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

2016 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: Banded Least Bell's Vireo feeding nestlings, by Lisa Allen

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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 30 March and 15 July 2016. Drainages containing riparian habitat suitable for vireos were surveyed two to four times. Seven hundred and thirteen male vireos and 40 transient vireos were detected. Territorial vireos were detected on 19 out of the 23 drainages/sites surveyed. Ninety-four percent of all vireo territories occurred on the six most populated drainages, with the Santa Margarita River containing 66% of all territories on Base. Eighty percent of male vireos were confirmed as paired.

The number of documented Least Bell's Vireo territories on MCBCP (713) increased 15% from 2015 to 2016. The number of territories on 13% (3/23) of drainages surveyed increased by 3-71 territories from 2015, while 4% of drainages (1/23) decreased by three or more territories, and 83% of drainages (19/23) showed no change or increased/decreased by two or fewer territories.

The increase in vireo numbers on MCBCP (15%) was inconsistent with population changes in surrounding areas, including the lower San Luis Rey River (decreased by 18%) and Marine Corps Air Station, Camp Pendleton (MCAS) (decreased by 35%). The local increase in the vireo population on MCBCP is likely a result of immigration from other areas and high recruitment of first-year vireos. Region-wide declines in the breeding population of Least Bell's Vireos since 2010 are likely largely attributable to drought.

The majority of vireo territories occurred in habitat characterized as willow (*Salix* spp.) riparian, with 78% of males in the study area found in this habitat. An additional 7% of birds occupied willow habitat co-dominated by sycamores (*Platanus racemosa*) or cottonwoods (*Populus fremontii*). Thirteen 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 although it decreased significantly in the 0-1 m and 1-2 m height categories between 2015 and 2016 (5-13.5%). Vegetation volume increased slightly in the 4-5 m and 5-6 m height categories (1.2-2%) and decreased slightly in upper height categories (<1%). Live canopy height increased between 2015 and 2016, but overall canopy height (including dead vegetation) decreased. In 2016, 3 years post-fire, exotic and herbaceous species comprised 44% of the vegetation under 1 m and 22% of the vegetation between 1 and 2 m, down from 1 year and 2 years post-fire, with a corresponding increase in the cover of woody vegetation in these height categories. 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. Low canopy cover at Las Flores Creek, in particular exotic herbaceous vegetation, was higher than at the Above Hospital site during the first 3 post-fire years. Mid-story vegetation at Las Flores Creek was less severely burned than at the Above Hospital site, and changed little over time, in contrast to the increase in the mid-canopy observed at the latter 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 was higher than at unburned Reference sites in 2016 and increased to pre-fire levels by the third-year post-fire (2016). Vireo territory density in areas that burned in May 2014 rebounded from an initial 34% decrease the first year post-fire (2015) back to pre-fire levels. 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. One hundred and seventy-seven Least Bell's Vireos were banded for the first time during the 2016 season. These included 17 adult vireos, 159 hatch-year vireos, and 1 vireo of unknown age. All adult vireos, vireos of unknown age, and one hatch-year bird were banded with unique color combinations. The remaining 158 hatch-year vireos (all nestlings) were banded with a single gold numbered federal band on the left leg.

One hundred and fifteen Least Bell's Vireos banded prior to the 2016 breeding season were resighted and identified on Base in 2016. Fourteen of these were originally banded on the San Luis Rey River, eight were originally banded at MCAS, two were 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 2015 to 2016, was 51% (74/146). Survivorship of first-year birds that fledged from MCBCP in 2015 and were documented on Base or elsewhere in 2016 was 20% (23/114), based on the number of uniquely banded individuals detected. Assuming an equal sex ratio of banded juveniles, first-year survivorship of males was 25% and females was 11%.

The majority of returning adult vireos showed strong between-year site fidelity. Sixty-two percent (32/52) of males present in 2015 and 2016 returned to within 100m of their previous territory. The average between-year movement for returning adult vireos was 0.7 ± 3.4 km. The average movement of first-year vireos detected in 2016 that fledged from a known nest on MCBCP in 2015 was 2.9 ± 2.6 km.

One vireo that originated at MCBCP moved off-Base and was detected elsewhere in 2016. This male was originally banded as a nestling in 2013 at an unburned Reference site and was re-detected on the San Diego River in 2016.

Two vireos that were detected on MCBCP in 2016 were originally banded on the wintering grounds in Baja California Sur in October 2015. Natal origin of these vireos is unknown.

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 56% and 47%, respectively. First-year survivorship was 13% and 22%, respectively. Ninety-three percent (14/15) of adults from Post-fire sites that were detected in both 2015 and 2016 returned in 2016 to the same territory occupied in 2015. Ninety-three percent (14/15) of adult vireos detected in 2015 Reference sites returned to Reference sites in 2016. Seven of 55 first-year vireos that were banded as nestlings at Post-fire sites in 2015 returned in 2016, one to a Post-fire site, one to a Reference site, and the rest to areas outside of our monitoring sites. Twelve of 55 first-year vireos that were banded as nestlings at Reference sites in 2015 returned in 2016, five to Post-fire sites, two to Reference sites, and the rest returned to areas outside of our monitoring sites.

Nesting activity was monitored between 23 March and 20 July in 53 territories within the Post-fire and Reference monitoring sites. All territories were occupied by pairs, for which all nesting attempts were monitored. One hundred and twenty-six nests (60 in Post-fire sites and 66 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 2016. Twenty-nine percent (16/55) of Post-fire nests and 40% (24/60) of Reference nests successfully fledged young. Predation was believed to be the primary source of nest failure at both sites. Predation accounted for 72% (28/39) and 89% (32/36) of nest failures at Post-fire and Reference sites, respectively. Of the remaining 15 nests that failed, failure was attributed to host plant collapse, egg infertility, and other unknown reasons. One Least Bell’s Vireo nest was parasitized by Brown-headed Cowbirds (*Molothrus ater*) in 2016. One cowbird egg was removed from this nest and the nest later successfully fledged two vireo young.

Breeding productivity was lower at Post-fire sites than at Reference sites (1.8 versus 2.7 young per pair), although the proportion of Post-fire pairs that successfully fledged at least one young did not differ from the proportion of Reference pairs in 2016 (58% versus 70%).

In 2016, successful nests at Post-fire 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. Fourteen plant species were used as hosts for vireo nests in 2016. Seventy-three percent of all nests were placed in arroyo willow (*S. lasiolepis*), sandbar willow, 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 third 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.

STUDY AREAS AND METHODS

Field Surveys

All of MCBCP's major drainages, and several minor ones supporting riparian habitat, were surveyed for vireos between 30 March and 15 July 2016 (Fig. 1). Field work was conducted by USGS biologists Katie Allen, Lisa Allen, Rachel del Rio, PJ Falatek, Christopher Frey, Aaron Gallagher, Sarah Harris, Scarlett Howell, Barbara Kus, Michael Lester, Ryan Pottinger, Ben Sandstrom, and Devin Taylor. 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 confluences of the Santa Margarita River with the Base boundary (Appendix A, Fig. 15).

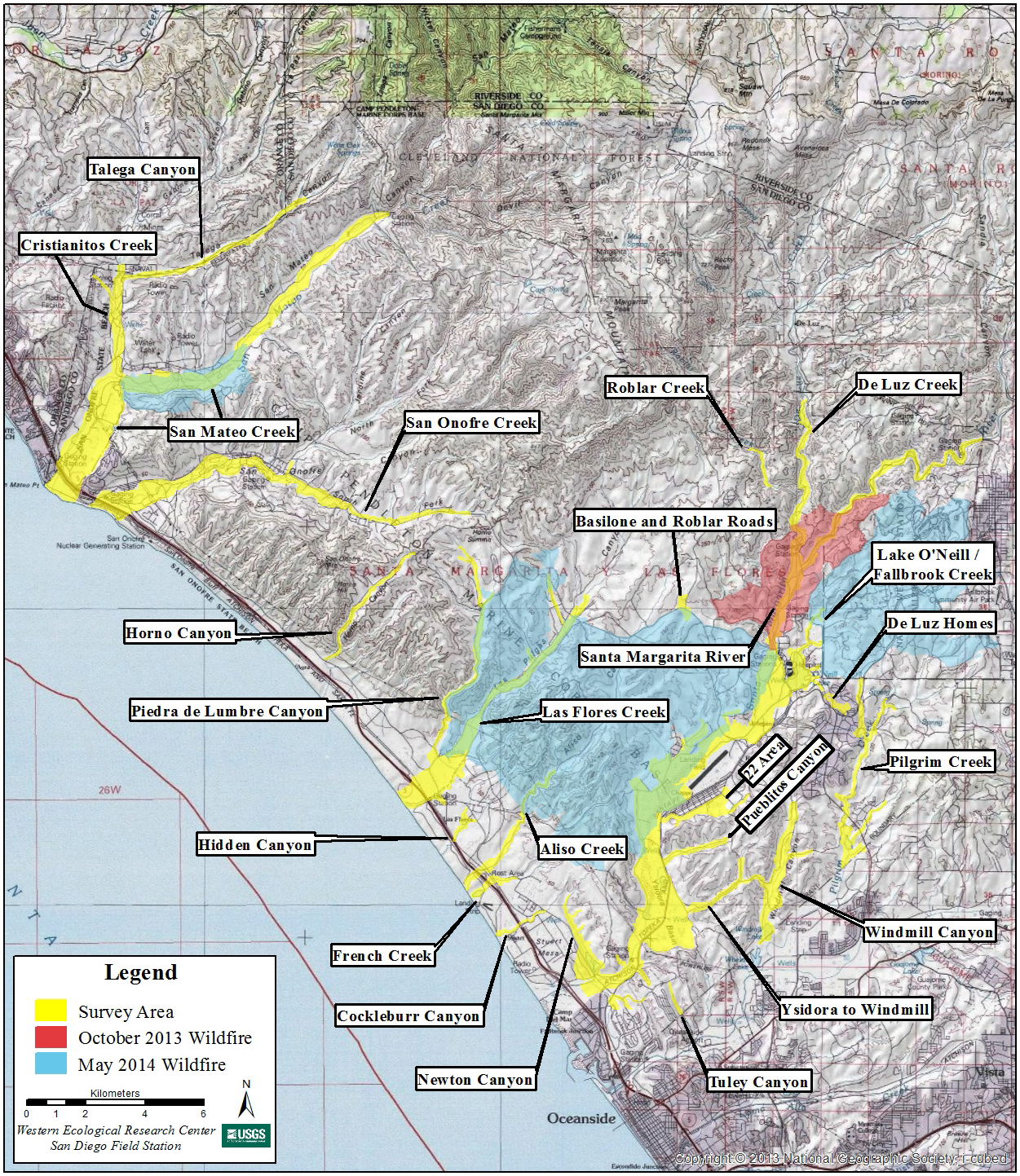

Fig. 1. Least Bell's Vireo survey areas at Marine Corps Base Camp Pendleton, 2016.

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), De Luz Creek, Roblar Creek, Lake O'Neill (4a), 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, Fallbrook Creek (4b), Pueblitos Canyon, Tuley Canyon, Newton Canyon, French Creek, Hidden Canyon, Horno Canyon, Piedra de Lumbre Canyon, San Onofre Creek (17b), San Mateo Creek (18b), Talega Canyon, Pilgrim Creek (21b), Windmill Canyon, Ysidora Basin to Windmill Canyon, and De Luz Homes habitat. The upper portion of the Santa Margarita River (1b) was surveyed twice for vireos.

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 Garmin GPS 60 (Olathe, KS) Global Positioning System (GPS) or 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. We collected species composition and vegetation structure data along 24 permanent linear transects (Fig. 3). 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 2016 to qualitatively assess the changes in vegetation (Appendix B).

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).

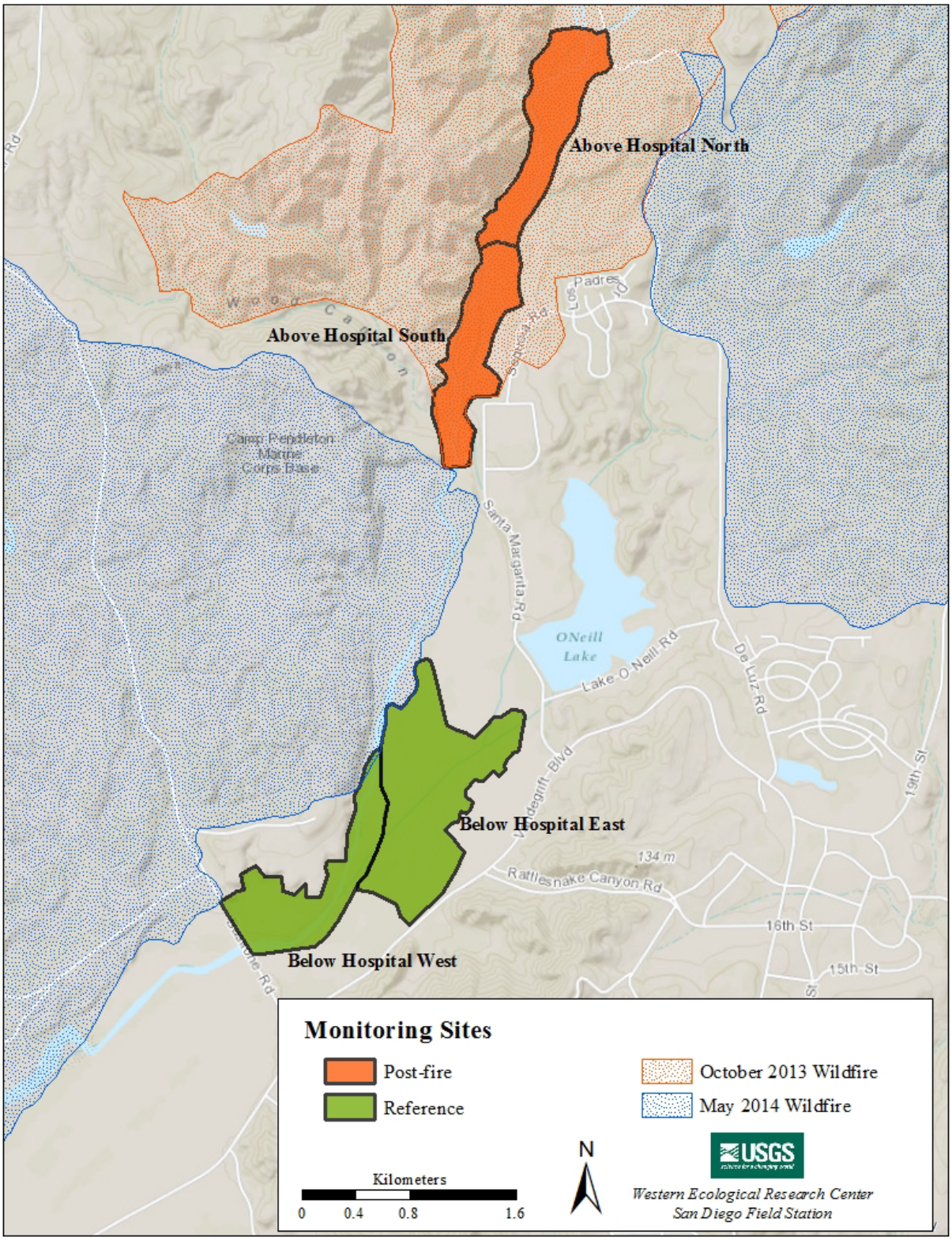

Fig. 2. Location of Least Bell's Vireo Post-fire and Reference study sites at Marine Corps Base Camp Pendleton, 2016.

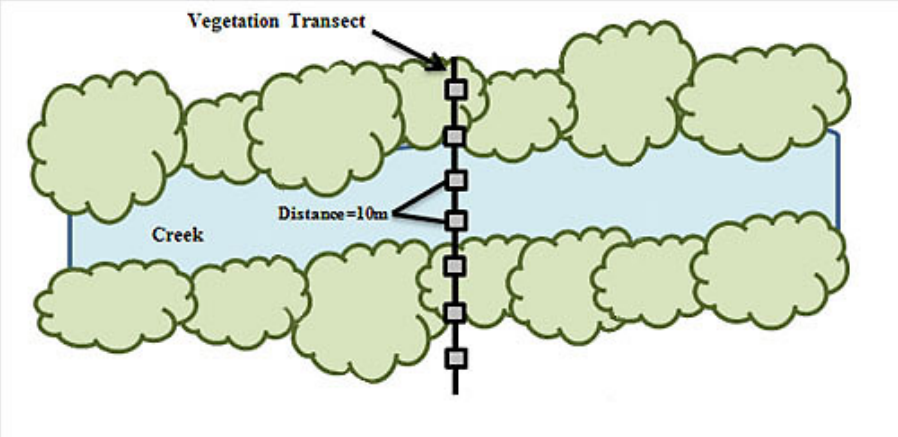

Fig. 3. Schematic diagram of a vegetation sampling transect.

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 2010, 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 left 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 2016) / (# known to be present in 2015)). 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 2015-2016 was calculated for known individuals that were: (1) adults in 2015 on Base and were resighted anywhere on Base in 2016; (2) adult vireos that held territories in Post-fire or Reference sites in 2015 and were resighted anywhere on Base in 2016; (3) first-year vireos that were banded as nestlings or juveniles anywhere on Base in 2015 and were resighted anywhere in 2016 (including off-Base); and (4) first-year vireos that were banded as nestlings or juveniles in Post-fire or Reference sites in 2015 and were resighted anywhere in

2016. 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 2015 and the center of the same vireo's breeding territory in 2016. Vireos exhibited site fidelity if they returned to within 100 m of their 2015 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 2016 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 2015-2016 Reference sites.

Table 2. Least Bell's Vireo study site categories from 2005 to 2016, Marine Corps Base Camp Pendleton.

	Study Years		
Site Location	**2005-2013**	**2014**	**2015-2016**
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 2015 and 2016 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 (Table 2).

We compared vireo breeding productivity between Post-fire and Reference sites in 2016 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 2016. 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 27 territories in Reference sites between 23 March and 20 July 2016. 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 11 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, in adult and juvenile survivorship at Post-fire and References sites between 2014-2015 and 2015-2016, 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, the proportion of nests that were parasitized by cowbirds, 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 2015 and 2016 at Post-fire sites and between 2016 Post-fire sites and vegetation data collected in 2010 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, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, and 2015 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. 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 753 male Least Bell's Vireos were detected during Base-wide surveys (Table 3; Appendix C, Figs. 20-39). Of these, 713 were territorial males, 80% of which were confirmed as paired, and 40 were transients. This represents a 15% increase in territories from 2015.

Transient vireos were observed on 10 of the 23 (43%) 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 (66%) 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.

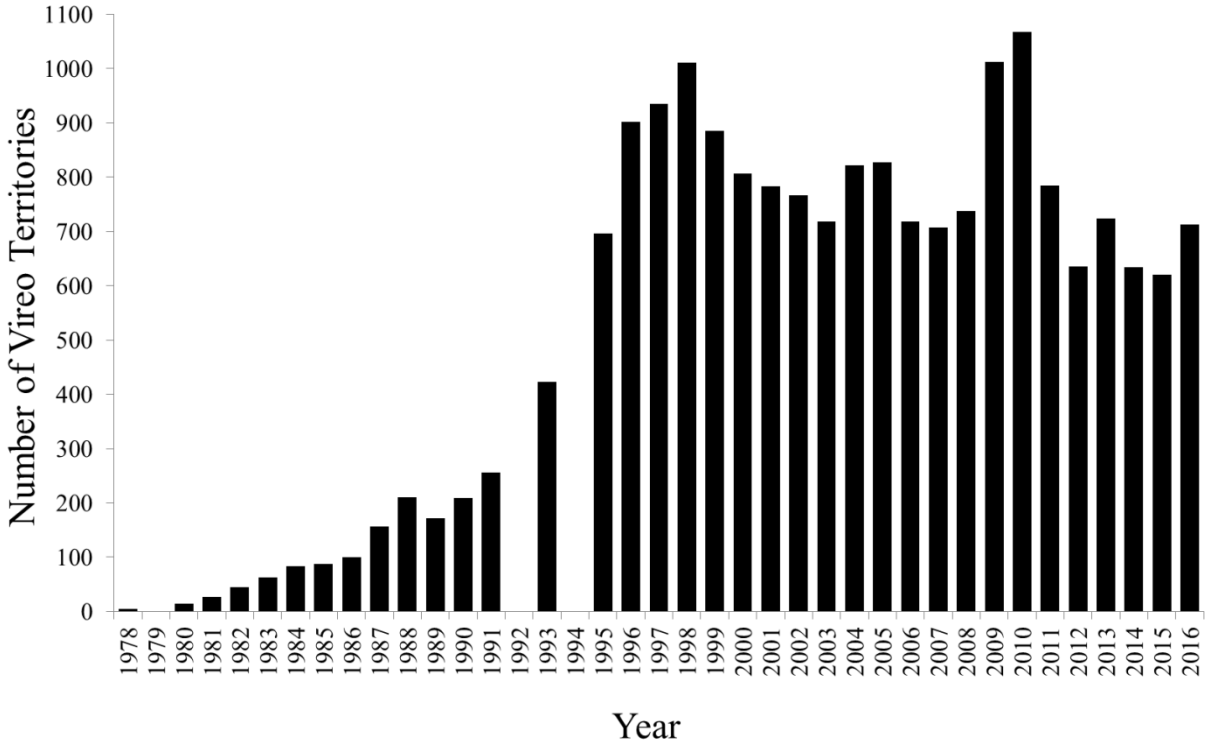

Fig. 4. Number of Least Bell's Vireo territories at Marine Corps Base Camp Pendleton, 1978–2016.

The distribution of Least Bell's Vireo territories documented on Base in 2016 appeared to shift compared to 2015, potentially at least partially in response to habitat recovery following the October 2013 and May 2014 wildfires (Table 4). Three (Santa Margarita River, Las Flores Creek, and Piedra de Lumbre Canyon) of the five drainages that burned in the October 2013 and May 2014 wildfires gained territories (total of 81) between 2015 and 2016. The remaining two burned drainages (De Luz Creek and San Mateo Creek) each lost one territory in the same period. Ten survey areas continued to fluctuate between zero and five territories over the past 10 years. Four of these (Basilone and Roblar Roads, Roblar Creek, French Canyon, and Hidden Canyon) gained one to two territories between 2015 and 2016 and six remained the same as in 2015 (Pueblitos Canyon, Cockleburr Creek, Horno Canyon, Talega Canyon, Tuley Canyon, and Ysidora Basin to Windmill Canyon). In 2016, the vireo population increased by more than two territories in 13% of drainages surveyed (3/23). Nineteen drainages (83%) showed no change or changed (increased or decreased) by two or fewer territories between 2015 and 2016 and one

drainage (4%) decreased by three territories. The drainages with the largest numeric increases in vireo territories were the Santa Margarita River, Las Flores Creek, and Windmill Canyon increasing by 3-71 territories each (18%, 19%, and 60%, respectively). The site with the largest numeric loss in vireo numbers was San Onofre Creek, losing three territories (6%).

Table 3. Number and distribution of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2016.

	Territories			
Drainage/Survey Site	**Known Pairs**	**Single/Status Undetermined**	**Transient**	**Total Territories**
Santa Margarita River:				
I-5 to De Luz Creek	346	69	15	415
De Luz Creek to Base Boundary	24	21	0	45
22 Area	8	6	0	14
De Luz Creek	20	2	4	22
Roblar Creek	2	1	0	3
Lake O'Neill/Fallbrook Creek	1	2	1	3
Basilone-Roblar Roads	3	1	0	4
Pueblitos Canyon	0	0	0	0
Newton Canyon	4	1	0	5
Cockleburr Creek	0	0	1	0
French Canyon	2	1	0	3
Aliso Creek	4	2	0	6
Hidden Canyon	1	4	0	5
Las Flores Creek:				
Pacific Ocean to Stuart Mesa Rd	0	0	0	0
Stuart Mesa Rd to Power Lines	23	7	2	30
Power Lines to Zulu Impact Area	21	5	0	26
Piedra de Lumbre Canyon	7	0	1	7
Horno Canyon	1	0	0	1
San Onofre Creek:				
Pacific Ocean to Basilone Rd	29	7	6	36
Basilone Rd to Access Rd to Range 219	6	3	1	9
San Mateo Creek				
Pacific Ocean to San Mateo Road	36	3	6	39
San Mateo Road to Yankee Training Area	0	0	0	0
Cristianitos Creek	5	1	1	6
Talega Canyon	0	0	0	0
Tuley Canyon	0	0	0	0
Pilgrim Creek:				
Base Boundary upstream to Vandegrift Blvd	7	6	0	13
Vandegrift Blvd to upstream riparian limit	8	2	2	10
Windmill Canyon	7	1	0	8
Ysidora Basin to Windmill Canyon	1	0	0	1
De Luz Homes	2	0	0	2
Total	568	145	40	713

Table 4. Number of territorial male Least Bell's Vireos at Marine Corps Base Camp Pendleton, by drainage, 2004-2016. Number includes only singing males determined to hold territories. Numeric change is the positive or negative change in the number of vireo territories between 2015 and 2016.

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

[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.

Least Bell's Vireos began arriving on Base during the last week of March 2016, with 74% 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 2005, 2008, 2009, and 2010. By the end of May, 93% of territories had been established. The first vireo detected on MCBCP in 2016 was found on 23 March. This is the same arrival date as in 2015, and the third 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 29 March – 2 April but vireo presence prior to surveys was noted when observed.

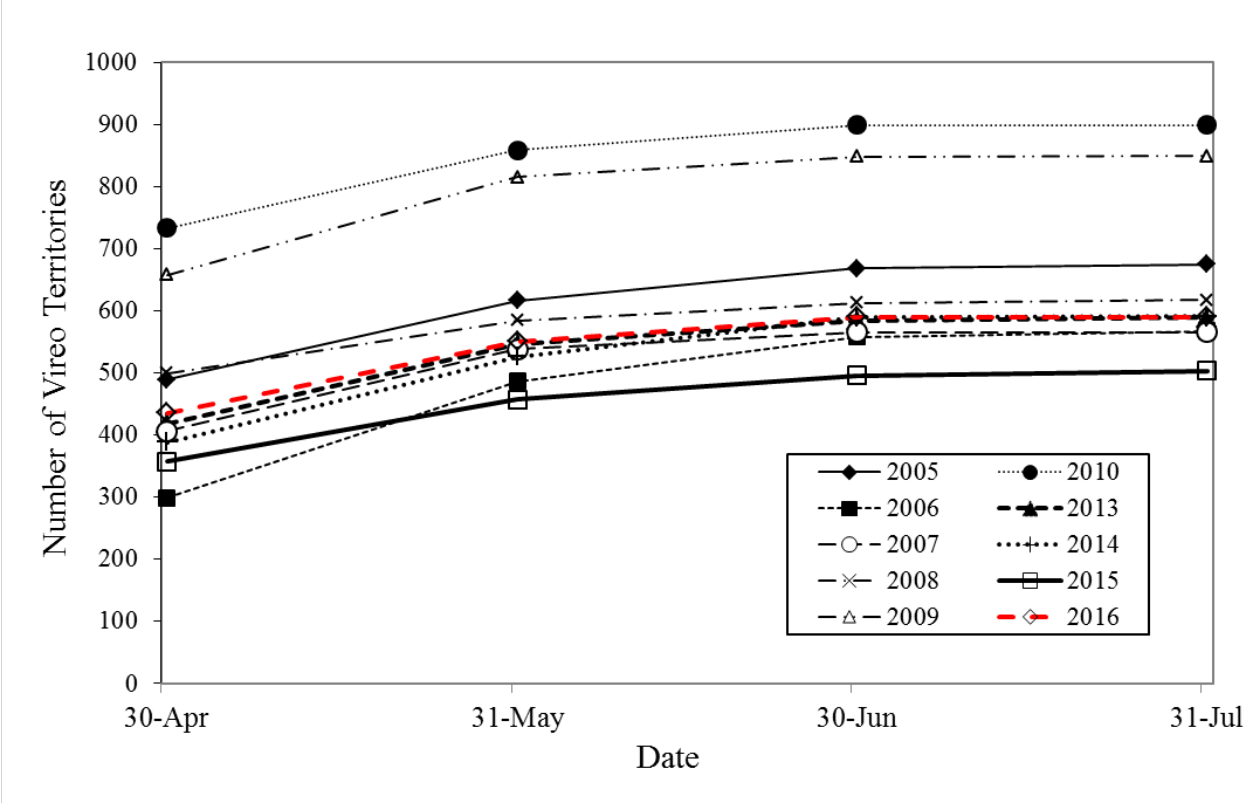

Fig. 5. Territory establishment of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2005-2016. Numbers include only vireos in areas that were surveyed at least four times per year. Dates represent period end-points. Surveys began late in 2011 and 2012; therefore, arrival dates for these years 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 territories occurred in habitat characterized as mixed willow riparian, with 78% of males in the study area found in this habitat. An additional 6% of birds occupied willow

habitat co-dominated by cottonwoods or sycamores. Thirteen percent of territories were found in riparian scrub, dominated by mule fat and/or sandbar willow. Two percent of vireos occupied drier habitats characterized by a mix of sycamore and oaks or upland scrub, and fewer than 1% of territories occurred in non-native vegetation.

