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

2015 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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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 2015. Drainages containing riparian habitat suitable for vireos were surveyed two to four times. Six hundred and twenty-one male vireos and 46 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 65% of all territories on Base. Seventy-two percent of male vireos were confirmed as paired.

The number of documented Least Bell's Vireo territories on MCBCP (621) decreased 2% from 2014 to 2015. The number of territories on 13% (3/23) of drainages surveyed increased by 3-14 territories from 2014, while 17% of drainages (4/23) decreased by three or more territories, and 70% of drainages (16/23) showed no change or increased/decreased by two or fewer territories.

The decrease in vireo numbers on MCBCP (2%) was consistent with population changes in surrounding areas, including the lower San Luis Rey River (decreased by 5%), the middle San Luis Rey River (decreased by 15%), and Marine Corps Air Station, Camp Pendleton MCAS (decreased by 6%). Region-wide declines in the breeding population of Least Bell's Vireos are likely largely attributable to four continuous years of drought.

The majority of vireo territories occurred in habitat characterized as willow riparian, with 72% of males in the study area found in this habitat. An additional 10% of birds occupied willow (*Salix* spp.) habitat co-dominated by sycamores (*Platanus racemosa*) or cottonwoods (*Populus fremontii*). Fourteen percent of territories were found in riparian scrub dominated by mule fat (*Baccharis salicifolia*) and/or sandbar willow (*S. exigua*). Four 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. Eighty-four percent of the riparian vegetation was classified as high burn severity and 16% was classified as moderate burn severity. Live vegetation was mostly concentrated below 4 m and increased slightly in volume between 2014 and 2015 (2-6%). Exotic and herbaceous species comprised > 50% of the vegetation under 1 m and 25% of the vegetation between 1 and 2 m. While the pattern of vegetation recovery at the Above Hospital sites was similar to that at Las Flores Creek (which burned in October 2007 and was sampled in 2008-2012), the fire was less severe at Las Flores Creek as documented by lower burn severity indices, and also demonstrated by greater vegetation cover at upper height categories.

In May 2014, a second wildfire event burned 8,906 ha on MCBCP, 837 ha of which was riparian vegetation that was occupied by vireos at the time of the fire. We evaluated vireo response to both the October 2013 and the May 2014 wildfires by calculating territory density

within the wildfire perimeters (pre- and post-fire) and also by monitoring vireo nests within the area burned in October 2013 (Post-fire sites) compared to Reference sites that have not experienced significant disturbance in the past 16-18 years.

Vireo territory density at the October 2013 Post-fire sites did not differ from unburned Reference sites in 2015 and exhibited a 1% decrease the first-year post-fire (2014) concurrent with a 12% decrease Base-wide. In contrast, vireo territory density in areas that burned in May 2014 had a 34% decrease in territory density the first year post-fire (2015) concurrent with a 2% decrease Base-wide. The different recovery rates following the two burns may be attributable to the timing of the wildfires. Vireos were not present when wildfires burned their breeding habitat in October 2013. Winter precipitation, even in a below-average year, likely allowed this area to recover sufficiently so that returning vireos found their territories adequate for nesting the following breeding season. However, the May 2014 fire destroyed vireo habitat while vireos were present, displacing the vireos that survived the fire and likely forcing them to establish new territories outside of the fire perimeter. Fewer vireos returned to occupy territories within the May 2014 fire perimeter in 2015 potentially either because the vegetation recovered poorly or because the vireos returned to their newly established territories outside of the fire perimeter instead of their old, burned territories.

We color-banded and resighted color-banded Least Bell's Vireos to evaluate adult site fidelity, natal dispersal, and the effect of wildfire on vireo site fidelity, dispersal, and survivorship. Two hundred and ten Least Bell's Vireos were banded for the first time during the 2015 season. These included 24 adult vireos and 186 hatch-year vireos. All adult vireos and seven hatch-year birds were banded with unique color combinations. The remaining 179 hatch-year vireos (all nestlings) were banded with a single gold numbered federal band on the right leg.

One hundred Least Bell's Vireos banded prior to the 2015 breeding season were resighted and identified on Base in 2015. Eleven of these were originally banded on the San Luis Rey River, six were originally banded at MCAS, and the remaining birds were banded at MCBCP. Adult birds of known age ranged from 1-9 years old. Adult survivorship, or the proportion of individuals known to survive from 2014 to 2015, was 52% (91/176). Survivorship of first-year birds that fledged from MCBCP in 2014 and were documented on Base or elsewhere in 2015 was 2% (2/96), based on the number of uniquely banded individuals detected. Both of the first-year vireos detected in 2015 were male.

The majority of returning adult vireos showed strong between-year site fidelity. Overall vireo territory fidelity between 2014 and 2015 was 66% (44/67). The average between-year movement for returning adult vireos was 0.7 ± 1.9 km (standard deviation [SD]). The one first-year vireo detected in 2015 that fledged from a known nest on MCBCP in 2014 dispersed 1.6 km to his 2015 breeding location. The other first-year vireo detected in 2015 was banded in 2014 at a Monitoring Avian Productivity and Survivorship banding station and therefore its natal location was unknown.

Two vireos (both males) that originated at MCBCP moved off-Base and were detected elsewhere in 2015. One of these was originally banded as a nestling in 2013 at an unburned Reference site and was re-detected on the Santa Ana River in Los Angeles County in 2015. The

other was observed holding a territory on MCBCP in 2013 and then re-detected at MCAS in 2015. The second male's 2013 territory was burned in the May 2014 wildfire.

We monitored Least Bell's Vireo nests 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 72% and 79%, respectively. First-year survivorship was 4% and 0%, respectively. Eighty-nine percent of adults from Post-fire sites that were detected in both 2014 and 2015 returned in 2015 to the same territory occupied in 2014. One hundred percent (15/15) of adult vireos detected in 2014 Reference sites returned to Reference sites in 2015. One male nestling from a 2014 Post-fire site returned to occupy a breeding territory outside of our monitoring areas in 2015.

Nesting activity was monitored between 30 March and 25 July in 54 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 forty-three nests (67 in Post-fire sites and 76 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 2015. Thirty-three percent (21/63) of Post-fire nests and 32% (21/65) of Reference nests successfully fledged young. Predation was believed to be the primary source of nest failure at both sites. Predation accounted for 83% (35/42) and 64% (28/44) of nest failures at Post-fire and Reference sites, respectively. Of the remaining ten nests that failed, failure was attributed to a rain storm, egg infertility, and other unknown reasons. No nest parasitism of Least Bell's Vireos by Brown-headed Cowbirds (*Molothrus ater*) was documented in 2015.

Breeding productivity per pair was higher at both sites in 2015 than in 2014, likely in response to several unseasonable rain events during the 2015 summer. Productivity did not differ between Post-fire and Reference sites (2.2 versus 2.0 young per pair). Similarly, the proportion of Post-fire pairs that successfully fledged at least one young did not differ from the proportion of Reference pairs in 2015 (58% versus 64%).

In 2015, successful and unsuccessful nests within Post-fire and Reference sites were similar in placement. Vireo nests at Post-fire sites were placed lower in the host plants than nests in Reference sites. Fourteen plant species were used as hosts for vireo nests in 2015. Sixty 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 over the past 2 years. 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 our analysis of vireo and vegetation response to these wildfires, 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 fecundity, 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 the 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 second 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 2015 (Fig. 1). Field work was conducted by USGS biologists Katie Allen, Lisa Allen, Andrea Bowling, Tom Dayton, Rachel del Rio, PJ Falatek, Aaron Gallagher, Sarah Harris, Alex Houston, Scarlett Howell, Jennifer Jacobs, Angela Johnson, Barbara Kus, Melanie Madden, Ryan Pottinger, Lea Squires, Devin Taylor, Jared Taylor, and Charlie Vettes. 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. 14, Fig. 15).
   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. 14).

2. ***De Luz Creek,*** between the confluences of the Santa Margarita River with the Base boundary (Appendix A, Fig. 14).

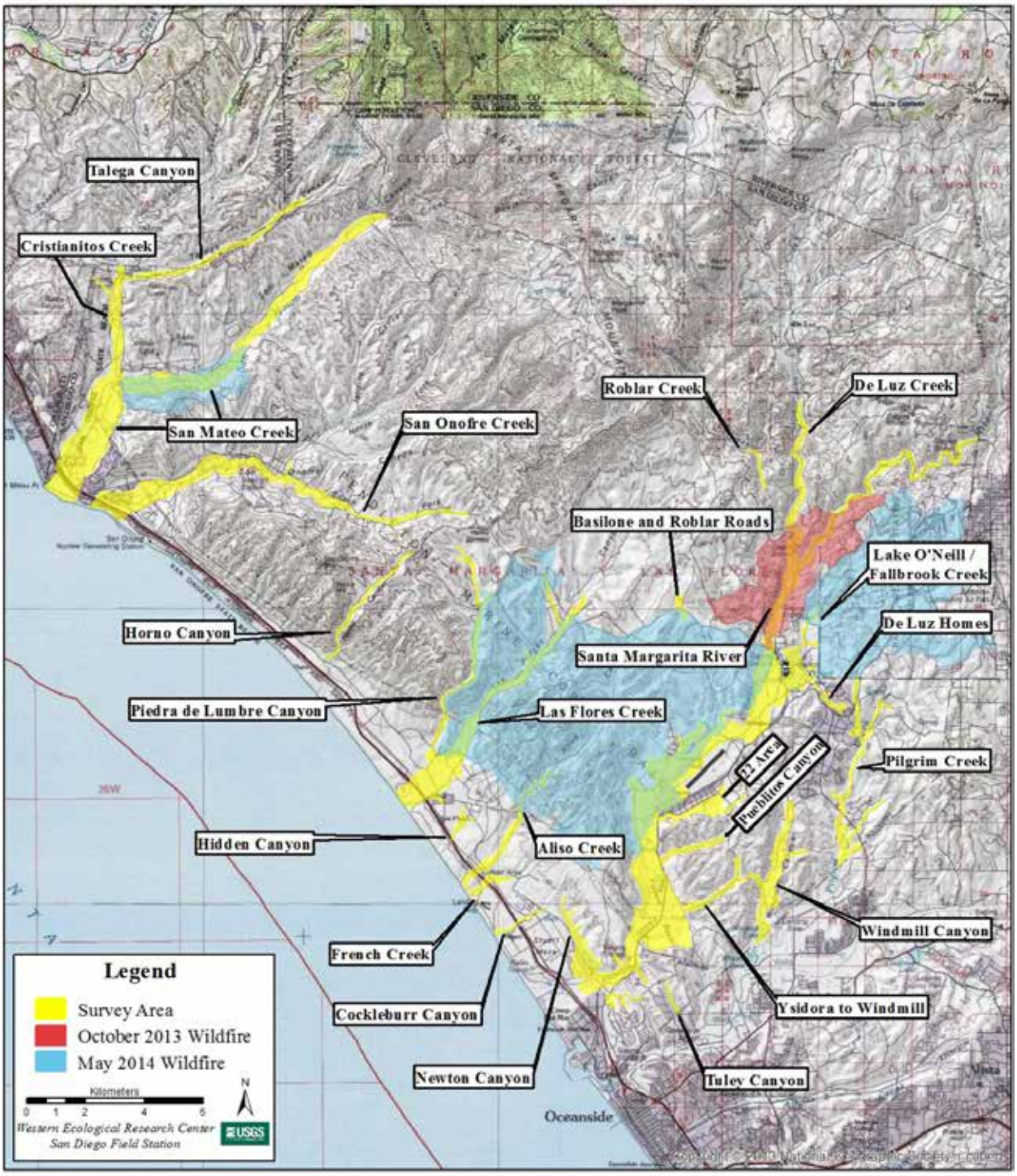

Fig. 1. Least Bell's Vireo survey areas at Marine Corps Base Camp Pendleton, 2015.

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. 14).

4. ***Lake O'Neill/Fallbrook Creek:***
   a. All riparian habitat around Lake O'Neill (Appendix A, Fig. 14).
   b. Between Lake O'Neill and the Base boundary with FNWS (Appendix A, Fig. 14).

5. ***Basilone and Roblar Roads,*** a small patch of habitat straddling Basilone Road at the intersection of Basilone and Roblar Roads (Appendix A, Fig. 14).

6. ***22 Area,*** all riparian habitat within the 22 Area, east of Vandegrift Road and the Supply Depot (Appendix A, Fig. 15).

7. ***Pueblitos Canyon,*** between Vandegrift Road and a point approximately 2.5 km upstream (Appendix A, Fig. 15).

8. ***Tuley Canyon,*** between the Base boundary and a point approximately 1.1 km upstream (Appendix A, Fig. 15).

9. ***Newton Canyon,*** between the confluence with the Santa Margarita River and the upstream limit of riparian habitat (Appendix A, Fig. 15).

10. ***Cockleburr Canyon,*** between the Pacific Ocean and a point 0.25 km east of Interstate 5 (Appendix A, Fig. 15).

11. ***French Creek,*** between the Pacific Ocean and the Edson Range Impact Area (Appendix A, Fig. 15).

12. ***Aliso Creek,*** between the Pacific Ocean and 0.5 km upstream of the electrical transmission lines (Appendix A, Fig. 15).

13. ***Hidden Canyon,*** between Interstate 5 and Stuart Mesa Road (Appendix A, Fig. 16).

14. ***Las Flores Creek (within Las Pulgas Canyon):***
   a. Between Stuart Mesa Road and the high voltage electrical transmission lines (Appendix A, Fig. 16).
   b. Between the Pacific Ocean and Stuart Mesa Road (Appendix A, Fig. 16).
   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. 16).

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. 16).

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

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. 16, Fig. 17).
b. From Basilone Road upstream to the access road to Range 219 (Appendix A, Fig. 16).

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. 17).
b. From San Mateo Road upstream to the Base boundary (Appendix A, Fig. 17, Fig. 18).

19. Cristianitos Creek, between the confluence with San Mateo Creek and the Base boundary (Appendix A, Fig. 17).

20. Talega Canyon, between the confluence with Cristianitos Creek and a point approximately 6.5 km upstream (Appendix A, Fig. 17).

21. Pilgrim Creek:

a. Between the southern Base boundary and Vandegrift Boulevard, including the two side drainages east of Pilgrim Creek (Appendix A, Fig. 19).
b. From Vandegrift Boulevard upstream to the limit of riparian habitat (Appendix A, Fig. 19).

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. 19).

23. Ysidora Basin to Windmill Canyon, between Upper Ysidora Basin and Windmill Canyon/ Pueblitos Canyon (Appendix A, Fig. 19).

