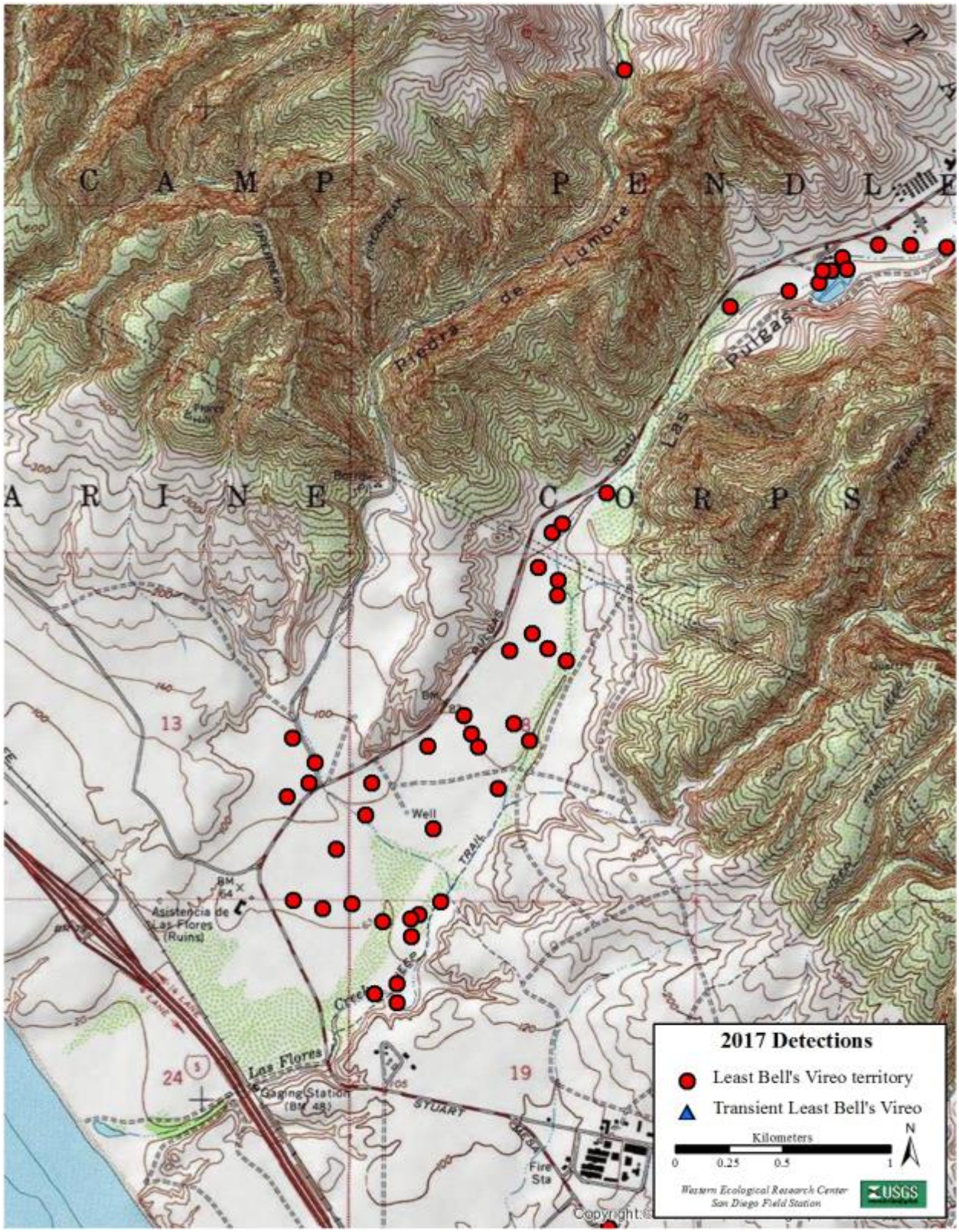

Fig. 33. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2017: Lower Las Flores Creek and Piedra de Lumbre Canyon.

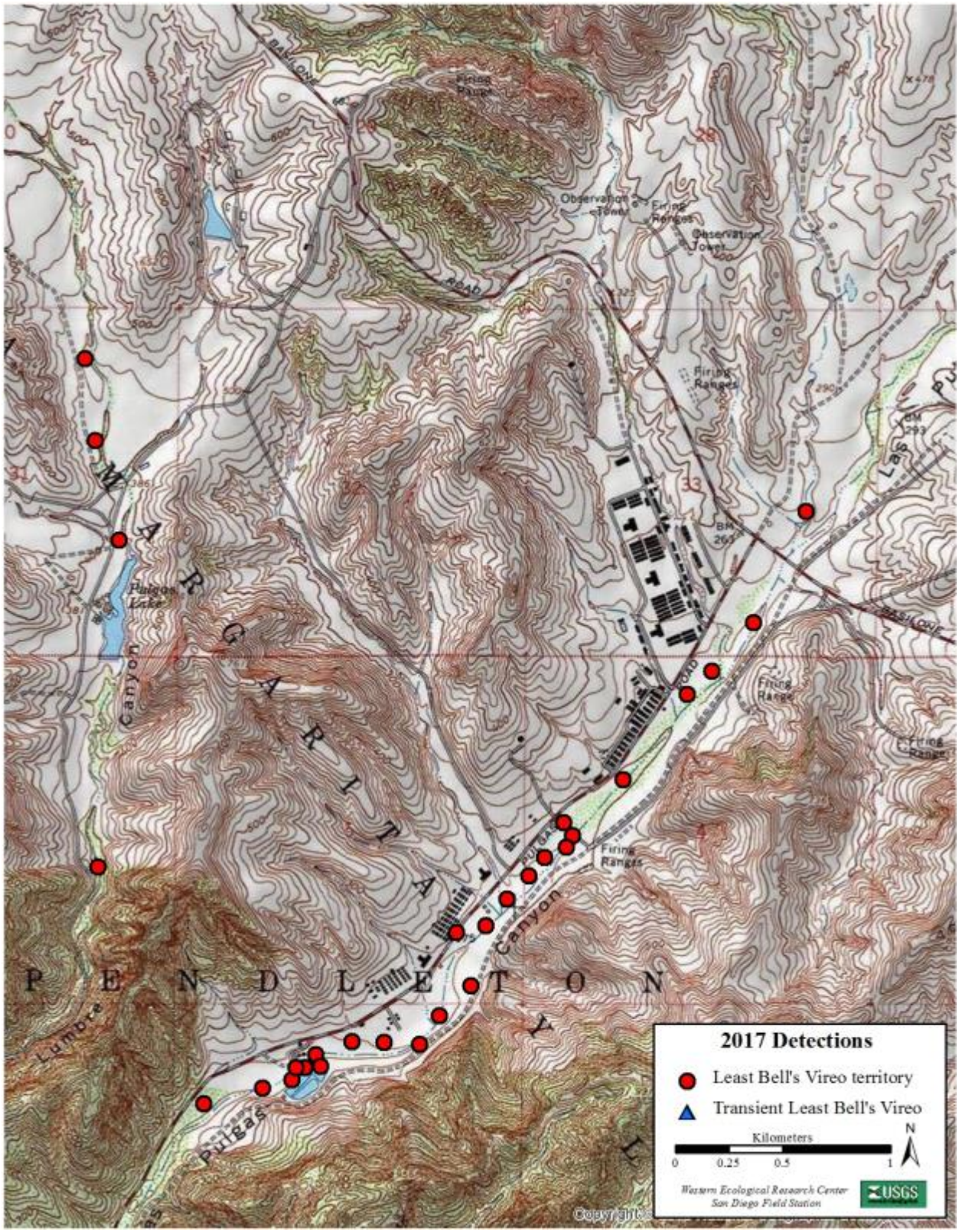

Fig. 34. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2017: Piedra de Lumbre Canyon and Upper Las Flores Creek.