Table 5. Habitat types used by Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2016.

	Number of Territories			
Habitat Type	**>50% Native**	**>50% Exotic**	**Total**	**Percent of Total**
Mixed Willow	568	15	584	78%
Riparian Scrub	95	6	101	13%
Willow/Sycamore	40	3	43	6%
Upland Scrub	8	1	9	1%
Oak/Sycamore	9	0	9	1%
Willow/Cottonwood	4	0	5	1%
Non-native	0	2	2	< 1%
Grand Total	724	27	753[1]	100%

[1] Includes two territories with habitat type recorded but exotic species composition not recorded

The proportion of vireo territories documented in exotic vegetation dropped by 60% from 2015 to 2016 (Table 6). Three percent (23/711) of vireo territories in 2016 were in areas where exotic species such as giant reed, poison hemlock (*Conium maculatum*), black mustard (*Brassica nigra*), and salt cedar comprised at least 50% of the habitat. Four drainages contained territories dominated by non-native vegetation in 2016, compared to six in 2015. 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. The proportion of vireo territories dominated by exotic vegetation decreased in 2016 after a 1-year increase in 2015, following a 4-year decrease (2011-2014). 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, 2005-2016.

	Proportion of Territories (Number of Territories within the Drainage)											
Drainage	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
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)**
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)**
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)**
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 (474)**
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)
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)
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)
Basilone-Roblar Roads	0 (2)	- -	- -	- -	0 (5)	0 (3)	0 (2)	**0.25 (4)**	- -	**0.33 (3)**	0 (2)	0 (4)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
Pueblitos Canyon	0 (5)	0 (3)	0 (2)	**0.50 (2)**	0 (1)	- -	- -	- -	- -	0 (1)	- -	- -
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]

[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; the first year after the fire, 84% of quadrats (245/291) were classified as high burn severity and 16% (46/291) were classified as moderate burn severity. No quadrats were classified as low burn severity. While vegetation cover in height categories over 4 m continued to be low (< 7%; Fig. 6A), vegetation cover increased slightly in the 4-5 m and 5-6 m height categories from 2015 to 2016 (2.0%, $t = 2.5$, $P = 0.01$; 1.2%, $t = 2.2$, $P = 0.03$, respectively). Vegetation cover decreased significantly from 2015 to 2016 in the lowest height categories (0-1 m: 13.5%, $t = 8.4$, $P < 0.01$; 1-2 m: 5.0%, $t = 3.8$, $P < 0.01$) and also decreased slightly in upper height categories (7-8 m, 0.7%, $t = 1.7$, $P = 0.09$; > 8 m, 0.8%, $t = 3.1$, $P < 0.01$).

From 2015 to 2016, the average live canopy height increased significantly from 3.8 m to 5.2 m ($t = 6.1$, $P < 0.01$), but the average maximum canopy height (including live and dead vegetation) decreased significantly during the same time period (6.1 m to 4.4 m; $t = 5.6$, $P < 0.01$). The proportion of vegetation cover < 1 m and between 1 and 2 m that was comprised of herbaceous species (exotic and native combined) declined from 52% and 34% (respectively) 1 year post-fire to 44% and 22% 3 years post-fire. The remaining cover < 2 m each year consisted mostly of stump-sprouted red and arroyo willow, dead/burned branches, mule fat, and sandbar willow.

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). However, cover in the low canopy at Las Flores Creek was substantially higher than at the Above Hospital site, both early in the recovery and by 3 years post-fire (0-1 m: $t = 8.5$, $P < 0.01$; 1-2 m: $t = 7.8$, $P < 0.01$). This difference is largely attributable to the higher cover of herbaceous vegetation, particularly exotic species, at Las Flores Creek following the fire. Similar to at the Above Hospital site, the proportion of vegetation in the low canopy made up by herbaceous species (exotic and native combined) has declined over time, from 60% and 52% at < 1 m and 1-2 m, respectively, 1 year post-fire to 43% and 28% 3 years post-fire. Cover in the mid-canopy at Las Flores Creek, which was less severely burned, changed little over the 3 years post-fire, in contrast to at the Above Hospital site, where mid-canopy vegetation has been re-establishing over the last 3 years.

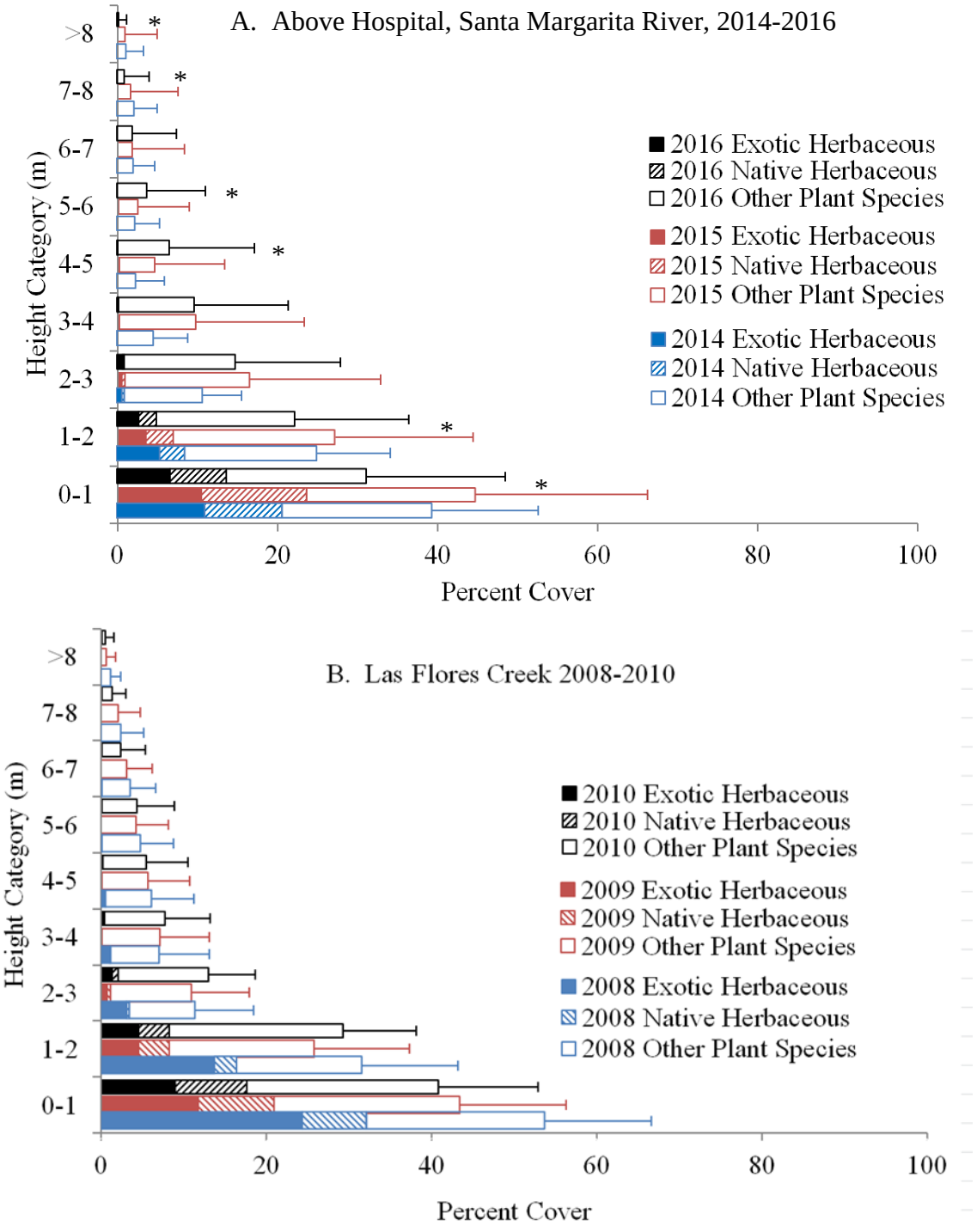

Fig. 6. Average total percent cover by height class (m) and plant type at A. Above Hospital, Santa Margarita River, 2014-2016, 1-3 years after the October 2013 wildfire and B. Las Flores Creek, 2008-2010, 1-3 years after the October 2007 wildfire (Ferree et al. 2012b), Marine Corps Base Camp Pendleton. Error bars represent 1 standard deviation. Asterisks (*) indicate statistically significant differences between 2015 and 2016 ($P \leq 0.10$, Student's *t*-tests).

Population Density

Of the 713 vireo territories documented in 2016, 60 (8%) were located within the October 2013 wildfire perimeter (0.17 territories/ha of burned riparian habitat). Fifty-four 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, and 2015 but did differ in 2014 and 2016. In 2014, Post-fire sites had significantly fewer vireo territories than Reference sites (t = -2.88, P = 0.10) but in 2016, Post-fire sites had significantly more territories than Reference sites (t = 3.38, P = 0.06; Fig. 7).

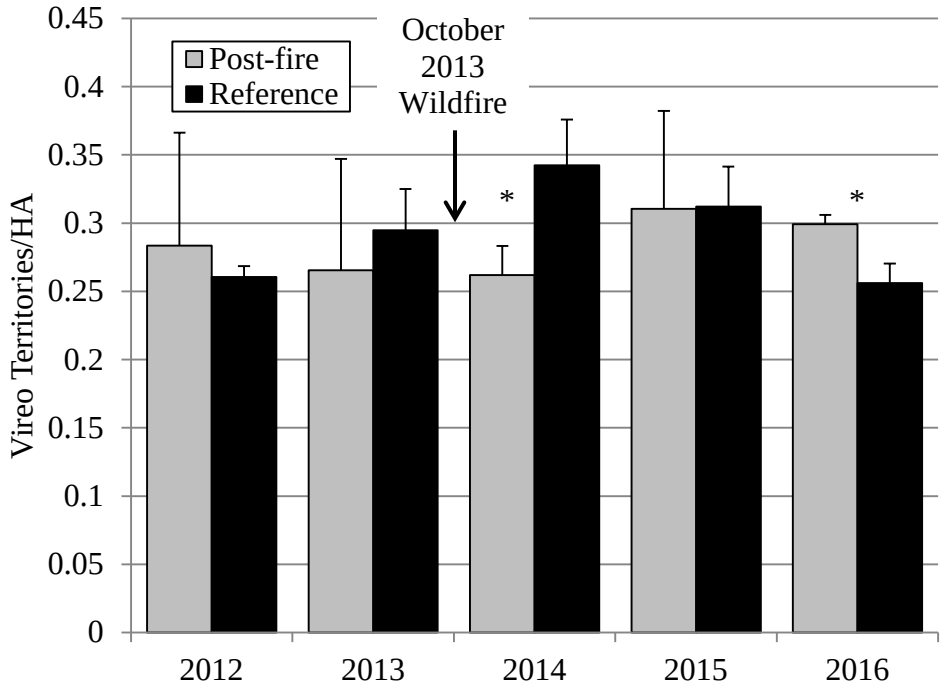

Fig. 7. Annual density of Least Bell's Vireo territories at Post-fire and Reference sites by year, averaged across sites, Marine Corps Base Camp Pendleton, 2012-2016. Error bars represent 1 standard deviation. Asterisks (*) indicate statistically significant differences ($P \leq 0.10$, Student's t-tests).

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 (0.20 territories/ha; Fig. 8). In 2016, 168 of 713 vireo territories (24%) were located within the May 2014 wildfire perimeter, almost identical to 2013, when 168 of 724 (23%) vireo territories were located within the same area.

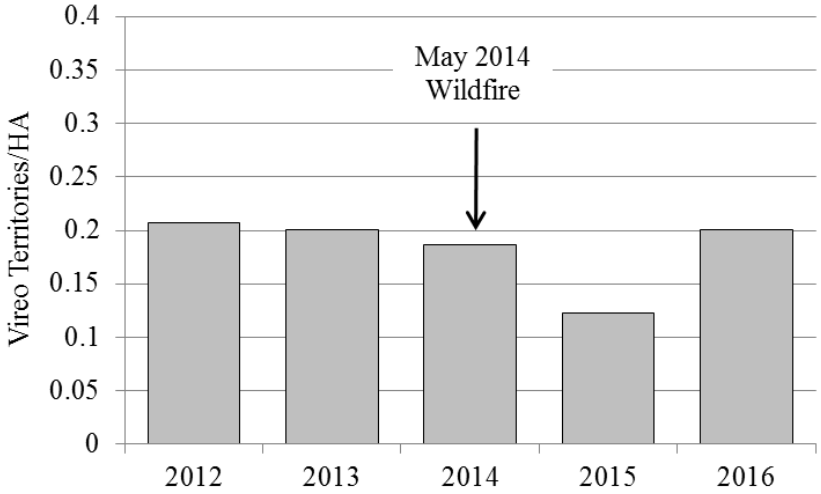

Fig. 8. Annual density of Least Bell's Vireo territories in riparian vegetation within the perimeter of the May 2014 wildfires, Marine Corps Base Camp Pendleton, 2012-2016. The 2014 number includes territories that were established prior to the May 2014 wildfire.

Banded Birds

Returning Banded Birds

We were able to observe 1,078 adult Least Bell's Vireos (728 males, 96% of all males, and 344 females, 60% of all females, and 6 (100%) of unknown sex) on Base well enough to determine banding status in 2016, although not all banded vireos were observed well enough to conclusively identify the individual. One hundred and thirty-one of these had been banded prior to the 2016 breeding season, 16 of which we could not identify because band combinations were not confirmed (14) 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 115 vireos on Base that had unique color band combinations in 2016 (Table 7, Appendix D). Of these, 91 vireos had been banded on Base and 24 vireos were originally banded off-Base (14 on the San Luis Rey River, Ferree et al. 2011, 2012a, 2013, 2015, Houston et al. 2015; eight on MCAS, Allen and Kus 2013, Howell and Kus 2015; and two 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 2016.

	Detected on Base[1]			Total on	Emigrants		
Banding Status	**Male**	**Female**	**Unknown Sex**	**Base**	**Male**	**Female**	**Total**
Uniquely banded prior to 2016	58	13	-	71	-	-	71
Natal[2] recaptured in 2016	28	15	1	44	1	-	45
Subtotal of known identity vireos	87	28	1	115	1	-	116
Unidentified (Partial resights)	13	1	-	14	-	-	14
Natal[2], not recaptured	-	2	-	2	-	-	2
Grand total	99	31	1	131	1	-	132

[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 2016 (Table 7). Both were banded as nestlings on Base or at MCAS. Efforts to recapture and identify these vireos were unsuccessful.

One vireo that was originally banded on Base (with a gold numbered metal federal band) was detected off-Base in in 2016 (Table 7). This male was observed on the San Diego River near Lakeside in 2016 (USGS unpubl. data) and was last detected on Base when it was banded as a nestling on the Santa Margarita River in 2013.

Two vireos were banded in October 2015 in Baja California Sur and were resighted on MCBCP in 2016. The natal territories for these two vireos were unknown. One other vireo was originally banded at the Santa Margarita MAPS station in 2013, was recaptured there in 2014, then resighted three times in Baja California Sur (October 2014, February 2015, and October 2015) before it was detected again on MCBCP (Allen and Kus 2014b, Madden et al. 2015, Hall and Kus 2016b, USGS Unpubl. data).

Table 8. Number of banded adult Least Bell's Vireos at Marine Corps Base Camp Pendleton in 2016, 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 2016	Male	Female	Unk[2]	Male	Female	Male	Male	Female	Total
2008	8 yrs.	0	1	0	0	0	0	0	0	1
2009	7 yrs.	0	2	0	0	0	0	0	0	2
2010	≥ 7 yrs.	4	0	0	0	0	0	0	0	4
	6 yrs.	2	1	0	0	0	0	0	0	3
2011	≥ 6 yrs.	1	0	0	0	0	0	0	0	1
	5 yrs.	1	0	0	1	0	0	0	0	2
2012	≥ 5 yrs.	8	0	0	0	0	0	0	0	8
	4 yrs.	3	1	0	1	0	0	0	0	5
2013	≥ 4 yrs.	3[3]	0	0	0	0	0	0	0	3
	3 yrs.	5	6	1	2	0	1	0	0	15
2014	≥ 3 yrs.	13	5	0	0	0	0	0	0	18
	3 yrs.	1	0	0	0	0	0	0	0	1
	2 yrs.	0	0	0	2	0	0	0	0	2
2015	≥ 2 yrs.	9	1	0	0	0	0	0	0	10
	≥ 1 yr.	0	0	0	0	0	0	0	1	1
	1 yr.	16	7	0	5	3	7	1	0	39
Subtotal		66	24	1	11	3	8	1	1	115
Unknown[4]	≥ 1 yr.	9	3	0	1	0	0	3	0	16
Total		75	27	1	12	3	8	4	1	131

[1] Both vireos were banded on the wintering grounds in Baja California Sur so natal territories are unknown.
[2] Vireos of unknown sex were captured at one of two MAPS stations at Marine Corps Base Camp Pendleton and not detected breeding in 2016 (Hall and Kus 2016b).
[3] One male was originally captured at the Santa Margarita MAPS station in 2013 and 2014, then redetected three times in Baja California Sur, Mexico, before it was recaptured again at the Santa Margarita MAPS station in 2016. (Allen and Kus 2014b, Madden et al. 2015, Hall and Kus 2016b, USGS Unpubl. data).
[4] Natal vireos banded with single numbered metal federal band or identity unknown because of inadequate resight, so natal year is not known. Twelve 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. Three vireos were banded but colors of bands were indeterminable.

New Banded Birds

A total of 177 Least Bell's Vireos were captured and banded for the first time during 2016 (Table 9). These included 17 adult vireos and one vireo of unknown age caught for the first time and banded with a unique color combination and 159 hatch-year birds (158 of which were banded as nestlings with a single gold numbered federal band and one of which was incidentally caught at one of the two MAPS stations on Base and given a unique color combination). 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 2016.

Age Banded	Males	Females	Unknown Sex	Total
Adult	6	8	3	17
Juvenile			1[1]	1
Unknown			1	1
Nestling			158	158
Total	6	8	163	177

[1] Incidentally captured post-fledging and given 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 2016. 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 2015-2016

Of 125 uniquely color banded adult vireos detected on Base during the 2015 breeding season, 42% (53/125) returned in 2016 (Table 10). Twenty-one additional adult vireos identified in 2016 but not detected on Base in 2015 were added to the calculations to yield an adjusted annual survivorship of 51% (74/146; Table 10). Fifty-six of the 105 adult male vireos known to be alive in 2015 were resighted in 2016, an over-winter survivorship rate of 53%. Seventeen of the 36 adult female vireos known to be alive in 2015 were resighted in 2016, an over-winter survivorship rate of 47%. One of the five vireos of unknown sex known to be alive in 2015 was resighted in 2016, an over-winter survivorship rate of 20%. The remaining 49 males, 19 females, and 4 vireos of unknown sex were not resighted in 2016.

Table 10. Number of banded adult Least Bell's Vireos detected in 2015 at Post-fire sites, Reference sites, and other areas on Marine Corps Base Camp Pendleton, and where those that returned were detected in 2016. Numbers in parentheses include the adjustments resulting from vireos that were identified in 2016 but not in 2015.

	Study Site Name and Type for each Year			
Year / Sex	**Post-fire**	**Reference**	**Other[1]**	**Total**
2015				
Male	22	29	43	94 (105)
Female	5	5	16	26 (36)
Unknown			5	5 (5)
Total	27	34	64	125 (146)
2016				
Male	12[2]	12[3]	21[4]	45 (56)
Female	2[2]	2[3]	3[5]	7 (17)
Unknown			1[6]	1 (1)
Total	14	14	27	53 (74)

[1] Includes all areas outside of study sites.
[2] All vireos occupied territories in Post-fire sites in 2015.
[3] All vireos occupied Reference sites in 2015.
[4] One occupied a territory at a Post-fire site, one occupied a territory at a Reference site, and the remaining 19 occupied territories outside of the monitoring sites in 2015.
[5] One occupied a territory at References site and the remaining two occupied territories outside of the monitoring sites in 2015.
[6] Occupied a territory outside of the monitoring sites in 2015.

First-year Survivorship from 2015-2016

Of the 114 hatch-year vireos banded in 2015 that survived to fledge, 23 (14 males, 6 females, and 3 vireos of unknown sex) were resighted with or captured and given unique color band combinations in 2016 (Table 11). This yields a conservative first-year survivorship of 20% (23/114) (Table 11, Table 12). Assuming an equal sex ratio of banded juveniles, first-year survivorship of males was 25% (14/57) and females was 11% (6/57).

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 2015, and where those that returned were detected in 2016.

	Study Site Name and Type for each Year			
Year/Sex	**Post-fire**	**Reference**	**Other[1]**	**Total**
2015				
Unknown	55	55	4	114
2016				
Male	4[2]	3[3]	7[4]	14
Female	2[5]	0	4[6]	6
Unknown	0	0	3[7]	3
Total	6	3	14	23

[1] Includes all areas outside of study sites.
[2] One banded as a nestling at a Post-fire site and three banded as nestlings at Reference sites in 2015.
[3] One banded as a nestling at a Post-fire site and two banded as nestlings at Reference sites in 2015.
[4] Four banded as nestlings at Post-fire sites and three banded as nestlings at Reference sites in 2015.
[5] Both banded as nestlings at Reference sites in 2015.
[6] One banded as a nestling at a Post-fire site, two banded as nestlings at Reference sites, and one banded as a fledgling at a MAPS station in 2015.
[7] Banded as fledglings at a MAPS station in 2015.

Adjusted Annual Survivorship

Twenty-one adult banded vireos (11 males and 10 females) that were detected in 2016 were not observed in 2015 (Table 10; Appendix E). 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 2009, 2010, 2011, 2012, 2013, 2014, and 2015 (Table 12).

Table 12. Adjustments to first-year and adult Least Bell's Vireo survivorship on Marine Corps Base Camp Pendleton, 2016. These numbers update survivorship estimates presented in Rourke and Kus 2007a, 2008, Lynn and Kus 2009, 2010a, 2010b, 2011c, 2012b, and 2013, Lynn et al. 2014 and 2015.

	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%	10%	11%	44%	56%	57%
2010-2011	4%	12%	14%	25%	41%	42%
2011-2012	10%	15%	-	38%	68%	69%
2012-2013	16%	17%	18%	76%	85%	86%
2013-2014	8%	13%	16%	51%	57%	59%
2014-2015	2%	-	-	46%	52%	59%
2015-2016	20%	-	20%	42%	-	51%

Survivorship at Post-fire and References Sites

Of the 27 banded adult vireos of known sex (22 males and 5 females) that were detected within Post-fire sites in 2015, 15 (13 males and 2 females) were resighted in 2016 for a 56% survival rate (59% for males and 40% for females; Table 10, Table 13, and Appendix E). Of the 34 banded adult vireos of known sex (29 males and 5 females) that were detected within the Reference sites in 2015, 16 (13 males and 3 females) were resighted in 2016 for a 47% survival rate (45% for males and 60% for females). Over-winter survival rate did not differ between vireos that occupied Post-fire or Reference sites in 2015 (Fisher's Exact $P = 0.61$). There were no differences in adult survivorship between 2014-2015 and 2015-2016 at Post-fire sites, although survivorship for adult males, and adults in general, was higher at Reference sites from 2014-2015 than from 2015-2016.

One hundred and ten of the 114 banded juveniles that were known to fledge in 2015 were banded on a Post-fire or Reference site (55 at Post-fire sites and 55 at Reference sites; Table 11, Table 13). Of these, six males and one female from Post-fire sites were recaptured on MCBCP and given unique color band combinations in 2016 for a first-year survival rate of 13% for fledglings from Post-fire sites (22% for males and 4% for females, assuming equal sex ratio of banded nestlings). Of nestlings banded at Reference sites in 2015, eight males and four females were recaptured on MCBCP and given unique color band combinations in 2016 for a first-year survival rate of 22% (29% for males and 15% 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 2015 (Fisher's Exact $P = 0.31$). There were no differences in juvenile survivorship between 2014-2015 and 2015-2016 at Post-fire sites, although survivorship for juvenile males and juveniles in general was higher at Reference sites from 2015-2016 than from 2014-2015.

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

	Percent Survival		
	2014-2015	**2015-2016**	**Fisher's Exact *P***
Post-fire Sites			
Adult Males	81%	59%	0.19
Adult Females	40%	40%	1.00
Total Adults	73%	56%	0.25
Juvenile Males	7%	22%	0.39
Juvenile Females	0%	4%	1.00
Total Juveniles	4%	13%	0.26
Reference Sites			
Adult Males	83%	45%	**0.01**
Adult Females	0%	60%	1.00
Total Adults	79%	44%	**0.02**
Juvenile Males	0%	29%	**0.08**
Juvenile Females	0%	15%	0.56
Total Juveniles	0%	22%	**0.03**

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 E). Fifty-two adult vireos (45 males and 7 females) that were identified at MCBCP in 2015 were resighted in 2016, all of which occupied known territories both years. The majority of returning adult vireos showed strong between-year site fidelity. Of the 52 returning territorial adults, 32 (62% of territorial adults; 31 males, 69% of males; one female, 14% of females) occupied a breeding site in 2016 that they had defended in 2015 (within 100 m). Ten additional vireos (19% of all vireos; seven males, 16% of males; three females, 43% of females) returned to sites adjacent to their previous territories (within 300 m). The average distance moved by returning adult vireos was 0.7 ± 3.4 km (range 0.0-24.1 km; 0.7 ± 3.6 km, range 0.0-24.1 km for males; 0.4 ± 0.4 km, range 0.0-1.2 km for females). One adult male vireo that was detected along the San Luis Rey River in 2015 was redetected on MCBCP in 2016, having moved 6.8 km between years.