24. De Luz Homes Habitat, patches of habitat adjacent to the De Luz Homes development (Appendix A, Fig. 19).

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 August 2015 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).

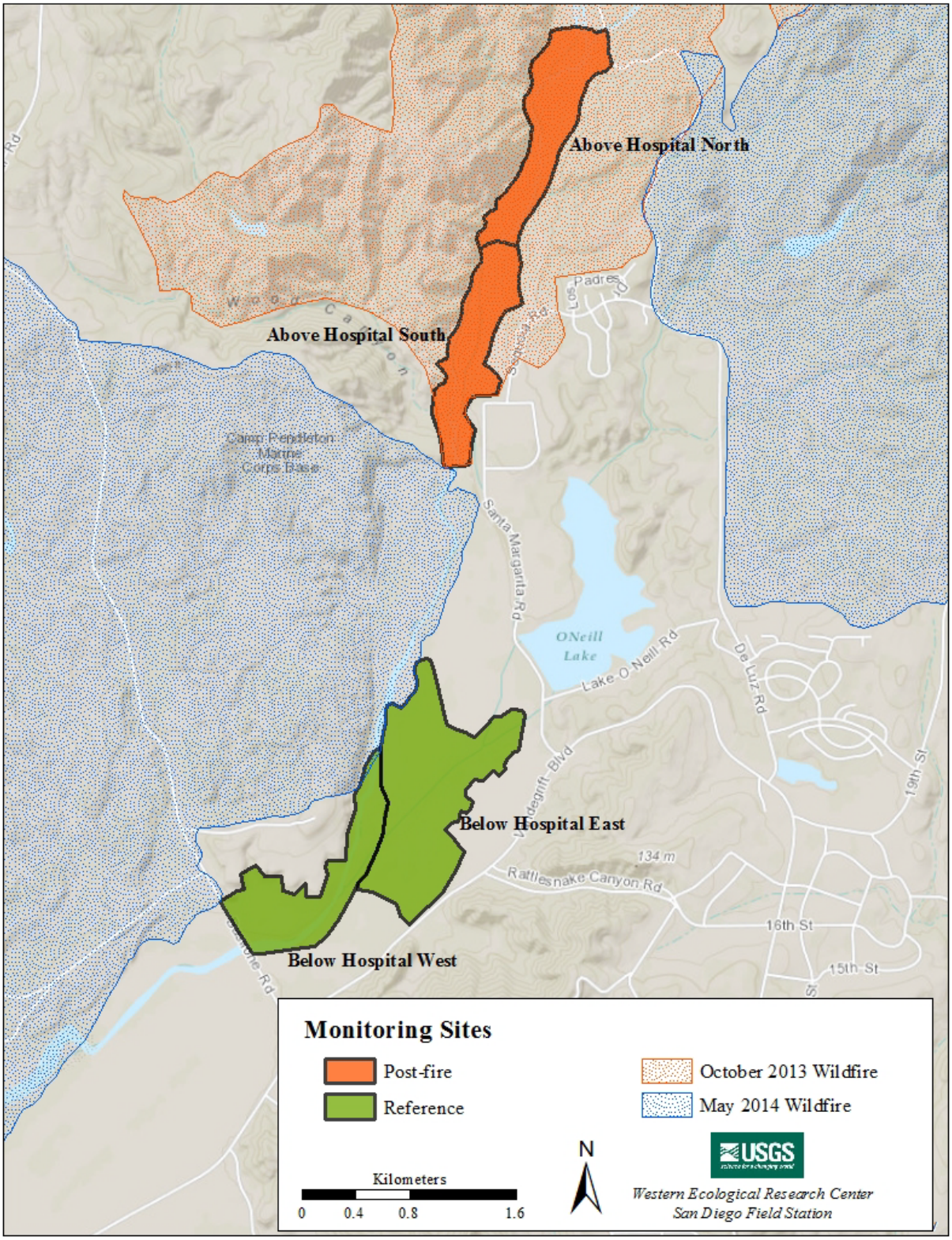

Fig. 2. Location of Least Bell's Vireo Post-fire and Reference study sites at Marine Corps Base Camp Pendleton, 2015.

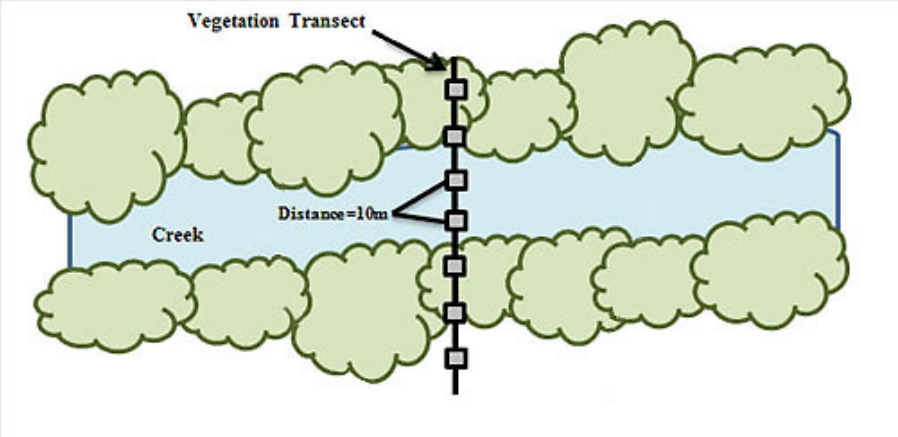

Fig. 3. Schematic diagram of a vegetation sampling transect.

We recorded burn severity within 5 m of each quadrat in August 2015 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 2008, 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 2015) / (# known to be present in 2014)). 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 2014-2015 was calculated for known individuals that were: (1) adults in 2014 on Base and were resighted anywhere on Base in 2015; (2) adult vireos that held territories in Post-fire or Reference sites in 2014 and were resighted anywhere on Base in 2015; (3) first-year vireos that were banded as nestlings or juveniles anywhere on Base in 2014 and were resighted anywhere in 2015 (including off-Base); and (4) first-year vireos that were banded as nestlings or juveniles in Post-fire or Reference sites in 2014 and were resighted anywhere in

2015. 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 2014 and the center of the same vireo's breeding territory in 2015. Vireos exhibited site fidelity if they returned to within 100 m of their 2014 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 2015 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 Reference sites.

Table 2. Least Bell's Vireo study site categories from 2005 to 2015, Marine Corps Base Camp Pendleton.

	Study Years		
Site Location	**2005-2013**	**2014**	**2015**
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 and 2015, we monitored 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, *Arundo donax*, 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 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 (Table 2).

We compared vireo breeding productivity and factors that potentially influenced productivity between Post-fire and Reference sites in 2015, to determine whether wildfires influenced vireo productivity. These factors included 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, the 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), the proportion of nests that were depredated, and the proportion of nests that were parasitized by cowbirds.

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 2015. 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 28 territories in Reference sites between 30 March and 25 July 2015. Territories were chosen based on their location within areas that were monitored in previous years or in order of their arrival at new sites, and all nests were found and monitored within these selected territories. 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, we were prepared to follow our standard protocol for manipulating nest contents in the event cowbird eggs or nestlings were detected in vireo nests. In nests with fewer than three vireo eggs, cowbird eggs are removed no sooner than the 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, likelihood of re-nesting after a first nesting attempt, likelihood of re-nesting if the first nesting attempt failed or was successful, nest success, and whether or not the first nest attempt was successful. 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 2014 and 2015 at Post-fire sites and between 2015 Post-fire sites and vegetation data collected in 2009 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, and 2014 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. See Griffith Wildlife Biology 2004 for data prior to 2005.

RESULTS

Population Size and Distribution

A total of 667 male Least Bell's Vireos were detected during Base-wide surveys (Table 3; Appendix C, Figs. 20-39). Of these, 621 were territorial males, 72% of which were confirmed as paired, and 46 were transients. This represents a 2% decrease in territories from 2014, and a 14% decrease from 2013 territories. Transient vireos were observed on ten of the 23 (43%) drainages/sites surveyed. Ninety-four percent of all vireo territories occurred on the six most populated drainages/sites (Santa Margarita River, San Onofre Creek, Las Flores Creek, San Mateo Creek, De Luz Creek, and Pilgrim Creek), and the majority of vireo territories (65%) occurred along the Santa Margarita River, the largest expanse of riparian vegetation on Base (Table 3, Table 4). The remaining 17 drainages/sites each contained fewer than ten territories.

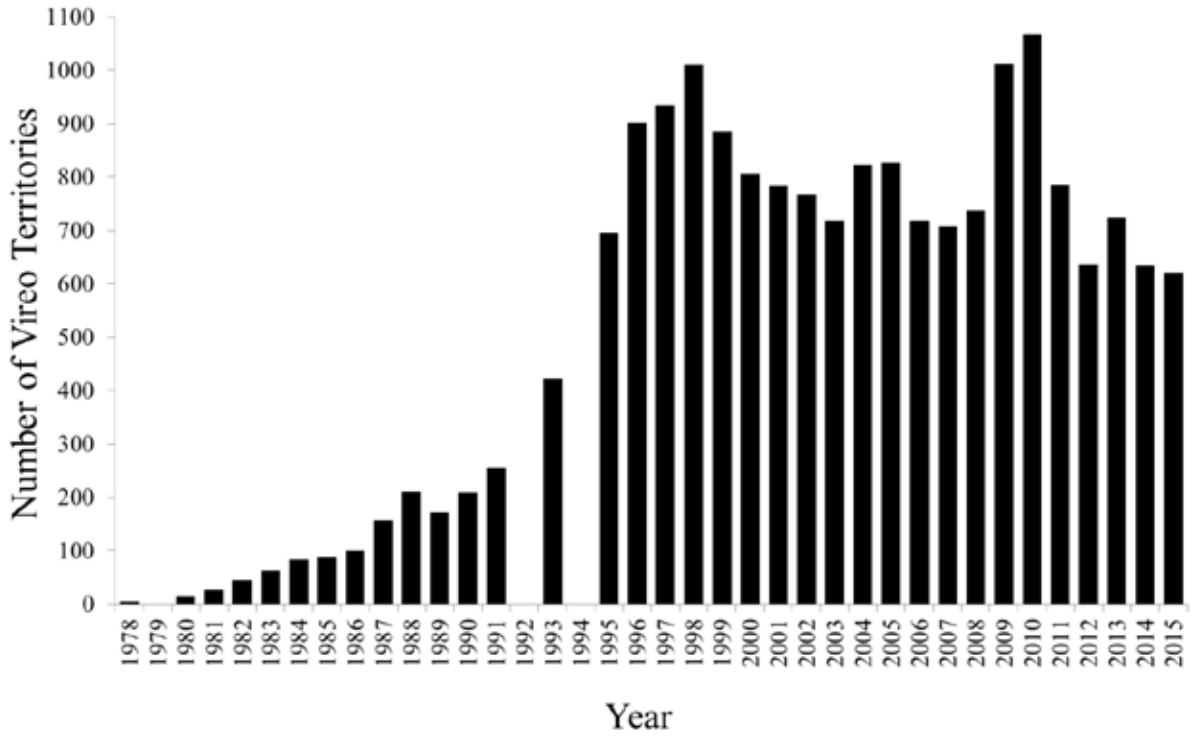

Fig. 4. Number of Least Bell's Vireo territories at Marine Corps Base Camp Pendleton, 1978–2015.

The distribution of Least Bell's Vireo territories documented on Base in 2015 appeared to shift compared to 2014, potentially in response to the October 2013 and May 2014 wildfires (Table 4). The five most heavily populated drainages on MCBCP contained 88% of all territories in 2014 and 90% of territories in 2015, although three of these drainages lost territories between 2014 and 2015. The Santa Margarita River, parts of which burned in both the October 2013 and May 2014 wildfires, lost 43 territories between 2013 and 2014 and lost another seven territories between 2014 and 2015. De Luz Creek, parts of which burned in the October 2013 wildfire, lost four territories between 2013 and 2014, and lost another four territories between 2014 and 2015. San Onofre Creek, which did not burn in either wildfire, gained two territories between 2013 and 2014 but lost six between 2014 and 2015. Both of the two heavily populated drainages that gained territories in 2015 were partially burned in the May 2014 wildfires. San Mateo Creek lost 15 territories between 2013 and 2014, but gained 14 back between 2014 and 2015. Las Flores Creek lost 22 territories between 2013 and 2014 but gained four between 2014 and 2015. Ten survey areas continued to fluctuate between zero and five territories over the past 9 years. Five of these (Basilone and Roblar Roads, Pueblitos Canyon, French Canyon, Hidden Canyon, and Ysidora Basin to Windmill Canyon) lost one to two territories between 2014 and 2015 and five remained the same as in 2014 (Roblar Creek, Cockleburr Creek, Horno Canyon, Talega Canyon, and Tuley Canyon). In 2015, the vireo population increased by more than two territories in 13% of drainages surveyed (3/23). Sixteen drainages (70%) showed no change or changed (increased or decreased) by two or fewer territories between 2014 and 2015 and four

drainages (17%) decreased by three or more territories. The drainages with the largest numeric increases in vireo territories were San Mateo Creek, Las Flores Creek, and Piedra de Lumbre Canyon increasing by 3-14 territories each (54%, 9%, and 100%, respectively). The sites with the largest numeric loss in vireo numbers were the Santa Margarita River, San Onofre Creek, De Luz Creek, and Fallbrook Creek, losing seven, six, four, and four territories, respectively (2%, 11%, 15%, and 57%, respectively).

Table 3. Number and distribution of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2015.

	Territories			
Drainage/Survey Site	Known Pairs	Single/Status Undetermined	Transient	Total Territories
Santa Margarita River:				
I-5 to De Luz Creek	273	80	27	353
De Luz Creek to Base Boundary	13	26	0	39
22 Area	4	7	0	11
De Luz Creek	17	6	5	23
Roblar Creek	1	1	0	2
Lake O'Neill/Fallbrook Creek	2	1	2	3
Basilone-Roblar Roads	0	2	0	2
Pueblitos Canyon	0	0	0	0
Newton Canyon	2	1	0	3
Cockleburr Creek	0	0	1	0
French Canyon	1	0	0	1
Aliso Creek	3	1	1	4
Hidden Canyon	2	1	0	3
Las Flores Creek:				
Pacific Ocean to Stuart Mesa Rd	0	0	0	0
Stuart Mesa Rd to Power Lines	17	10	1	27
Power Lines to Zulu Impact Area	15	5	1	20
Piedra de Lumbre Canyon	5	1	0	6
Horno Canyon	1	0	0	1
San Onofre Creek:				
Pacific Ocean to Basilone Rd	23	13	3	36
Basilone Rd to Access Rd to Range 219	9	3	0	12
San Mateo Creek				
Pacific Ocean to San Mateo Road	36	4	3	40
San Mateo Road to Yankee Training Area	0	0	0	0
Cristianitos Creek	4	1	1	5
Talega Canyon	0	0	0	0
Tuley Canyon	0	0	0	0
Pilgrim Creek:				
Base Boundary upstream to Vandegrift Blvd	10	6	1	16
Vandegrift Blvd to upstream riparian limit	5	0	0	5
Windmill Canyon	3	2	0	5
Ysidora Basin to Windmill Canyon	1	0	0	1
De Luz Homes	3	0	0	3
Total	450	171	46	621

Table 4. Number of territorial male Least Bell's Vireos at Marine Corps Base Camp Pendleton, by drainage, 2004-2015. Number includes only singing males determined to hold territories. Numeric change is the positive or negative change in the number of vireo territories between 2014 and 2015.