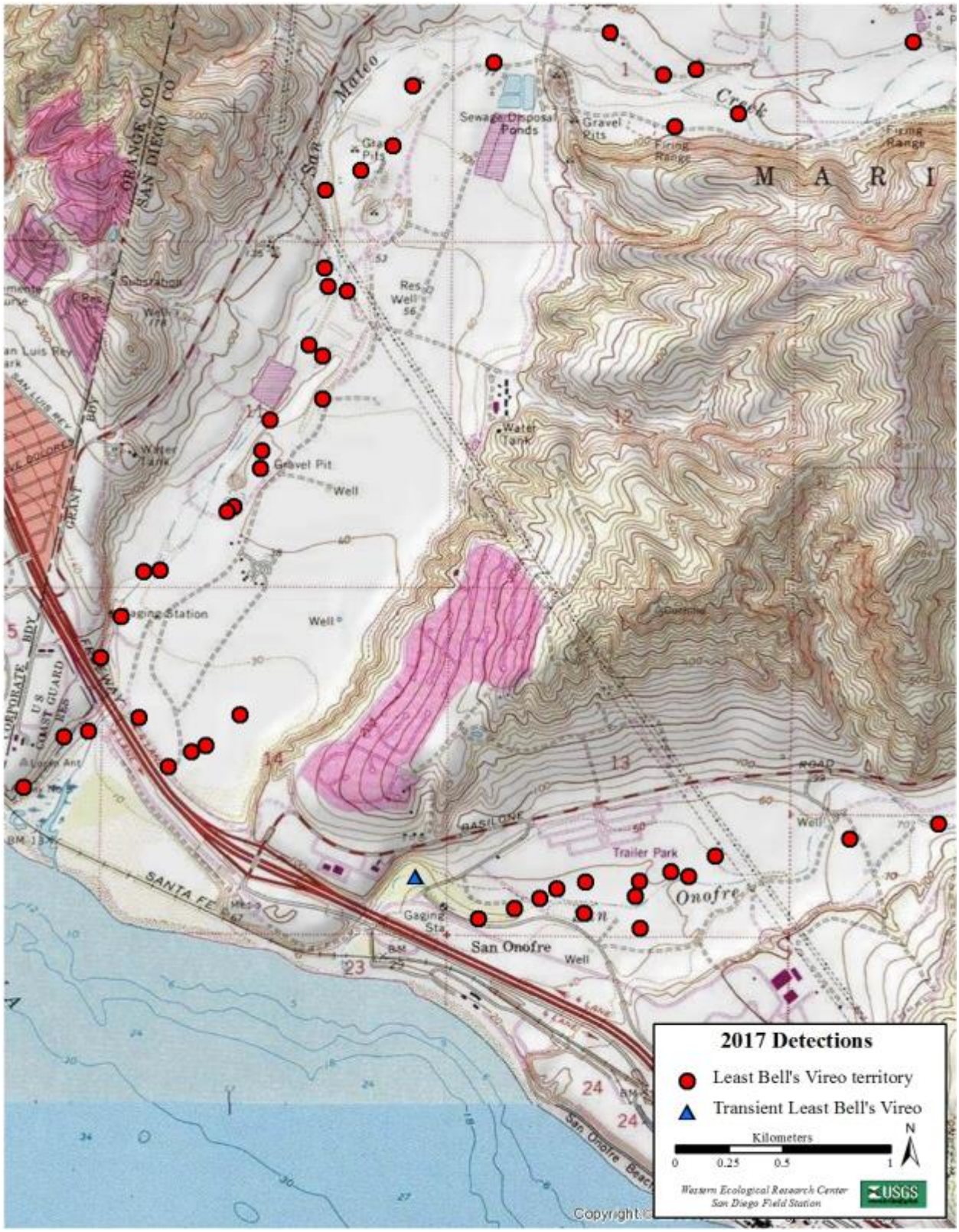

Fig. 35. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2017: Lower San Onofre Creek and Lower San Mateo Creek.

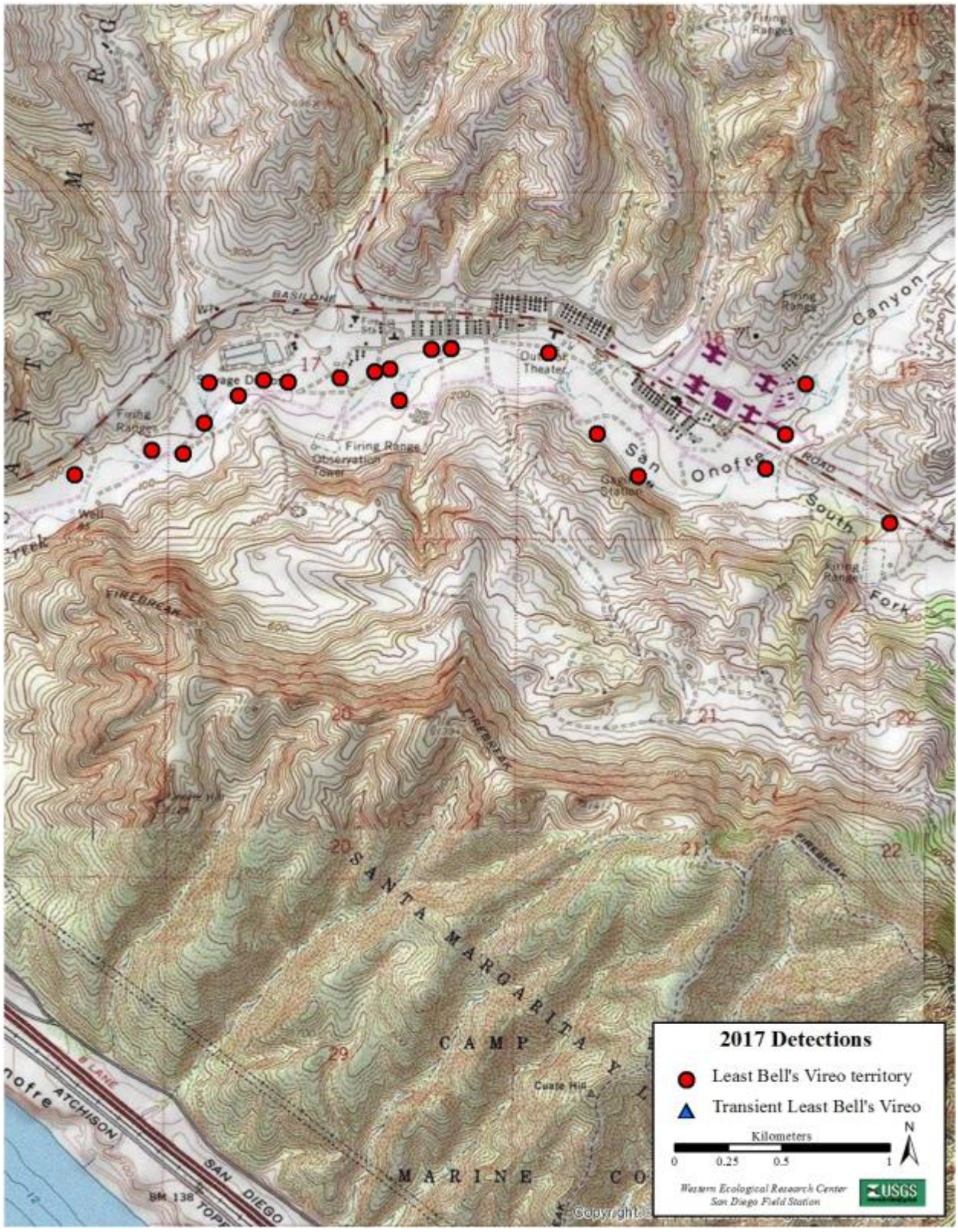

Fig. 36. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2017: San Onofre Creek.