Two vireos that were detected on MCBCP in 2016 were originally banded in Baja California Sur in October 2015. The female was resighted breeding at a Reference site on the Santa Margarita River in 2016, 1,360 km from her banding site. The male was resighted holding a territory outside of the monitoring sites on San Onofre Creek in 2016, 1,373 km from his banding site.

Nineteen first-year vireos that were banded as nestlings in 2015 on MCBCP were resighted in 2016 and occupied known territories (14 males and 5 females). The average distance that first-year vireos moved from their natal territories was 2.9 ± 2.6 km (range 0.1-12.5 km; males moved 3.2 ± 2.9 km, range 0.1-12.5 km; females moved 2.0 ± 1.3 km, range 0.2-3.8 km). Fifteen other first-year vireos that were originally banded as nestlings along the San Luis Rey River (eight, five males and three females) and on MCAS (seven males) in 2015 dispersed 5.0 ± 4.2 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 2015 and 2016, 14 of the 15 vireos that held territories at Post-fire sites in 2015 returned to Post-fire sites in 2016 (93%), although not necessarily to the same Post-fire site. Similarly, 14 of the 15 vireos that held territories at Reference sites in 2015 returned to Reference sites in 2016 (93%; Appendix E). The remaining vireos that were detected at a Post-fire site or at a References site in 2015 were redetected in 2016 outside of the monitoring sites. Seven first-year vireos that fledged from Post-fire sites in 2015 were redetected in 2016. One of these returned to a Post-fire site (14%), one returned to a Reference site (14%), and five returned to areas outside of the monitoring sites (71%). Twelve first-year vireos that fledged from Reference sites in 2015 were redetected in 2016. Five returned to Post-fire sites (42%), two returned to Reference sites (17%), and five returned to areas outside of the monitoring sites (42%).

Nest Monitoring

Nesting activity was monitored in a total of 53 territories within the Post-fire and Reference monitoring areas (Table 14, Fig. 9-12, Appendix F). All of the territories were considered fully monitored, meaning that all nests within the territory were found and documented during the breeding season. One Reference territory was held briefly by a pair but no nests were found. A total of 126 nests were monitored during the breeding season; 11 of these were not completed (coded as "INC" or "FAL" in Appendix F) and have been excluded from calculations of nest success and productivity.

Table 14. Number of Least Bell's Vireo territories and nests monitored at Post-fire and Reference sites on Marine Corps Base Camp Pendleton, 2016.

	Nest Monitoring Area Type	
	Post-fire	**Reference**
Territories	26	27
Nests (# complete)	60 (55)	66 (60)
Completed nests per pair	2.1 ± 1.0	2.2 ± 0.8
Total number of nests per pair (includes incomplete nests)	2.3 ± 1.2	2.4 ± 0.8
Total # of nests monitored	60	66

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 2016 breeding season (Table 14; $t = -0.47$, $P = 0.64$). Post-fire pairs (17/26; 65%) were less likely to re-nest after an initial attempt than Reference pairs (25/26; 96%; Fisher's Exact $P = 0.02$). The incidence of re-nesting after a failed first nesting attempt did not differ between Post-fire pairs (13/15; 87%) and Reference pairs (18/19; 95%; Fisher's Exact $P = 0.57$). However, fewer pairs at Post-fire sites (4/11; 36%) than at Reference sites (7/7; 100%) re-nested after a successful attempt, a difference that approached statistical significance (Fisher's Exact $P = 0.13$). 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 2016 (Fisher's Exact $P = 0.02$). However, this difference was not evident within Post-fire sites (87% vs. 36%, Fisher's Exact $P = 0.14$) or Reference sites (95% vs. 100%, Fisher's Exact $P > 0.99$). Overall, 91% (31/34) of vireo pairs attempted to re-nest after a failed first nesting attempt, similar to 2014 and 2015 (Fig. 13). However, 61% (11/18) of pairs attempted to re-nest after a successful first nesting attempt in 2016, a smaller proportion than in 2015 but a larger proportion than in 2014. Eleven pairs at Post-fire sites and 13 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 2016. One pair at a Post-fire site initiated five nesting attempts in 2016.

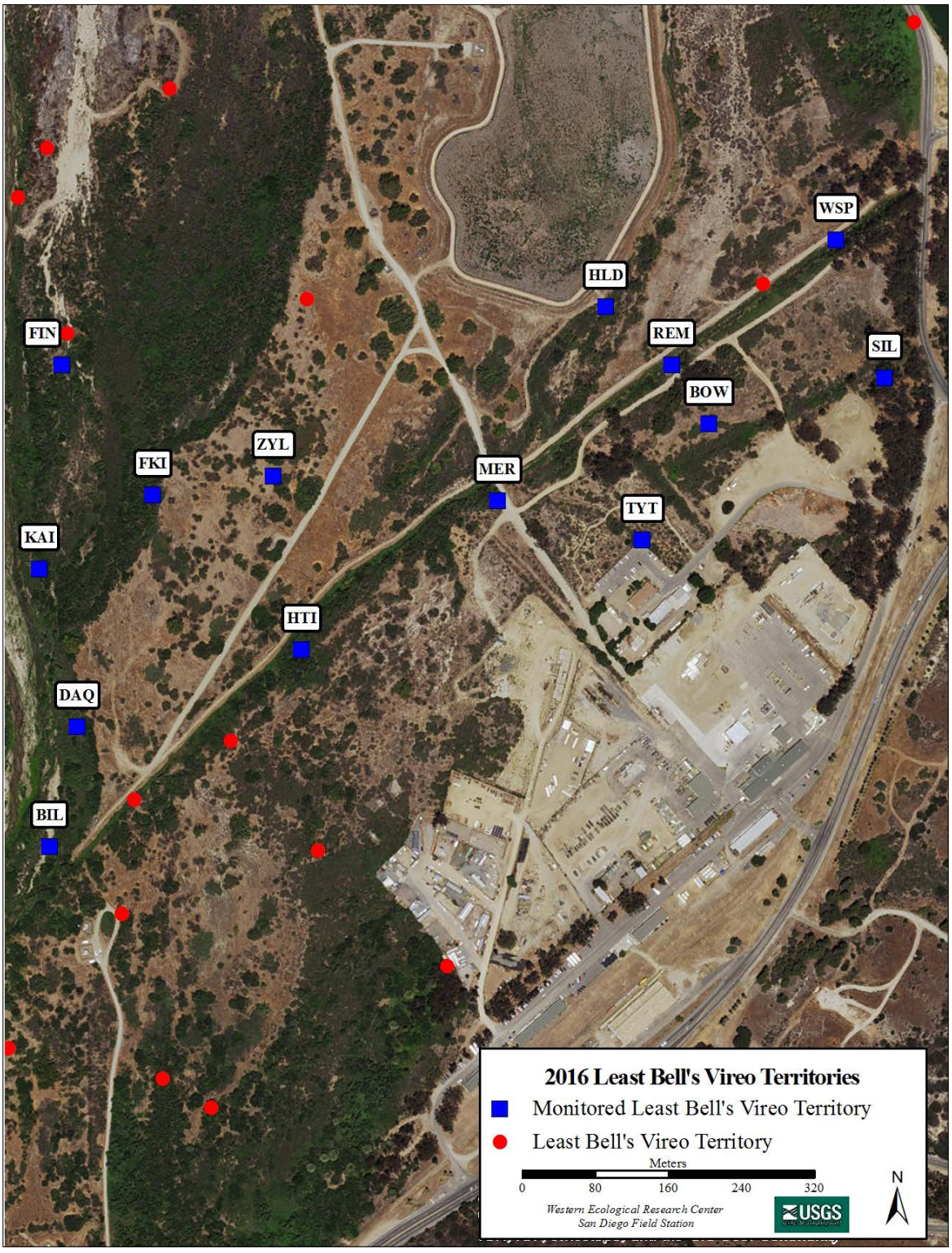

Fig. 9. Locations of monitored Least Bell's Vireo territories at the Below Hospital West Reference site, Marine Corps Base Camp Pendleton, 2016.

Fig. 10. Locations of monitored Least Bell's Vireo territories at the Below Hospital East Reference site, Marine Corps Base Camp Pendleton, 2016.

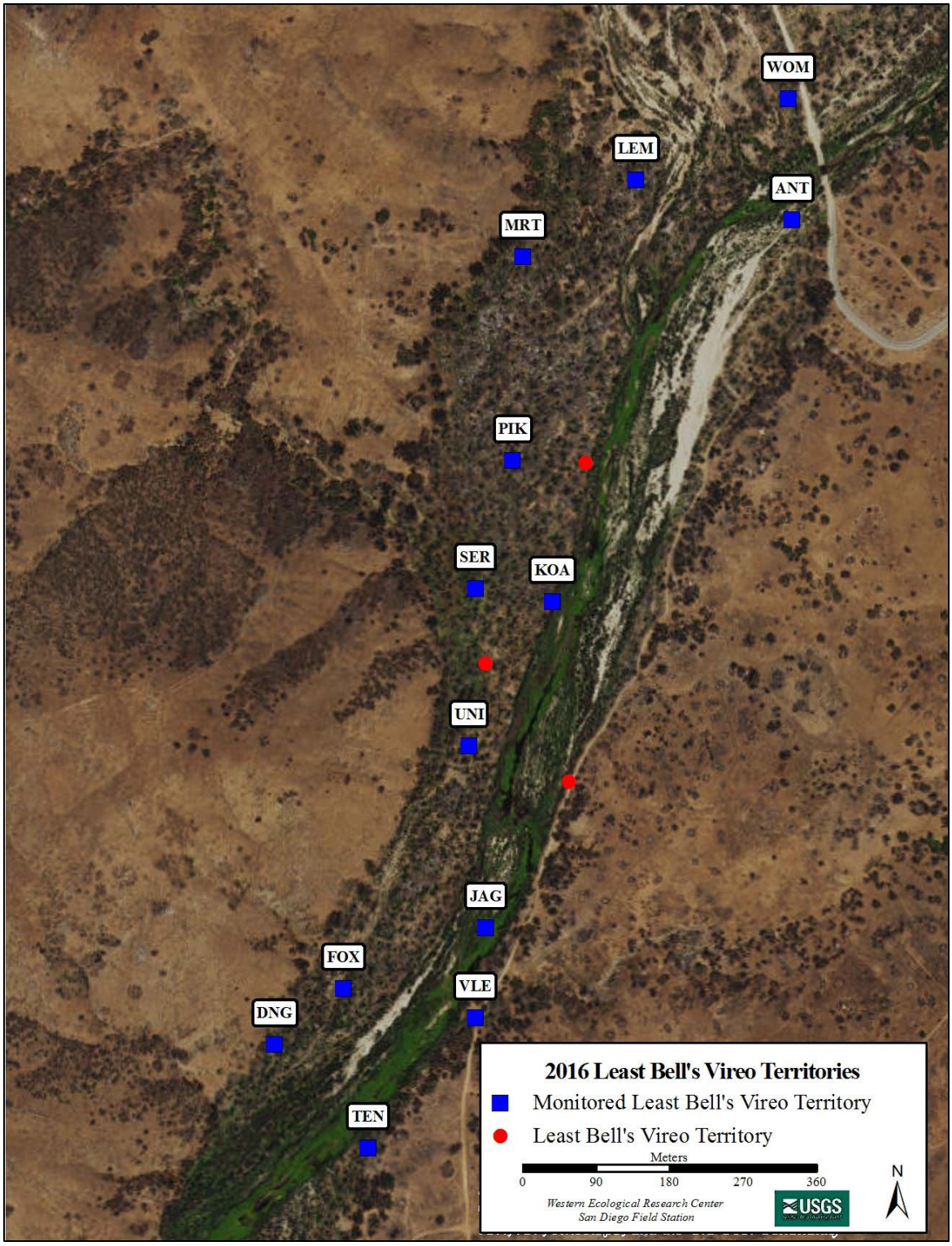

Fig. 11. Locations of monitored Least Bell's Vireo territories at the Above Hospital North Post-fire site, Marine Corps Base Camp Pendleton, 2016.

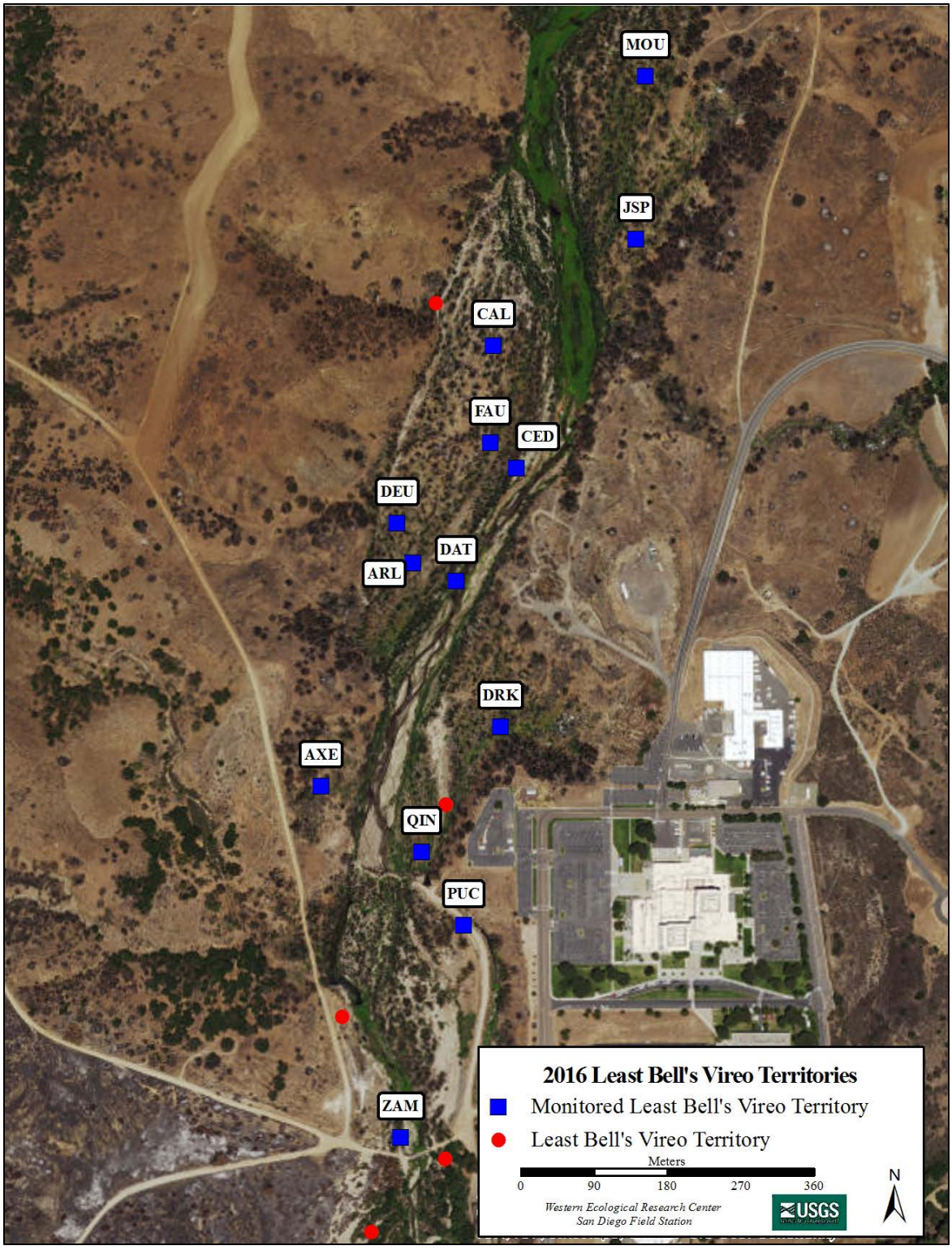

Fig. 12. Locations of monitored Least Bell's Vireo territories at the Above Hospital South Post-fire site, Marine Corps Base Camp Pendleton, 2016.

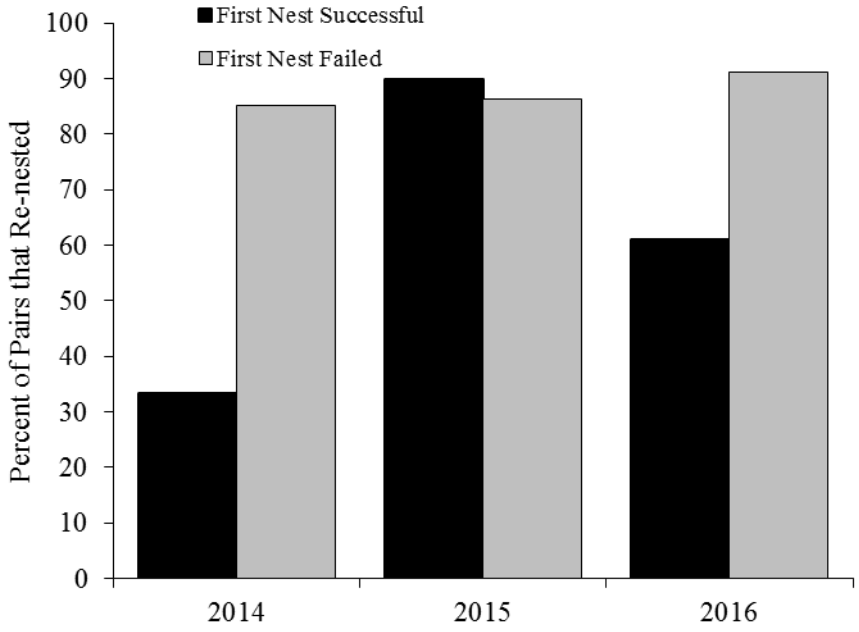

Fig. 13. Percent of Least Bell's Vireo pairs that re-nested after a successful or failed first nesting attempt by year, Post-fire and Reference sites combined, Marine Corps Base Camp Pendleton, 2014-2016.

Nest Success

Completed nests in Post-fire sites were as likely to be successful as completed nests in Reference sites ($\chi^2 = 1.06$, $P = 0.30$), as 29% (16/55) of nests in Post-fire sites successfully fledged young and 40% (24/60) of those in Reference sites successfully fledged young (Table 15). First nesting attempts were also as likely to be successful at Post-fire sites (42%) as at Reference sites (27%; $\chi^2 = 0.97$, $P = 0.33$) in 2016. Overall, 35% of first nesting attempts were successful in 2016.

Table 15. Fate of completed Least Bell's Vireo nests in fully monitored territories at Post-fire and Reference sites, Marine Corps Base Camp Pendleton, 2016. Numbers in parentheses are proportions of total nests.

	Number of Nests		
Nest Fate	**Post-fire**	**Reference**	**Total**
Successful	16	24	40 (0.35)
Failed			
Predation	28	32	60 (0.52)
Parasitism	0	0	0 (0.00)
Other/Unknown	11	4	15 (0.13)
Total Completed Nests	55	60	115 (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 15). Predation accounted for 72% (28/39) of nest failures at Post-fire sites and 89% (32/36) of nest failures at Reference sites. We documented 15 nests that failed for other known and unknown reasons at our monitoring sites (Appendix F). One nest failed when the host plant collapsed. One nest was found failed with eggs on the ground under the nest. Seven nests failed between nest-building and egg-laying from unknown causes. At four other nests, eggs were likely infertile and did not hatch. Two nests were abandoned with eggs for unknown reasons. Overall, 71% and 60% of completed vireo nests at Post-fire and References sites, respectively, were lost to predation or other causes.

Cowbird Parasitism

One Least Bell's Vireo nest was parasitized by Brown-headed Cowbirds in 2016. One cowbird egg was removed from this nest during incubation and the rescued nest was successful, fledging two young.

Productivity

Clutch size did not differ between Post-fire sites and Reference sites (Table 16). Measures of hatching and fledging success were similar at Post-fire and Reference sites. Pairs at Post-fire sites produced significantly fewer fledglings than did pairs at Reference sites (1.8 vs.

2.7 young fledged per pair, respectively; Table 16). There was no difference in the proportion of pairs that successfully fledged young from at least one nest between Post-fire sites (58%) and Reference sites (70%). One pair at a Post-fire site and five pairs at Reference sites successfully double-brooded during the 2016 breeding season. Vireo pairs at Post-fire and Reference sites combined fledged 2.2 vireo young per pair, and 64% of monitored pairs were successful in fledging at least one young in 2016.

Table 16. Reproductive success and productivity of nesting Least Bell's Vireos at Post-fire and Reference sites, Marine Corps Base Camp Pendleton, 2016.

Parameter	Post-fire Sites	Reference Sites	Total
Nests with eggs	48	59	107
Eggs laid	152	194	346
Average clutch size[1]	3.4 ± 0.5	3.5 ± 0.5	3.5 ± 0.5
Hatchlings	75	106	181
Nests with hatchlings	26	34	60
Hatching success:			
Eggs[2]	49%	55%	52%
Nests[3]	54%	58%	56%
Fledglings	46	73	119
Nests with fledglings	16	24	40
Fledging success:			
Hatchlings[4]	61%	69%	66%
Nests[5]	62%	71%	67%
Fledglings per egg	0.3	0.4	0.3
Average number of young fledged per pair[6]	1.8 ± 1.7	2.7 ± 2.1	2.2 ± 2.0
Pairs fledging ≥ 1 young[7]	15 (58%)	19 (70%)	34 (64%)

[1] Based on 36 Post-fire and 49 Reference non-parasitized nests with a full clutch (t = -0.99; P = 0.33).
[2] Percent of all eggs that hatched (Chi-squared = 0.76, P = 0.38).
[3] Percent of all nests with eggs in which at least one egg hatched (Chi-squared = 0.03, P = 0.87).
[4] Percent of all nestlings that fledged (Chi-squared = 0.65, P = 0.42).
[5] Percent of all nests with nestlings in which at least one young fledged (Chi-squared = 0.21, P = 0.65).
[6] Based on 26 Post-fire and 27 Reference pairs (t = -1.77, P = 0.08).
[7] Based on 26 Post-fire and 27 Reference pairs (Fisher's Exact P = 0.40).

Daily Nest Survival

Analysis of DSR showed that the constant model (with neither type of monitoring site, Post-fire or Reference, nor year) was the best supported model for predicting vireo nest survival (Table 17). According to the constant model, nests at Post-fire sites were equally as likely to produce fledglings as nests at Reference sites (Fig. 14, Table 18). Although models that included treatment and year received some support, the odds ratios for the type of monitoring site and year in these less-supported models had confidence intervals that included 1, which indicates that they were not significant contributing factors to the models (Table 18).

Table 17. Logistic regression models for the effect of Treatment (whether a nest was in a Post-fire or Reference site) on nest survival of Least Bell's Vireos on Marine Corps Base Camp Pendleton, 2015-2016. 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
Constant	730.15	1	732.15	0	0.51
Treatment	729.93	2	733.94	1.78	0.21
Year	730.08	2	734.08	1.93	0.20
Treatment + Year	729.85	3	735.85	3.70	0.08

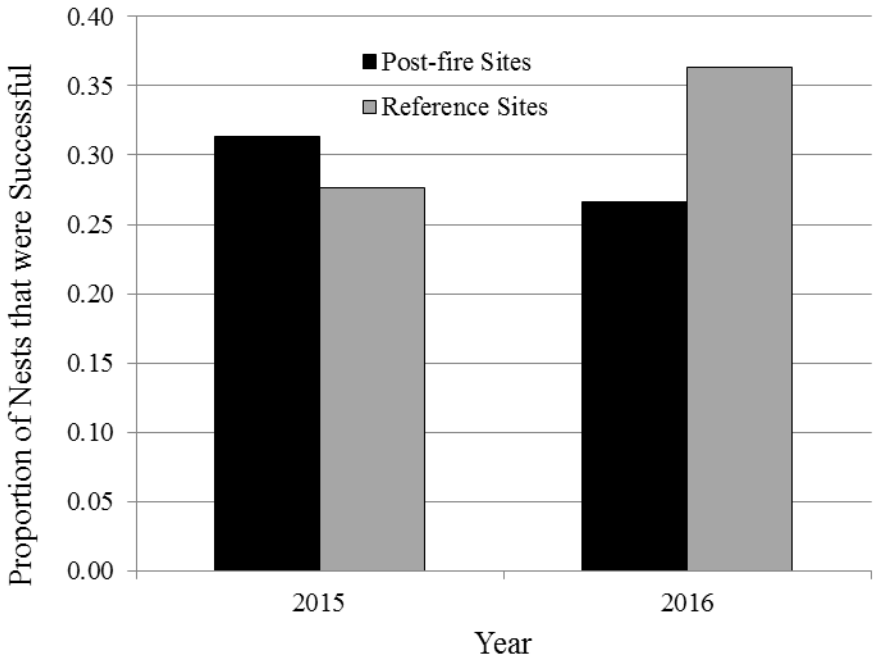

Fig. 14. Proportion of nests that survived to fledge young at Post-fire and Reference sites, Marine Corps Base Camp Pendleton, 2015-2016.

Table 18. 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, 2015-2016. Models are in order of best-supported to least-supported.

Model	Effect	β	SE	Odds Ratio	95% CI
Constant	Constant	3.35	0.09		
Treatment	Treatment	-0.08	0.17	0.92	0.66-1.30
	Constant	3.39	0.12		
Year	Year	-0.04	0.17	0.95	0.68-1.34
	Constant	3.38	0.12		
Treatment + Year	Treatment	-0.08	0.14	0.92	0.65-1.29
	Year	-0.05	0.17	0.95	0.67-1.34
	Constant	3.42	0.15		

Nest Characteristics

Least Bell's Vireos used 14 plant species for nesting at Post-fire and Reference sites in 2016, although not all were used within each treatment (Table 19). Vireos used 12 species at Post-fire sites and ten species at Reference sites. Seventy-three percent of all nests (58% at Post-fire sites, and 86% at Reference sites) were placed in arroyo willow, sandbar willow, or mule fat. At Post-fire sites, six vireo nests (10%) were placed in herbaceous vegetation and 54 nests (90%) were placed in woody vegetation. At Reference sites, three vireo nests (5%) were placed in herbaceous vegetation and 63 nests (95%) were placed in woody vegetation. Five vireo nests were built in an exotic plant species (two in poison hemlock, two in black mustard and one in bull thistle, *Circium vulgare*). All five of the nests that were built in exotic vegetation were located in the Post-fire sites.

In 2016, successful nests at Post-fire sites were placed significantly higher in the host plant than unsuccessful nests at Post-fire sites, but there were no other differences in nest placement characteristics between successful and unsuccessful nests at Post-fire sites or at Reference sites (Table 20). Vireo nests at Post-fire sites were placed lower in the host plant but in taller host plants than those at Reference sites.

Table 19. Host plant species used by Least Bell's Vireos at Post-fire and Reference sites, Marine Corps Base Camp Pendleton, 2016. Numbers in parentheses are proportions of total nests within treatment types.

	Number of Nests	
Host Species	**Post-fire**	**Reference**
Arroyo or red willow	29 (0.48)	21 (0.32)
Sandbar willow	1 (0.02)	21 (0.32)
Mule fat	5 (0.08)	15 (0.23)
California sycamore	8 (0.13)	1 (0.02)
Blue elderberry (*Sambucus nigra*)	5 (0.08)	1 (0.02)
Wild grape (*Vitus* sp.)	4 (0.07)	1 (0.02)
Poison oak (*Toxicodendron diversilobum*)	1 (0.02)	2 (0.03)
Fremont cottonwood	1 (0.02)	1 (0.02)
Coyote brush (*Baccharis pilularis*)	-	2 (0.03)
Poison hemlock	2 (0.03)	-
Black mustard	2 (0.03)	-
California blackberry (*Rubus ursinus*)	-	1 (0.02)
Coast live oak	1 (0.02)	-
Bull thistle	1 (0.02)	-

Table 20. 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, 2016.