	Number of Territorial Males												
Drainage	**2004[1]**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**Numeric Change**
Santa Margarita River[2]	440	472	417	423	463	599	678	467	382	453	410	403	-7
De Luz Creek	26	18	25	24	25	39	34	27	28	31	27	23	-4
Roblar Creek	1	0	0	0	0	2	1	1	1	2	2	2	0
Lake O'Neill/Fallbrook Creek	16	20	10	9	11	11	15	6	5	5	7	3	-4
Basilone-Roblar Roads	-	2	0	0	0	5	4	2	4	0	3	2	-1
Pueblitos Canyon	3	5	3	2	2	1	0	0	0	0	1	0	-1
Newton Canyon	9	8	8	5	4	6	7	6	4	6	5	3	-2
Cockleburr Creek	0	2	2	2	1	2	0	0	1	0	0	0	0
French Canyon	5	6	4	2	2	2	2	2	2	3	3	1	-2
Aliso Creek	21	21	11	9	11	21	16	9	8	9	6	4	-2
Hidden Canyon	5	8	5	4	4	2	4	3	3	3	4	3	-1
Las Flores Creek	84	85	76	81	70	107	124	92	61	65	43	47	4
Piedra de Lumbre Canyon	5	8	9	6	3	5	6	3	5	3	3	6	3
Horno Canyon	0	1	0	0	0	1	1	4	1	1	1	1	0
San Onofre Creek	56	52	43	44	41	62	54	57	46	52	54	48	-6
San Mateo Creek	68	56	59	46	53	83	71	56	45	41	26	40	14
Cristianitos Creek	8	6	8	8	4	13	10	11	10	11	6	5	-1
Talega Canyon	0	1	0	0	0	1	0	0	0	0	0	0	0
Tuley Canyon	2	-	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	-2
Windmill Canyon	20	12	7	8	12	13	10	7	6	5	6	5	-1
Ysidora Basin to Windmill Canyon	8	4	6	5	4	5	2	1	1	1	2	1	-1
De Luz Homes	5	4	2	3	2	6	5	5	3	3	2	3	1
Total	819	827	718	707	738	1,013	1,068	784	636	724	634	621	-13

[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 2015, with 71% established by the end of April (Fig. 5). This represented a lower proportion of territories established by the end of April than all years except 2006, 2013, and 2014. By the end of May, 91% of territories had been established. The first vireo detected on MCBCP in 2015 was found on 23 March. This is 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.

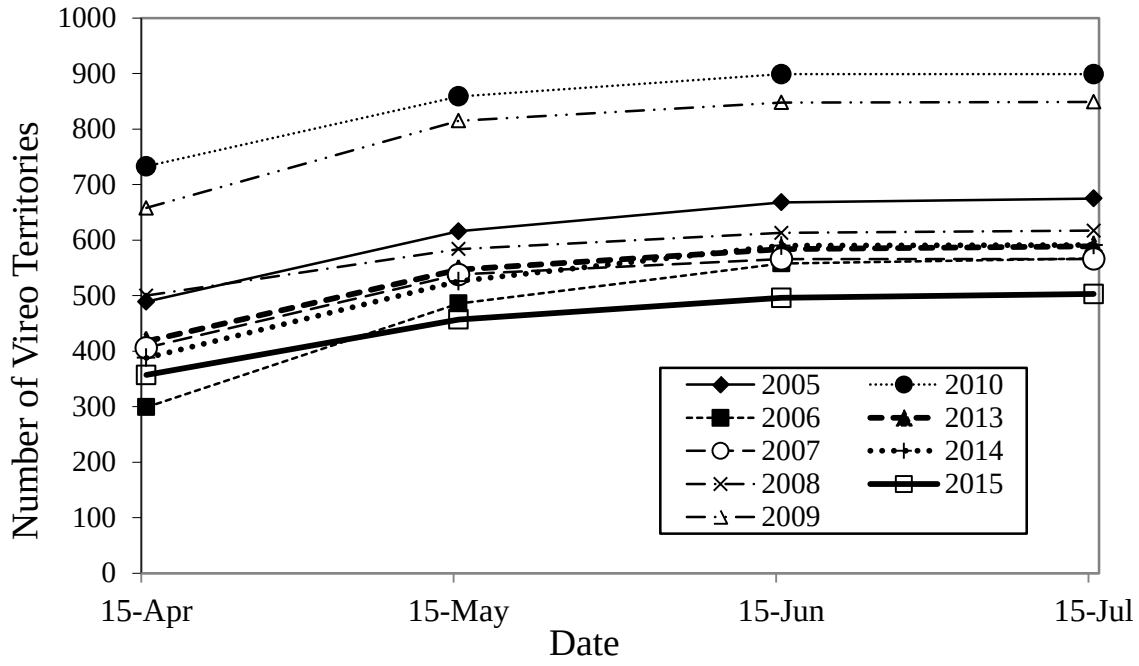

Fig. 5. Territory establishment of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2005-2015. Numbers include only vireos in areas that were surveyed at least four times per year. Dates represent period mid-points. Surveys began late in 2011 and 2012; therefore, arrival dates for these years 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 72% of males in the study area found in this habitat. An additional 10% of birds occupied willow habitat co-dominated by cottonwoods or sycamores. Fourteen percent of territories were found in riparian scrub, dominated by mule fat and/or sandbar willow. Four percent of vireos

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

Table 5. Habitat types used by Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2015.

	Number of Territories			
Habitat Type	**>50% Native**	**>50% Exotic**	**Total**	**Percent of Total**
Mixed Willow	411	32	443	72%
Riparian Scrub	78	6	84	14%
Willow/Sycamore	50	3	53	9%
Oak/Sycamore	13	3	16	3%
Upland Scrub	4	3	7	1%
Non-native	4	3	7	1%
Willow/Cottonwood	5	0	5	< 1%
Total	565	50	615[1]	100%

[1] Data not recorded at six territories.

Twice the proportion of vireo territories were documented in exotic vegetation in 2015 as in 2014 (Table 6). Eight percent (50/616) of vireo territories in 2015 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. Six drainages contained territories dominated by non-native vegetation in 2015, compared to five in 2014. Three of these drainages (the Santa Margarita River, De Luz Creek, and San Onofre Creek) also contained territories dominated by non-native vegetation in 2014. The proportion of vireo territories dominated by exotic vegetation increased in 2015 after having decreased over the previous 4 years. 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, 2005-2015. Numbers in parentheses are the number of territories in the drainage.

	Proportion of Territories																			
Drainage	**2005**		**2006**		**2007**		**2008**		**2009**		**2010**		**2011**		**2012**		**2013**		**2014**		**2015**	
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)**
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)**
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)**
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)**
San Onofre Creek	**0.23**	**(52)**	0	(43)	0	(44)	**0.13**	**(41)**	**0.21**	**(62)**	**0.11**	**(54)**	**0.07**	**(57)**	**0.00**	**(46)**	**0.04**	**(52)**	**0.02**	**(54)**	**0.11**	**(47)**
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)**	**0.04**	**(410)**	**0.07**	**(399)**
Basilone-Roblar Roads	0	(2)	-	-	-	-	-	-	0	(5)	0	(3)	0	(2)	**0.25**	**(4)**	-	-	**0.33**	**(3)**	0	(2)
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)
French Canyon	**0.00**	**(6)**	0	(4)	0	(2)	0	(2)	0	(2)	0	(2)	**0.00**	**(2)**	**0.50**	**(2)**	0	(3)	0	(3)	0	(1)
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)
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)
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)
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)
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)
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)
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)
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)
Horno Canyon	**1.00**	**(1)**	-	-	-	-	-	-	0	(1)	0	(1)	0	(4)	0	(1)	0	(1)	0	(1)	0	(1)
Roblar Creek	-	-	-	-	-	-	-	-	0	(2)	0	(1)	0	(1)	0	(1)	0	(2)	0	(2)	0	(2)
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	(1,009[2])	0.10	(1,059[2])	0.12	(784)	0.07	(636)	0.04	(722[2])	0.04	(634)	0.08	(616[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; 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. As in 2014, vegetation cover in height categories over 4 m was low (< 3%; Fig. 6A) and consisted primarily of burned snags and trees that crown-sprouted after the fire (California sycamore and red or arroyo willow).

From 2014 to 2015, the average live canopy height decreased significantly from 4.4 m to 3.8 m ($t = 1.92$, $P = 0.06$), but the average maximum canopy height (including live and dead vegetation) did not differ between 2014 (6.5 m) and 2015 (6.1 m; $t = 1.27$, $P = 0.20$). Total vegetation cover in the lower height categories increased slightly but significantly from 2014 to 2015 (0-1 m: 5.3%; 1-2 m: 2.1%; 2-3 m: 5.7%; 3-4 m: 5.2%; 4-5 m: 2.1%), and decreased slightly (0.7%) but significantly ($P = 0.09$) in the 7-8 m height category (Fig. 6A). Exotic and herbaceous species comprised more than half of the vegetation cover < 1 m and 25% of the cover between 1 and 2 m. The remaining cover < 2 m consisted mostly of stump-sprouted red and arroyo willow, dead/burned branches, mule fat, and sandbar willow.

A similar wildfire occurred in October 2007 on MCBCP, burning a large section of riparian habitat in Las Flores Creek. At Las Flores Creek, the average burn severity 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 (Ferree et al. 2012b). The pattern of vegetation cover at the Above Hospital site in 2015 was similar to that at Las Flores Creek in 2009, 2 years after the October 2007 wildfires, with the bulk of vegetation occurring below 2 m (Fig. 6B). However, vegetation cover at the Above Hospital site was greater between 2 and 4 m (2-3 m: $t = 5.5$, $P < 0.01$; 3-4 m: $t = 3.2$, $P < 0.01$) and less between 4 and 7 m (4-5 m: $t = 1.8$, $P = 0.07$; 5-6 m: $t = 4.0$, $P < 0.01$, 6-7 m: $t = 3.3$, $P < 0.01$) than at Las Flores Creek.

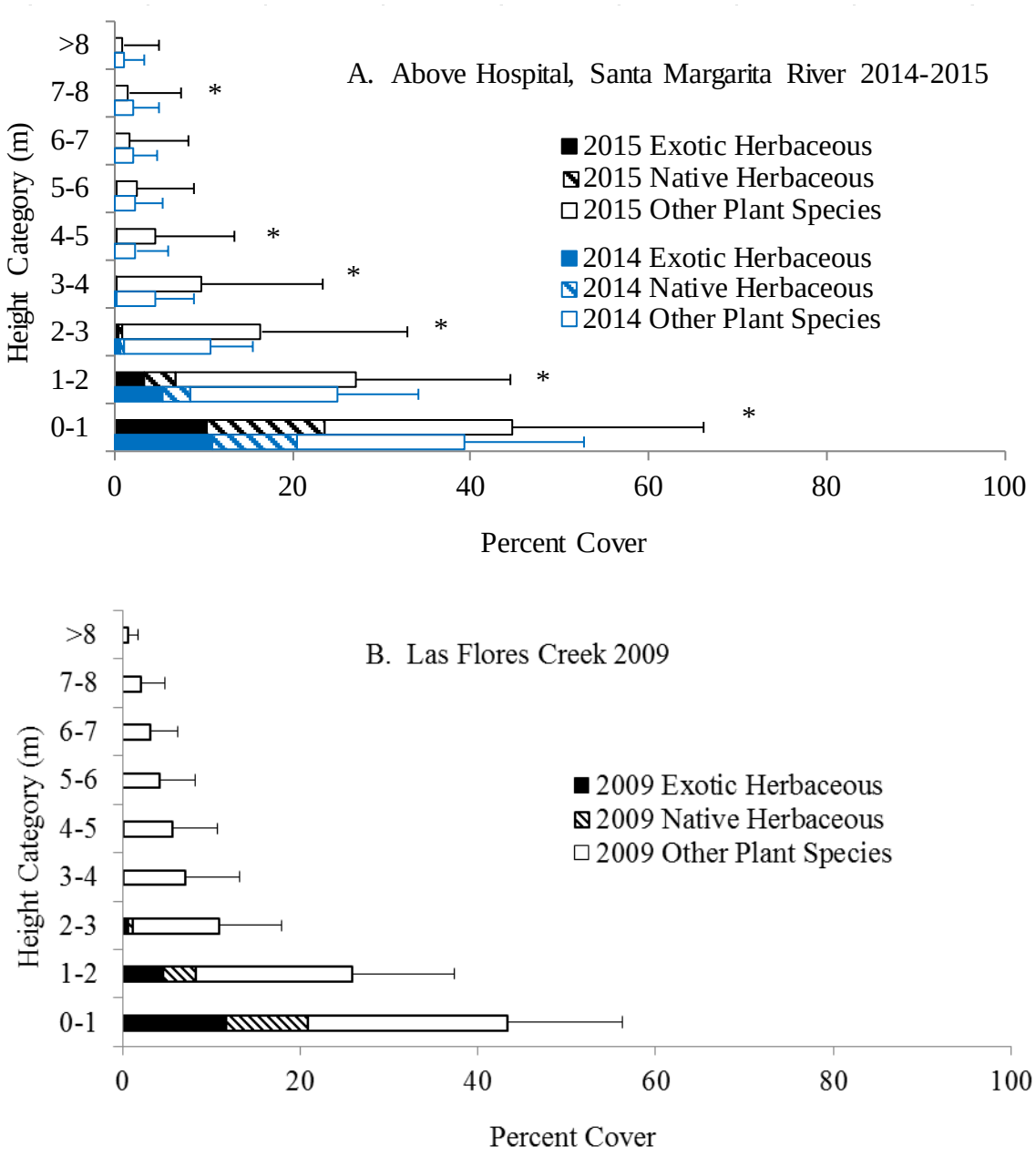

Fig. 6. Average total percent cover by height class (m) and plant type at A. Above Hospital, Santa Margarita River, in 2014 and 2015, 1-2 years after the October 2013 wildfire and B. Las Flores Creek, in 2009, 2 years after the October 2007 wildfire (Ferree et al. 2012b), Marine Corps Base Camp Pendleton. Error bars represent 1 standard deviation. Asterisks (*) indicate statistically significant differences ($P \leq 0.10$, Student's *t*-tests).