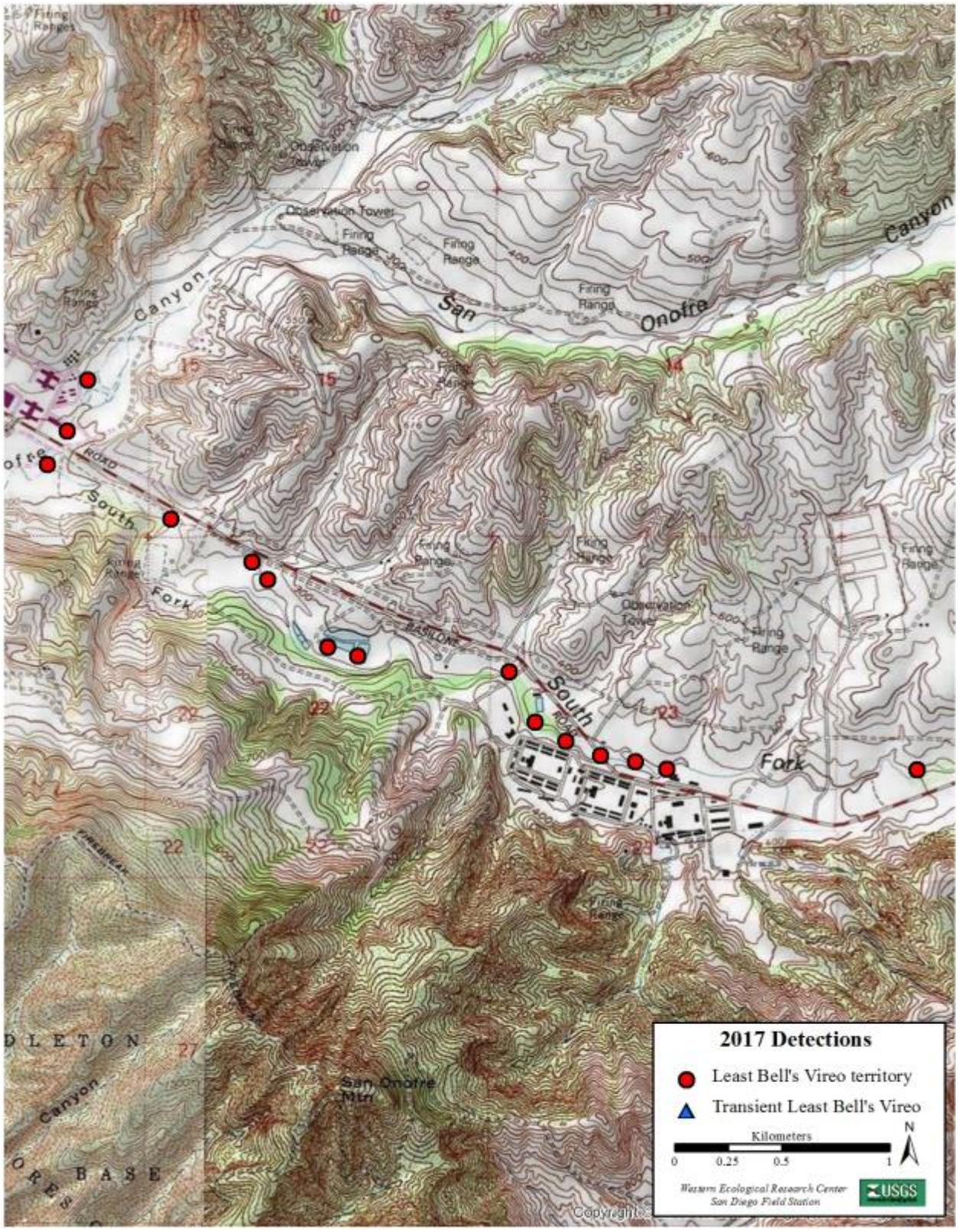

Fig. 37. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2017: South Fork San Onofre Creek.

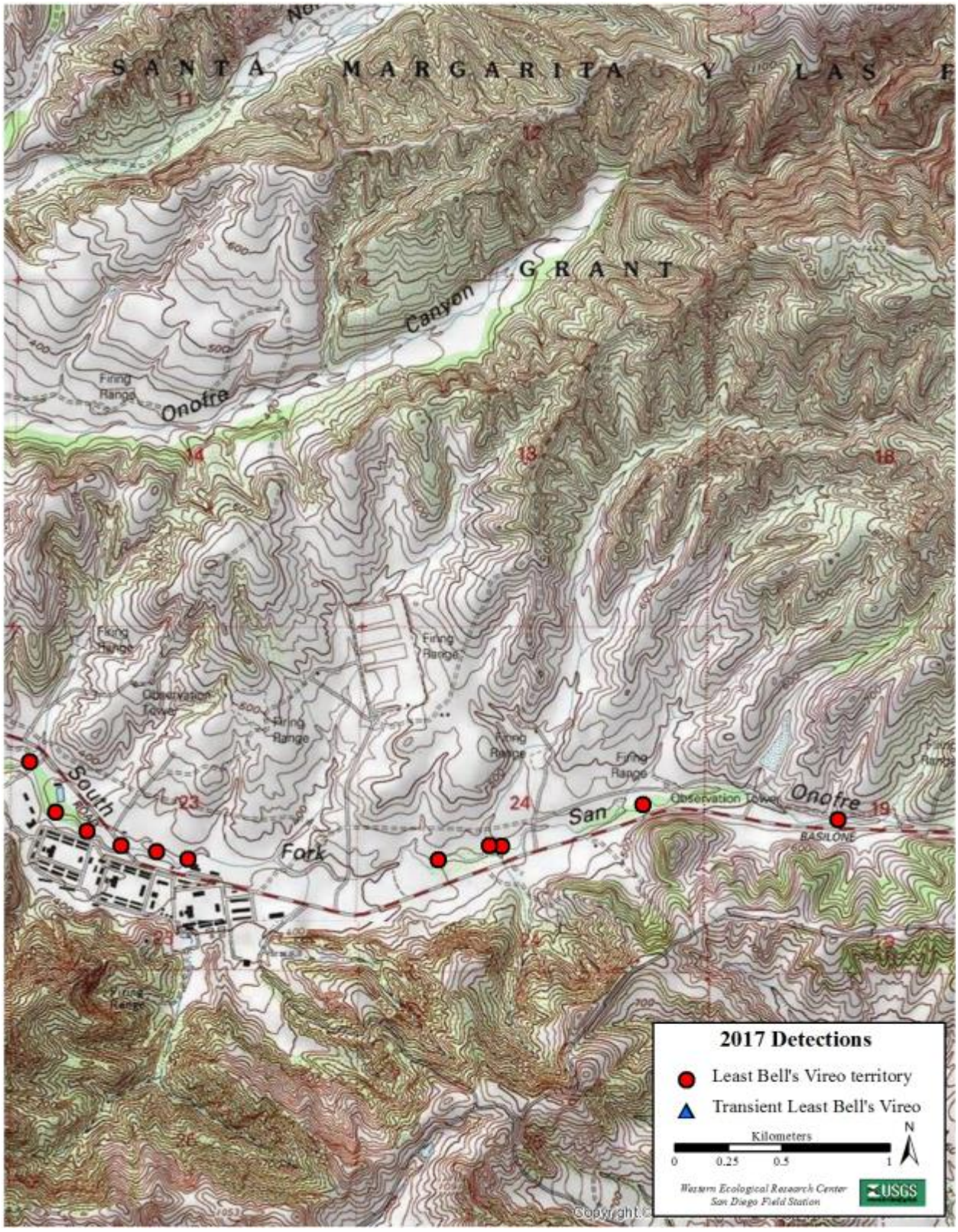

Fig. 38. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2017: San Onofre Creek.