	Nest Fate				
Nest Characteristic	**Successful**	**Unsuccessful**	***n*[1]**	***t*[2]**	***P*[3]**
Post-fire Site					
Average nest height (m)	0.82	0.71	16, 44	1.74	**0.09**
Average host height (m)	3.94	4.65	16, 44	-1.07	0.29
Average distance to edge of host (m)	0.69	0.84	16, 44	-1.11	0.28
Average distance to edge of clump (m)	1.21	1.95	16, 44	-1.47	0.15
Reference Site					
Average nest height (m)	0.97	0.98	24, 42	-0.04	0.97
Average host height (m)	3.68	3.68	24, 42	0.01	0.99
Average distance to edge of host (m)	0.68	0.72	24, 42	-0.27	0.79
Average distance to edge of clump (m)	2.76	1.75	24, 42	1.25	0.22
Post-fire and Reference Sites	**Post-fire**	**Reference**	***n*[4]**	***t*[2]**	***P*[3]**
Average nest height (m)	0.74	0.98	60, 66	-3.82	< **0.01**
Average host height (m)	4.46	3.68	60, 66	2.09	**0.04**
Average distance to edge of host (m)	0.78	0.71	60, 66	0.91	0.37
Average distance to edge of clump (m)	1.75	2.12	60, 66	-0.79	0.43

[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 until 2016 across several study areas in San Diego County including MCBCP, the San Luis Rey River, the San Diego River, MCAS, and the Sweetwater Reservoir. 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 increasing again in 2013 and 2014, and declining in 2015 (Allen and Kus 2013, 2014a; Ferree and Kus 2007, 2008a, 2008b, Ferree et al. 2010a, 2010b, 2011, 2012a, 2013, 2015; Houston et al. 2015; Howell and Kus 2015; Jones 1985; Kus 1988, 1989, 1991a, 1991b, 1994, 1995; Kus and Beck 1998; Lynn and Kus 2008, 2010c, 2011a, 2011b, 2012a, Lynn et al. 2010, 2012; Peterson et al. 2002; Pottinger and Kus 2013; Rourke and Kus 2006b, 2007b; USGS unpubl. data). From 2015 to 2016, the population trends at different study areas within the vireo's range were not consistent. Vireos increased on MCBCP from 2015 to 2016, but decreased on MCAS (35%; Hall and Kus 2016a) and on the lower San Luis Rey River (18%; Houston et al. 2016). Doubtless, management for vireos on MCBCP has affected the vireo population positively, especially with the implementation of cowbird control and exotic plant removal in vireo habitat during the early 1980's. Habitat management in adjacent riparian areas also may be affecting vireo numbers on MCBCP in 2016. During the winter of 2015-2016, a large portion of riparian vegetation was mowed and removed from the lower San Luis Rey River (Houston et al. 2016). During the same time period, the tops of a large portion of riparian trees at MCAS were trimmed, reducing canopy height, to mitigate risk to aircraft using the runway adjacent to the vireos' habitat. This loss and/or degradation of habitat may have influenced vireos returning from the wintering grounds to relocate to nearby MCBCP. In fact, the number of known first-year vireos from natal territories off-Base that moved to MCBCP was high in 2016 (15) compared to previous years (one to seven annually from 2011 to 2015). The increase in the vireo population on MCBCP in 2016 may also be, in part, a response to higher breeding productivity in 2015 (compared to 2014) and higher recruitment of young vireos in 2016. First-year survivorship for juveniles that fledged in 2015 was 20%, the highest first-year recruitment rate observed since nest monitoring began in 2005. This recruitment rate is likely to be adjusted upward in subsequent years when we are able to resight and identify vireos that were not seen in 2016.

The general decrease in vireo numbers since 2010 region-wide is likely largely attributable to drought conditions that have persisted on the breeding grounds for the past 5 years. San Diego County has been experiencing a drought since 2012, with precipitation for each bio-year (1 July–30 June) from July 2011 to June 2015 totaling < 70% of average precipitation between 2002 and 2010 (The Weather Company 2016). Low precipitation compromises primary productivity and, consequently, arthropod abundance and the wildlife (i.e., vireos) that depend on them. Rainfall during the 2015-2016 bio-year was 3% above the 2002-2010 average and may have contributed to increased breeding productivity in 2016. However, the long-term effects of drought are unlikely to be eliminated by a single year of normal rainfall, so vireo breeding productivity and population size may take several years to recover to pre-drought levels.

Vireo territory density within the perimeters of the October 2013 and May 2014 wildfires in the first year immediately post-fire was lower than pre-fire levels. However, during the second and third years post-fire, vireo territory density increased again to equal or surpass pre-fire levels. Similarly, within the nest monitoring sites, vireo territory density at the Post-fire sites was significantly lower than at the Reference sites the first year post-fire. By 3 years post-fire, vireo territory density in Post-fire sites was significantly greater than at Reference sites. This is similar to the pattern of increasing number of vireo territories at Las Flores, relative to unburned drainages on MCBCP, by 3 years post-fire. Adult males and females showed strong fidelity to their breeding territories in both the Post-fire sites and the Reference sites, holding the same territories for several years in a row. Additionally, of the 19 first-year vireos from 2015 that returned to MCBCP, six were detected at Post-fire sites while only three were detected at Reference sites in 2016, even though 12 of the 19 fledged from Reference sites. This suggests that vireo habitat within the burned areas has recovered to or exceeded pre-fire quality. However, vireo productivity within the Post-fire sites was lower than at Reference sites in 2016 (1.8 young/pair versus 2.7 young per pair, respectively), suggesting that while the riparian vegetation has recovered sufficiently to harbor vireo territories, it may not have the same quality of attributes as Reference sites for supporting high breeding productivity. High breeding productivity at Reference sites was likely driven by the fact that vireos were less likely to initiate more than one nest at Post-fire sites than at Reference sites (65% vs 96%, respectively), and that five pairs at Reference sites successfully fledged two clutches (five-six fledglings per pair). The difference in breeding productivity between Post-fire and Reference sites was not evident in 2014 or 2015, so 2016 may be a temporary anomaly, attributable to other factors such as local and temporal prey abundance or local predators.

We continued to see a decrease in the average total canopy height in the Post-fire sites 3 years post-fire, although we also saw an increase in average live canopy height. Total canopy height includes all dead trees as well as live trees, so a reduction in total canopy height with a concurrent increase in live canopy height suggests that dead branches and snags are falling over time, while live trees continue to grow upward. Vegetation cover at the Post-fire sites decreased at the lower levels and increased at the mid-range levels, as would be expected with annual tree growth producing more shade, thereby diminishing vegetative volume in the herbaceous understory. Additionally, we found a shift from a greater proportion of native and exotic herbaceous cover in the lower height categories to a greater proportion of woody vegetation over 3 years. Concurrent with this shift, vireos have placed 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 sufficiently 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.

Vegetation recovery at the Post-fire sites at Above Hospital has shown a superficially similar pattern to vegetation recovery at Las Flores Creek following wildfires in October 2007. However, vegetation cover at Above Hospital was less than that at Las Flores Creek at the lowest height categories for the first and third years post-fire. 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 this shift at Las Flores during the 3 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 more quickly recovering 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 3 years post-fire at Above Hospital have coincided with an extended drought, potentially inhibiting new growth.

In 2016 we detected vireos (23) that originated outside of MCBCP holding territories on drainages on MCBCP. Conversely, in 2016 we found only one vireo that hatched on MCBCP and bred off-Base at the San Diego River. This vireo was last detected on MCBCP in 2013. In 2016, we also resighted three 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. 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 but rebounding again in 2016. In 2016, an unusually high number of immigrant vireos were detected on MCBCP. Additionally, the population increase on MCBCP in 2016 was not reflected in other parts of the vireos' range, suggesting that vireo habitat on MCBCP likely was more attractive to vireos than surrounding natal areas. This suggests that vireos were responding 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. There was one cowbird parasitism event documented on MCBCP during 2016, the first cowbird parasitism since 2006. 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), 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 to keep the herbaceous vegetation from drying out and collapsing. As the proportion of woody vegetation has increased in the 3 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 outcompete 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 2016, 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. Increased communication between the Assistant Chief of Staff, Environmental Security, and other military departments 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. Coordination of 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 will minimize impacts to active territories. This coordination and cooperation among various departments will 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, 2016

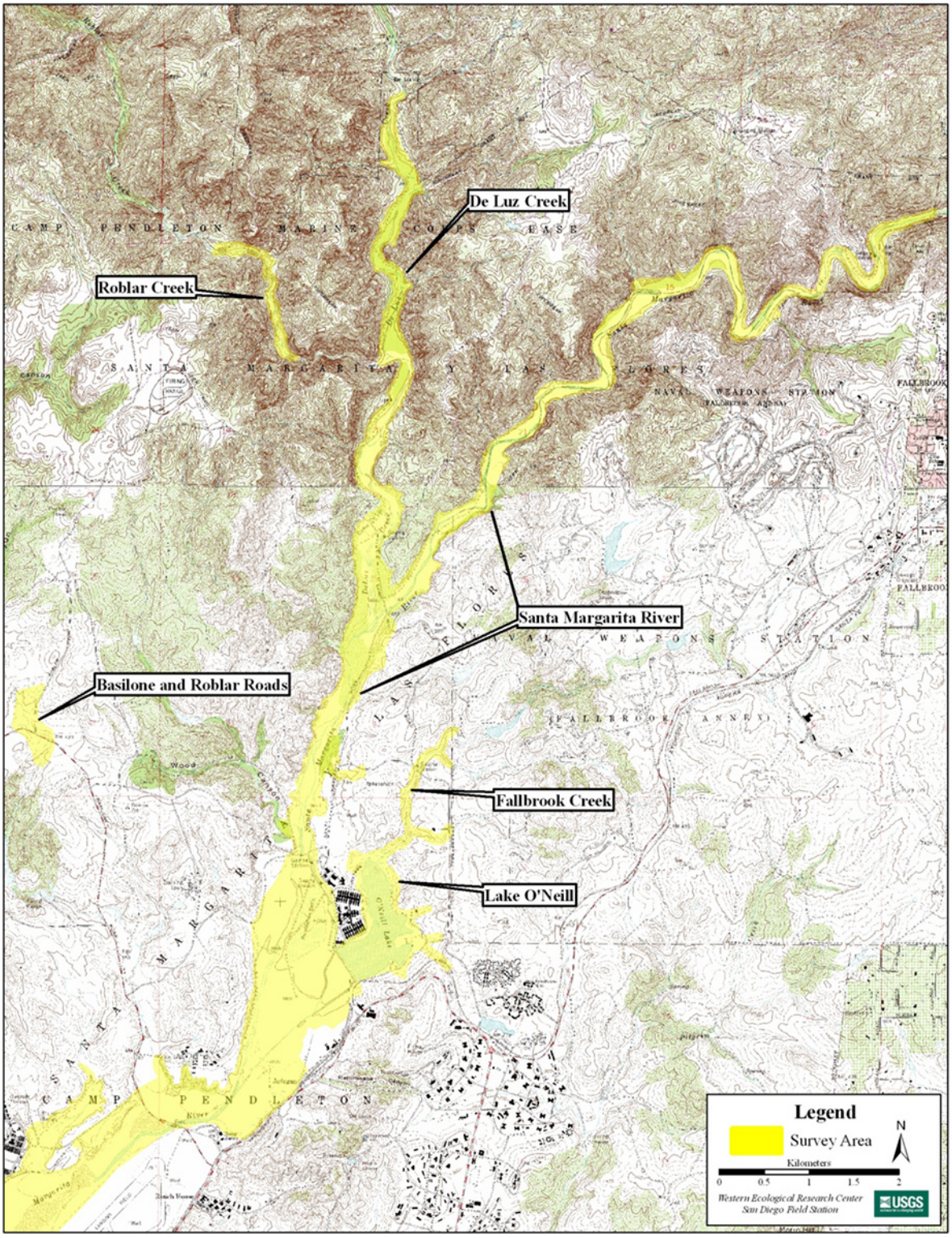


Fig. 15. Least Bell's Vireo survey areas at Marine Corps Base Camp Pendleton, 2016: Upper Santa Margarita River, Fallbrook Creek, Lake O'Neill, De Luz Creek, Roblar Creek, and Basilone and Roblar Roads.

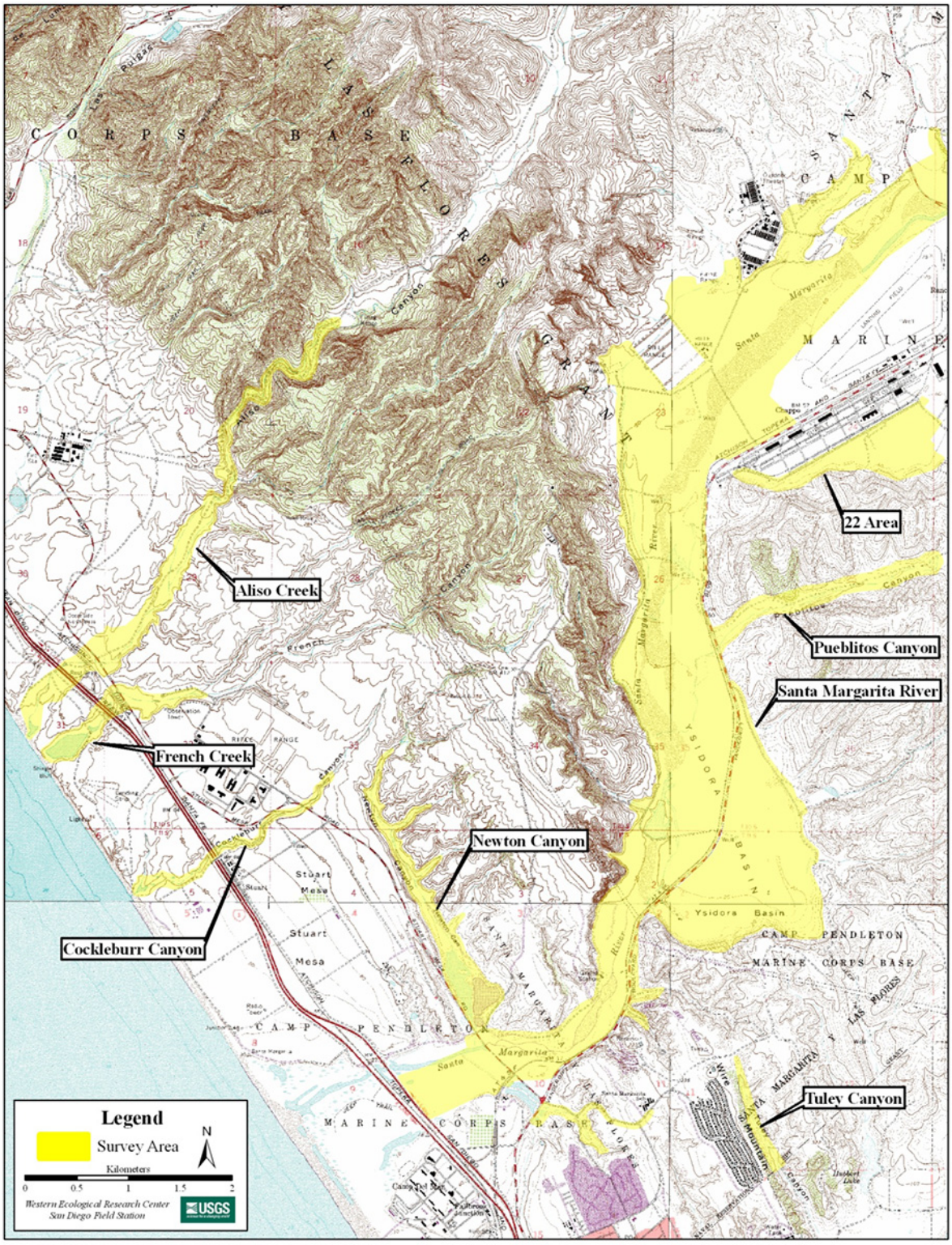


Fig. 16. Least Bell's Vireo survey areas at Marine Corps Base Camp Pendleton, 2016: Lower Santa Margarita River, 22 Area, Pueblitos Canyon, Tuley Canyon, Newton Canyon, Cockleburr Canyon, French Creek, and Aliso Creek.

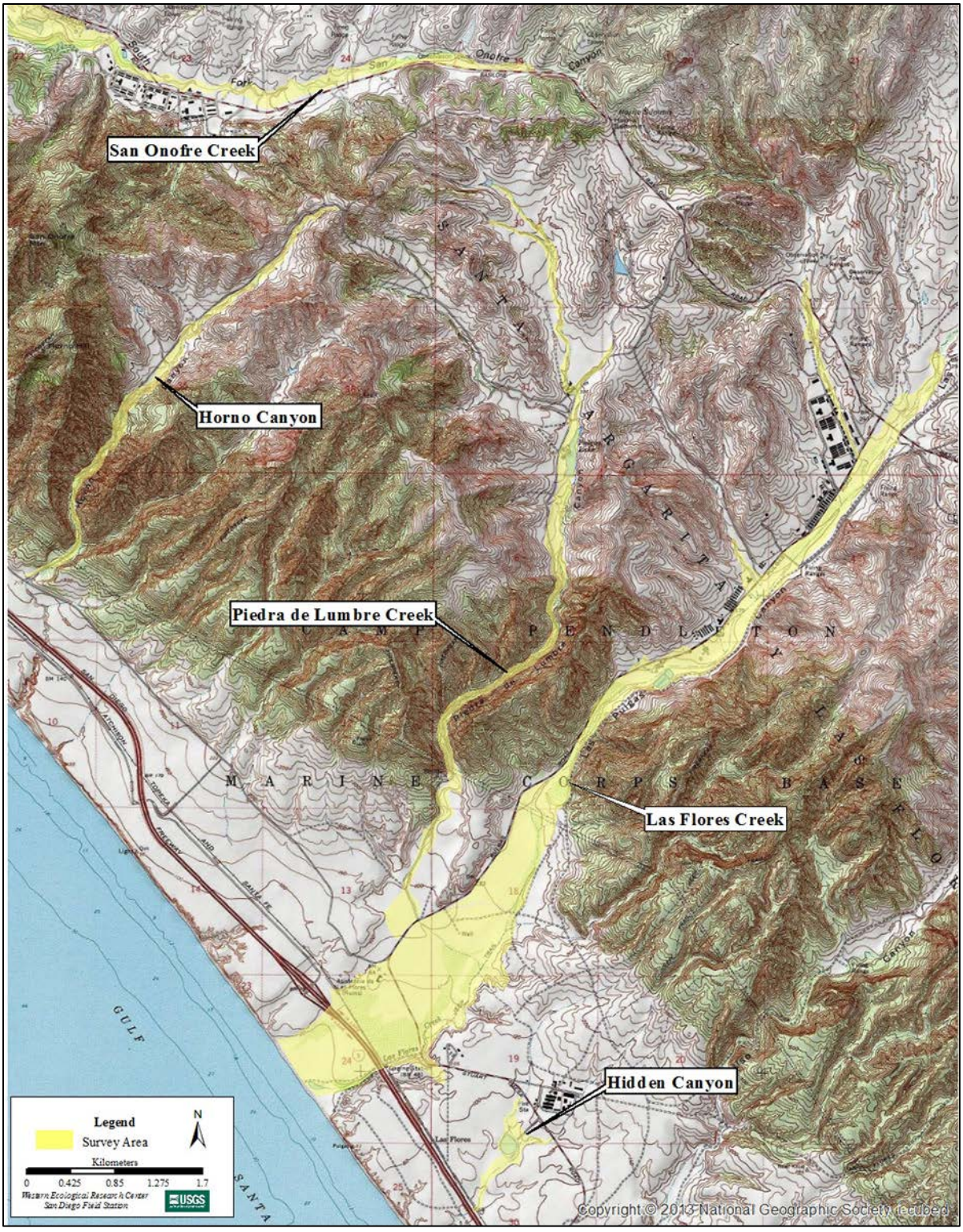


Fig. 17. Least Bell's Vireo survey areas at Marine Corps Base Camp Pendleton, 2016: San Onofre Creek South Fork, Ammunition Supply Point, Horno Canyon, Piedra de Lumbre Creek, Las Flores Creek, and Hidden Canyon.

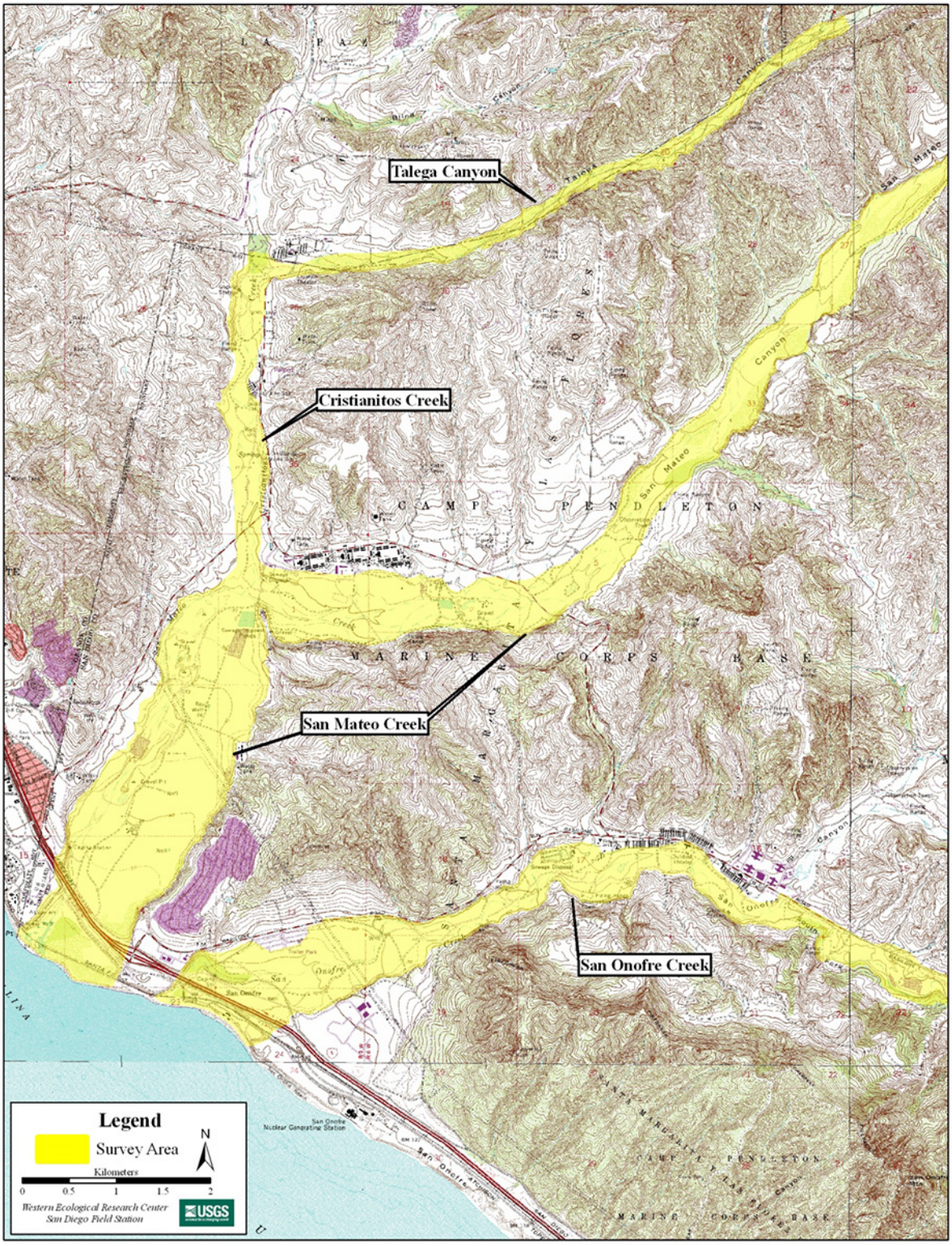


Fig. 18. Least Bell's Vireo survey areas at Marine Corps Base Camp Pendleton, 2016: Talega Canyon, Cristianitos Creek, San Mateo Creek, and San Onofre Creek.

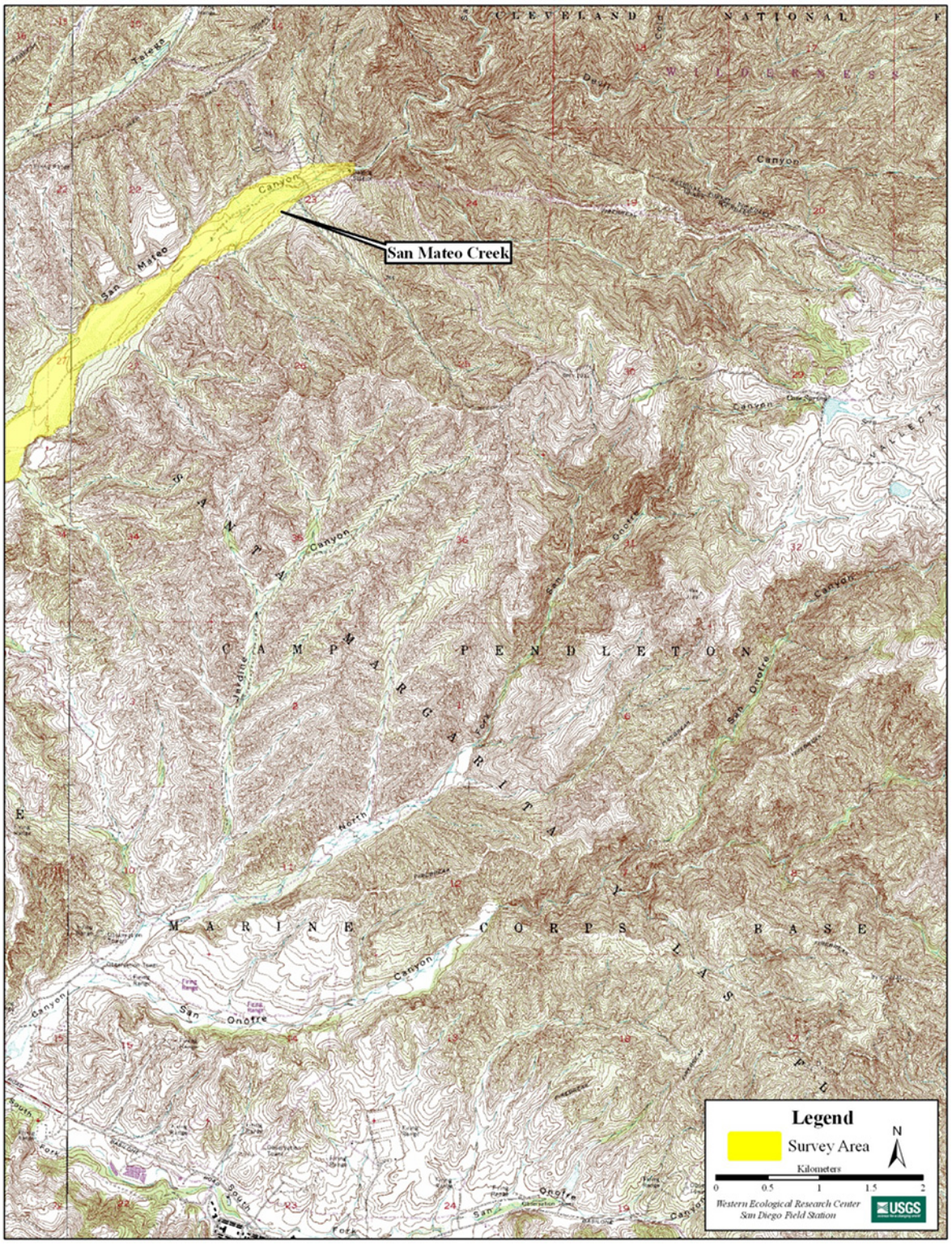


Fig. 19. Least Bell's Vireo survey areas at Marine Corps Base Camp Pendleton, 2016: Upper San Mateo Creek.