Population Density

Of the 621 vireo territories documented in 2015, 54 (9%) were located within the October 2013 wildfire perimeter. Forty-eight territories (8%) were recorded in the same area in 2014, the year after the fire. In 2013, the year just prior to the fire, 59 territories (8%) were recorded within the same area.

Vireo territory density did not differ significantly between Post-fire and Reference sites in all years between 2012 and 2015, except for 2014, when Post-fire sites had significantly fewer vireo territories than Reference sites (Fig. 7).

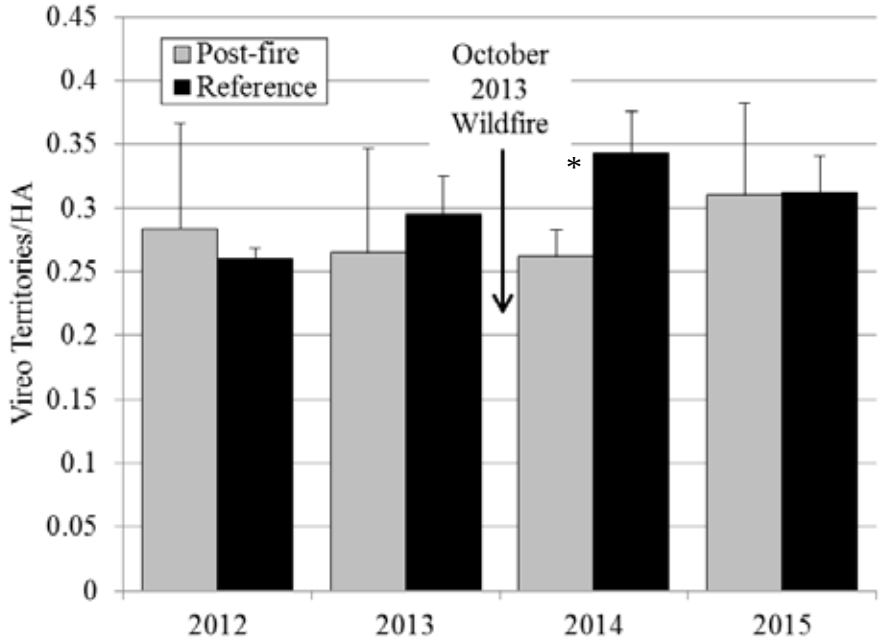

Fig. 7. Annual density of Least Bell's Vireo territories at Post-fire and Reference sites by year, averaged across sites, Marine Corps Base Camp Pendleton, 2012-2015. Error bars represent 1 standard deviation. Asterisks (*) indicate statistically significant differences ($P \leq 0.10$, Student's *t*-tests).

The density of vireo territories in the area that burned in May 2014 remained relatively stable between 2012 and 2014 prior to the wildfire (annual decline of 3-7%) but then declined sharply (by 34%) in 2015, the year after the fire (Fig. 8). In 2015, 95 vireo territories (15%) were located within the May 2014 wildfire perimeter, while in 2013, 168 (23%) of vireo territories were located within the same area.

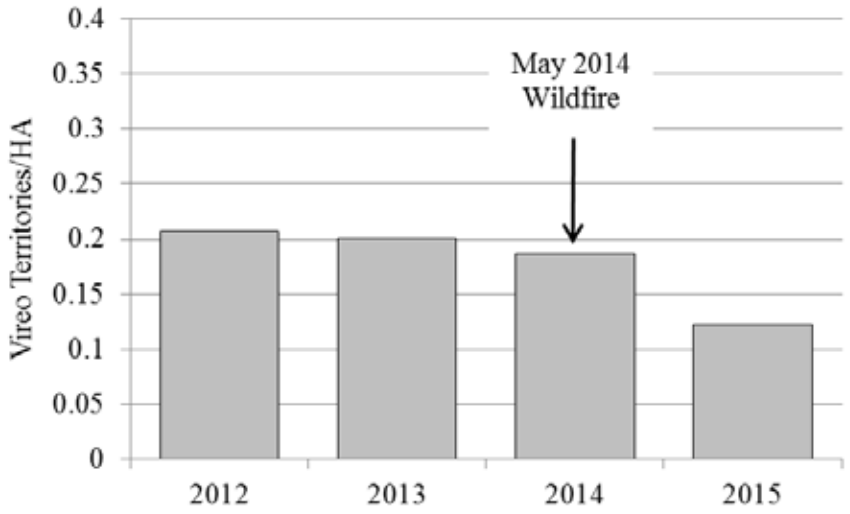

Fig. 8. Annual density of Least Bell's Vireo territories in riparian vegetation within the perimeter of the May 2014 wildfires, Marine Corps Base Camp Pendleton, 2012-2015. The 2014 number includes territories that were established prior to the May 2014 wildfire.

Banded Birds

Returning Banded Birds

We were able to observe 892 adult Least Bell's Vireos (617 males, 93% of all males, and 275 females, 61% of all females) on Base well enough to determine banding status in 2015, although not all banded vireos were observed well enough to conclusively identify the individual. One hundred and eleven of these had been banded prior to the 2015 breeding season, 11 of which we could not identify because band combinations were not confirmed (seven) or because the vireos were banded with only a single numbered metal federal band as nestlings and not recaptured ("natal"; four total; Table 7). Therefore, we were able to identify 100 vireos on Base that were banded with unique color band combinations in 2015 (Table 7, Appendix D). Of these, 82 vireos had been banded on Base and 18 vireos were originally banded off-Base (12 on the San Luis Rey River, Ferree et al. 2011, 2012a, 2013, 2015; and six on MCAS, Lynn et al. 2012, Allen and Kus 2013, 2014; Table 8). Adult birds of known age ranged from 1-9 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 2015.

	Detected on Base[1]			Total on	Emigrants		
Banding Status	**Male**	**Female**	**Unknown Sex**	**Base**	**Male**	**Female**	**Total**
Uniquely banded prior to 2015	66	14	2	82	1	-	83
Natal[2] recaptured in 2015	11	7	-	18	1	-	19
Subtotal of known identity vireos	77	21	2	100	2	-	102
Unidentified (Partial resights)	5	2	-	7	-	-	7
Natal[2], not recaptured	2	2	-	4	-	-	4
Grand total	84	25	2	111	2	-	113

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

Four natal vireos (two males and two females) were resighted on Base in 2015 (Table 7). Three (two males and one female) were banded as nestlings on Base or at MCAS. The fourth natal vireo was banded on the San Luis Rey River. Efforts to recapture and identify these vireos were unsuccessful.

Two vireos that were originally banded on Base (with gold numbered metal federal bands) were detected off-Base in in 2015 (Table 7). One of these, a male that was observed breeding at MCAS in 2015, was last seen nearby on Base in 2013 (Howell and Kus 2015). The other, a male that was banded as a fledgling on Base in 2013, was observed in 2015 on the Santa Ana River in Los Angeles County (J. Pike personal communication).

Table 8. Number of banded adult Least Bell's Vireos at Marine Corps Base Camp Pendleton in 2015, 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		Unknown Site	
Year Originally Banded	Age in 2015	Male	Female	Unk[1]	Male	Female	Male	Female	Male	Total
2006	9 yrs.	0	1	0	0	0	0	0	0	1
2008	7 yrs.	1	1	0	0	0	0	0	0	2
2009	≥ 7 yrs.	0	2	0	0	0	0	0	0	2
2010	≥ 7 yrs.	1	0	0	0	0	0	0	0	1
	≥ 6 yrs.	5	0	0	0	0	0	0	0	5
2011	≥ 5 yrs.	2	0	0	1	0	0	0	0	3
	4 yrs.	1	0	1	1	1	0	0	0	4
2012	≥ 4 yrs.	10	0	0	0	0	0	0	0	10
	3 yrs.	1	3	0	1	0	1	0	0	6
2013	≥ 3 yrs.	8	2	1	0	0	0	0	0	11
	2 yrs.	7	5	0	2	0	3	1	0	18
2014	≥ 2 yrs.	25	4	0	1	0	0	0	0	30
	1 yr.	2	0	0	4	0	0	1	0	7
Subtotal		63	18	2	10	1	4	2	0	100
Unknown[2]	≥ 1 yr.	6	3	0	0	1	0	0	1	11
Total		69	21	2	10	2	4	2	1	111

[1] Vireos of unknown sex were banded at one of two MAPS stations at Marine Corps Base Camp Pendleton and not detected breeding in 2015.

[2] Natal vireos banded with single numbered metal federal band or identity unknown because of inadequate resight, so natal year is not known. Nine 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. One vireo was banded but colors of bands were indeterminable.

New Banded Birds

A total of 210 Least Bell's Vireos were captured and banded for the first time during 2015 (Table 9). These included 24 adult vireos caught for the first time and banded with a unique color combination and 186 hatch-year birds (179 of which were banded as nestlings with a single gold numbered federal band and seven of which were incidentally caught while attempting to target net an adult vireo or at one of the two MAPS stations on Base and given

unique color combinations). 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 2015.

Age Banded	Males	Females	Unknown Sex	Total
Adult	17	5	2	24
Juvenile			7[1]	7
Nestling			179	179
Total	17	5	188	210

[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 2015. 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 2014-2015

Of 158 uniquely color banded adult vireos detected on Base during the 2014 breeding season, 46% (73/158) returned in 2015 (Table 10). Eighteen additional adult vireos identified in 2015 but not detected on Base in 2014 were added to the calculations to yield an adjusted annual survivorship of 52% (91/176; Table 10). Seventy of the 120 adult male vireos known to be alive in 2014 were resighted in 2015, an over-winter survivorship rate of 58%. Nineteen of the 38 adult female vireos known to be alive in 2014 were resighted in 2015, an over-winter survivorship rate of 50%. The remaining 50 males, 19 females, and 16 vireos of unknown sex were not resighted in 2015.

Table 10. Number of banded adult Least Bell's Vireos detected in 2014 at Post-fire sites, Reference sites, and other areas on Marine Corps Base Camp Pendleton, and where those that returned were detected in 2015. Numbers in parentheses include the adjustments resulting from vireos that were identified in 2015 but not in 2014.

	Study Site Name and Type for each Year			
Year / Sex	**Post-fire**	**Reference**	**Other[1]**	**Total**
2014				
Male	21	18	73	112 (120)
Female	5	1	24	30 (38)
Unknown			16	16 (18)
Total	26	19	113	158 (176)
2015				
Male	17[2]	20[3]	25[4]	62 (70)
Female	3[5]	1[6]	7[7]	11 (19)
Unknown				0 (2)
Total	20	21	32	73 (91)

[1] Includes all areas outside of study sites.
[2] Fifteen occupied territories at Post-fire sites in 2014, one occupied a territory in the 2014 Reference site that burned in 2014, and one occupied a territory outside of the monitoring areas in 2014.
[3] Fifteen occupied territories at Reference sites in 2014, three occupied territories in the 2014 Reference site that burned in May 2014, one occupied a 2014 Post-fire site, and one occupied a territory outside of the monitoring areas in 2014.
[4] One occupied a territory at a Post-fire site and the remaining 24 occupied territories outside of the monitoring sites in 2014.
[5] Two occupied territories at Post-fire sites in 2014 and one occupied a territory in the 2014 Reference site that burned in May 2014.
[6] Occupied a territory outside of the monitoring areas in 2014.
[7] All occupied territories outside of the monitoring areas in 2014.

First-year Survivorship from 2014-2015

Of the 96 hatch-year vireos banded in 2014 that survived to fledge, two (both males) were resighted with or captured and given unique color band combinations in 2015 (Table 11). This yields a conservative first-year survivorship of 2% (2/96) (Table 11, Table 12). Assuming an equal sex ratio of banded juveniles, first-year survivorship of males was 4% (2/48) and females was 0% (0/48).

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 2014, and where those that returned were detected in 2015.

	Study Site Name and Type for each Year			
Year/Sex	**Post-fire**	**Reference**	**Other[1]**	**Total**
2014				
Unknown	27	21	48	96
2015				
Male	0		2[2]	2
Total	0	0	2	2

[1] Includes all areas outside of study sites.
[2] One banded as a nestling at a Post-fire site and the other banded as a fledgling at a MAPS station.

Adjusted Annual Survivorship

Eighteen adult banded vireos (eight males, eight females, and two vireos of unknown sex) that were detected in 2015 were not observed in 2014 (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 2009, 2011, 2012, 2013, and 2014 (Table 12).

Table 12. Adjustments to first-year and adult Least Bell's Vireo survivorship on Marine Corps Base Camp Pendleton, 2013. 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.

	First-year Survivorship			Adult Survivorship		
Years	**Original**	**Previous Estimate**	**New**	**Original**	**Previous Estimate**	**New**
2005-2006	10%	16%	-	30%	41%	-
2006-2007	10%	27%	-	63%	76%	-
2007-2008	12%	24%	-	49%	63%	-
2008-2009	10%	15%	16%	53%	61%	-
2009-2010	7%	10%	-	50%	56%	56%
2010-2011	5%	12%	-	27%	40%	41%
2011-2012	10%	15%	-	54%	67%	68%
2012-2013	16%	16%	17%	76%	85%	85%
2013-2014	8%	-	13%	53%	-	57%
2014-2015	-		2%	-	-	52%

Survivorship at Post-fire and References Sites

Of the 26 banded adult vireos of known sex (21 males and 5 females) that were detected within Post-fire sites in 2014, 19 (17 males and 2 females) were resighted in 2015 for a 73%

survival rate (81% for males and 40% for females; Table 10 and Appendix E). Of the 19 banded adult vireos of known sex (18 males and 1 female) that were detected within the 2015 Reference sites in 2014, 15 (all males) were resighted in 2015 for a 79% survival rate (83% for males and 0% for females). Over-winter survival rate did not differ between vireos that occupied Post-fire or Reference sites in 2014 (Fisher's Exact $P = 0.74$).