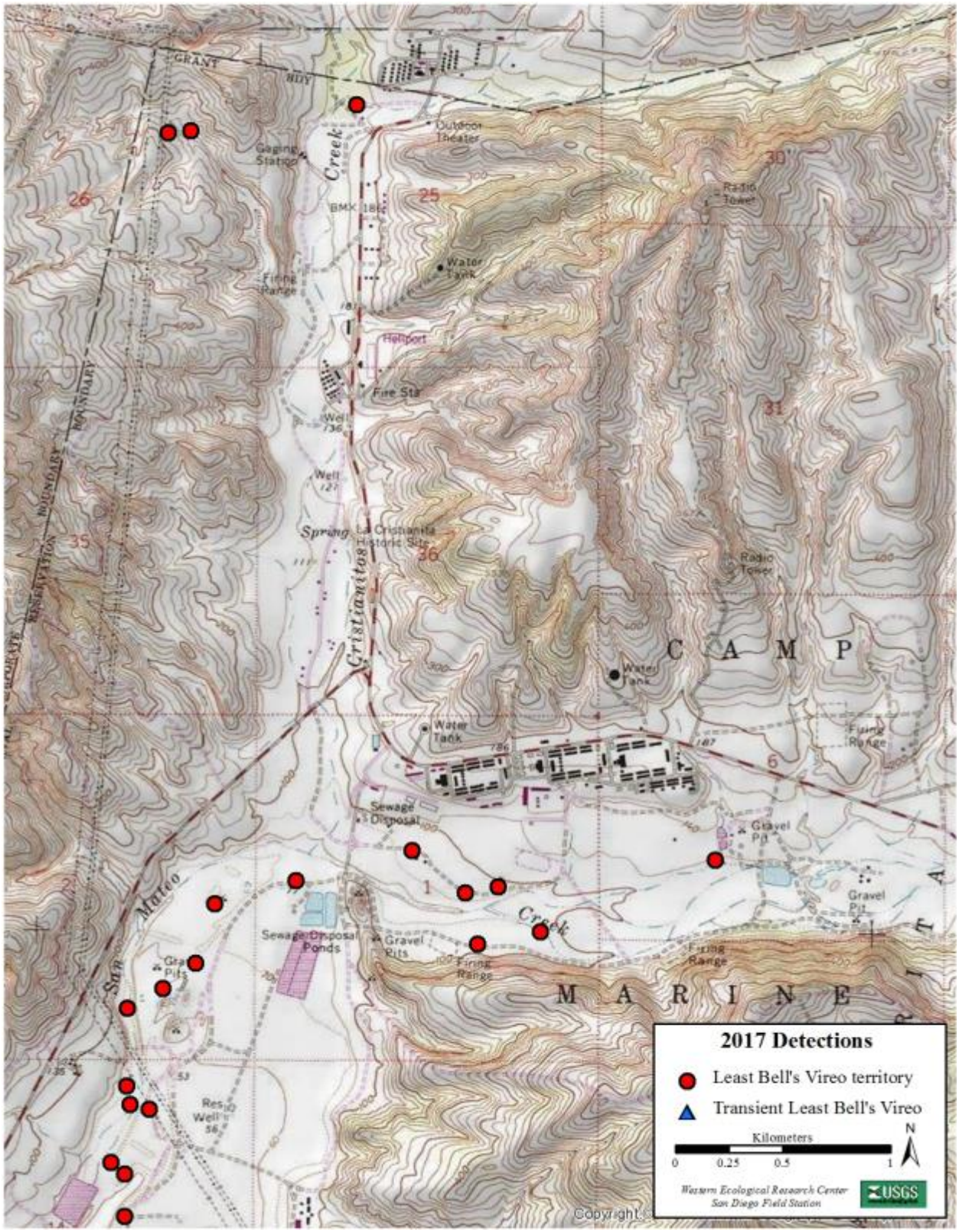

Fig. 39. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2017: San Mateo Creek and Cristianitos Creek.

Appendix E. Banded Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2017.

Drainage / Sex[2]	Band Combination[1] Left Leg	Right Leg	Age	Comments[3]
De Luz Creek				
M	LPBK	YEPU/Mgo	≥ 5 yrs.	Banded as an adult at DL MAPS in 2013.
U	BKBK	PUOR/Msi	HY	Banded as a juvenile at DL MAPS in 2017.
U	BKBK	DGOR/Msi	HY	Banded as a juvenile at DL MAPS in 2017.
U	YEYE	BYST/Mgo	HY	Banded as a juvenile at DL MAPS in 2017.
U	ORDG/Msi	BKBK	HY	Banded as a juvenile at DL MAPS in 2017.
Las Flores Creek				
F	PUYE	DBWH/Mdb	2 yrs.	Banded as a nestling on the SLR in 2015.
F	BWST/Mdb	BKBK	1 yr.	Banded as a nestling on the SLR in 2016.
M	WHDP	LPBK/Mgo	4 yrs.	Banded as a nestling at TRP in 2013.
M	PUYE/Mdb	WHDB	3 yrs.	Banded as a nestling on the SLR in 2014.
Newton Canyon				
F	Mdb		≥ 1 yrs.	Banded as a nestling on the SLR before 2017.
M	DPDP	DPDP/Mdb	2 yrs.	Banded as a nestling on the SLR in 2015.
Roblar Creek				
M	DPWH	YEPU/Mgo	8 yrs.	Banded as a nestling at HDX in 2009.
M	OROR/Mgo	YEYE	1 yr.	Banded as a nestling at ARL in 2016.
San Mateo Creek				
F	DPWH/Mdb	BYST	5 yrs.	Banded as a nestling on the SLR in 2012.
San Onofre Creek				
M	Mye	WHWH/sisi	2 yrs.	Banded as a juvenile in BCS in 2015.
Santa Margarita River				
F	LPBK/Mgo	DPDP	≥ 7 yrs.	Banded as unknown age at DL MAPS in 2010.
F	OROR/Mgo	LPBK	≥ 4 yrs.	Banded as an adult at SM MAPS in 2014.
F	LPBK	BKLP/Mgo	≥ 4 yrs.	Banded as an adult at PIK in 2014.
F	WHDP	PUPU/Mgo	4 yrs.	Banded as a nestling at HOL in 2013.
F	YEPU	PUOR/Mgo	4 yrs.	Banded as a nestling at MIN in 2013.
F	WHDP	YEYE/Mgo	4 yrs.	Banded as a nestling at HDX in 2013.
F	ORDG	DPWH/Mgo	4 yrs.	Banded as a nestling at WSP in 2013.
F	WHDP	BKLP/Mgo	4 yrs.	Banded as a nestling at STR in 2013.
F	PUWH	DPDP/Mgo	≥ 3 yrs.	Banded as an adult at SM MAPS in 2015.
F	OROR/Mgo	BKBK	≥ 3 yrs.	Banded as an adult at SM MAPS in 2015.
F	ORDG/Mgo	BKBK	≥ 3 yrs.	Banded as an adult at SM MAPS in 2015.
F	PUPU/Mgo	BYST	3 yrs.	Banded as a nestling at SHA in 2014.
F	PUWH	DPWH/Mgo	≥ 2 yrs.	Banded as an adult at SM MAPS in 2016.
F	YEPU	ORDG/Mgo	≥ 2 yrs.	Banded as an adult at SM MAPS in 2016.
F	BYST/Mgo	YEPU	≥ 2 yrs.	Banded as an adult at SM MAPS in 2016.
F	YEPU	BKLP/Mgo	2 yrs.	Banded as a juvenile at SM MAPS in 2015.
F	DPDP/Mgo	ORDG	2 yrs.	Banded as an adult at SM MAPS in 2016.
F	PUPU	BPST/Mgo	2 yrs.	Banded as a nestling at CLE in 2015.
F	BYST	DPDP/Mgo	2 yrs.	Banded as a nestling at REM in 2015.
F	PUPU/Mgo		≥ 1 yrs.	Banded as unknown age at SM MAPS in 2016.
F	OROR	DPDP/Mgo	≥ 1 yrs.	Banded as an adult at SM MAPS in 2017.
F	PUPU/Mgo	ORDG	≥ 1 yrs.	Banded as an adult at SM MAPS in 2017.
F	DGOR/Mgo	YEPU	≥ 1 yrs.	Banded as an adult at SM MAPS in 2017.
F	YEYE	DGOR/Mgo	≥ 1 yrs.	Banded as an adult at ARL in 2017.
F	Mgo		≥ 1 yrs.	Banded as a nestling on the SMR or at MCAS before 2017.