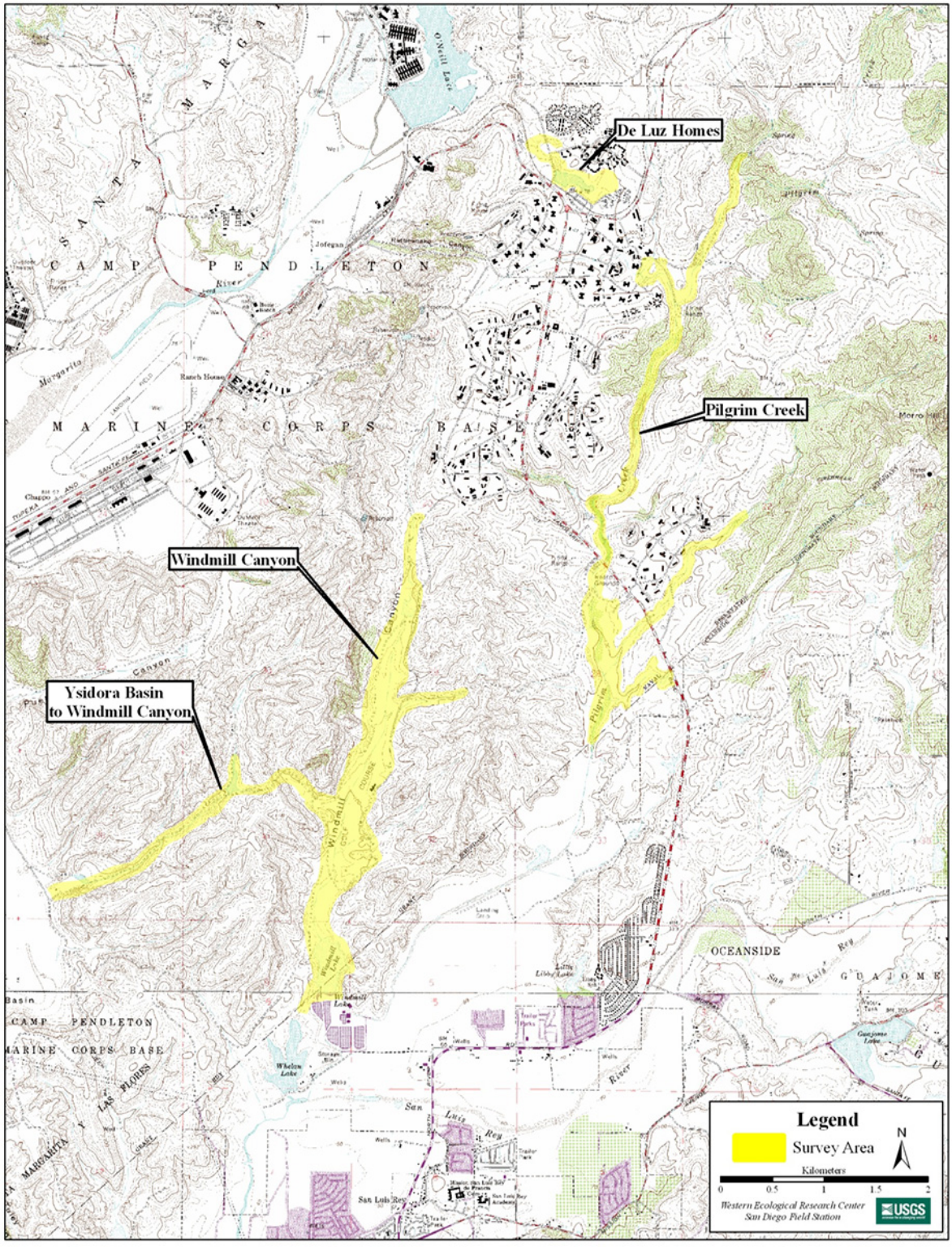
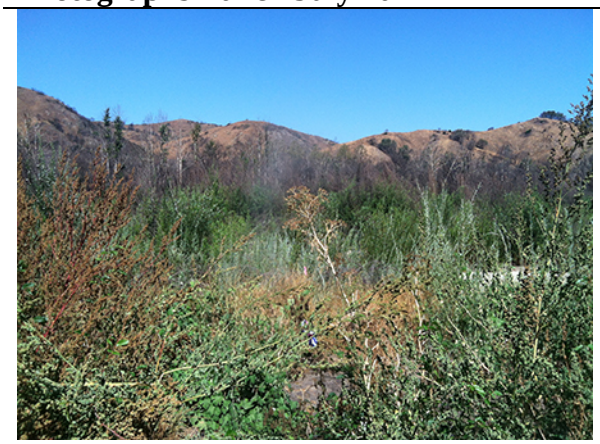


Fig. 20. Least Bell's Vireo survey areas at Marine Corps Base Camp Pendleton, 2016: Windmill Canyon, Ysidora Basin to Windmill Canyon, Pilgrim Creek, and De Luz Homes Habitat.

Appendix B. 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 2016, Marine Corps Base Camp Pendleton. All photographs in July 2014 were taken by L. Allen. Photographs from August 2015 were taken by Armand Amico, Aaron Gallagher, Sarah Harris, Devin Taylor, and Michelle Treadwell.

Photographs Taken July 2014	Photographs Taken July/August 2016
	
Transect 1	B. Sandstrom and M. Lester depicted
	
Transect 2	
	
Transect 3	M. Lester depicted

Photographs Taken July 2014	Photographs Taken July/August 2016
	
Transect 4	
	
Transect 5	
	
Transect 6	

Photographs Taken July 2014	Photographs Taken July/August 2016
	
Transect 7	
	
Transect 8	

Photographs Taken July 2014	Photographs Taken July/August 2016
	
Transect 9	
	
Transect 10	

Photographs Taken July 2014	Photographs Taken July/August 2016
	
Transect 11	
	
Transect 12	
	
Transect 13	

Photographs Taken July 2014	Photographs Taken July/August 2016
	
Transect 14	
	
Transect 15	
	
Transect 16	

Photographs Taken July 2014	Photographs Taken July/August 2016
 Transect 17	
 Transect 18	 P. Falatek depicted

Photographs Taken July 2014	Photographs Taken July/August 2016
	
Transect 19	B. Sandstrom depicted
	
Transect 20	
	
Transect 21	S. Harris depicted

Photographs Taken July 2014	Photographs Taken July/August 2016
	
Transect 22	
	
Transect 23	
	
Transect 24	

Appendix C. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2016

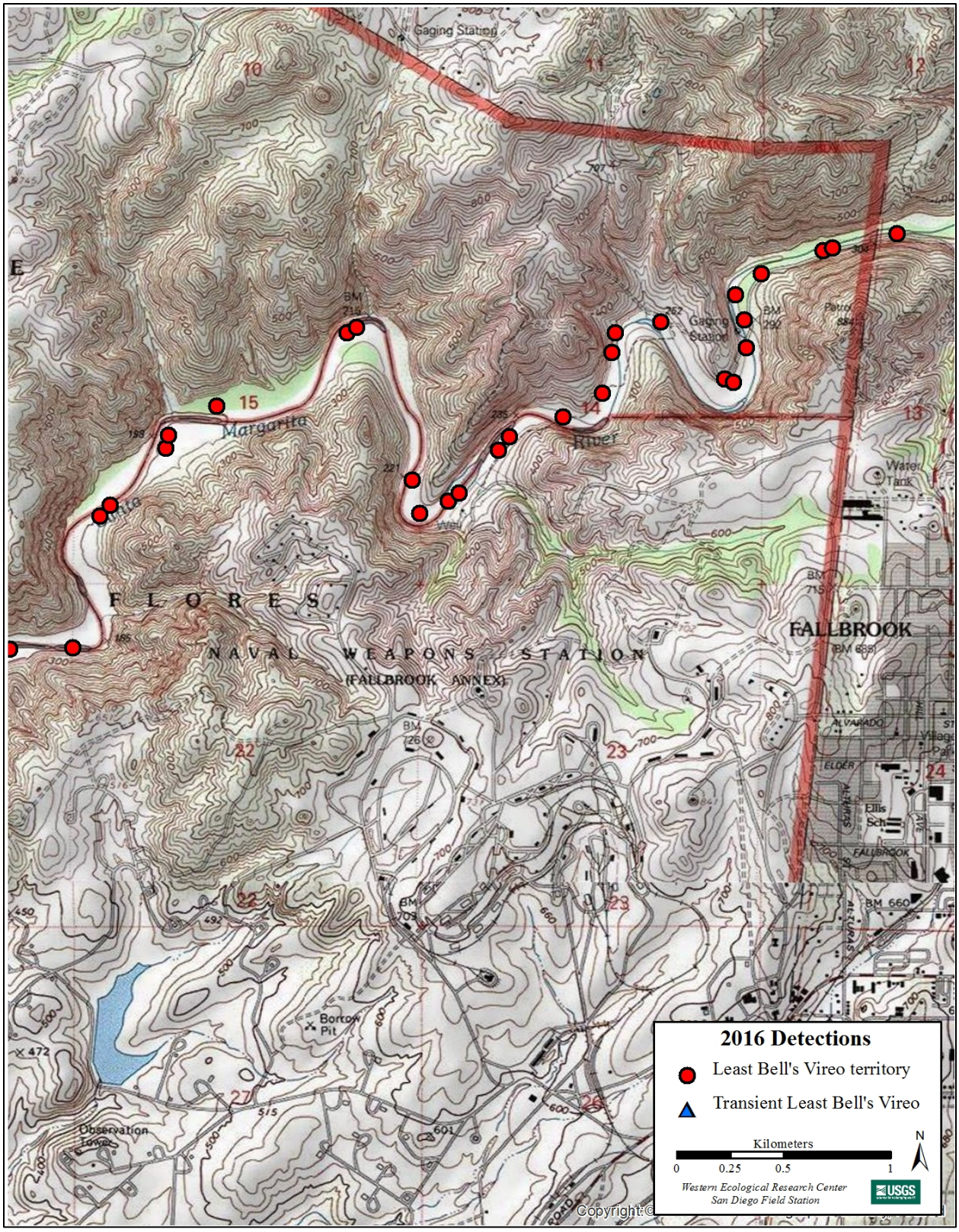


Fig. 21. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2016: Upper Santa Margarita River.

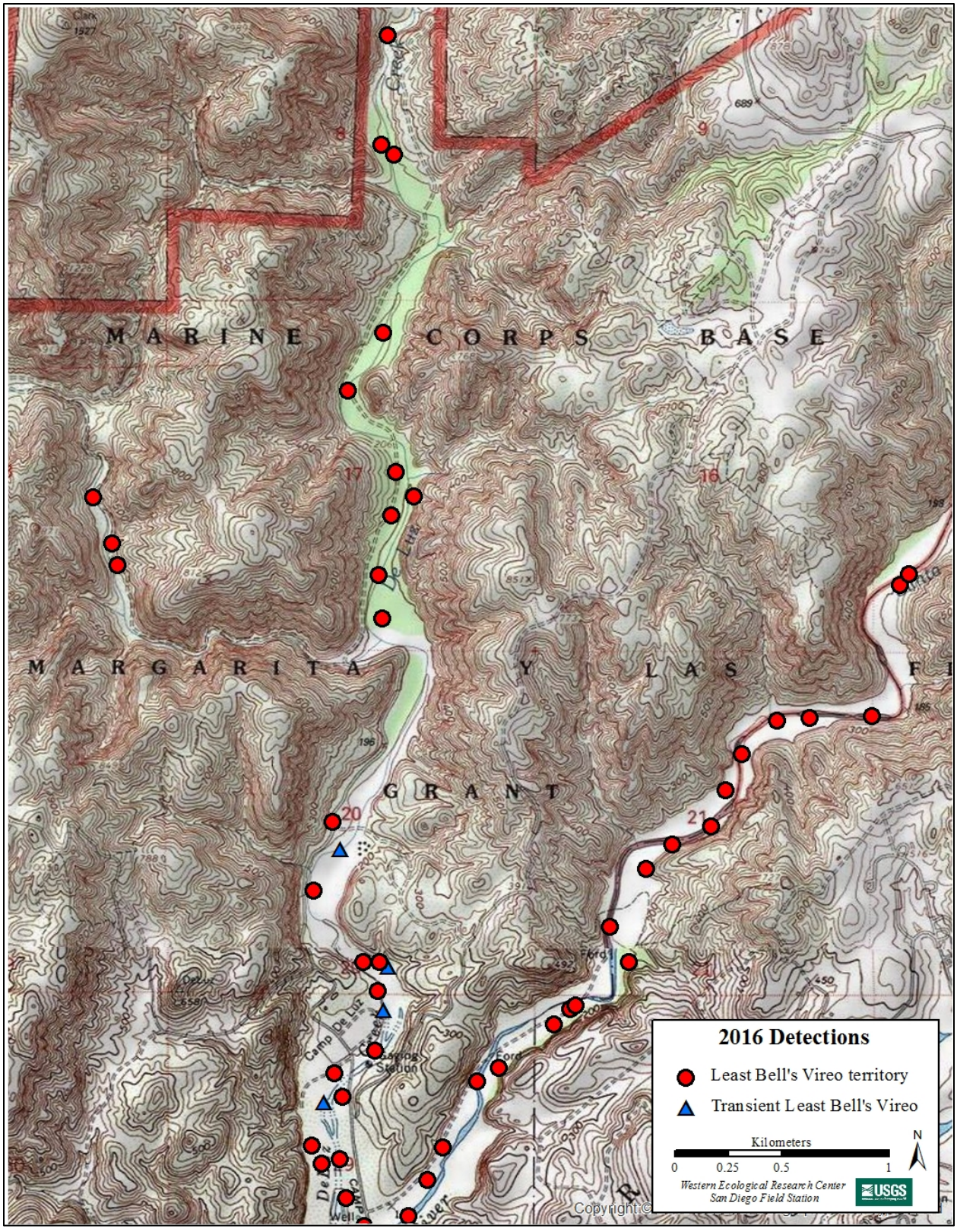


Fig. 22. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2016: Upper Santa Margarita River, De Luz Creek, and Roblar Creek.

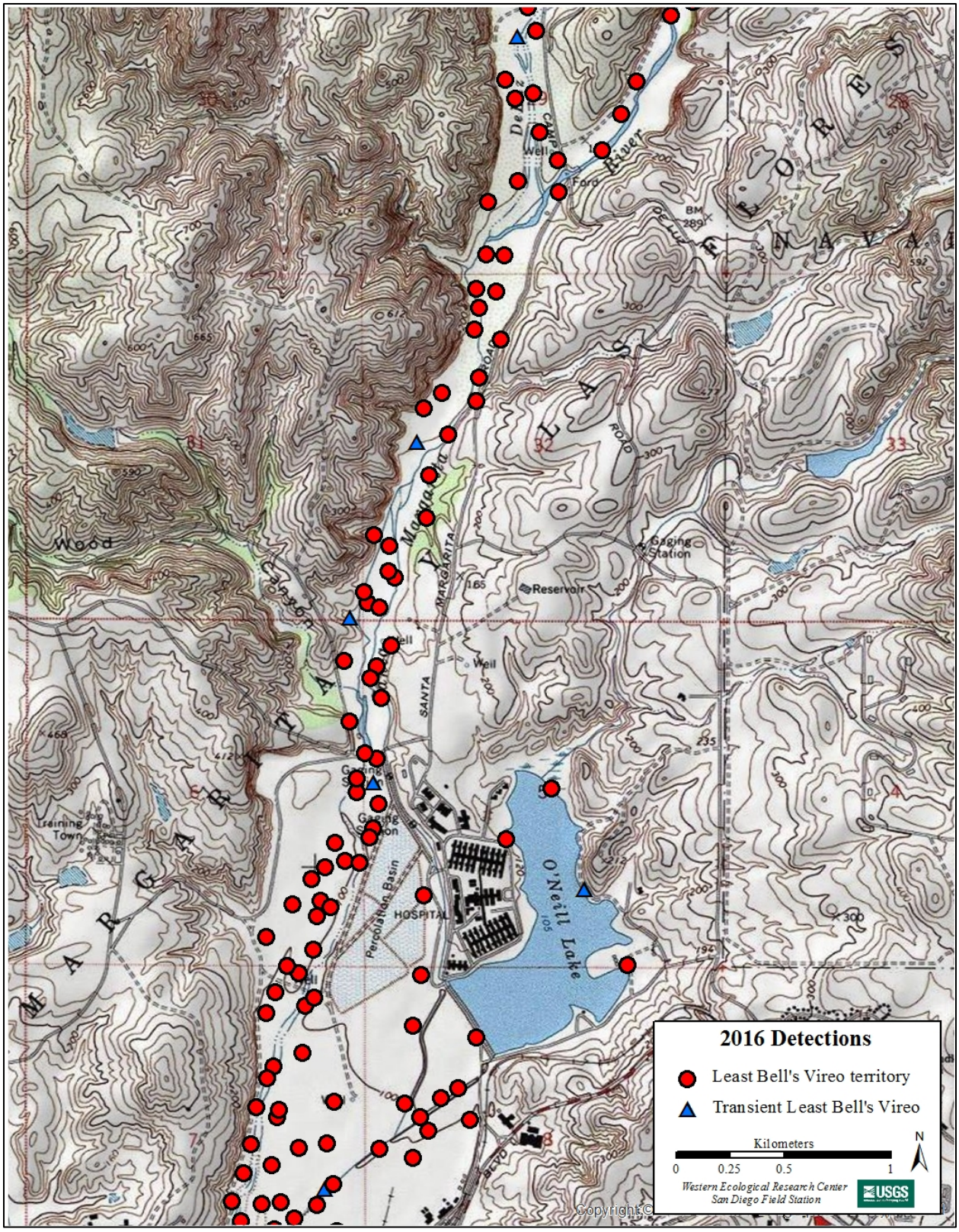


Fig. 23. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2016 Santa Margarita River, Lake O'Neill, and Fallbrook Creek.

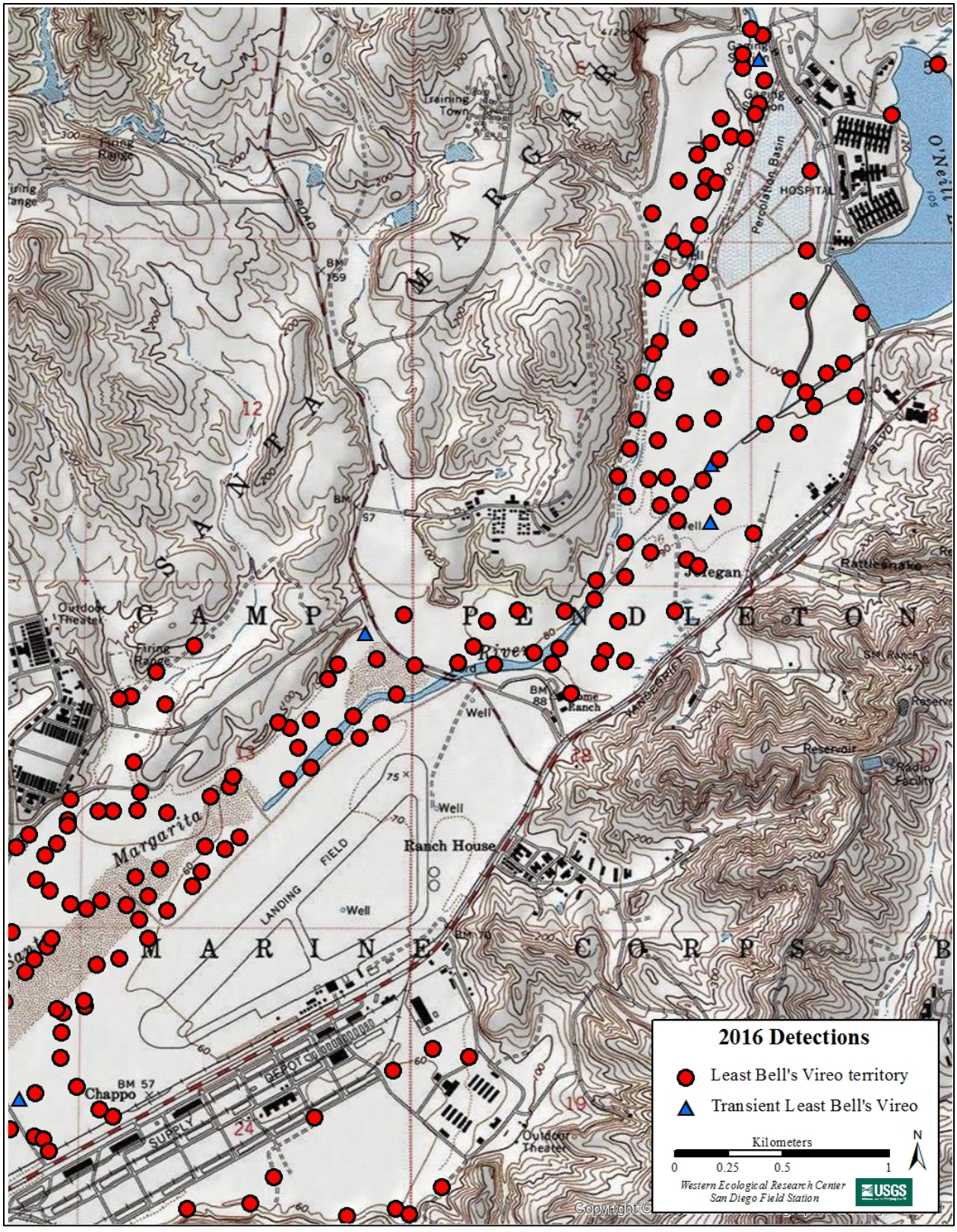


Fig. 24. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2016: Santa Margarita River.

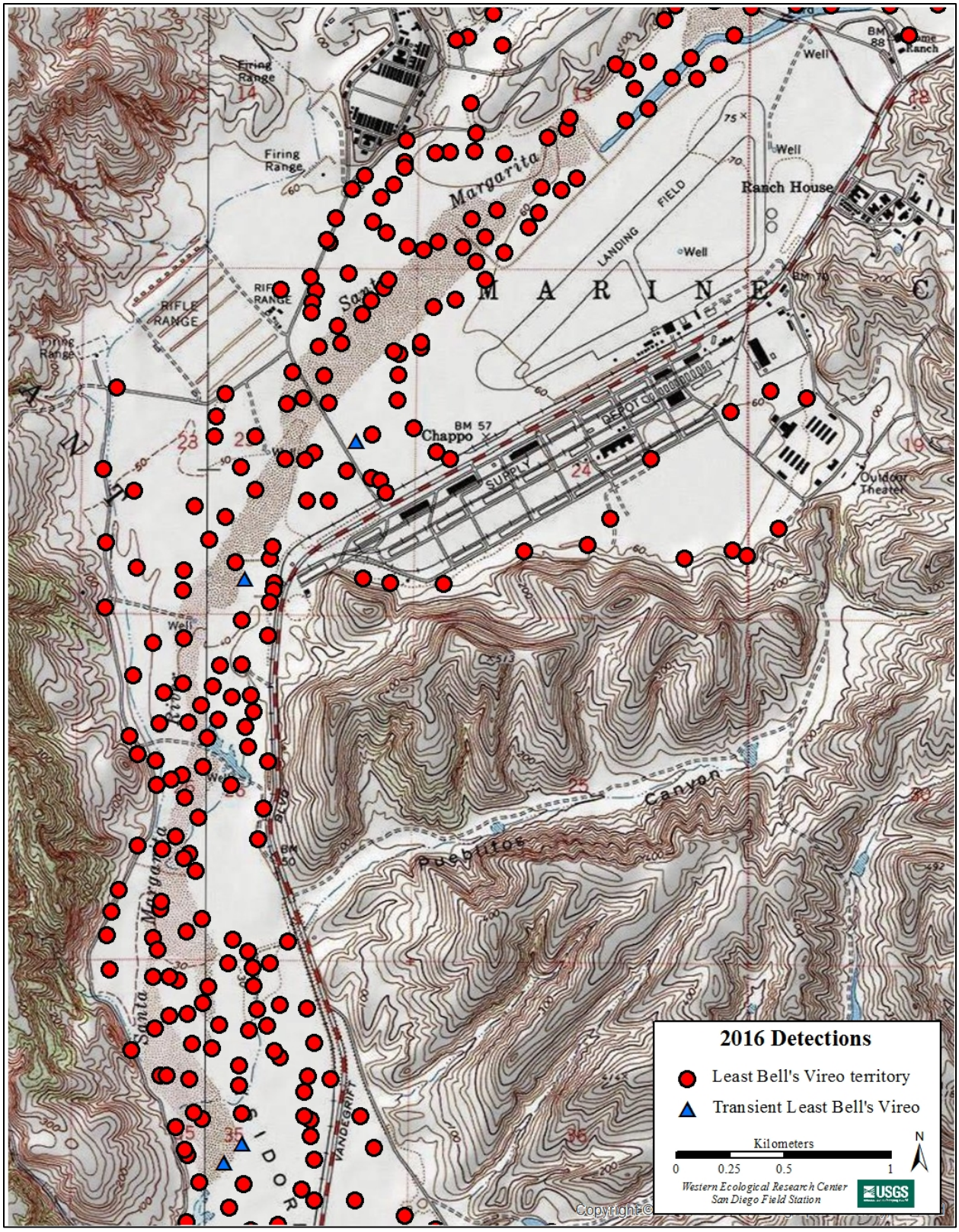


Fig. 25. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2016: Santa Margarita River, 22 Area, and Pueblitos Canyon.