Forty-eight of the 96 banded juveniles that were known to fledge in 2014 were banded on a Post-fire or Reference site (27 at Post-fire sites and 21 at Reference sites). Of these, one (a male from a Post-fire site) was recaptured on MCBCP and given a unique color band combination in 2015 for an overall first-year survival rate of 4% for fledglings from Post-fire sites and 0% for fledglings from Reference sites (Table 11).

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). Seventy-three adult vireos (62 males, and 11 females) that were identified in 2014 were resighted in 2015, 67 of which occupied known territories both years (61 males and 6 females). The remaining six vireos were detected only during MAPS banding activities and therefore we could not assign them to a territory. The majority of returning adult vireos showed strong between-year site fidelity. Of the 67 returning territorial adults, 44 (all males; 66% of all territorial adults; 72% of males) occupied a breeding site in 2015 that they had defended in 2014 (within 100 m). Six additional vireos (five males and one female; 9% of all vireos, 8% of males and 17% of females) returned to sites adjacent to their previous territories (within 300 m). The average distance moved by returning adult vireos was 0.7 ± 1.9 km (standard deviation (SD); 0.6 ± 1.9 km (SD) for males and 1.5 ± 1.6 km (SD); range 0.4-4.6 km for females).

One first-year vireo that was banded as a nestling in 2014 on MCBCP was resighted in 2015 and occupied a known territory. This male dispersed 1.6 km upstream from his 2014 natal site on the Santa Margarita River. The other first-year vireo detected in 2015 that originated on MCBCP was captured and banded as a fledgling at a MAPS station in 2014 so we could not assign it to a natal territory. Five other first-year vireos that were originally banded as nestlings along the San Luis Rey River (four males) and on MCAS (one female) in 2014 dispersed an average 8.1 ± 6.6 km (SD) to MCBCP.

Site Fidelity and Movement – Post-fire and Reference Sites

Fidelity to Post-fire sites was high as 89% (17/19) of adults seen both years that were detected in Post-fire sites in 2014 were re-detected in Post-fire sites in 2015, although not necessarily in the same Post-fire site. All of the 15 vireos seen both years that were detected at Reference sites in 2014 were re-detected at Reference sites in 2015 (Appendix E). One first-year male vireo detected in 2015 that fledged from a Post-fire site in 2014 returned to occupy a breeding territory outside of the monitoring areas.

Nest Monitoring

Nesting activity was monitored in a total of 54 territories within the Post-fire and Reference monitoring areas (Table 13, 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. A total of 143 nests were monitored during the breeding season; 15 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 13. Number of Least Bell's Vireo territories and nests monitored Post-fire and Reference sites on Marine Corps Base Camp Pendleton, 2015.

	Nest Monitoring Area Type	
	Post-fire	**Reference**
Territories	26	28
Nests (# complete)	67 (63)	76 (65)
Completed nests per pair	2.4 ± 0.9 (SD)	2.4 ± 1.0 (SD)
Total number of nests per pair (includes incomplete nests)	2.6 ± 0.9 (SD)	2.7 ± 1.3 (SD)
Total # of nests monitored	67	76

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 2015 breeding season (Table 13; $t = -0.45$, $P = 0.65$). There was no difference in re-nesting rate after an initial attempt between Post-fire pairs (88%) and Reference pairs (92%; Fisher's Exact $P > 0.99$). Similarly, incidence of re-nesting after a failed first nesting attempt did not differ between Post-fire pairs (84%, 16/19) and Reference pairs (88%, 22/25; Fisher's Exact $P > 0.99$). Re-nesting rate after a successful first nesting attempt also did not differ between Post-fire pairs (100%) and Reference pairs (67%; Fisher's Exact $P = 0.30$). Re-nest rate after a failed first nesting attempt in 2015 was also similar to re-nest rate after a successful first nesting attempt for all pairs combined (Fisher's Exact $P > 0.99$) and also for Post-fire pairs (Fisher's Exact $P = 0.54$) and Reference pairs (Fisher's Exact $P = 0.38$) separately. Overall, 86% (38/44) of vireo pairs attempted to re-nest after a failed first nesting attempt, similar to 2014 (Fig. 13) and 90% (9/10) pairs attempted to re-nest after a successful first nesting attempt, a larger proportion than in 2014 (Fisher's Exact $P = 0.02$). Eleven pairs at Post-fire sites and 15 pairs at Reference sites attempted three or more nests. Three pairs, all at Reference sites initiated four nesting attempts in 2015. One pair at a Reference site initiated five nesting attempts and one pair at a Reference site initiated seven nesting attempts in 2015.

Fig. 9. Locations of monitored Least Bell's Vireo territories at the Below Hospital West Reference site, Marine Corps Base Camp Pendleton, 2015. This was a new Reference site in 2015.

Fig. 10. Locations of monitored Least Bell's Vireo territories at the Below Hospital East Reference site, Marine Corps Base Camp Pendleton, 2015. This has been a Reference site since 2005 and remained a Reference site in 2015.

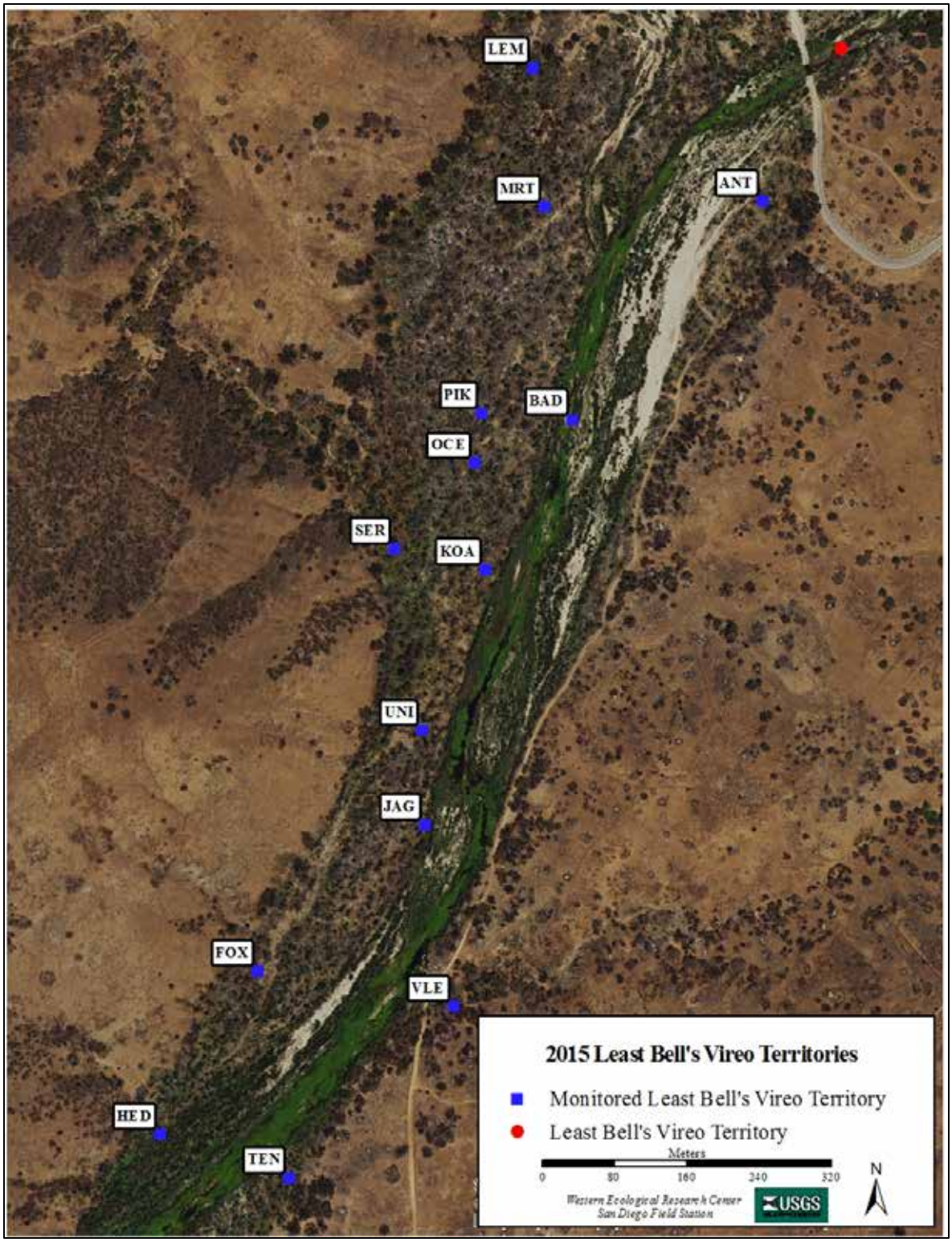

Fig. 11. Locations of monitored Least Bell's Vireo territories at the Above Hospital North Post-fire site, Marine Corps Base Camp Pendleton, 2015.

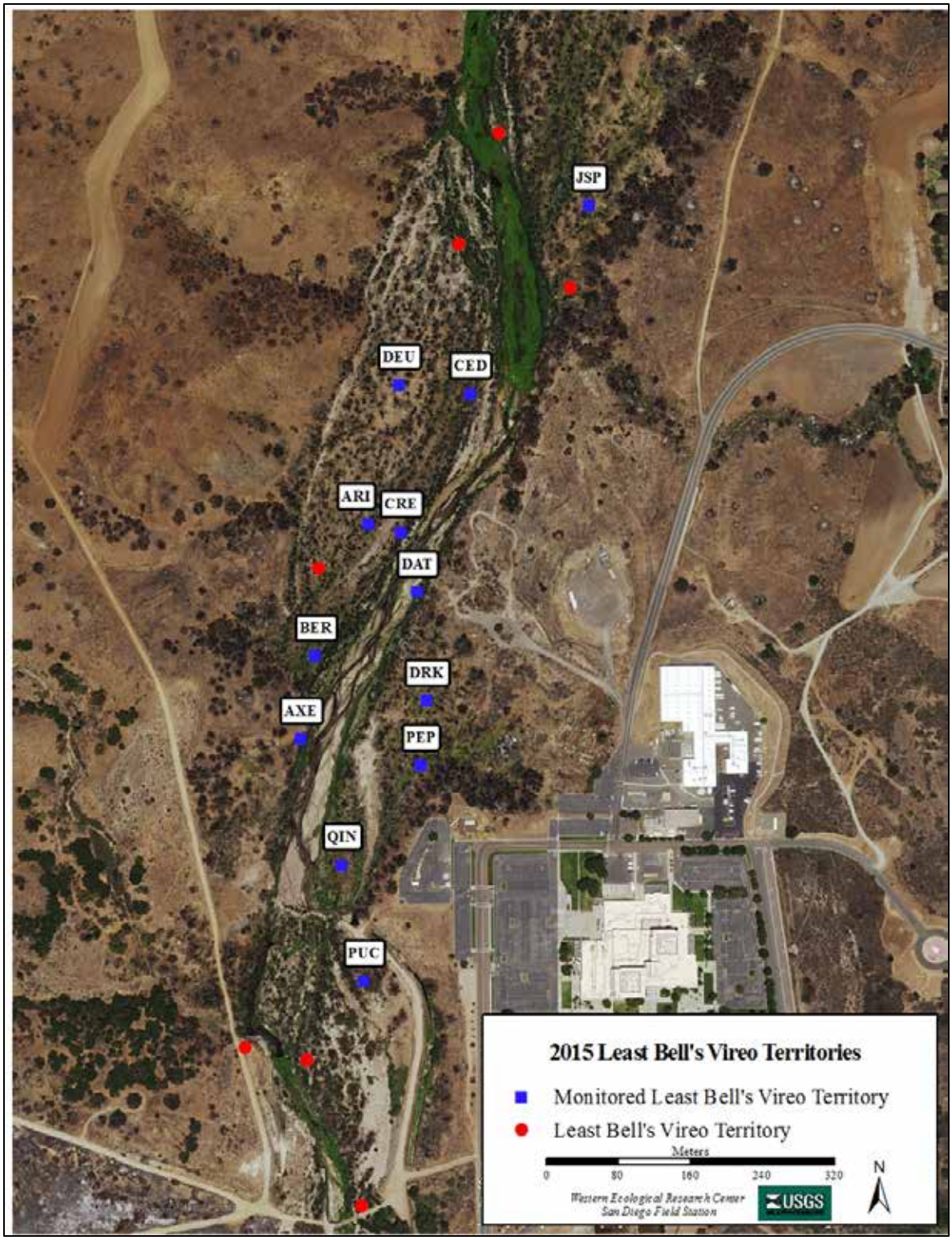

Fig. 12. Locations of monitored Least Bell's Vireo territories at the Above Hospital South Post-fire site, Marine Corps Base Camp Pendleton, 2015. This was a Reference site from 2005 until 2013, when it burned in the October 2013 wildfire.

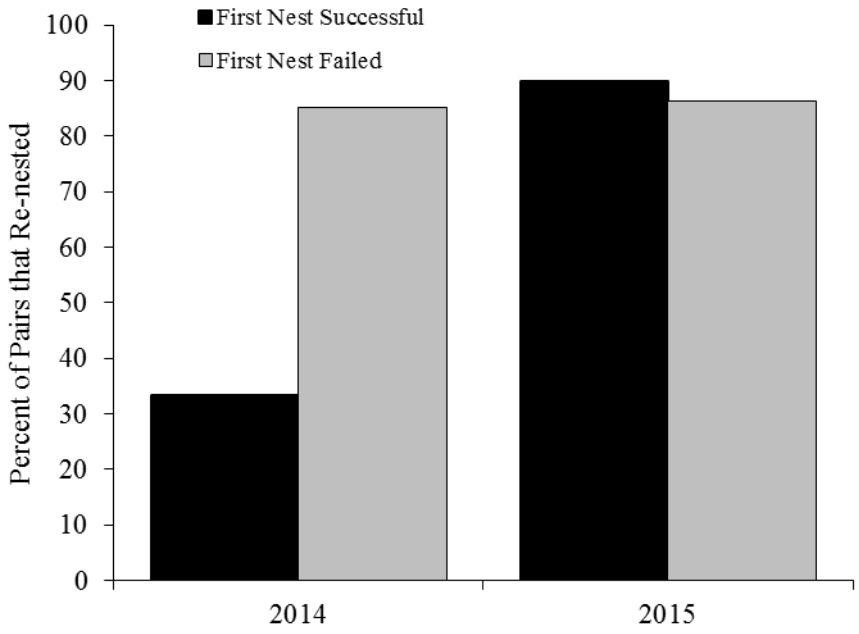

Fig. 13. Percent of Least Bell's Vireo pairs that re-nested after a successful or failed first nesting attempt at Post-fire and Reference sites, Marine Corps Base Camp Pendleton, 2014-2015.