Appendix E. Continued.

Drainage	Band Combination[1]			
Sex[2]	Left Leg	Right Leg	Age	Comments[3]
Santa Margarita River continued				
F		DPWH/Mdb	1 yr.	Banded as a nestling on the SLR in 2016.
F	OROR/Mgo	BYST	1 yr.	Banded as a nestling at REM in 2016.
F	DPDP/Mgo	DPDP	1 yr.	Banded as a nestling at HTI in 2016.
M	DPWH	PUOR/Mgo	≥ 8 yrs.	Banded as an adult at AE50 in 2010.
M	Mgo	WHDP	≥ 8 yrs.	Banded as an adult at MER in 2010.
M	DPWH/Mgo	PUYE	≥ 6 yrs.	Banded as an adult at ES24 in 2012.
M	PUPU	ORDG/Mgo	≥ 6 yrs.	Banded as an adult at HRP in 2012.
M	BPST/Mgo[4]		≥ 6 yrs.	Banded as an adult at JAS in 2012.
M	YEPU	ORPU/Mgo	6 yrs.	Banded as a juvenile at HDX in 2011.
M	PUWH	PUYE/Mgo	≥ 5 yrs.	Banded as an adult at DL MAPS in 2013.
M	BKLP/Mgo	PUWH	≥ 5 yrs.	Banded as an adult at SM MAPS in 2013.
M	ORDG/Mgo	YEYE	5 yrs.	Banded as a nestling at ONX in 2012.
M	YEPU/Mdb	YEYE	5 yrs.	Banded as a nestling on the SLR in 2012.
M	PUYE/Mgo	PUWH	≥ 4 yrs.	Banded as an adult at IBX in 2014.
M	PUWH	ORPU/Mgo	≥ 4 yrs.	Banded as an adult at QIN in 2014.
M	BKLP/Mgo	PUPU	≥ 4 yrs.	Banded as an adult at QIN in 2014.
M	DGOR/Mgo	OROR	≥ 4 yrs.	Banded as an adult at HLD in 2014.
M	DGOR/Mgo	BKBK	≥ 4 yrs.	Banded as an adult at OOR in 2014.
M	YEPU	WHDP/Mgo	≥ 4 yrs.	Banded as an adult at PR51 in 2014.
M	BKBK	YEYE/Mgo	≥ 4 yrs.	Banded as an adult at PIK in 2014.
M	DPWH	YEYE/Mdb	4 yrs.	Banded as a nestling on the SLR in 2013.
M	BKBK	PUOR/Mgo	4 yrs.	Banded as a nestling at QIN in 2013.
M		DPDP/Mgo	4 yrs.	Banded as a nestling at FAU in 2013.
M	BKBK	LPBK/Mgo	≥ 3 yrs.	Banded as an adult at SM MAPS in 2014.
M	PUPU/Mgo	WHDP	≥ 3 yrs.	Banded as an adult at SM MAPS in 2015.
M	WHDP	ORDG/Mgo	≥ 3 yrs.	Banded as an adult at SM MAPS in 2015.
M	ORDG	DPDP/Mgo	≥ 3 yrs.	Banded as an adult at KHA in 2015.
M	ORPU/Mgo	ORPU	≥ 3 yrs.	Banded as an adult at DRO in 2015.
M	ORDG	PUOR/Mgo	≥ 3 yrs.	Banded as an adult at UNI in 2015.
M	PUYE/Mgo	ORPU	≥ 3 yrs.	Banded as an adult at OCE in 2015.
M	PUPU/Mgo	DGOR	≥ 3 yrs.	Banded as an adult at HOL in 2015.
M	BYST/Mgo	ORDG	≥ 3 yrs.	Banded as an adult at HOU in 2015.
M	DPWH/Mdb	YEYE	3 yrs.	Banded as a nestling on the SLR in 2014.
M	YEPU	YEPU/Mgo	≥ 2 yrs.	Banded as an adult at HTI in 2016.
M	BKBK/Mgo	OROR	≥ 2 yrs.	Banded as an adult at SIL in 2016.
M	DPDP/Mgo	YEPU	≥ 2 yrs.	Banded as an adult at SM MAPS in 2016.
M	DPDP/Mgo	BYST	≥ 2 yrs.	Banded as an adult at REM in 2016.
M	WHDP/Mgo	ORDG	≥ 2 yrs.	Banded as an adult at DAT in 2016.
M	WHWH	DBDP/Mdb	2 yrs.	Banded as a nestling on the SLR in 2015.
M	PUWH	BKBK/Mdb	2 yrs.	Banded as a nestling on the SLR in 2015.
M	PUYE	DPDP/Mdb	2 yrs.	Banded as a nestling on the SLR in 2015.
M	YEYE/Mgo	YEPU	2 yrs.	Banded as a juvenile at SM MAPS in 2015.
M	PUPU	ORPU/Mgo	2 yrs.	Banded as a nestling at MCAS in 2015.
M	PUWH	WHWH/Mgo	2 yrs.	Banded as a nestling at MCAS in 2015.
M	DPWH	BYST/Mdb	2 yrs.	Banded as a nestling on the SLR in 2015.

Appendix E. Continued.