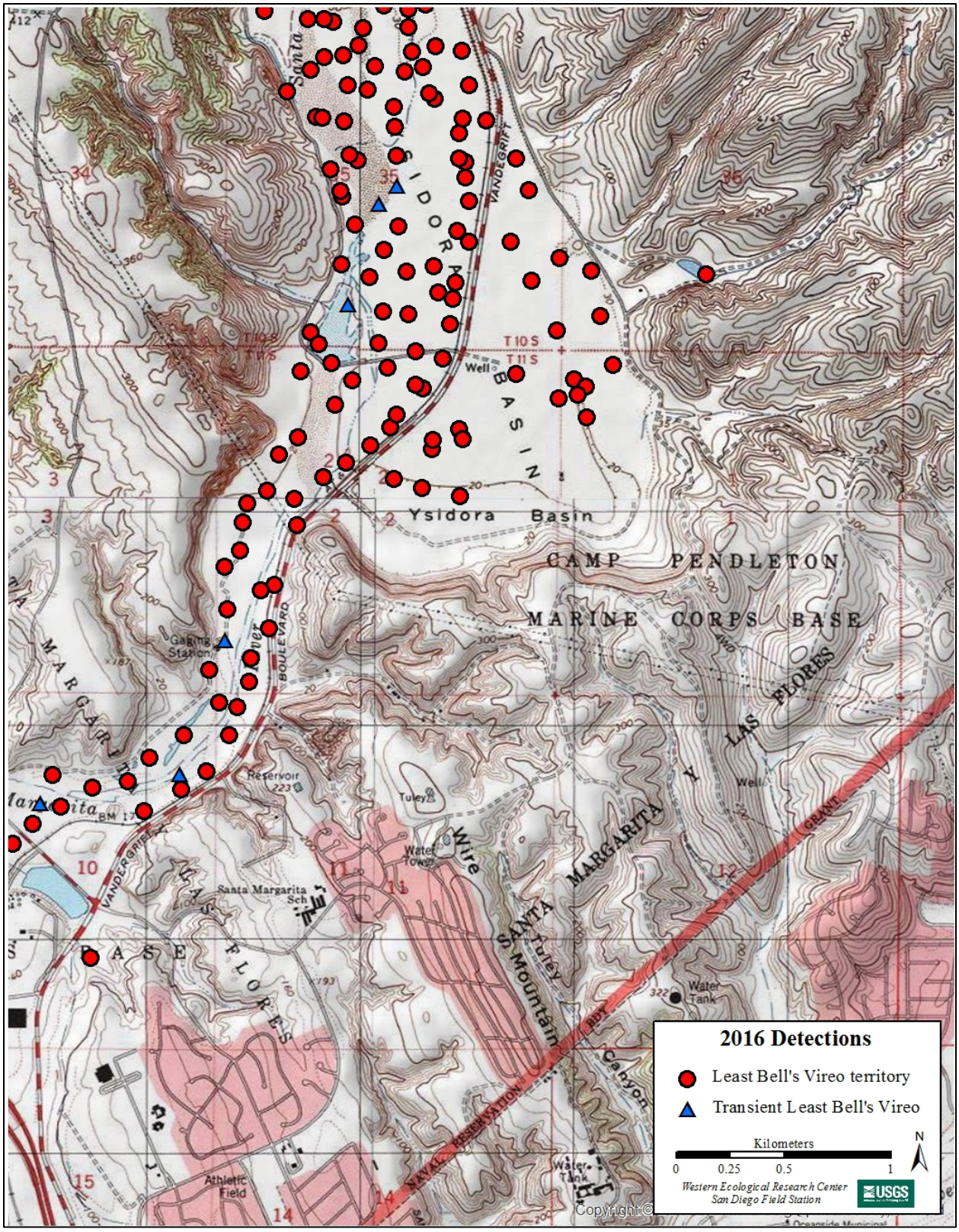


Fig. 26. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2016: Santa Margarita River, Ysidora Basin, and Ysidora Basin to Windmill Canyon.

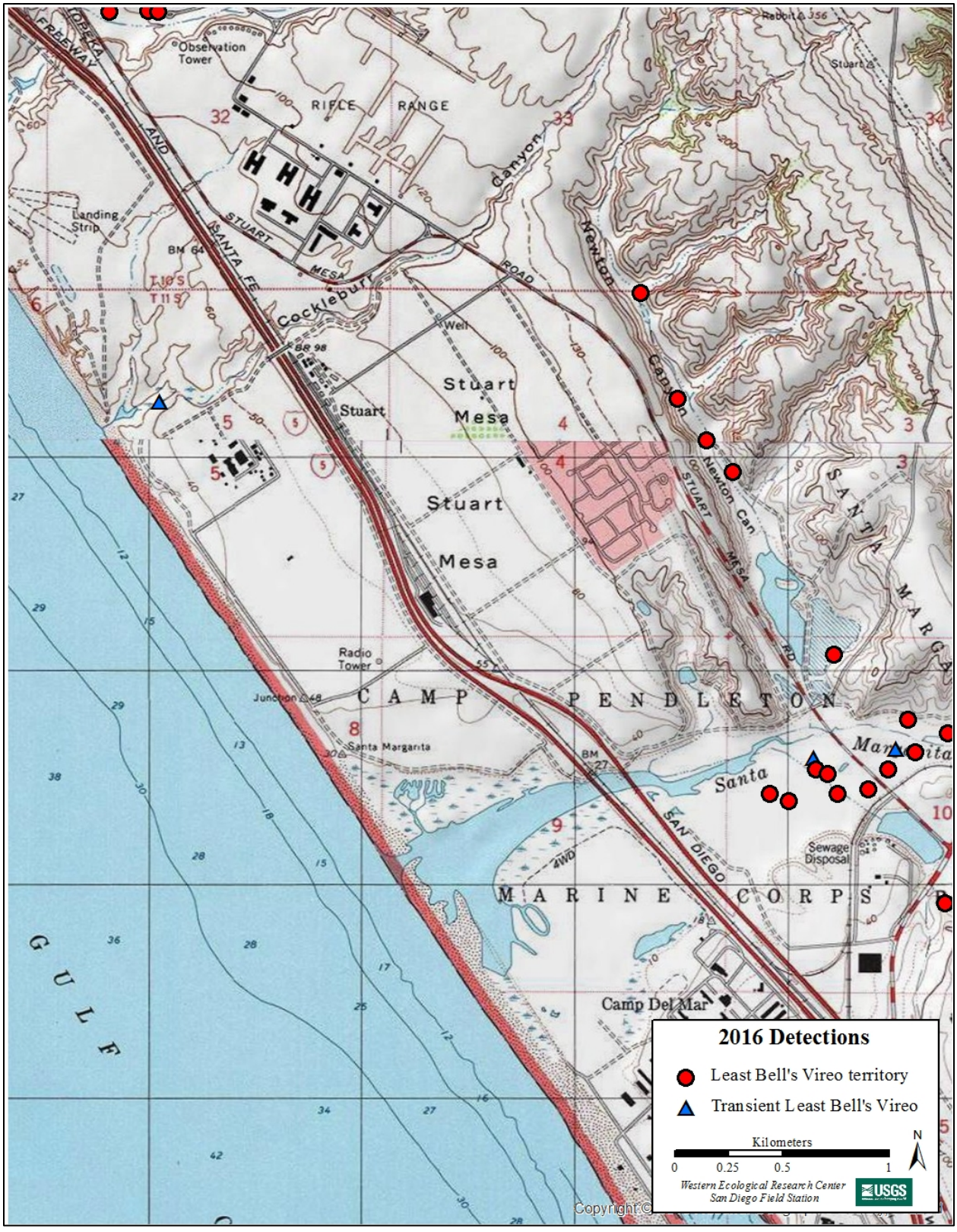


Fig. 27. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2016: Lower Santa Margarita River, Newton Canyon, and Cockleburr Canyon.

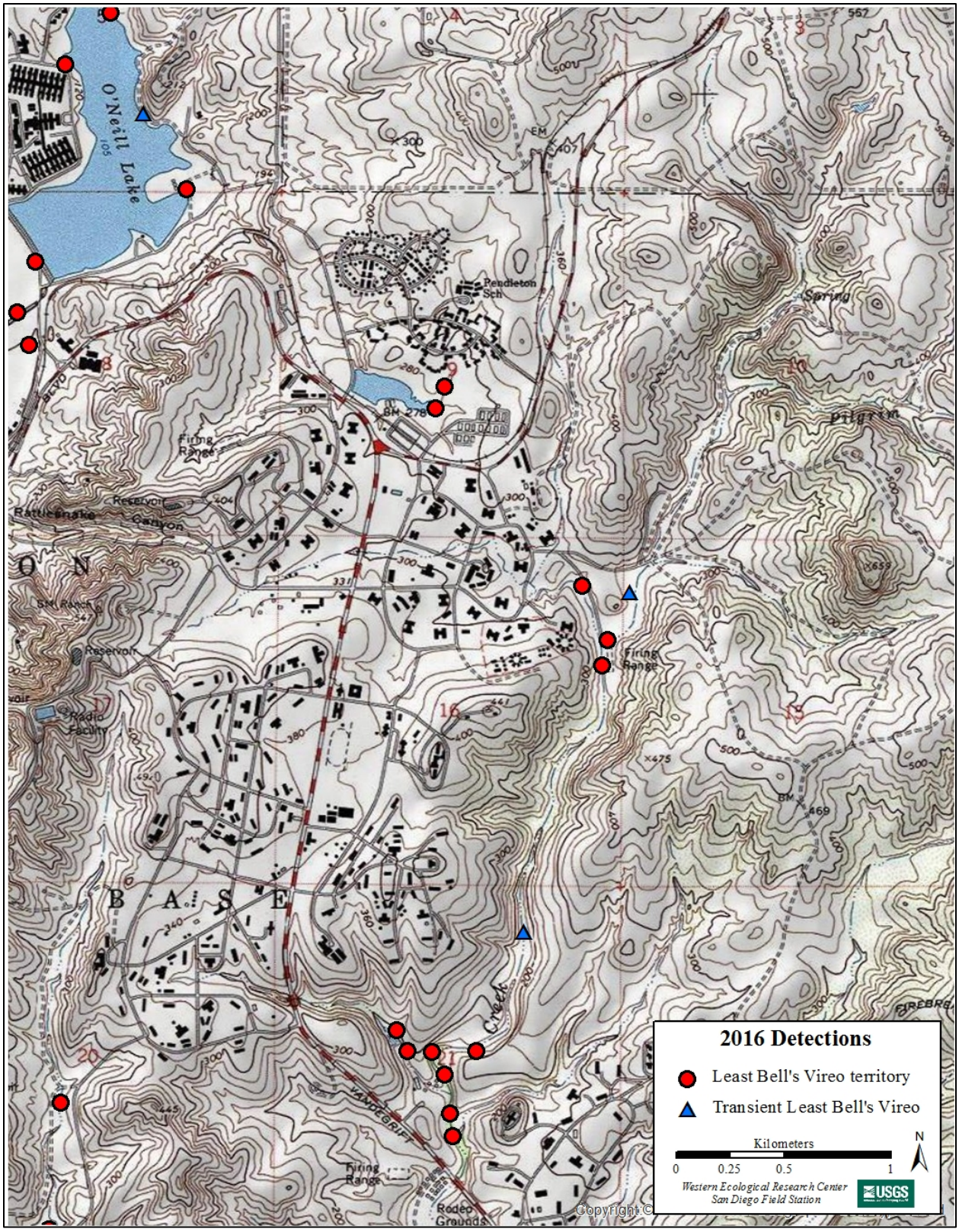


Fig. 28. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2016: Upper Pilgrim Creek, De Luz Homes Habitat, and Lake O'Neill.

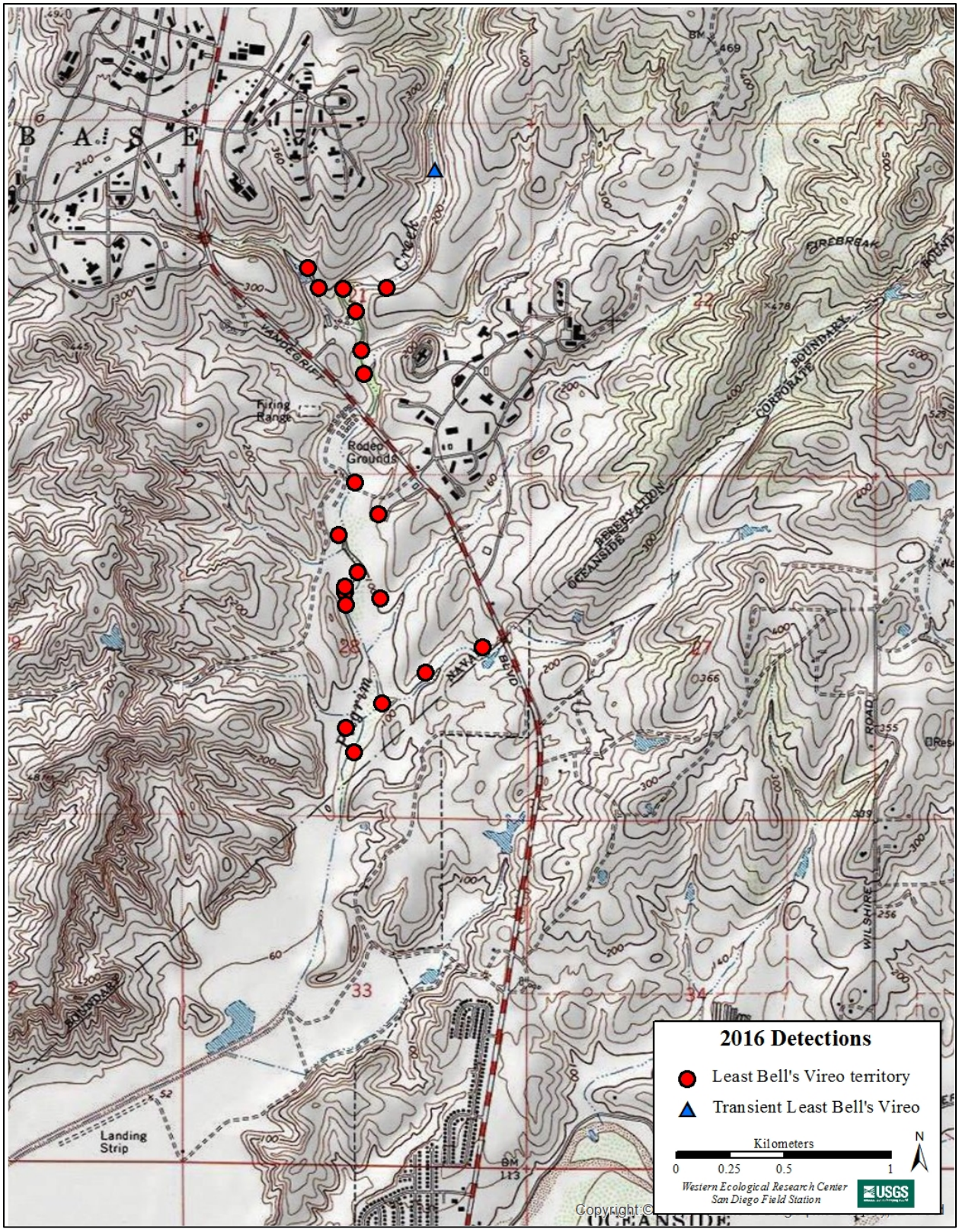


Fig. 29. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2016: Upper and Lower Pilgrim Creek.

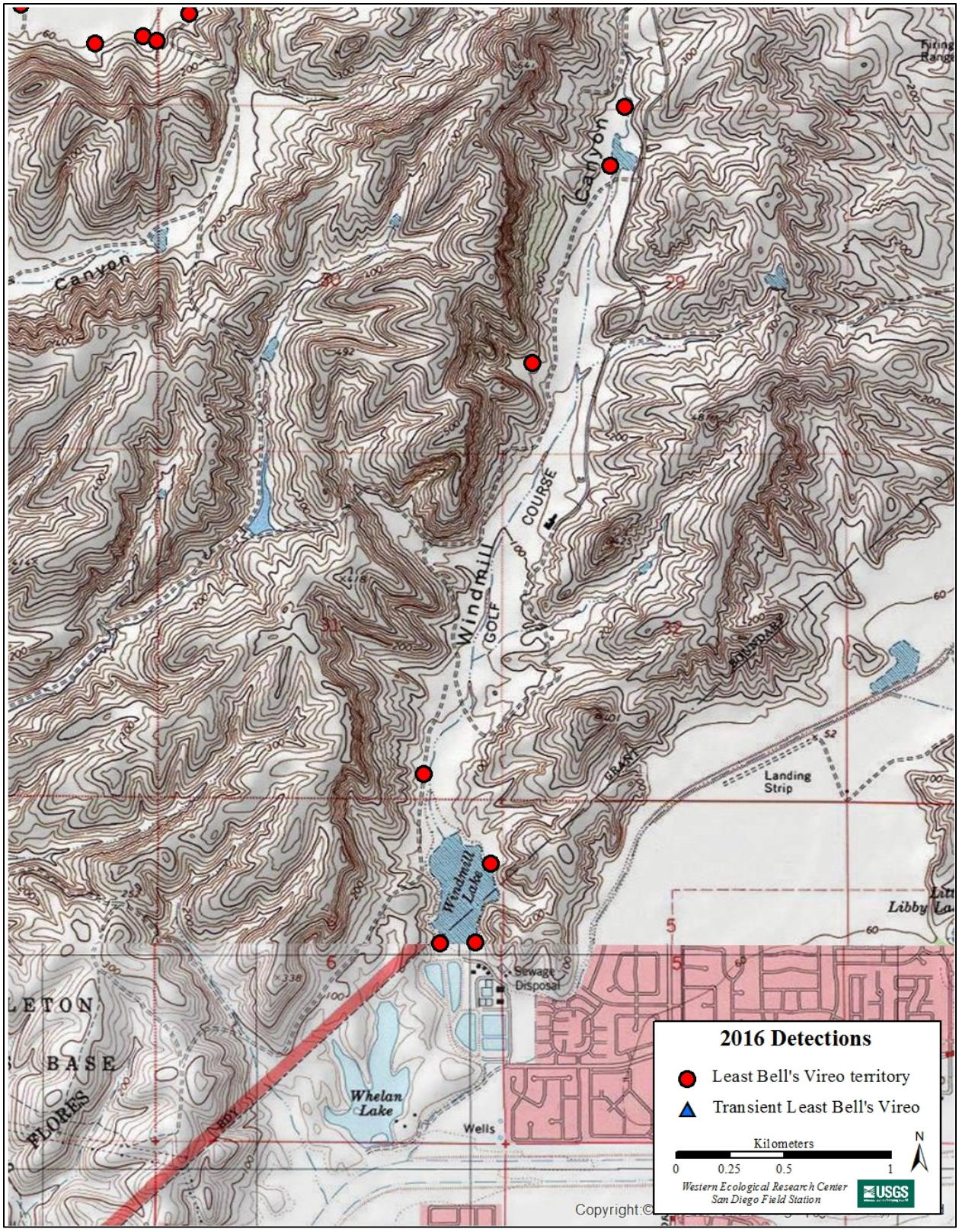


Fig. 30. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2016: Windmill Canyon and Ysidora Basin to Windmill Canyon.

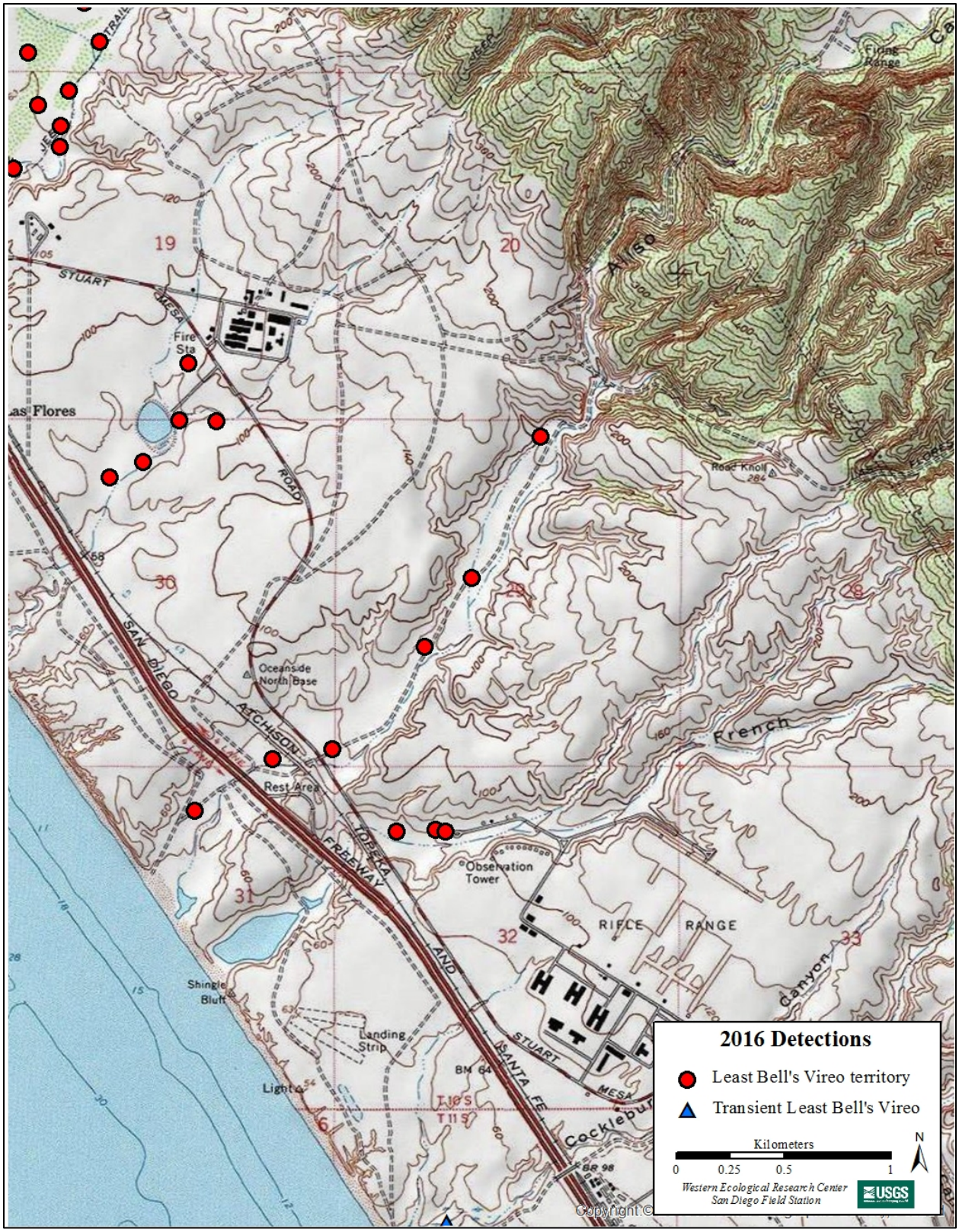


Fig. 31. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2016: French Creek, Aliso Creek, and Hidden Canyon.

Fig. 32. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2016: Basilone and Roblar Roads.

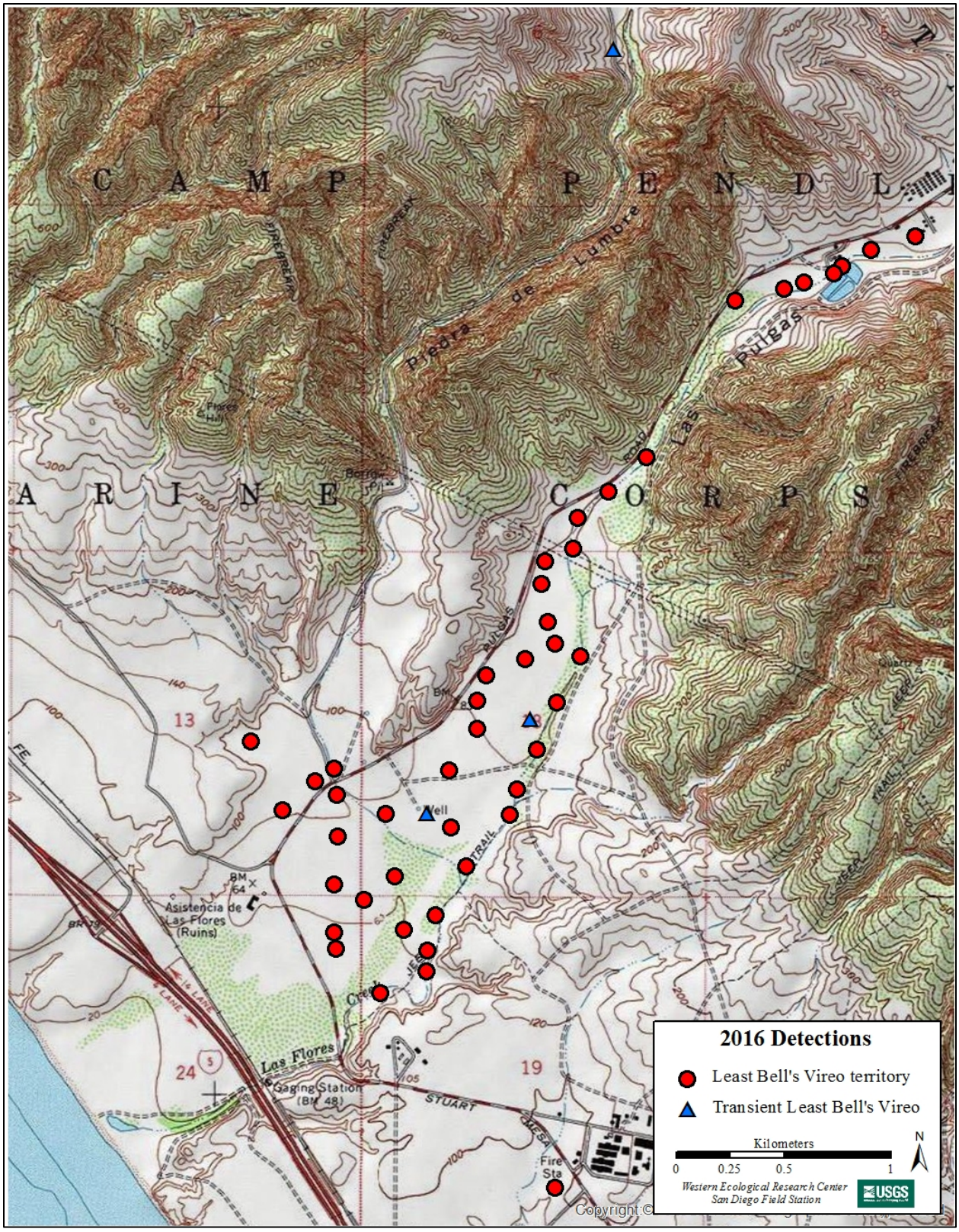


Fig. 33. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2016: Lower Las Flores Creek and Piedra de Lumbre Canyon.