Nest Success

Completed nests in Post-fire sites were as likely to be successful as completed nests in Reference sites ($\chi^2 = 0.02$, $P = 0.90$), as 33% (21/63) of nests in Post-fire sites successfully fledged young and 32% (21/65) of those in Reference sites successfully fledged young (Table 14). First nesting attempts were also as likely to be successful at Post-fire sites (27%) as at Reference sites (11%; Fisher's Exact $P = 0.17$) in 2015. Overall, 19% of first nesting attempts were successful in 2015.

Table 14. Fate of completed Least Bell's Vireo nests in fully monitored territories at Post-fire and Reference sites, Marine Corps Base Camp Pendleton, 2015. Numbers in parentheses are proportions of total nests.

	Number of Nests		
Nest Fate	**Post-fire**	**Reference**	**Total**
Successful	21	21	42 (0.33)
Failed			
Predation	35	28	63 (0.49)
Parasitism	0	0	0 (0.00)
Other/Unknown	7	16	23 (0.18)
Total Completed Nests	63	65	128 (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 14). Nest failure was probably caused by ant predation for at least one nest at a Post-fire site (Appendix F). Predation accounted for 83% (35/42) of nest failures at Post-fire sites and 64% (28/44) of nest failures at Reference sites. We documented 23 nests that failed for other known and unknown reasons at our monitoring sites. One nest failed when the host plant collapsed. Three nests likely failed as the result of a rain storm. Thirteen nests failed between nest-building and egg-laying from unknown causes. At two other nests, eggs were likely infertile and did not hatch. Three nests were abandoned with eggs and one nest was abandoned with nestlings for unknown reasons. Overall, 67% and 68% of completed vireo nests at Post-fire and References sites, respectively, were lost to predation or other causes.

Cowbird Parasitism

No nest parasitism of Least Bell's Vireos by Brown-headed Cowbirds was documented in 2015.

Productivity

Clutch size was significantly greater at Post-fire sites than at Reference sites (Table 15). Measures of hatching and fledging success were similar at Post-fire and Reference sites. Productivity per pair did not significantly differ between Post-fire and Reference sites (2.2 versus

2.0 young fledged per pair, respectively; Table 15). Fifty-eight percent of pairs at Post-fire sites and 64% of pairs at Reference sites were ultimately successful in fledging young from at least one nest. Six pairs at Post-fire sites and three pairs at Reference sites successfully double-brooded during the 2015 breeding season. Vireo pairs at Post-fire and Reference sites combined fledged 2.1 vireo young per pair, and 61% of monitored pairs were successful in fledging at least one young in 2015.

Table 15. Reproductive success and productivity of nesting Least Bell's Vireos at Post-fire and Reference sites, Marine Corps Base Camp Pendleton, 2015.

Parameter	Post-fire Sites	Reference Sites	Total
Nests with eggs	58	54	112
Eggs laid	187	161	348
Average clutch size[1]	3.4 ± 0.6 (SD)	3.2 ± 0.5 (SD)	3.3 ± 0.6 (SD)
Hatchlings	114	101	215
Nests with hatchlings	37	36	73
Hatching success:			
Eggs[2]	61%	63%	62%
Nests[3]	64%	67%	65%
Fledglings	57	57	114
Nests with fledglings	21	21	42
Fledging success:			
Hatchlings[4]	50%	56%	53%
Nests[5]	57%	58%	58%
Fledglings per egg	0.3	0.4	0.3
Fledglings per nest	1.0	1.1	1.0
Average number of young fledged per pair[6]	2.2 ± 2.3 (SD)	2.0 ± 1.8 (SD)	2.1 ± 2.0 (SD)
Pairs fledging ≥ 1 young	15 (58%)	18 (64%)	33 (61%)

[1] Based on 49 Post-fire and 45 Reference non-parasitized nests with a full clutch (t = 1.81; P = 0.07).
[2] Percent of all eggs that hatched.
[3] Percent of all nests with eggs in which at least one egg hatched.
[4] Percent of all nestlings that fledged.
[5] Percent of all nests with nestlings in which at least one young fledged.
[6] Based on 26 Post-fire and 28 Reference pairs (t = 0.28, P = 0.78).

Nest Characteristics

Least Bell's Vireos used 14 plant species for nesting at Post-fire and Reference sites in 2015, although not all were used within each treatment (Table 16). Vireos used ten species at Post-fire sites and ten species at Reference sites. Sixty-two percent of all nests (52% at Post-fire

sites, and 70% at Reference sites) were placed in arroyo willow, mule fat, or wild grape (*Vitus* sp.). Seven vireo nests were built in an exotic plant species (six in black mustard and one in poison hemlock). All seven of the nests that were built in exotic vegetation were located in the Post-fire sites.

Table 16. Host plant species used by Least Bell's Vireos at Post-fire and Reference sites, Marine Corps Base Camp Pendleton, 2015. Numbers in parentheses are proportions of total nests within treatment types.

	Number of Nests	
Host Species	**Post-fire**	**Reference**
Arroyo or red willow	18 (0.27)	35 (0.46)
Mule fat	9 (0.13)	11 (0.14)
Wild grape	8 (0.12)	7 (0.09)
Sandbar willow	3 (0.04)	9 (0.12)
California sycamore	8 (0.12)	2 (0.03)
Blue elderberry (*Sambucus nigra*)	7 (0.10)	-
Mugwort (*Artemisia douglasiana*)	6 (0.09)	1 (0.01)
Black mustard	6 (0.09)	-
Poison oak (*Toxicodendron diversilobum*)	-	6 (0.08)
California blackberry (*Rubus ursinus*)	-	2 (0.03)
Coyotebrush (*Baccharis pilularis*)	-	2 (0.03)
Poison hemlock	1 (0.01)	-
Wild rose (*Rosa californica*)	1 (0.01)	-
Black willow	-	1 (0.01)

In 2015, nest placement characteristics did not differ between successful and unsuccessful nests at Post-fire sites or at Reference sites (Table 17). However, vireo nests at Post-fire sites were placed lower in the host plant than those at Reference sites.

Table 17. 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, 2015.

	Nest Fate				
Nest Characteristic	**Successful**	**Unsuccessful**	***n*[1]**	***t*[2]**	***P*[3]**
Post-fire Site					
Average nest height (m)	0.71	0.69	21, 46	0.29	0.78
Average host height (m)	2.60	2.65	21, 46	-0.12	0.91
Average distance to edge of host (m)	0.60	0.50	21, 46	0.82	0.42
Average distance to edge of clump (m)	1.37	1.19	21, 46	0.96	0.35
Reference Site					
Average nest height (m)	0.84	0.86	21, 55	-0.44	0.66
Average host height (m)	3.00	2.88	21, 55	0.25	0.80
Average distance to edge of host (m)	0.61	0.59	21, 55	0.11	0.91
Average distance to edge of clump (m)	1.44	1.20	21, 55	1.04	0.30
Post-fire and Reference Sites	**Post-fire**	**Reference**	***n*[4]**	***t*[2]**	***P*[3]**
Average nest height (m)	0.70	0.85	67, 76	-4.92	< **0.01**
Average host height (m)	2.63	2.91	67, 76	-0.93	0.35
Average distance to edge of host (m)	0.53	0.60	67, 76	-0.82	0.42
Average distance to edge of clump (m)	1.25	1.27	67, 76	-0.14	0.89

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

DISCUSSION

Least Bell's Vireo numbers have fluctuated over the past several years, manifested relatively consistently across several study areas in San Diego County including MCBCP, the San Luis Rey River, the San Diego River, MCAS, and the Sweetwater Reservoir. 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 again in 2015 (Allen and Kus 2013, 2014; 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). Doubtless, local management for vireos 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. However, recent declines in the vireo population region-wide are likely largely attributable to drought conditions that have persisted on the breeding grounds for the past 4 years. San Diego County has been experiencing a drought since 2012, with precipitation for each bio-year (1 July–30 June) since July 2011 totaling < 75% of average precipitation between 2002 and 2010 (OWR 2015). Low

precipitation compromises primary productivity and, consequently, arthropod abundance and the wildlife (i.e., vireos) that depends on them.

In 2015, the number of documented Least Bell's Vireo territories (621) on MCBCP dropped by 2% from 2014 and constituted the lowest number of vireo territories on MCBCP since 1993. This recent decline is consistent with populations elsewhere in San Diego County where vireo populations also decreased slightly from 2014 to 2015. Vireo populations decreased slightly from 2014 to 2015 on the lower San Luis Rey River (5%; Houston et al. 2015), decreased on the middle San Luis Rey River (15%; Houston et al. 2015), and decreased at MCAS (6%; Howell and Kus 2015). The population decrease on MCBCP is likely influenced by low breeding success in 2014 and subsequently low recruitment of young vireos into the breeding population in 2015. We banded 141 nestlings (96 of which fledged) and seven juveniles in 2014; only two returned to establish territories in 2015. This is the lowest juvenile survivorship documented since we began banding nestlings in 2005. Breeding productivity was undoubtedly adversely affected by the cumulative effect of 4 years of drought. The return of adults and recruitment of young birds to MCBCP was probably affected by a combination of drought and the destruction of vireo habitat by wildfires in May 2014.

In addition to causing slower and less vigorous plant growth, drought conditions also decrease the overall health of plants, causing increased plant death and desiccation and therefore exacerbating the risk of wildfire. Wildfires in riparian habitat have the potential to negatively affect vireos in the short-term with destruction of breeding habitat; however, with adequate precipitation, this negative effect should diminish with the recovery of early successional vegetation attractive to breeding vireos. The October 2013 wildfire burned a substantial section of De Luz Creek and Santa Margarita River vireo habitat after vireos had migrated south and were therefore not present when the wildfires occurred. Vegetation in these areas began re-sprouting immediately after the onset of winter precipitation, even though precipitation was below average for the third year in a row. In the breeding season immediately following the fall wildfires, vireos re-established territories and had similar breeding productivity at the Post-fire sites compared to the Reference sites, a pattern that continued into 2015. Conversely, the May 2014 wildfire on MCBCP had an immediate negative effect on vireos as territorial individuals were displaced or died and nests were destroyed. The timing of this wildfire (during the spring) may have long-term effects on the recovery of riparian vegetation and subsequent re-colonization by breeding vireos. Vireo territory density during the 2015 breeding season in areas burned by the May 2014 wildfire decreased by 34% from territory density before the wildfire. The difference in occupancy by vireos following the 2013 and 2014 fires may result from poor recovery of vegetation after the spring wildfires (i.e., there was a longer stretch of time between the wildfires and the onset of winter precipitation, trees were damaged or destroyed during their peak reproductive season) so that habitat was inadequate to support similar numbers of breeding vireos the year following the fire. Alternatively (or additionally), vireos that survived the spring wildfires were displaced from the burned areas and likely established territories elsewhere. Vireos display strong site fidelity, and therefore, these vireos likely returned to their newly established, unburned territories instead of re-occupying their old, burned territories. Corroborating this assertion, three of the six drainages that burned in the May 2014 wildfire showed an increase in vireo territories between 2014 and 2015, but all of the new territories were established outside of the fire perimeter. In future years, if the vegetation that burned in the

spring wildfires recovers adequately and vireo populations begin to expand, we expect to see more vireos establishing territories in these unoccupied burned areas.

Vegetation recovery at the Post-fire sites has shown a similar pattern to vegetation recovery at Las Flores Creek following wildfires in October 2007. Of interest, however, the average live canopy height in the Post-fire sites decreased between 2014 and 2015. Biologically this difference was small (< 1 m decrease); however, it may be a result of natural post-fire processes. At our Post-fire sites, the species composition in the taller height categories changed between 2014 and 2015: missing in 2015 were live grape, live white alder (*Alnus rhombifolia*), live Fremont cottonwood, and live California walnut (*Juglans californica*). Observer variability may account for some of this difference (some of these species may have been missed or lumped in to the unknown tree species category) but the area may also be experiencing delayed death of trees that were weakened during the wildfire and were not able to thrive under drought conditions. Similarly, the number of standing, burned snags likely declined as they succumbed to the forces of wind, rainfall, and gravity.

There was no difference in vireo territory density between Post-fire sites and Reference sites in 2015. This suggests that vegetation recovered quickly in the Post-fire sites to a structure comparable to the Reference sites and also comparable to the Post-fire sites before the fall wildfires. Vireo habitat recovery in the Post-fire sites is supported by our vegetation sampling results, which show that vegetation volume increased over the past two winters in the understory (below 2 m), an important element of vireo breeding habitat and where they place their nests. Interestingly, the only difference in vireo nest placement that we found was that vireos placed their nests significantly lower at Post-fire sites than at Reference sites, even though host plant height did not differ between the sites. This suggests that the height of the vegetation is less important than the volume of vegetation to nesting vireos.

As in past years, adult males and females showed strong fidelity to their breeding territories in our monitoring sites, holding the same territories for several years in a row. This continued in 2015 at the Post-fire sites and the Reference sites.

Also as in past years, in 2015 we detected vireos (19) that originated outside of MCBCP holding territories on drainages on MCBCP. Conversely, in 2015 we found only two vireos that hatched on MCBCP and bred off-Base, one at MCAS and one on the Santa Ana River in Los Angeles County, both of which were last detected in 2013. These movements demonstrate the ability of vireos to disperse well beyond their natal drainages. Further banding and resighting of vireos within southern California continues to increase our understanding of the extent of movement between populations and the role such movements play in maintaining genetic diversity and persistence in these populations. Continued monitoring of cohorts banded as nestlings provides the opportunity to collect 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.

Breeding productivity was similar between Post-fire and Reference sites in 2015, and improved in 2015 over 2014 in both Post-fire and Reference sites. The percent of nests that successfully fledged increased from 21% to 33% at Post-fire sites and from 23% to 32% at

Reference sites. Similarly, the number of fledglings per pair at Post-fire sites increased from 1.2 to 2.2, and at Reference sites, the number of fledglings per pair increased from 1.5 to 2.0. The difference in breeding productivity between 2014 and 2015 was most evident in the hatching stage. At Post-fire sites, the number of nests with eggs that hatched increased from 41% to 64%, and the number of eggs that hatched increased from 43% to 61%. Similarly, at Reference sites hatching success of nests increased from 53% to 67% and hatching success of eggs increased from 50% to 63% from 2014 to 2015. Once a nest had made it to the nestling stage, the percent that fledged stayed relatively constant from 2014 to 2015 at both Post-fire and Reference sites (53% to 58%). The overall improvement in breeding productivity between 2014 and 2015 may be a direct response to precipitation. The lowest recorded precipitation accumulation since the 1999–2000 bio-year was in the 2013-2014 bio-year, when vireo breeding productivity was at its lowest. Low annual precipitation translates to low primary productivity and a corresponding dearth of prey for vireos. Without an adequate prey-base, vireos in 2014 were likely unable to amass sufficient energy reserves to provide for their offspring. Survivorship of adult vireos may also have been compromised by reduced prey availability in 2014. However, in 2015, San Diego County experienced several unseasonal rainfall events during the vireo breeding season. Precipitation was higher than average in May, June, and July and vireos likely were able to profit from increased insect abundance as a result of these precipitation events.