Drainage	Band Combination[1]			
Sex[2]	Left Leg	Right Leg	Age	Comments[3]
Santa Margarita River continued				
M	YEYE	DBWH/Mdb	2 yrs.	Banded as a nestling on the SLR in 2015.
M	PUOR	DPDP/Mgo	2 yrs.	Banded as a nestling at KHA in 2015.
M	YEPU	DPWH/Mgo	2 yrs.	Banded as a nestling at MCAS in 2015.
M	BYST	BYST/Mgo	2 yrs.	Banded as a nestling at MCAS in 2015.
M	DGOR	YEYE/Mgo	2 yrs.	Banded as a nestling at MCAS in 2015.
M	PUYE	PUPU/Mgo	2 yrs.	Banded as a nestling at ARI in 2015.
M	BYST	ORDG/Mgo	2 yrs.	Banded as a nestling at DEU in 2015.
M	WHDP	ORPU/Mgo	2 yrs.	Banded as a nestling at HDX in 2015.
M	PUYE	PUWH/Mgo	2 yrs.	Banded as a nestling at QIN in 2015.
M	PUOR	PUYE/Mgo	2 yrs.	Banded as a nestling at WSP in 2015.
M	ORDG	BKBK/Mgo	2 yrs.	Banded as a nestling at KNG in 2015.
M	BYST	WHWH/Mgo	2 yrs.	Banded as a nestling at TYR in 2015.
M	ORDG	YEYE/Mgo	2 yrs.	Banded as a nestling at KOA in 2015.
M	ORDG	WHWH/Mgo	2 yrs.	Banded as a nestling at MRT in 2015.
M	BYST	WHDP/Mgo	2 yrs.	Banded as a nestling at HED in 2015.
M	WHWH/Mgo	YEYE	≥ 1 yrs.	Banded as an adult at BOW in 2017.
M	ORDG	PUWH/Mgo	≥ 1 yrs.	Banded as an adult at TRL in 2017.
M	YEYE/Mgo	BYST	≥ 1 yrs.	Banded as an adult at IBX in 2017.
M	OROR	PUOR/Mgo	≥ 1 yrs.	Banded as an adult at LEM in 2017.
M	YEYE	OROR/Mgo	≥ 1 yrs.	Banded as an adult at SM MAPS in 2017.
M	BKBK/Mgo	ORDG	≥ 1 yrs.	Banded as an adult at SM MAPS in 2017.
M	PUWH/Mgo	YEPU	≥ 1 yrs.	Banded as an adult at SM MAPS in 2017.
M	OROR/Mgo	ORDG	≥ 1 yrs.	Banded as an adult at DNG in 2017.
M	WHDP/Mgo	YEYE	≥ 1 yrs.	Banded as an adult at BRA in 2017.
M	BYST	PUOR/Mgo	≥ 1 yrs.	Banded as an adult at ARY in 2017.
M	ORDG	YEPU/Mgo	≥ 1 yrs.	Banded as an adult at BRU in 2017.
M	ORDG	ORDG/Mgo	≥ 1 yrs.	Banded as an adult at ZAM in 2017.
M	WHPU/Mgo	ORDG	≥ 1 yrs.	Banded as an adult at PEP in 2017.
M	PUYE/Mgo	YEYE	≥ 1 yrs.	Banded as an adult at CAL in 2017.
M	DPWH	YEYE/Mgo	≥ 1 yrs.	Banded as an adult at FIN in 2017.
M	DPDP/Mgo	DPWH	≥ 1 yrs.	Banded as an adult at HOL in 2017.
M	YEYE/Mgo	DPDP	≥ 1 yrs.	Banded as an adult at BIL in 2017.
M	BKBK/Mgo	PUYE	≥ 1 yrs.	Banded as an adult at ZYL in 2017.
M	BYST/Mgo	YEYE	≥ 1 yrs.	Banded as an adult at WIN in 2017.
M	WHDP	PUWH/Mgo	≥ 1 yrs.	Banded as an adult at MOR in 2017.
M	PUPU	YEPU/Mgo	≥ 1 yrs.	Banded as an adult at SE12 in 2017.
M	BKBK/Mgo	YEPU	≥ 1 yrs.	Banded as an adult at WOM in 2017.
M	?	YEPU/Mgo	≥ 1 yrs.	Banded as unknown age on the SMR or at MCAS before 2017.
M	DPDB/Mdb	YEYE	1 yr.	Banded as a nestling on the SLR in 2016.
M	DPWH/Mgo	DGOR	1 yr.	Banded as a nestling at UNI in 2016.
M	YEYE/Mdb	PUPU	1 yr.	Banded as a nestling on the SLR in 2016.
M	PUWH/Mdb	BYST	1 yr.	Banded as a nestling on the SLR in 2016.
M	PUPU/Mgo	DPWH	1 yr.	Banded as a nestling at SNO in 2016.
U	DPWH/Mgo	YEPU	≥ 1 yrs.	Banded as an adult at SM MAPS in 2017.
U	OROR	ORPU/Mgo	≥ 1 yrs.	Banded as an adult at SM MAPS in 2017.

Appendix E. Continued.

Drainage	Band Combination[1]			
Sex[2]	Left Leg	Right Leg	Age	Comments[3]
Santa Margarita River continued				
U	OROR	PUPU/Mgo	HY	Banded as a nestling at DNG in 2017.
U	YEPU/Mgo	ORDG	HY	Banded as a juvenile at SM MAPS in 2017.
U	OROR/Mgo	YEPU	HY	Banded as a juvenile at SM MAPS in 2017.
U	YEYE	DPDP/Mgo	HY	Banded as a juvenile at SM MAPS in 2017.
U	YEYE	BKBK/Mgo	HY	Banded as a juvenile at SM MAPS in 2017.
U	WHWH/Mgo	YEPU	HY	Banded as a juvenile at SM MAPS in 2017.
U	OROR	WHDP/Mgo	HY	Banded as a juvenile at SM MAPS in 2017.
Ysidora Basin to Windmill Canyon				
M	WHWH/Mdb	BYST	1 yr.	Banded as a nestling on the SLR in 2016.

[1] Band colors: Mdb = dark blue numbered federal band; Mgo = gold numbered federal band; Mye = yellow numbered metal band; gogo = metal gold; sisi = metal silver; BKBK = plastic black; BKLP = plastic black-light pink split; BPST = plastic black-pink striped; BWST = plastic dark blue-white striped; BYST = plastic black-yellow striped; DBDP = plastic dark blue-dark pink split; DBWH = plastic dark blue-white split; DGOR = plastic dark green-orange split; DPDB = plastic dark pink-dark blue split; DPDP = plastic dark pink; DPWH = plastic dark pink-white split; 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; PUYE = plastic purple-yellow split; WHDB = plastic white-dark blue split; WHDP = plastic white-dark pink split; WHPU = plastic white-purple split; WHWH = plastic white; YEPU = plastic yellow-purple split; YEYE = plastic yellow.

[2] Sex: F = Female; M = Male; U = Unknown.

[3] Three-letter codes are Least Bell's Vireo territories (see Appendix G) except: BCS = Baja California Sur; DL MAPS = De Luz MAPS; DLC = De Luz Creek; MCAS = Marine Corps Air Station, Camp Pendleton; SLR = San Luis Rey River; SM MAPS = Santa Margarita MAPS Station; SMR = Santa Margarita River.

[4] Originally banded as PUPU : BKLP/Mgo, recaptured in 2017 and bands replaced with current color combination.

Appendix F. Between-Year Movement of Adult Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2017.