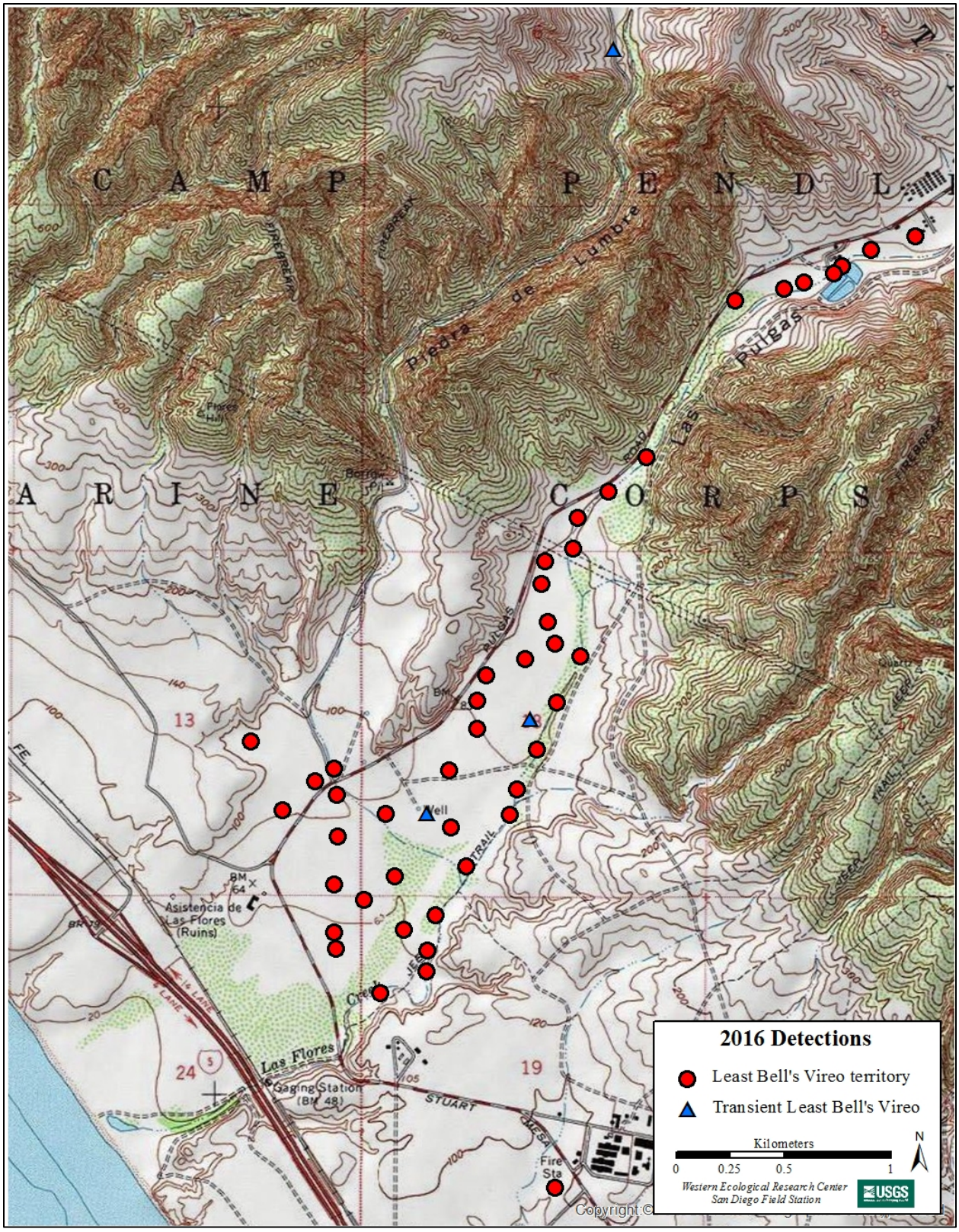


Fig. 34. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2016: Piedra de Lumbre Canyon and Upper Las Flores Creek.

Fig. 35. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2016: Horno Canyon.

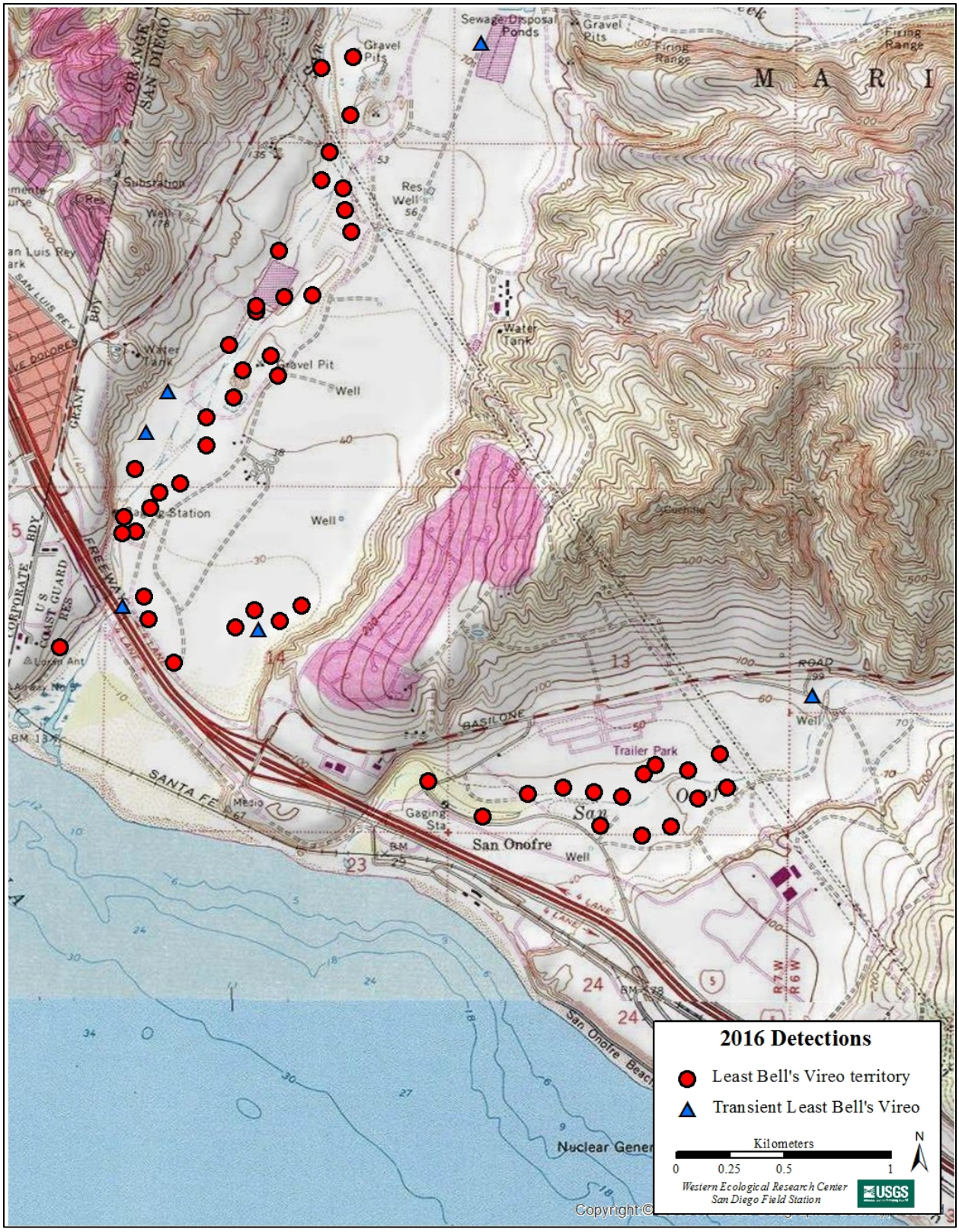


Fig. 36. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2016: Lower San Onofre Creek and Lower San Mateo Creek.

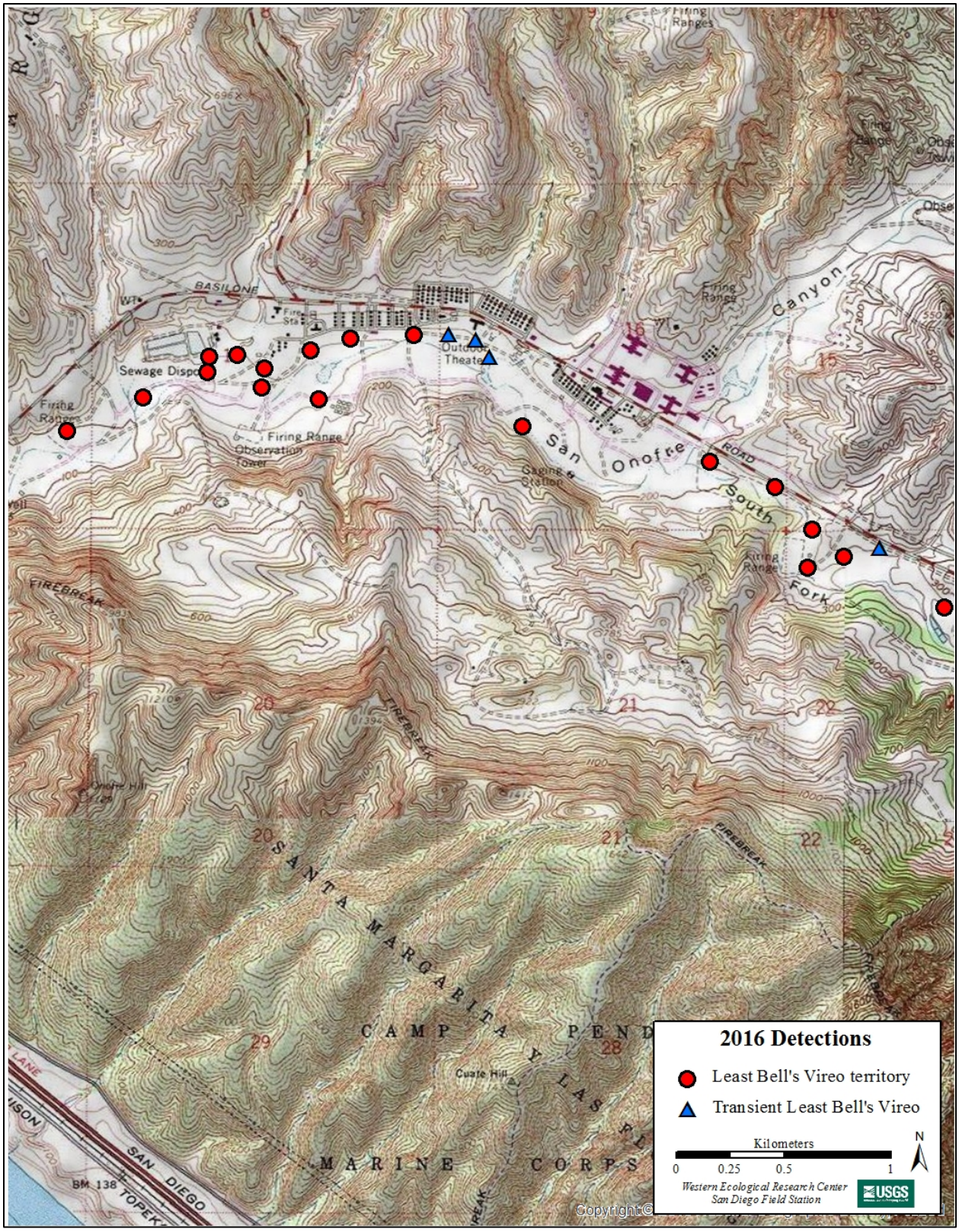


Fig. 37. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2016: San Onofre Creek.

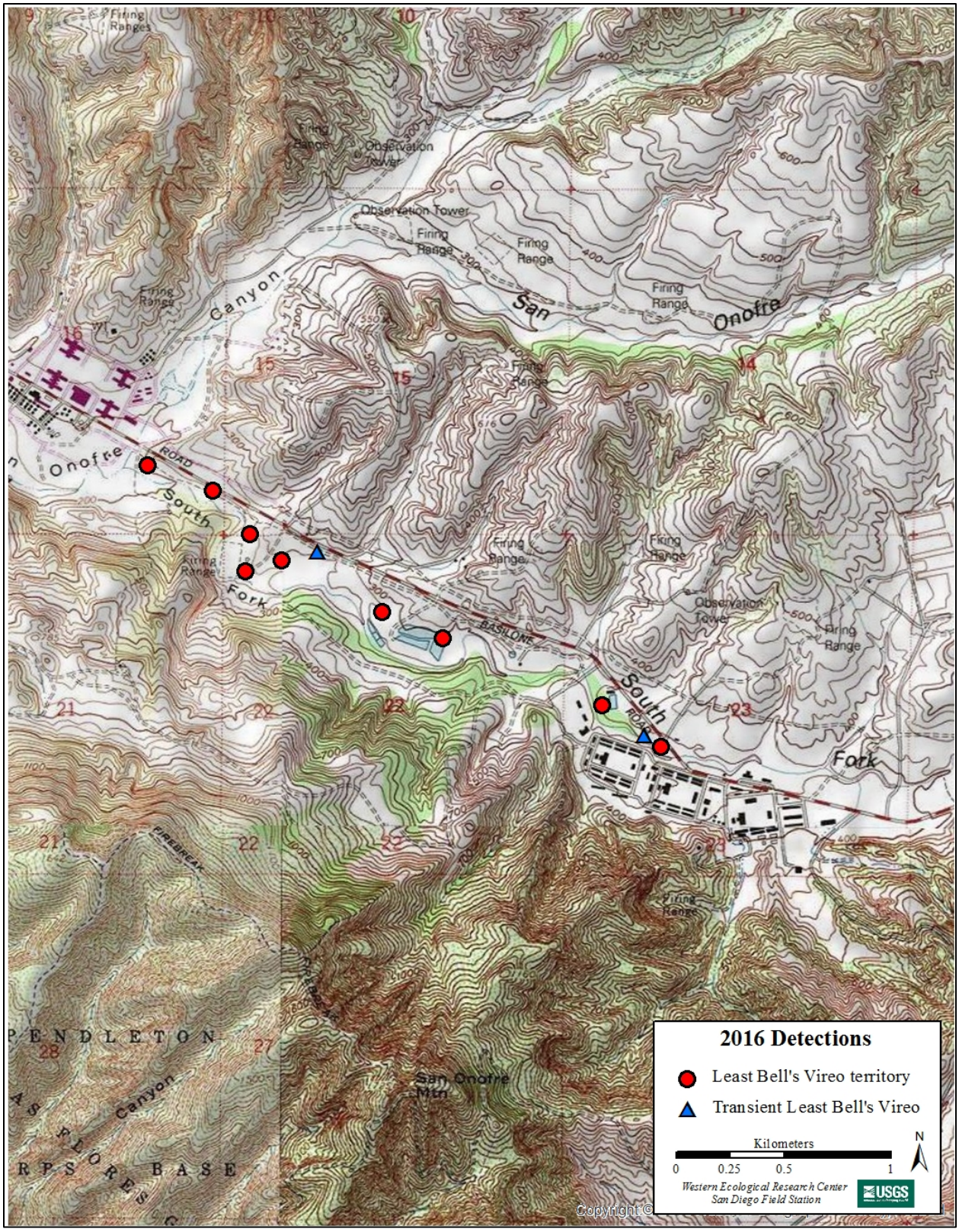


Fig. 38. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2016: South Fork San Onofre Creek.

Fig. 39. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2016: San Onofre Creek.

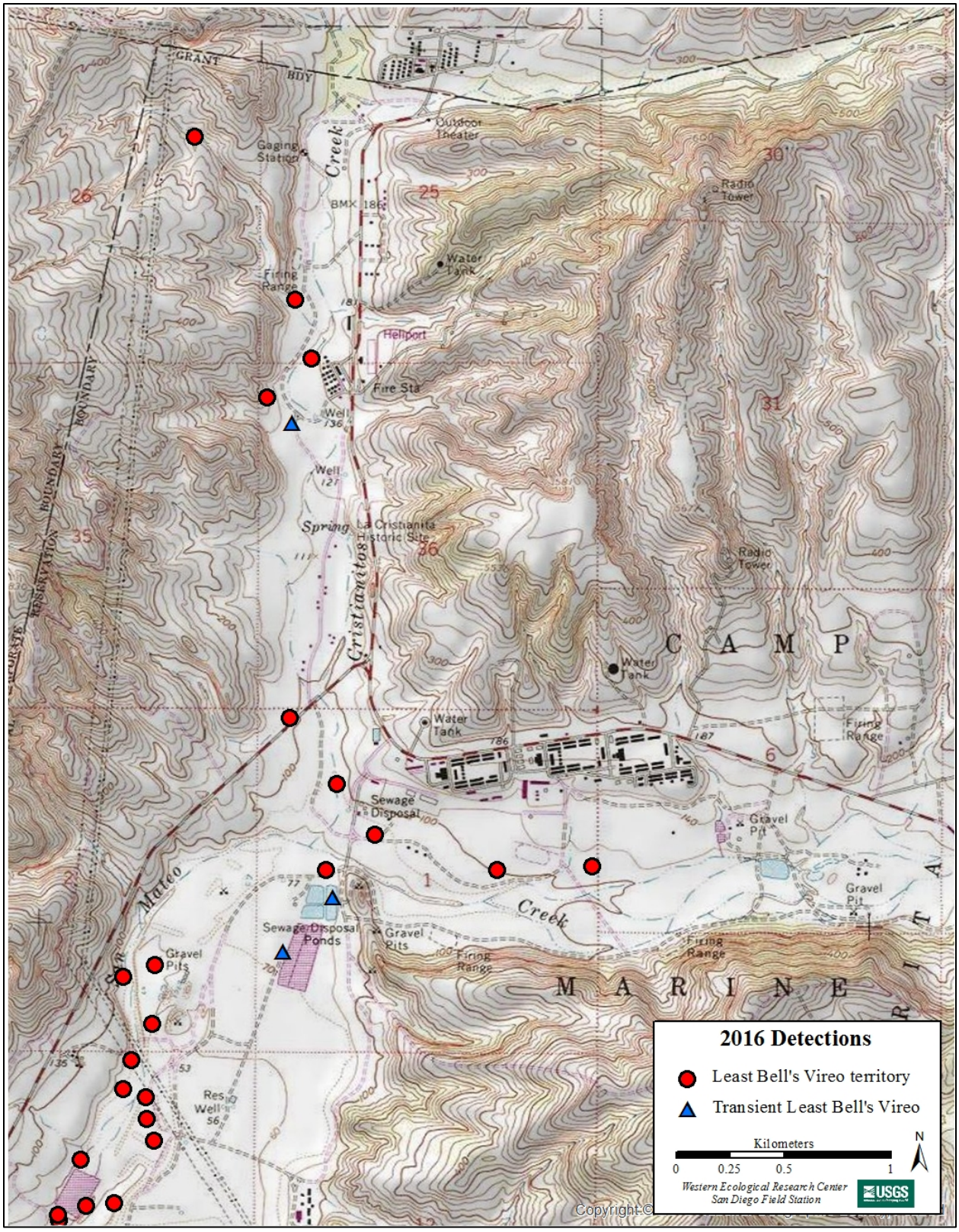


Fig. 40. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2016: San Mateo Creek and Cristianitos Creek.

Appendix D. Banded Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2016

Drainage	Band Combination[1]			
Sex[2]	Left Leg	Right Leg	Age	Comments[3]
Basilone and Roblar Roads				
F	DPWH	PUYE/Mdb	1 yr.	Banded as a nestling on the SLR in 2015.
De Luz Creek				
F	BYST/Mgo	WHDP	8 yrs.	Banded as a nestling at DRK in 2008.
F	PUWH/Mgo	PUWH	≥ 3 yrs.	Banded as an adult at DL MAPS in 2014.
F	-	Mgo	≥ 1 yrs.	Banded as unknown age on the SMR or at MCAS before 2016.
M	LPBK	YEPU/Mgo	≥ 4 yrs.	Banded as an adult at DL MAPS in 2013.
M	DPDP	WHWH/Mgo	≥ 3 yrs.	Banded as an adult at LEM in 2014.
M	WHDP	DGOR/Mgo	3 yrs.	Banded as a nestling at BEA in 2013.
M	?	?	≥ 1 yrs.	Banded as unknown age prior to 2016.
M	?	?/Mgo	≥ 1 yrs.	Banded as unknown age on the SMR or at MCAS before 2016.
M	?/Mgo	?	≥ 1 yrs.	Banded as unknown age on the SMR or at MCAS before 2016.
M	BYST	ORDG/Mgo	1 yr.	Banded as a nestling at DEU in 2015.
U	YEYE	DPWH/Mgo	≥ 1 yrs.	Banded as an adult at DL MAPS in 2016.
Las Flores Creek				
M	PUWH/Mdb	YEYE	2 yrs.	Banded as a nestling on the SLR in 2014.
M	?	?/Mgo	≥ 1 yrs.	Banded as unknown age on the SMR or at MCAS before 2016.
Newton Canyon				
M	DPDP	DPDP/Mdb	1 yr.	Banded as a nestling on the SLR in 2015.
San Mateo Creek				
F	BYST	ORPU/Mgo	3 yrs.	Banded as a nestling at PIE in 2013.
San Onofre Creek				
M	Mye	WHWH/sisi	1 yr.	Banded as a juvenile in BCS in Winter 2015.
Santa Margarita River				
F	PUOR	BKBK/Mgo	7 yrs.	Banded as a nestling at ORN in 2009.
F	WHDP	YEPU/Mgo	7 yrs.	Banded as a nestling at BER in 2009.
F	DPDP/Mgo	YEYE	6 yrs.	Banded as a nestling at EMB in 2010.
F	OROR/Mgo	PUPU	4 yrs.	Banded as a nestling at AXE in 2012.
F	WHWH/Mgo	PUWH	> 3 yrs.	Banded as an adult at SM MAPS in 2014.
F	BKBK/Mgo	LPBK	> 3 yrs.	Banded as an adult at DL MAPS in 2014.
F	ORPU/Mgo	PUPU	> 3 yrs.	Banded as an adult at ZAM in 2014.
F	LPBK	BKLP/Mgo	> 3 yrs.	Banded as an adult at PIK in 2014.
F	WHDP	PUPU/Mgo	3 yrs.	Banded as a nestling at HOL in 2013.
F	WHDP	YEYE/Mgo	3 yrs.	Banded as a nestling at HDX in 2013.
F	ORDG	DPWH/Mgo	3 yrs.	Banded as a nestling at WSP in 2013.
F	YEYE	PUWH/Mgo	3 yrs.	Banded as a nestling at TRP in 2013.
F	WHDP	BKLP/Mgo	3 yrs.	Banded as a nestling at STR in 2013.
F	PUYE/Mgo	ORDG	> 2 yrs.	Banded as an adult at BAT in 2015.
F	Mye	YEPU/gogo	> 1 yrs.	Banded as unknown age in BCS in Fall 2015.
F	BKBK/Mgo	WHDP	> 1 yrs.	Banded as an adult at SM MAPS in 2016.
F	YEYE/Mgo	WHDP	> 1 yrs.	Banded as an adult at SM MAPS in 2016.
F	BYST/Mgo	BKBK	> 1 yrs.	Banded as an adult at SM MAPS in 2016.
F	YEPU	ORDG/Mgo	> 1 yrs.	Banded as an adult at SM MAPS in 2016.
F	BYST/Mgo	YEPU	> 1 yrs.	Banded as an adult at SM MAPS in 2016.
F	DPDP/Mgo	-	> 1 yrs.	Banded as an adult at SM MAPS in 2016.
F	BYST/Mgo	DGOR	> 1 yrs.	Banded as an adult at DEU in 2016.
F	?/Mgo	?	> 1 yrs.	Banded as unknown age on the SMR or at MCAS before 2016.

Appendix D. Continued.

Drainage	Band Combination[1]			
Sex[2]	Left Leg	Right Leg	Age	Comments[3]
Santa Margarita River continued				
F	-	Mgo	> 1 yrs.	Banded as unknown age on the SMR or at MCAS before 2016.
F	BKBK	PUWH/Mdb	1 yr.	Banded as a nestling on the SLR in 2015.
F	gogo	WHDB/Mdb	1 yr.	Banded as a nestling on the SLR in 2015.
F	PUYE/Mgo	BKBK	1 yr.	Banded as a juvenile at SM MAPS in 2015.
F	YEPU	BKLP/Mgo	1 yr.	Banded as a juvenile at SM MAPS in 2015.
F	DPDP/Mgo	ORDG	1 yr.	Banded as an adult at SM MAPS in 2016.
F	BYST	WHPU/Mgo	1 yr.	Banded as a nestling at WIN in 2015.
F	BYST	DPDP/Mgo	1 yr.	Banded as a nestling at REM in 2015.
F	BYST	ORDG/Mgo	1 yr.	Banded as a nestling at ARI in 2015.
F	ORDG	WHDP/Mgo	1 yr.	Banded as a nestling at HDX in 2015.
F	PUPU	DGOR/Mgo	1 yr.	Banded as a nestling at TYR in 2015.
M	ORPU	ORDG/Mgo	> 7 yrs.	Banded as an adult at TOP in 2010.
M	WHPU	Mgo	> 7 yrs.	Banded as an adult on the SMR in 2010.
M	Mgo	WHDP	> 7 yrs.	Banded as an adult at MER in 2010.
M	DPDP	YEYE/Mgo	> 7 yrs.	Banded as an adult at CKI in 2010.
M	WHWH/Mdb	WHDB	> 6 yrs.	Banded as an adult on the SLR in 2007.
M	BKLP/Mgo	WHWH	6 yrs.	Banded as a juvenile at SM MAPS in 2010.
M	DPDP	PUWH/Mgo	6 yrs.	Banded as a juvenile at SM MAPS in 2010.
M	PUPU	BKLP/Mgo	> 5 yrs.	Banded as an adult at JSP in 2012.
M	WHWH	PUWH/Mgo	> 5 yrs.	Banded as an adult at QIN in 2012.
M	DPWH/Mgo	WHWH	> 5 yrs.	Banded as an adult on the SMR in 2012.
M	ORDG/Mgo	WHWH	> 5 yrs.	Banded as an adult at DEU in 2012.
M	ORPU	PUYE/Mgo	> 5 yrs.	Banded as an adult at CED in 2012.
M	PUPU	ORDG/Mgo	> 5 yrs.	Banded as an adult at HRP in 2012.
M	DPDP/Mgo	PUPU	> 5 yrs.	Banded as an adult on the SMR in 2012.
M	BKBK	ORDG/Mgo	> 5 yrs.	Banded as an adult at POE in 2012.
M	YEPU	ORPU/Mgo	5 yrs.	Banded as a juvenile at HDX in 2011.
M	WHWH	DBWH/Mdb	5 yrs.	Banded as a nestling on the SLR in 2011.
M	PUWH	PUYE/Mgo	> 4 yrs.	Banded as an adult at DL MAPS in 2013.
M	BKLP/Mgo	LPBK	> 4 yrs.	Banded as an adult at SM MAPS in 2013.
M	PUPU/Mgo	ORPU	4 yrs.	Banded as a nestling at HTI in 2012.
M	ORDG/Mgo	YEYE	4 yrs.	Banded as a nestling at ONX in 2012.
M	DPWH/Mgo	DPWH	4 yrs.	Banded as a nestling at CKE in 2012.
M	YEPU/Mdb	YEYE	4 yrs.	Banded as a nestling on the SLR in 2012.
M	PUYE/Mgo	PUWH	> 3 yrs.	Banded as an adult at IBX in 2014.
M	BKBK	LPBK/Mgo	> 3 yrs.	Banded as an adult at SM MAPS in 2014.
M	BKLP/Mgo	PUPU	> 3 yrs.	Banded as an adult at QIN in 2014.
M	PUOR	WHPU/Mgo	> 3 yrs.	Banded as an adult at ZAM in 2014.
M	DGOR	BKLP/Mgo	> 3 yrs.	Banded as an adult at HDX in 2014.
M	DGOR/Mgo	ORDG	> 3 yrs.	Banded as an adult at HLD in 2014.
M	LPBK	WHDP/Mgo	> 3 yrs.	Banded as an adult at BOW in 2014.
M	YEPU	WHDP/Mgo	> 3 yrs.	Banded as an adult on the SMR in 2014.
M	BKBK	YEYE/Mgo	> 3 yrs.	Banded as an adult at PIK in 2014.
M	DGOR	WHDP/Mgo	> 3 yrs.	Banded as an adult at BAD in 2014.
M	BKBK	WHPU/Mgo	> 3 yrs.	Banded as an adult at ANT in 2014.

Appendix D. Continued.