In 2014, a relatively large number of nest failures at the Post-fire site (6 of 38) were a result of host plant collapse. These failed nests were built in poison hemlock, an exotic annual that typically is one of the first early successional plants to colonize a burned or disturbed site. Vireos frequently place their nests in tall annuals such as mustard and poison hemlock when native plants such as willow and mule fat are not available. During dry years, these exotic annuals typically desiccate as the season progresses and break or tip over under the weight of a nest with eggs or nestlings. In 2014, 11 of 55 nests were placed in poison hemlock or black mustard in the Post-fire sites. Of 67 nests in 2015, only one nest was placed in poison hemlock and six nests were placed in black mustard at these sites. None of these nests failed as a result of host plant collapse. As expected, more nests in Post-fire sites in 2015 were placed in woody host species, including stump-sprouting arroyo willow, mule fat, and sandbar willow. There was not a significant decrease in the volume of exotic herbaceous plants below 2m at the Post-fire sites; however, other plants (all non-herbaceous vegetation) increased in volume, even if only by 2.5%, providing incrementally more structurally sound options for vireo nest placement.

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 42%. The increasing pattern 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 no cowbird parasitism documented on MCBCP during 2015. 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. Ultimately, the recent fluctuations in the vireo population may be a consequence of a variety of interacting factors including wildfire (affecting apparent population size and distribution), drought (affecting breeding productivity), and the inherent carrying capacity of the current habitat (whether breeding, migratory, or wintering). These three factors are difficult to parse and their additive effects place the vireo population in a position vulnerable to future decline.

As noted in 2014, 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. 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. Reproducing 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. 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.

The timing of wildfires may also drive the planning process for vireo habitat restoration. It is evident that the wildfires that burned vireo habitat in May had a more lasting, negative effect on vireos than previous fires that occurred in the Fall. In 2015, 1 year after the fire, vireo occupancy of areas that burned in May 2014 was drastically reduced compared to the overall vireo population on Base. It remains to be seen whether this was driven by poor recovery of vireo habitat or by displaced vireos finding new territories and therefore not returning to their old, burned areas. Over time, if the vegetation in the areas burned during the spring wildfires recovers adequately, we should see dispersing vireos re-colonizing these areas.

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. Direct human impacts to vireo habitat were not documented in 2015, 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, 2015

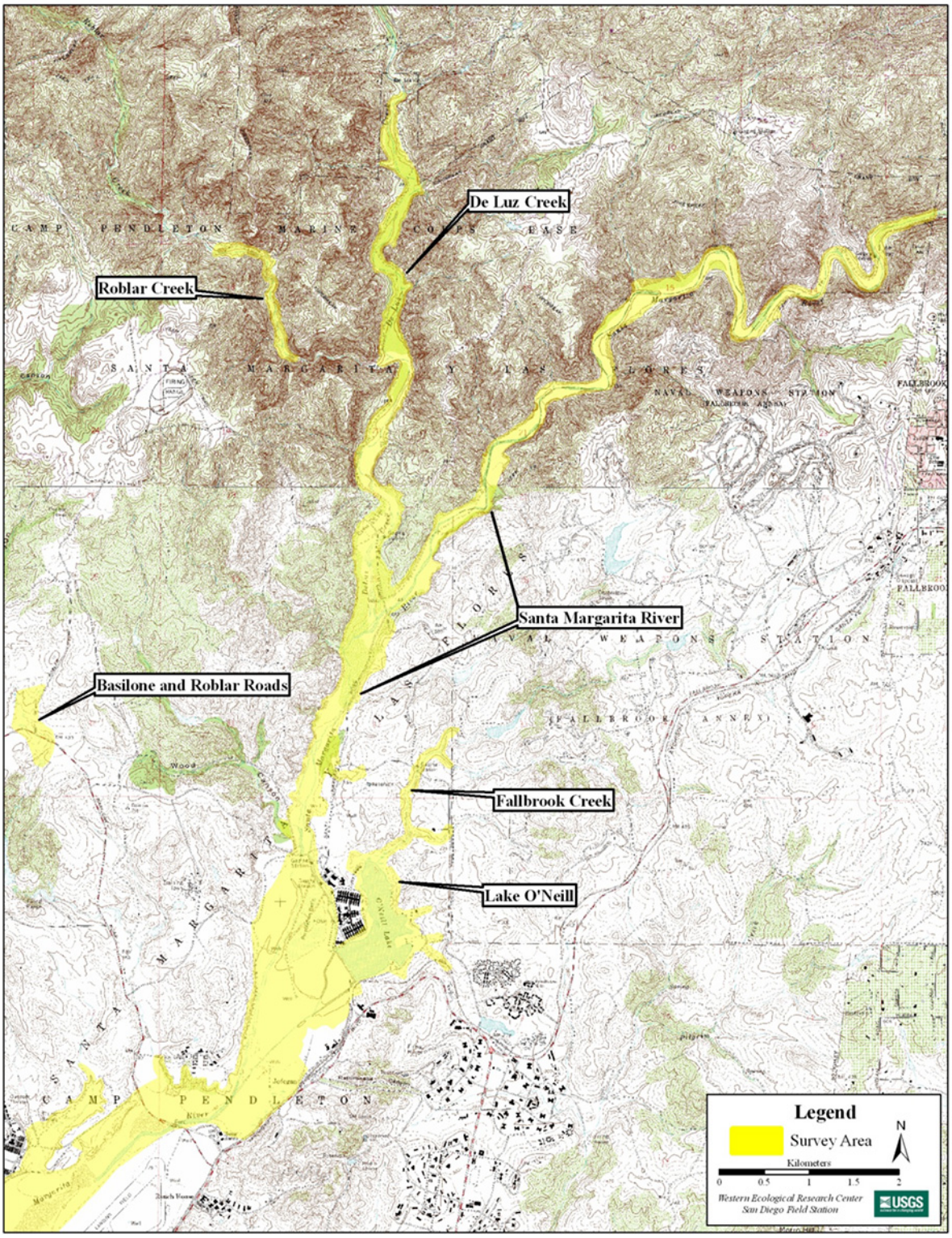


Fig. 14. Least Bell's Vireo survey areas at Marine Corps Base Camp Pendleton, 2015: Upper Santa Margarita River, Fallbrook Creek, Lake O'Neill, De Luz Creek, Roblar Creek, and Basilone and Roblar Roads.

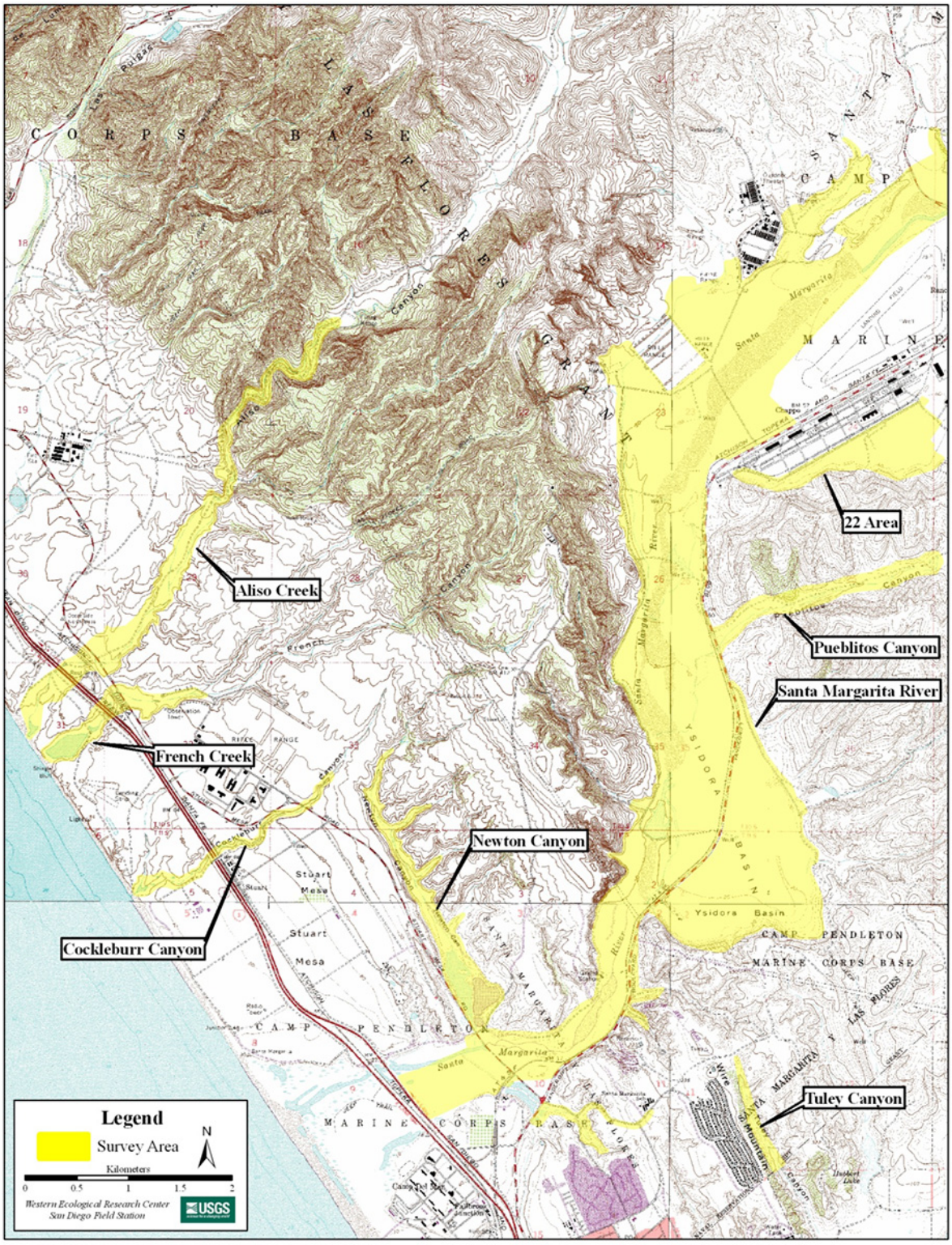


Fig. 15. Least Bell's Vireo survey areas at Marine Corps Base Camp Pendleton, 2015: Lower Santa Margarita River, 22 Area, Pueblitos Canyon, Tuley Canyon, Newton Canyon, Cockleburr Canyon, French Creek, and Aliso Creek.

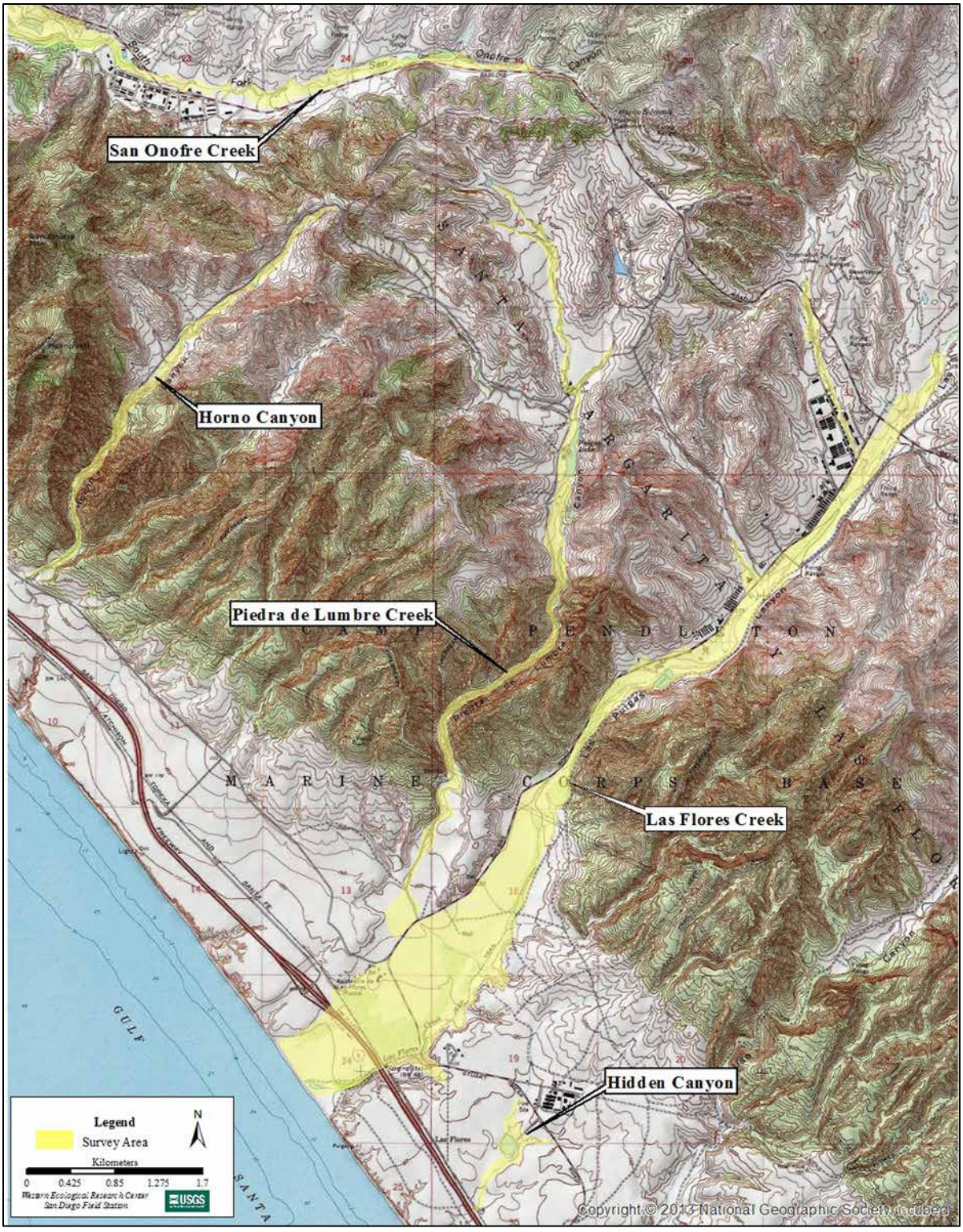


Fig. 16. Least Bell's Vireo survey areas at Marine Corps Base Camp Pendleton, 2015: San Onofre Creek South Fork, Ammunition Supply Point, Horno Canyon, Piedra de Lumbre Creek, Las Flores Creek, and Hidden Canyon.