Year Last Det.	Drainage / Territory / Monitoring Site Type[1]		Dist. Moved (km)	Band Combination[2]		Age in 2017	Sex[3]
	Last Seen	2017		Left Leg	Right Leg		
2016	SMR / HW12	SLR / CQTI	11.1	BYST	OROR/Mgo	2 yrs.	F
2016	SLR / FO6	SMR / AR04	3.8	PUWH	BKBK/Mdb	2 yrs.	M
2016	DL / DS12	SMR / DEU / PF	3.4	BYST	ORDG/Mgo	2 yrs.	M
2016	WC / WC06	SMR / HE21	2.7		DPDP/Mgo	4 yrs.	M
2016	SMR / SM MAPS	SMR / ES25	1.7	YEPU	ORDG/Mgo	≥ 2 yrs.	F
2016	SMR / SM MAPS	SMR / ES34	1.6	BYST/Mgo	YEPU	≥ 2 yrs.	F
2016	SMR / MOU / PF	SMR / ZAM / PF	1.2	BYST	DPDP/Mgo	2 yrs.	F
2016	SMR / MOU / PF	SMR / DRK / PF	0.8	BKBK	YEYE/Mgo	≥ 4 yrs.	M
2016	SMR / SM MAPS	SMR / ES41	0.8	PUWH	DPWH/Mgo	≥ 2 yrs.	F
2016	SMR / HOL / REF	SMR / HE16	0.5	PUYE	PUPU/Mgo	2 yrs.	M
2016	SMR / CLE / REF	SMR / HE09	0.4	WHDP	BKLP/Mgo	4 yrs.	F
2016	SMR / RR14	SMR / RR04	0.4	PUPU	ORPU/Mgo	2 yrs.	M
2016	SMR / AXE / PF	SMR / FAU / PF	0.4	PUOR	DPDP/Mgo	2 yrs.	M
2016	SMR / ES10	SMR / ES15	0.3	DPDP/Mgo	ORDG	2 yrs.	F
2016	SMR / SM MAPS	SMR / BN21	0.3	PUPU/Mgo		≥ 1 yrs.	F
2016	SMR / HE16	SMR / HE03	0.2	PUYE	PUWH/Mgo	2 yrs.	M
2016	SMR / SM MAPS	SMR / ES03	0.2	YEPU	PUOR/Mgo	4 yrs.	F
2016	SMR / UNI / PF	SMR / UNI / PF	0.2	BPST/Mgo		≥ 6 yrs.	M
2016	SMR / HW23	SMR / HW10	0.2	BYST	WHDP/Mgo	2 yrs.	M
2016	SMR / PIK / PF	SMR / MRT / PF	0.2	LPBK	BKLP/Mgo	≥ 4 yrs.	F
2016	SMR / REM / REF	SMR / WSP / REF	0.2	WHDP	YEYE/Mgo	4 yrs.	F
2016	SMR / AW15	SMR / AW05	0.2	DGOR	YEYE/Mgo	2 yrs.	M
2016	SMR / BN18	SMR / BN20	0.1	PUPU/Mgo	WHDP	≥ 3 yrs.	M
2016	SMR / PO06	SMR / PO11	0.1	ORDG	DPWH/Mgo	4 yrs.	F
2016	SMR / HTI / REF	SMR / HTI / REF	0.1	YEPU	YEPU/Mgo	≥ 2 yrs.	M
2016	SMR / AE50	SMR / AE01	0.1	DPWH/Mdb	YEYE	3 yrs.	M
2016	SMR / HE17 / REF	SMR / MNT / REF	0.1	ORDG/Mgo	YEYE	5 yrs.	M
2016	SMR / TYT / REF	SMR / TYT / REF	0.1	BKBK	PUOR/Mgo	4 yrs.	M
2016	NW / WC06	NW / NC02	0.1	DPDP	DPDP/Mdb	2 yrs.	M
2016	SMR / AW37	SMR / AW44	0.1	BYST	WHWH/Mgo	2 yrs.	M
2016	SMR / 2211	SMR / 2205	0.1	DPWH	YEYE/Mdb	4 yrs.	M
2016	SMR / PUC / PF	SMR / PUC / PF	0.1	WHDP	ORPU/Mgo	2 yrs.	M
2016	SMR / MRT / PF	SMR / MRT / PF	0.1	PUYE/Mgo	ORPU	≥ 3 yrs.	M
2016	SMR / HOU / REF	SMR / HOU / REF	0.1	BYST/Mgo	ORDG	≥ 3 yrs.	M
2016	SMR / HLD / REF	SMR / FUR / REF	0.1	DGOR/Mgo	OROR	≥ 4 yrs.	M
2016	SMR / SE03B	SMR / SE06	0.1	PUYE	DPDP/Mdb	2 yrs.	M
2016	SMR / VAR / REF	SMR / VAR / REF	0.1	PUOR	PUYE/Mgo	2 yrs.	M
2016	SMR / KNG / REF	SMR / KNG / REF	0.1	PUPU	ORDG/Mgo	≥ 6 yrs.	M
2016	SMR / AW35	SMR / AW47	0.1	PUWH	WHWH/Mgo	2 yrs.	M
2016	SMR / ES01	SMR / ES13	0.1	YEYE/Mgo	YEPU	2 yrs.	M
2016	SMR / QIN / PF	SMR / QIN / PF	0.1	BKLP/Mgo	PUPU	≥ 4 yrs.	M
2016	SMR / DRO / REF	SMR / DRO / REF	0.1	ORPU/Mgo	ORPU	≥ 3 yrs.	M
2016	SMR / WSP / REF	SMR / WSP / REF	0.1	YEPU	ORPU/Mgo	6 yrs.	M
2016	SMR / KOA / PF	SMR / KOA / PF	0.0	PUYE/Mgo	PUWH	≥ 4 yrs.	M
2016	SMR / SM MAPS	SMR / ES11	0.0	DPDP/Mgo	YEPU	≥ 2 yrs.	M
2016	SMR / ES07	SMR / ES06	0.0	YEPU	WHDP/Mgo	≥ 4 yrs.	M

Appendix F. Continued.

Year Last Det.	Drainage / Territory / Monitoring Site Type[1]		Dist. Moved (km)	Band Combination[2]		Age in 2017	Sex[3]
	Last Seen	2017		Left Leg	Right Leg		
2016	SMR / ES16	SMR / ES02	0.0	DPWH/Mgo	PUYE	≥ 6 yrs.	M
2016	SOF / FE07	SOF / FE03	0.0	Mye	WHWH/sisi	2 yrs.	M
2016	SMR / AE34	SMR / AE23	0.0	DPWH	PUOR/Mgo	≥ 8 yrs.	M
2016	SMR / KHA / REF	SMR / KHA / REF	0.0	ORDG	DPDP/Mgo	≥ 3 yrs.	M
2016	SMR / ES33	SMR / ES25	0.0	YEPU/Mdb	YEYE	5 yrs.	M
2016	SMR / RR19	SMR / RR03	0.0	YEPU	DPWH/Mgo	2 yrs.	M
2016	SMR / MER / REF	SMR / MER / REF	0.0	Mgo	WHDP	≥ 8 yrs.	M
2016	SMR / RR16	SMR / RR08	0.0	BYST	BYST/Mgo	2 yrs.	M
2016	SMR / ES17	SMR / ES01	0.0	WHDP	ORDG/Mgo	≥ 3 yrs.	M
2016	SMR / UM24	SMR / UM37	0.0	PUWH	PUYE/Mgo	≥ 5 yrs.	M
2016	SMR / SIL / REF	SMR / SIL / REF	0.0	WHDP	PUPU/Mgo	4 yrs.	F
2016	SMR / SIL / REF	SMR / SIL / REF	0.0	BKBK/Mgo	OROR	≥ 2 yrs.	M
2016	DL / DS02	DL / DS04	0.0	LPBK	YEPU/Mgo	≥ 5 yrs.	M
2016	SMR / VLE / PF	SMR / VLE / PF	0.0	ORDG	WHWH/Mgo	2 yrs.	M
2016	SMR / DAT / PF	SMR / ARI / PF	0.0	WHDP/Mgo	ORDG	≥ 2 yrs.	M
2016	SMR / PR21	SMR / PR19	0.0	DPWH	BYST/Mdb	2 yrs.	M
2016	SMR / REM / REF	SMR / REM / REF	0.0	DPDP/Mgo	BYST	≥ 2 yrs.	M
2016	SMR / ES01	SMR / ES11	0.0	YEPU	BKLP/Mgo	2 yrs.	F
2016	SMR / ES10	SMR / ES03	0.0	BKBK	LPBK/Mgo	≥ 3 yrs.	M
2016	SMR / DAQ / REF	SMR / DAQ / REF	0.0	PUPU/Mgo	DGOR	≥ 3 yrs.	M
2016	SMR / ES39	SMR / ES26	0.0	ORDG	BKBK/Mgo	2 yrs.	M
2015	SMR / FUR / REF	ZC / ZC01	158.3	DPDP/Mgo	LPBK	≥ 4 yrs.	M
2015	SLR / WDOC	LF / UL07	12.8	PUYE	DBWH/Mdb	2 yrs.	F
2015	SMR / CLE / REF	SMR / BN19	6.0	PUPU	BPST/Mgo	2 yrs.	F
2015	SLR / WGIL	SMR / BS11	3.4	YEYE	DBWH/Mdb	2 yrs.	M
2015	SLR / BORR	SMR / SE12	3.2	WHWH	DBDP/Mdb	2 yrs.	M
2015	SMR / KOA / PF	SMR / HW09	2.8	ORDG	YEYE/Mgo	2 yrs.	M
2015	SMR / SM MAPS	SMR / PR16	1.2	PUWH	DPDP/Mgo	≥ 3 yrs.	F
2015	SMR / UNI / PF	SMR / MOU / PF	0.7	ORDG	PUOR/Mgo	≥ 3 yrs.	M
2015	SMR / ES42	SMR / YB04	0.3	OROR/Mgo	BKBK	≥ 3 yrs.	F
2015	SMR / SM MAPS	SMR / ES14	0.1	ORDG/Mgo	BKBK	≥ 3 yrs.	F
2015	SMR / RR07	SMR / RR11	0.1	PUWH	ORPU/Mgo	≥ 4 yrs.	M
2015	LF / FS07	LF / FS16	0.1	PUYE/Mdb	WHDB	3 yrs.	M
2014	SMR / SHA / REF	SMR / YB14	8.3	PUPU/Mgo	BYST	3 yrs.	F
2014	SMR / OOR	SMR / YB19	2.1	DGOR/Mgo	BKBK	≥ 4 yrs.	M
2014	DL / DN09	RO / DN08	1.2	DPWH	YEPU/Mgo	8 yrs.	M
2014	SMR / SM MAPS	SMR / BN15	0.2	OROR/Mgo	LPBK	≥ 4 yrs.	F
2014	LF / LL17	LF / LL14	0.1	WHDP	LPBK/Mgo	4 yrs.	M
2013	SMR / ES44	SMR / BN21	0.0	BKLP/Mgo	PUWH	≥ 5 yrs.	M
2012	SMR / ES12	TJ / TJ123	84.4	DPWH	DGOR/Mgo	6 yrs.	M
2012	SMR / BIL / REF	SGO / SD01	35.8	WHDP/Mgo	PUPU	5 yrs.	M
2012	SLR / BPAR	SMO / MB17	29.0	DPWH/Mdb	BYST	5 yrs.	F
2010	DL / DL MAPS	SMR / WIN / REF	8.0	LPBK/Mgo	DPDP	≥ 7 yrs.	F

Appendix F. Continued.