Drainage	Band Combination[1]			
Sex[2]	Left Leg	Right Leg	Age	Comments[3]
Santa Margarita River continued				
M	DGOR	PUOR/Mgo	> 3 yrs.	Banded as an adult at FOX in 2014.
M	PUOR	ORDG/Mgo	3 yrs.	Banded as a nestling at CKE in 2013.
M	DPWH	YEYE/Mdb	3 yrs.	Banded as a nestling on the SLR in 2013.
M	WHDP	WHDP/Mgo	3 yrs.	Banded as a nestling at CKI in 2013.
M	BYST	BKBK/Mgo	3 yrs.	Banded as a nestling at TOF in 2013.
M	DBDP/gogo	Mdb	3 yrs.	Banded as a nestling on the SLR in 2013.
M	BKBK	PUOR/Mgo	3 yrs.	Banded as a nestling at QIN in 2013.
M	DGOR	ORDG/Mgo	3 yrs.	Banded as an adult on the SMR in 2014.
M	PUPU/Mgo	WHDP	> 2 yrs.	Banded as an adult at SM MAPS in 2015.
M	WHDP	ORDG/Mgo	> 2 yrs.	Banded as an adult at SM MAPS in 2015.
M	ORDG	DPDP/Mgo	> 2 yrs.	Banded as an adult at KHA in 2015.
M	ORPU/Mgo	ORPU	> 2 yrs.	Banded as an adult at DRO in 2015.
M	ORDG	BYST/Mgo	> 2 yrs.	Banded as an adult at CLE in 2015.
M	PUYE/Mgo	ORPU	> 2 yrs.	Banded as an adult at OCE in 2015.
M	PUPU/Mgo	DGOR	> 2 yrs.	Banded as an adult at HOL in 2015.
M	BYST/Mgo	ORDG	> 2 yrs.	Banded as an adult at HOU in 2015.
M	YEPU/Mgo	WHDP	> 2 yrs.	Banded as an adult at ZYL in 2015.
M	DPWH/Mdb	YEYE	2 yrs.	Banded as a nestling on the SLR in 2014.
M	YEPU	YEPU/Mgo	> 1 yrs.	Banded as an adult at HTI in 2016.
M	BKBK/Mgo	ORDG	> 1 yrs.	Banded as an adult at SIL in 2016.
M	ORDG/Mgo	ORDG	> 1 yrs.	Banded as an adult at LNS in 2016.
M	BKBK/Mgo	YEYE	> 1 yrs.	Banded as an adult at SER in 2016.
M	DPDP/Mgo	BYST	> 1 yrs.	Banded as an adult at REM in 2016.
M	WHDP/Mgo	ORDG	> 1 yrs.	Banded as an adult at DAT in 2016.
M	?	?/Mgo	> 1 yrs.	Banded as unknown age on the SMR or at MCAS before 2016.
M	?	?/Mgo	> 1 yrs.	Banded as unknown age on the SMR or at MCAS before 2016.
M	?/Mgo	?	> 1 yrs.	Banded as unknown age on the SMR or at MCAS before 2016.
M	?	?	> 1 yrs.	Banded as unknown age before 2016.
M	?	?	> 1 yrs.	Banded as unknown age before 2016.
M	?/Mgo	?	> 1 yrs.	Banded as unknown age on the SMR or at MCAS before 2016.
M	?/Mdb	?	> 1 yrs.	Banded as unknown age on the SLR before 2016.
M	?	?/Mgo	> 1 yrs.	Banded as unknown age on the SMR or at MCAS before 2016.
M	?/Mgo	?	> 1 yrs.	Banded as unknown age on the SMR or at MCAS before 2016.
M	YEYE	BWST/Mdb	1 yr.	Banded as a nestling on the SLR in 2015.
M	PUYE	DPDP/Mdb	1 yr.	Banded as a nestling on the SLR in 2015.
M	YEYE	DPDB/Mdb	1 yr.	Banded as a nestling on the SLR in 2015.
M	YEPU	WHPU/Mgo	1 yr.	Banded as a juvenile at DL MAPS in 2015.
M	YEYE/Mgo	YEPU	1 yr.	Banded as a juvenile at SM MAPS in 2015.
M	PUPU	ORPU/Mgo	1 yr.	Banded as a nestling at MNV in 2015.
M	PUWH	WHWH/Mgo	1 yr.	Banded as a nestling at LUC in 2015.
M	DPWH	BYST/Mdb	1 yr.	Banded as a nestling on the SLR in 2015.
M	YEYE	PUPU/Mgo	1 yr.	Banded as a nestling at SNO in 2015.
M	BYST	DGOR/Mgo	1 yr.	Banded as a nestling at DRO in 2015.
M	PUOR	DPDP/Mgo	1 yr.	Banded as a nestling at KHA in 2015.
M	YEPU	DPWH/Mgo	1 yr.	Banded as a nestling at LUC in 2015.

Appendix D. Continued.

Drainage	Band Combination[1]			
Sex[2]	Left Leg	Right Leg	Age	Comments[3]
Santa Margarita River continued				
M	BYST	BYST/Mgo	1 yr.	Banded as a nestling at OLL in 2015.
M	YEYE	ORPU/Mgo	1 yr.	Banded as a nestling at XNO in 2015.
M	DGOR	YEYE/Mgo	1 yr.	Banded as a nestling at XNO in 2015.
M	BYST	PUPU/Mgo	1 yr.	Banded as a nestling at QID in 2015.
M	PUYE	PUPU/Mgo	1 yr.	Banded as a nestling at ARI in 2015.
M	WHDP	ORPU/Mgo	1 yr.	Banded as a nestling at HDX in 2015.
M	PUOR	BYST/Mgo	1 yr.	Banded as a nestling at HDX in 2015.
M	PUYE	PUWH/Mgo	1 yr.	Banded as a nestling at QIN in 2015.
M	PUOR	PUYE/Mgo	1 yr.	Banded as a nestling at WSP in 2015.
M	PUYE	DPDP/Mgo	1 yr.	Banded as a nestling at DAT in 2015.
M	ORDG	BKBK/Mgo	1 yr.	Banded as a nestling at KNG in 2015.
M	BYST	WHWH/Mgo	1 yr.	Banded as a nestling at TYR in 2015.
M	ORDG	WHWH/Mgo	1 yr.	Banded as a nestling at MRT in 2015.
M	BYST	WHDP/Mgo	1 yr.	Banded as a nestling at HED in 2015.
U	YEPU	PUOR/Mgo	3 yrs.	Banded as a nestling at MIN in 2013.
U	PUWH	DPWH/Mgo	> 1 yrs.	Banded as an adult at SM MAPS in 2016.
U	DPDP/Mgo	YEPU	> 1 yrs.	Banded as an adult at SM MAPS in 2016.
U	WHWH/Mgo	ORDG	HY	Banded as a juvenile at SM MAPS in 2016.
U	PUPU/Mgo	YEPU	U	Banded witn unknown age at SM MAPS in 2016.
Windmill Creek				
M	PUPU	DPDP/Mgo	3 yrs.	Banded as a nestling at FAU in 2013.

[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; 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 F) 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.

Appendix E. Between-Year Movement of Adult Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2016

Year Last Det.	Drainage / Territory / Treatment[1]		Dist. Moved (km)	Band Combination[2]		Age in 2016	Sex[3]
	Last Seen	2016		Left Leg	Right Leg		
2015	BSJ / SJBV63	SMR / TYT / REF	1360.25	Mye	YEPU/gogo	> 1 yr.	F
2015	SLR / CACD	BAR / BA01	13.00	DPWH	PUYE/Mdb	1 yr.	F
2015	SLR / WANI	SMR / AW20	7.84	BKBK	PUWH/Mdb	1 yr.	F
2015	SLR / CACE	SMR / AE52	7.70	gogo	WHDB/Mdb	1 yr.	F
2015	SMR / WIN / REF	SMR / DAT / PF	3.82	BYST	WHPU/Mgo	1 yr.	F
2015	SMR / SM MAPS	SMR / RR05	3.04	PUYE/Mgo	BKBK	1 yr.	F
2015	SMR / REM / REF	SMR / MOU / PF	2.99	BYST	DPDP/Mgo	1 yr.	F
2015	SMR / TYR / REF	SMR / AW25	1.84	PUPU	DGOR/Mgo	1 yr.	F
2015	SMR / HDX / REF	SMR / HW21	1.34	ORDG	WHDP/Mgo	1 yr.	F
2015	SMR / BAT / REF	SMR / HW06	1.17	PUYE/Mgo	ORDG	> 2 yrs.	F
2015	SMR / ARI / PF	SMR / HW12	0.94	BYST	ORDR/Mgo	1 yr.	F
2015	SMR / TEN / PF	SMR / PIK / PF	0.90	LPBK	BKLP/Mgo	> 3 yrs.	F
2015	SMR / JSP / PF	SMR / FAU / PF	0.31	ORDR/Mgo	PUPU	4 yrs.	F
2015	SMR / AE22	SMR / AE11	0.29	BKBK/Mgo	LPBK	> 3 yrs.	F
2015	DL / DS03	DL / DS02	0.23	PUWH/Mgo	PUWH	> 3 yrs.	F
2015	SMR / BOW / REF	SMR / SIL / REF	0.21	WHDP	PUPU/Mgo	3 yrs.	F
2015	SMR / SM MAPS	SMR / ES01	0.19	YEPU	BKLP/Mgo	1 yr.	F
2015	SMR / CLE / REF	SMR / CLE / REF	0.05	WHDP	BKLP/Mgo	3 yrs.	F
2015	BSJ / SJBV147	SOF / FE07	1372.64	Mye	WHWH/sisi	1 yr.	M
2015	BLU / LUBV14	SMR / SM MAPS	1073.86	BKLP/Mgo	LPBK	> 4 yrs.	M
2015	SMO / MB01	DL / DS01	24.12	WHDP	DGOR/Mgo	3 yrs.	M
2015	SLR / BKEN	SMR / HW04	12.79	YEYE	BWST/Mdb	1 yr.	M
2015	DL / DL MAPS	SMR / PR33	12.55	YEPU	WHPU/Mgo	1 yr.	M
2015	SLR / CSAN	SMR / SE03B	7.93	PUYE	DPDP/Mdb	1 yr.	M
2015	SLR / WDOB	SMR / ES33	6.77	YEPU/Mdb	YEYE	4 yrs.	M
2015	SLR / CPAT	SMR / SE01	6.70	YEYE	DPDB/Mdb	1 yr.	M
2015	SMR / DAT / PF	SMR / AW08	5.98	PUYE	DPDP/Mgo	1 yr.	M
2015	SMR / KNG / REF	SMR / ES39	5.14	ORDG	BKBK/Mgo	1 yr.	M
2015	SLR / BPAT	NW / NC03	5.11	DPDP	DPDP/Mdb	1 yr.	M
2015	SLR / WGEE	SMR / PR21	4.32	DPWH	BYST/Mdb	1 yr.	M
2015	PD / PD06	LF / LN13	3.82	PUWH/Mdb	YEYE	2 yrs.	M
2015	SMR / DRO / REF	SMR / TEN / PF	3.70	BYST	DGOR/Mgo	1 yr.	M
2015	SMR / HDX / REF	SMR / AE31	3.41	PUOR	BYST/Mgo	1 yr.	M
2015	SMR / DEU / PF	DL / DS12	3.38	BYST	ORDG/Mgo	1 yr.	M
2015	SMR / ARI / PF	SMR / HOL / REF	2.88	PUYE	PUPU/Mgo	1 yr.	M
2015	SMR / KHA / REF	SMR / AXE / PF	2.67	PUOR	DPDP/Mgo	1 yr.	M
2015	SMR / HED / PF	SMR / HW23	2.57	BYST	WHDP/Mgo	1 yr.	M
2015	SMR / HDX / REF	SMR / PUC / PF	2.34	WHDP	ORPU/Mgo	1 yr.	M
2015	SMR / QIN / PF	SMR / HE16	1.95	PUYE	PUWH/Mgo	1 yr.	M
2015	SMR / TYR / REF	SMR / AW37	1.89	BYST	WHWH/Mgo	1 yr.	M
2015	MCAS / OLL	SMR / RR16	1.84	BYST	BYST/Mgo	1 yr.	M
2015	MCAS / XNO	SMR / 2207	1.65	YEYE	ORPU/Mgo	1 yr.	M
2015	SMR / WSP / REF	SMR / VAR / REF	1.48	PUOR	PUYE/Mgo	1 yr.	M
2015	MCAS / MNV	SMR / RR14	1.39	PUPU	ORPU/Mgo	1 yr.	M
2015	MCAS / QID	SMR / AW20	1.32	BYST	PUPU/Mgo	1 yr.	M
2015	MCAS / LUC	SMR / RR19	1.18	YEPU	DPWH/Mgo	1 yr.	M

Appendix E. Continued.

Year Last Det.	Drainage / Territory / Treatment[1]		Dist. Moved (km)	Band Combination[2]		Age in 2016	Sex[3]
	Last Seen	2016		Left Leg	Right Leg		
2015	MCAS / XNO	SMR / AW15	1.10	DGOR	YEYE/Mgo	1 yr.	M
2015	SMR / SNO / REF	SMR / CST / REF	1.07	YEYE	PUPU/Mgo	1 yr.	M
2015	SMR / JSP / PF	SMR / UNI / PF	0.90	PUPU	BKLP/Mgo	> 5 yrs.	M
2015	SMR / MRT / PF	SMR / VLE / PF	0.90	ORDG	WHWH/Mgo	1 yr.	M
2015	MCAS / LUC	SMR / AW35	0.72	PUWH	WHWH/Mgo	1 yr.	M
2015	SMR / BAD / PF	SMR / JAG / PF	0.56	DGOR	WHDP/Mgo	> 3 yrs.	M
2015	SMR / BN10	SMR / BN18	0.48	PUPU/Mgo	WHDP	> 2 yrs.	M
2015	SMR / OCE / PF	SMR / MRT / PF	0.33	PUYE/Mgo	ORPU	> 2 yrs.	M
2015	SMR / PRS22	SMR / ES44	0.32	PUOR	ORDG/Mgo	3 yrs.	M
2015	SMR / HDX / REF	SMR / KAI / REF	0.26	DGOR	BKLP/Mgo	> 3 yrs.	M
2015	SMR / AXE / PF	SMR / DEU / PF	0.24	WHWH	PUWH/Mgo	> 5 yrs.	M
2015	SMR / UM29	SMR / UM31	0.17	WHWH/Mdb	WHDB	> 6 yrs.	M
2015	SMR / LAN / PF	SMR / HW15	0.13	PUOR	WHPU/Mgo	> 3 yrs.	M
2015	SMR / HED / PF	SMR / DNG / PF	0.12	ORPU	OROR/Mgo	> 7 yrs.	M
2015	SMR / HLD / REF	SMR / HLD / REF	0.12	DGOR/Mgo	OROR	> 3 yrs.	M
2015	DL / DS10	DL / DS04	0.11	DPDP	WHWH/Mgo	> 3 yrs.	M
2015	SMR / HOL / REF	SMR / DAQ / REF	0.10	PUPU/Mgo	DGOR	> 2 yrs.	M
2015	SMR / YB09	SMR / YB10	0.09	WHWH	DBWH/Mdb	5 yrs.	M
2015	SMR / AE06	SMR / AE34	0.09	WHPU	Mgo	> 7 yrs.	M
2015	SMR / ANT / PF	SMR / ANT / PF	0.09	BKBK	WHPU/Mgo	> 3 yrs.	M
2015	SMR / MOU / PF	SMR / MOU / PF	0.08	BKBK	YEYE/Mgo	> 3 yrs.	M
2015	SMR / AE33	SMR / AE50	0.08	DPWH/Mdb	YEYE	2 yrs.	M
2015	SMR / CED / PF	SMR / CED / PF	0.08	ORPU	PUYE/Mgo	> 5 yrs.	M
2015	DL / DS15	DL / DS02	0.08	LPBK	YEPU/Mgo	> 4 yrs.	M
2015	SMR / 2202	SMR / 2211	0.08	DPWH	YEYE/Mdb	3 yrs.	M
2015	SMR / ES02	SMR / ES29	0.07	DPDP/Mgo	PUPU	> 5 yrs.	M
2015	SMR / FAU / PF	SMR / FAU / PF	0.06	OROR/Mgo	WHWH	> 5 yrs.	M
2015	SMR / SM MAPS	SMR / ES01	0.06	YEYE/Mgo	YEPU	1 yr.	M
2015	SMR / CLE / REF	SMR / CLE / REF	0.05	ORDG	BYST/Mgo	> 2 yrs.	M
2015	SMR / ES44	SMR / ES10	0.05	BKBK	LPBK/Mgo	> 3 yrs.	M
2015	SMR / HW04	SMR / HW17	0.05	PUPU/Mgo	ORPU	4 yrs.	M
2015	SMR / ES50	SMR / ES43	0.05	DPDP	YEYE/Mgo	> 7 yrs.	M
2015	SMR / PO07	SMR / PO07	0.05	BYST	BKBK/Mgo	3 yrs.	M
2015	SMR / ES41	SMR / ES16	0.04	DPWH/Mgo	WHWH	> 5 yrs.	M
2015	SMR / KOA / PF	SMR / KOA / PF	0.04	PUYE/Mgo	PUWH	> 3 yrs.	M
2015	SMR / TYT / REF	SMR / TYT / REF	0.04	BKBK	PUOR/Mgo	3 yrs.	M
2015	SMR / ES25	SMR / ES27	0.04	WHDP	WHDP/Mgo	3 yrs.	M
2015	SMR / MER / REF	SMR / MER / REF	0.03	Mgo	WHDP	> 7 yrs.	M
2015	SMR / QIN / PF	SMR / QIN / PF	0.03	BKLP/Mgo	PUPU	> 3 yrs.	M
2015	SMR / ZYL / REF	SMR / ZYL / REF	0.03	YEPU/Mgo	WHDP	> 2 yrs.	M
2015	SMR / FOX / PF	SMR / FOX / PF	0.02	DGOR	PUOR/Mgo	> 3 yrs.	M
2015	SMR / HOU / REF	SMR / HOU / REF	0.02	BYST/Mgo	ORDG	> 2 yrs.	M
2015	SMR / ES42	SMR / ES17	0.02	WHDP	ORDG/Mgo	> 2 yrs.	M

Appendix E. Continued.

Year Last Det.	Drainage / Territory / Treatment[1]		Dist. Moved (km)	Band Combination[2]		Age in 2016	Sex[3]
	Last Seen	2016		Left Leg	Right Leg		
2015	SMR / PRS21	SMR / PR08	0.02	BKBK	ORDG/Mgo	> 5 yrs.	M
2015	SMR / DRO / REF	SMR / DRO / REF	0.02	ORPU/Mgo	ORPU	> 2 yrs.	M
2015	SMR / BOW / REF	SMR / BOW / REF	0.01	LPBK	WHDP/Mgo	> 3 yrs.	M
2015	SMR / KHA / REF	SMR / KHA / REF	0.01	ORDG	DPDP/Mgo	> 2 yrs.	M
2015	SMR / KNG / REF	SMR / KNG / REF	0.01	PUPU	ORDG/Mgo	> 5 yrs.	M
2014	SMR / ZAM / REF	SMR / JSP / PF	1.03	ORPU/Mgo	PUPU	> 3 yrs.	F
2014	SMR / ES24	SMR / PR21	0.74	WHWH/Mgo	PUWH	> 3 yrs.	F
2014	SMR / ES11	SMR / ES29	0.04	PUOR	BKBK/Mgo	7 yrs.	F
2014	SMR / AE87	SMR / PR09	2.80	DPWH/Mgo	DPWH	4 yrs.	M
2014	SMR / PR56	SMR / BN34	0.63	DGOR	ORDG/Mgo	3 yrs.	M
2014	SMR / PR50	SMR / ES07	0.47	YEPU	WHDP/Mgo	> 3 yrs.	M
2014	SMR / YB13	SMR / YB02	0.40	DBDP/gogo	Mdb	3 yrs.	M
2014	SMR / UM62	SMR / UM24	0.17	PUWH	PUYE/Mgo	> 4 yrs.	M
2013	SMR / PIE	SMO / MB19	24.31	BYST	ORPU/Mgo	3 yrs.	F
2013	SMR / WSP / REF	SMR / PO06	9.23	ORDG	DPWH/Mgo	3 yrs.	F
2013	SMR / TRP	SMR / BN13	0.61	YEYE	PUWH/Mgo	3 yrs.	F
2013	SMR / HDX / REF	SMR / REM / REF	0.46	WHDP	YEYE/Mgo	3 yrs.	F
2013	SMR / MER / REF	SDO / LA01	63.07	DPWH	WHDP/Mgo	3 yrs.	M
2013	SMR / FAU / PF	WC / WC06	6.19	PUPU	DPDP/Mgo	3 yrs.	M
2013	SMR / WSP / REF	SMR / WSP / REF	0.09	YEPU	ORPU/Mgo	5 yrs.	M
2013	SMR / MIN	SMR / SM MAPS	0.78	YEPU	PUOR/Mgo	3 yrs.	U
2012	SMR / ONX / PF	SMR / HE17	3.72	ORDG/Mgo	YEYE	4 yrs.	M
2010	SMR / EMB	SMR / BN05	1.28	DPDP/Mgo	YEYE	6 yrs.	F
2010	SMR / SM MAPS	SMR / ES30	1.87	DPDP	PUWH/Mgo	6 yrs.	M
2010	SMR / SM MAPS	SMR / BN17	0.18	BKLP/Mgo	WHWH	6 yrs.	M
2009	SMR / BER / PF	SMR / SER / PF	1.63	WHDP	YEPU/Mgo	7 yrs.	F
2008	SMR / DRK / PF	DL / DS08	2.52	BYST/Mgo	WHDP	8 yrs.	F

[1] Drainage Codes: BAR = Basilone/Roblar Road Drainage; BLU = Baja California Sur, Arroyo San Luis; BSJ = Baja California Sur, Rio San Jose; DL = De Luz Creek; LF = Las Flores Creek; MCAS = Marine Corps Air Station, Camp Pendleton; NW = Newton Canyon; PD = Piedra de Lumbre Canyon; SDO = San Diego River; SLR = San Luis Rey River; SMR = Santa Margarita River; SMO = San Mateo Creek; SOF = San Onofre Creek; WC = Windmill Creek; 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; gogo = metal gold; sisi = metal silver; BKBK = plastic black; BKLP = plastic black-light pink split; 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.

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

Appendix F. Status and Nesting Activities of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2016

Post-fire Site Territories

Territory	Nest	Monitoring[1]	Nest Fate[2]	# Fledged	Comments
ANT	1	F	PRE		
ANT	2	F	UNK		No eggs seen.
ARL	1	F	SUC	4	
AXE	1	F	PRE		
CAL	1	F	PRE		
CAL	2	F	INC		
CAL	3	F	SUC	3	
CED	1	F	SUC	2	One Brown-headed Cowbird egg removed from nest.
DAT	1	F	SUC	3	
DEU	1	F	PRE		
DEU	2	F	PRE		
DEU	3	F	PRE		
DEU	4	F	SUC	3	
DNG	1	F	SUC	2	
DNG	2	F	SUC	3	
DRK	1	F	UNK		No eggs seen.
DRK	2	F	PRE		
DRK	3	F	SUC	3	
FAU	1	F	PRE		
FAU	2	F	PRE		
FAU	3	F	INC		
FAU	4	F	SUC	3	
FOX	1	F	SUC	4	
FOX	2	F	PRE		
FOX	3	F	PRE		
FOX	4	F	INC		
FOX	5	F	PRE		
JAG	1	F	OTH		Eggs infertile.
JAG	2	F	PRE		
JAG	3	F	OTH		Eggs infertile.
JSP	1	F	SUC	3	
KOA	1	F	PRE		
KOA	2	F	UNK		No eggs seen.
KOA	3	F	UNK		No eggs seen.
KOA	4	F	PRE		
LEM	1	F	SUC	3	
MOU	1	F	PRE		
MOU	2	F	PRE		
MRT	1	F	PRE		
MRT	2	F	PRE		
MRT	3	F	PRE		
PIK	1	F	UNK		Host plant collapsed.
PIK	2	F	PRE		
PUC	1	F	PRE		

Post-fire Site Territories (continued)

Territory	Nest	Monitoring[1]	Nest Fate[2]	# Fledged	Comments
QIN	1	F	FAL		
QIN	2	F	PRE		
QIN	3	F	INC		
QIN	4	F	UNK		Abandoned with eggs.
SER	1	F	SUC	1	
SER	2	F	PRE		
SER	3	F	UNK		Nest disturbed, eggs on ground.
TEN	1	F	PRE		
TEN	2	F	UNK		No eggs seen.
UNI	1	F	SUC	3	
VLE	1	F	SUC	3	
WOM	1	F	SUC	3	
WOM	2	F	UNK		No eggs seen.
WOM	3	F	PRE		
ZAM	1	F	PRE		
ZAM	2	F	PRE		

Reference Site Territories

Territory	Nest	Monitoring[1]	Nest Fate[2]	# Fledged	Comments
ARY	1	F	PRE		
BIL	1	F	SUC	4	
BIL	2	F	PRE		
BOW	1	F	UNK		No eggs seen.
BOW	2	F	PRE		
BOW	3	F	SUC	3	
CLE	1	F	PRE		
CLE	2	F	PRE		
CLE	3	F	SUC	4	
DAQ	1	F	SUC	1	
DAQ	2	F	INC		
DAQ	3	F	SUC	4	
DRO	1	F	SUC	3	
DRO	2	F	SUC	3	
FIN	1	F	PRE		
FIN	2	F	SUC	3	
FKI	1	F	SUC	3	
FKI	2	F	SUC	3	
HLD	1	F	PRE		
HLD	2	F	INC		
HLD	3	F	PRE		
HOU	1	F	PRE		
HOU	2	F	PRE		
HOU	3	F	PRE		
HTI	1	F	PRE		
HTI	2	F	SUC	3	

Reference Site Territories (continued)

Territory	Nest	Monitoring[1]	Nest Fate[2]	# Fledged	Comments
KAI	1	F	PRE		
KAI	2	F	PRE		
KAI	3	F	PRE		
KHA	1	F	PRE		
KHA	2	F	PRE		
KHA	3	F	OTH		Eggs infertile.
KHA	4	F	OTH		Eggs infertile.
KNG	1	F	UNK		Abandoned with eggs.
KNG	2	F	SUC	2	
KNG	3	F	PRE		
MER	1	F	PRE		
MER	2	F	PRE		
MER	3	F	PRE		
MER	4	F	SUC	4	
MOR	1	F	PRE		
MOR	2	F	SUC	2	
REM	1	F	SUC	3	
REM	2	F	SUC	3	
SAN	1	F	INC		
SAN	2	F	PRE		
SAN	3	F	SUC	3	
SIL	1	F	SUC	3	
SIL	2	F	INC		
SIL	3	F	PRE		
SNO	1	F	SUC	3	
SNO	2	F	SUC	3	
STA	1	F	PRE		
STA	2	F	PRE		
TYR	1	F	PRE		
TYR	2	F	SUC	3	
TYT	1	F	PRE		
TYT	2	F	SUC	4	
VAR	1	F	PRE		
VAR	2	F	PRE		
WSP	1	F	INC		
WSP	2	F	SUC	4	
WSP	3	F	INC		
ZYL	1	F	PRE		
ZYL	2	F	PRE		
ZYL	3	F	SUC	2	

[1] Monitoring: F = fully monitored territory.

[2] Nest Fate: FAL = false nests, built by male only and not completed; 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.