[1] Drainage Codes: DL = De Luz Creek; LF = Las Flores Creek; NW = Newton Canyon; RO = Roblar Creek; SGO = San Dieguito River; SLR = San Luis Rey River; SMR = Santa Margarita River; SMO = San Mateo Creek; SOF = San Onofre Creek; TJ = Tijuana River; WC = Windmill Creek; ZC = Zuma Canyon, Santa Monica Mountains; DL MAPS = De Luz MAPS Station; SM MAPS = Santa Margarita MAPS Station; Treatment Codes: PF = Post-fire; REF = Reference.

[2] Band colors: Mdb = dark blue numbered federal band; Mgo = gold numbered federal band; Mye = yellow numbered metal band; sisi = metal silver; BKBK = plastic black; BKLP = plastic black-light pink split; BPST = plastic black-pink striped; BYST = plastic black-yellow striped; DBDP = plastic dark blue-dark pink split; DBWH = plastic dark blue-white split; DGOR = plastic dark green-orange split; DPDP = plastic dark pink; DPWH = plastic dark pink-white split; 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; PUYE = plastic purple-yellow split; WHDB = plastic white-dark blue split; WHDP = plastic white-dark pink split; WHWH = plastic white; YEPU = plastic yellow-purple split; YEYE = plastic yellow.

[3] Sex: F = female; M = male; U = unknown.

Appendix G. Status and Nesting Activities of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2017.

Post-fire Site Territories

Territory	Nest	Monitoring[1]	Nest Fate[2]	# Fledged	Comments
ANT	1	F	PRE		
ANT	2	F	PRE		Eggs not confirmed, but nest destroyed, so likely depredated.
ARI	1	F	INC		
ARI	2	F	SUC	1	
ARI	3	F	UNK		Female disappeared during nestling phase.
ARL	1	F	PRE		
ARL	2	F	SUC	3	
BAD	1	F	SUC	3	
CAL	1	F	SUC	2	
DEU	1	F	PRE		
DEU	2	F	PRE		
DEU	3	F	SUC	3	
DNG	1	F	SUC	3	
DNG	2	F	PRE		
DRK	1	F	OTH		Nestlings cold and wet when discovered dead.
DRK	2	F	SUC	3	
FAU	1	F	PRE		
IBX	1	F	PRE		
IBX	2	F	SUC	1	
IBX	3	F	INC		
IBX	4	F	SUC	4	
JSP	1	F	INC		
JSP	2	F	PRE		
KOA	1	F	UNK		Eggs not confirmed, but nest destroyed so likely depredated.
KOA	2	F	SUC	2	
KOA	3	F	PRE		
KOA	4	F	SUC	4	
LEM	1	F	UNK		Eggs not confirmed.
LEM	2	F	SUC	3	
MOU	1	F	OTH		Nestlings cold and wet when discovered dead.
MOU	2	F	SUC	3	
MRT	1	F	PRE		
MRT	2	F	PRE		
MRT	3	F	UNK		Eggs not confirmed.
MRT	4	F	INC		
MRT	5	F	PRE		
PEP	1	F	SUC	4	
PEP	2	F	PRE		
PEP	3	F	SUC	3	
PUC	1	F	UNK		Eggs not confirmed.
PUC	2	F	PRE		
PUC	3	F	SUC	3	

Appendix G. Continued.

Post-fire Site Territories (continued)

Territory	Nest	Monitoring[1]	Nest Fate[2]	# Fledged	Comments
QIN	1	F	PRE		
QIN	2	F	PRE		
QIN	3	F	SUC	3	
SCO	1	F	PRE		
SCO	2	F	INC		
SCO	3	F	PRE		
SCO	4	F	SUC	4	
SER	1	F	UNK		Eggs not confirmed.
SER	2	F	INC		
UNI	1	F	OTH		Eggs cold and wet when discovered dead.
UNI	2	F	OTH		Eggs infertile.
VLE	1	F	SUC	3	
WOM	1	F	SUC	1	
WOM	2	F	PRE		
WOM	3	F	PRE		
YAK	1	F	SUC	4	
ZAM	1	F	OTH		Nestlings cold and wet when discovered dead.
ZAM	2	F	SUC	4	

Reference Site Territories

Territory	Nest	Monitoring[1]	Nest Fate[2]	# Fledged	Comments
ARY	1	F	OTH		Nestlings cold and wet when discovered dead.
ARY	2	F	SUC	3	
BIL	1	F	PRE		
BIL	2	F	SUC	1	
BIL	3	F	PRE		
BOW	1	F	SUC	4	
BRA	1	F	SUC	2	
BRU	1	F	OTH		Nestlings cold and wet when discovered dead.
BRU	2	F	SUC	3	
DAQ	1	F	SUC	3	
DAQ	2	F	SUC	4	
DRO	1	F	PRE		
DRO	2	F	SUC	2	
DRO	3	F	UNK		Nest abandoned with eggs.
FUR	1	F	SUC	4	
FUR	2	F	PRE		
HDX	1	F	SUC	1	
HOL	1	F	PRE		
HOL	2	F	SUC	3	
HOU	1	F	SUC	3	
HOU	2	F	PRE		
HTI	1	F	PRE		
HTI	2	F	PRE		
HTI	3	F	SUC	3	

Appendix G. Continued.

Reference Site Territories (continued)

Territory	Nest	Monitoring[1]	Nest Fate[2]	# Fledged	Comments
KHA	1	F	SUC	2	
KHA	2	F	SUC	2	
KNG	1	F	SUC	3	
KNG	2	F	SUC	3	
MER	1	F	SUC	3	
MER	2	F	PRE		
MOR	1	F	PRE		
MOR	2	F	SUC	4	
SIL	1	F	UNK		Eggs not confirmed.
SIL	2	F	UNK		Eggs not confirmed.
SIL	3	F	SUC	4	
SIL	4	F	SUC	4	
SNO	1	F	SUC	4	
SNO	2	F	SUC	3	
STA	1	F	PRE		
STA	2	F	UNK		Eggs not confirmed.
STA	3	F	PRE		
STA	4	F	SUC	3	
TRL	1	F	PRE		
TRL	2	F	SUC	1	
TYT	1	F	SUC	4	
VAR	1	F	PRE		
VAR	2	F	INC		
VAR	3	F	PRE		
WIN	1	F	UNK		Eggs not confirmed.
WIN	2	F	INC		
WIN	3	F	SUC	3	
WSP	1	F	SUC	3	
WSP	2	F	SUC	2	
ZYL	1	F	PRE		
ZYL	2	F	SUC	2	

[1] Monitoring: F = fully monitored territory.

[2] Nest Fate: INC = nest not completed; OTH = nest failed with known cause other than predation or parasitism; PRE = nest failure caused by predation; SUC = fledged at least one Least Bell's Vireo young; UNK = reason for nest failure/abandonment unknown.