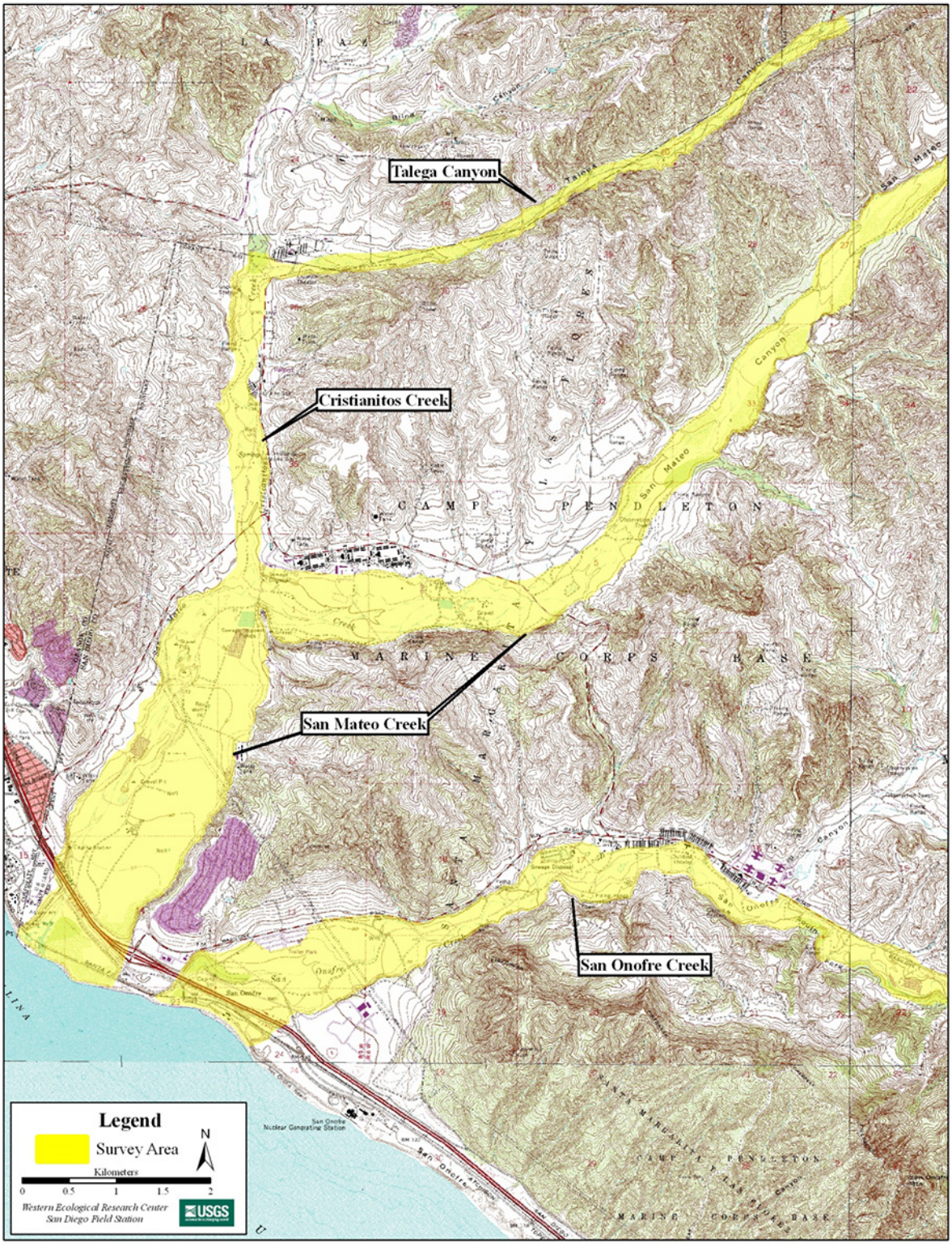


Fig. 17. Least Bell's Vireo survey areas at Marine Corps Base Camp Pendleton, 2015: Talega Canyon, Cristianitos Creek, San Mateo Creek, and San Onofre Creek.

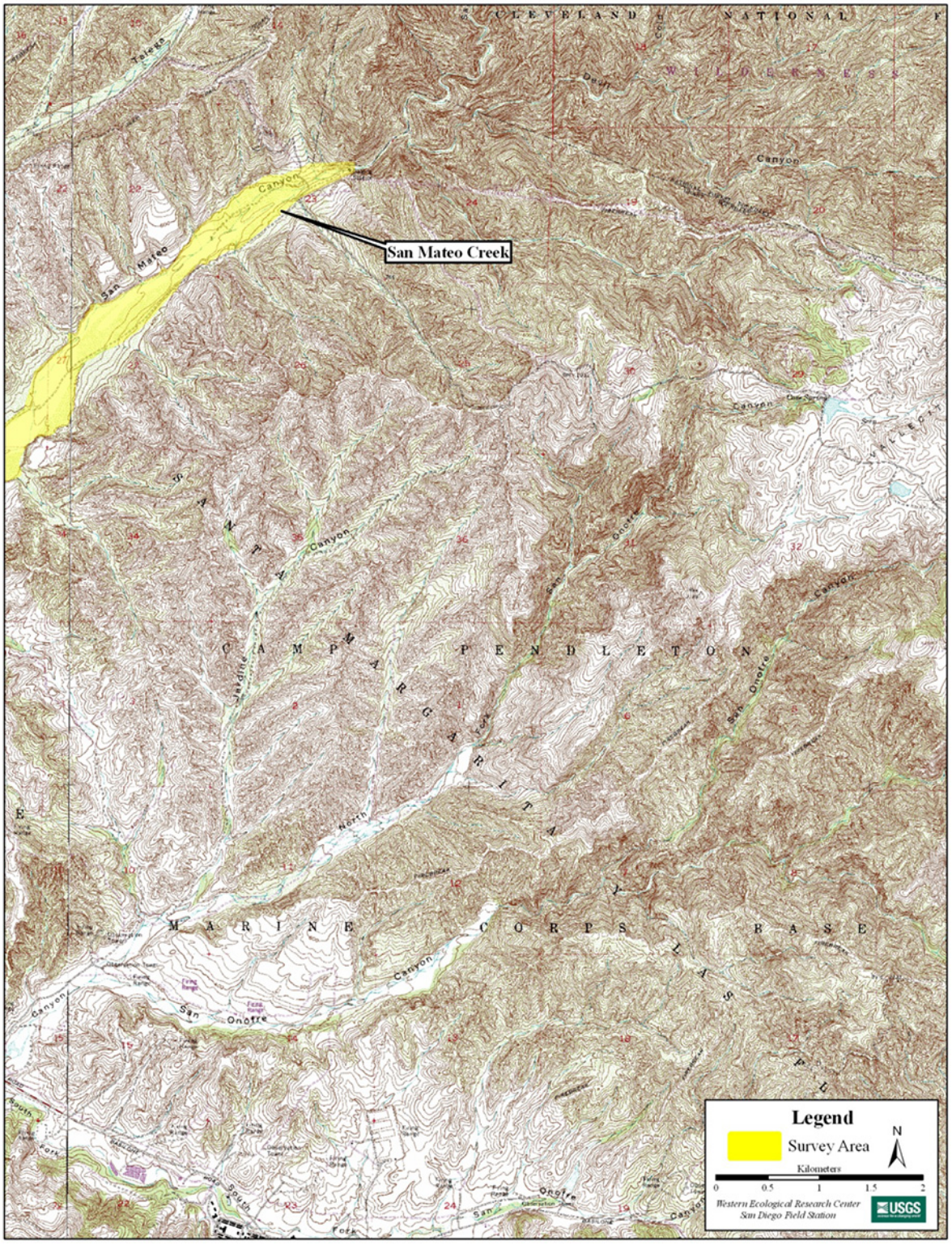


Fig. 18. Least Bell's Vireo survey areas at Marine Corps Base Camp Pendleton, 2015: Upper San Mateo Creek.

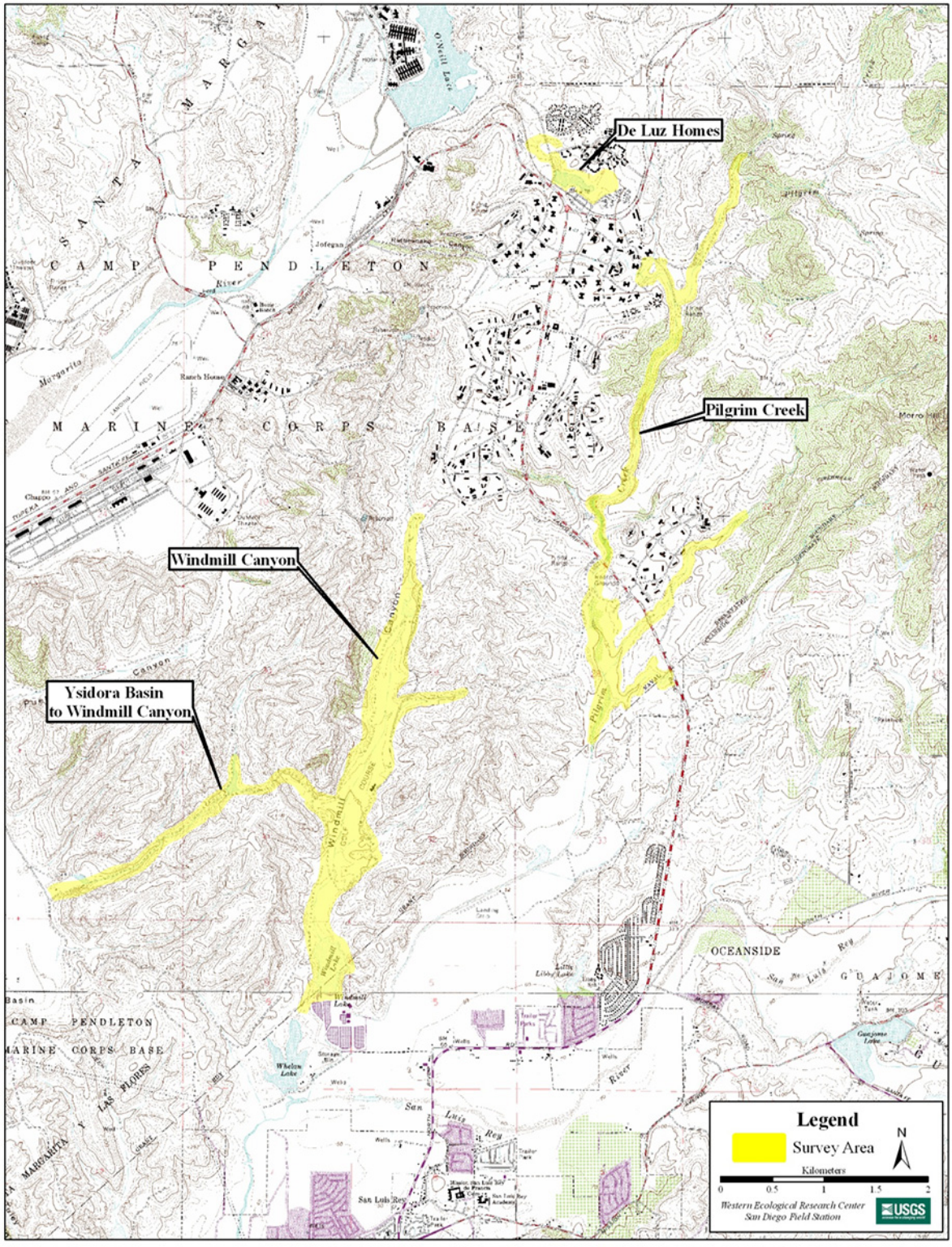
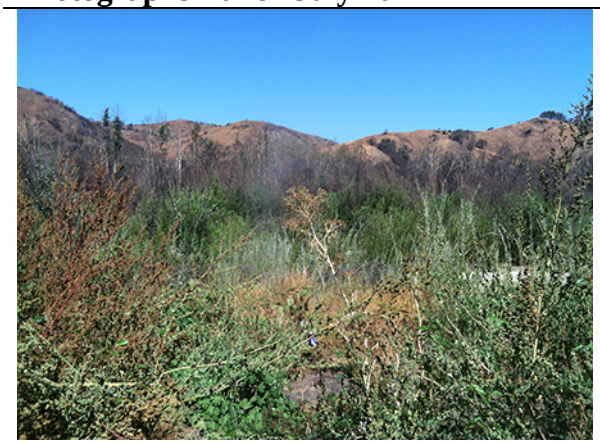


Fig. 19. Least Bell's Vireo survey areas at Marine Corps Base Camp Pendleton, 2015: Windmill Canyon, Ysidora Basin to Windmill Canyon, Pilgrim Creek, and De Luz Homes Habitat.

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 August 2015, Marine Corps Base Camp Pendleton. All photographs in July 2014 were taken by L. Allen. Photographs from August 2015 were taken by Thomas Dayton, P.J. Falatek, Jennifer Jacobs, Angela Johnson, Devin Taylor, and Charlie Vettes.

Photographs Taken July 2014	Photographs Taken August 2015
	
Transect 1	
	
Transect 2	
	
Transect 3	

Photographs Taken July 2014	Photographs Taken August 2015
	
Transect 4	
	
Transect 5	
	
Transect 6	

Photographs Taken July 2014	Photographs Taken August 2015
	
Transect 7	
	
Transect 8	

Photographs Taken July 2014	Photographs Taken August 2015
	
Transect 9	
	
Transect 10	

Photographs Taken July 2014	Photographs Taken August 2015
	
Transect 11	
	
Transect 12	
	
Transect 13	J. Jacobs depicted

Photographs Taken July 2014	Photographs Taken August 2015
	
Transect 14	
	
Transect 15	

Photographs Taken July 2014	Photographs Taken August 2015
	
Transect 16	
	
Transect 17	

Photographs Taken July 2014	Photographs Taken August 2015
	
Transect 18	
	
Transect 19	

Photographs Taken July 2014	Photographs Taken August 2015
	
Transect 20	
	
Transect 21	

Photographs Taken July 2014	Photographs Taken August 2015
	
Transect 22	
	
Transect 23	
	
Transect 24	

Appendix C. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2015

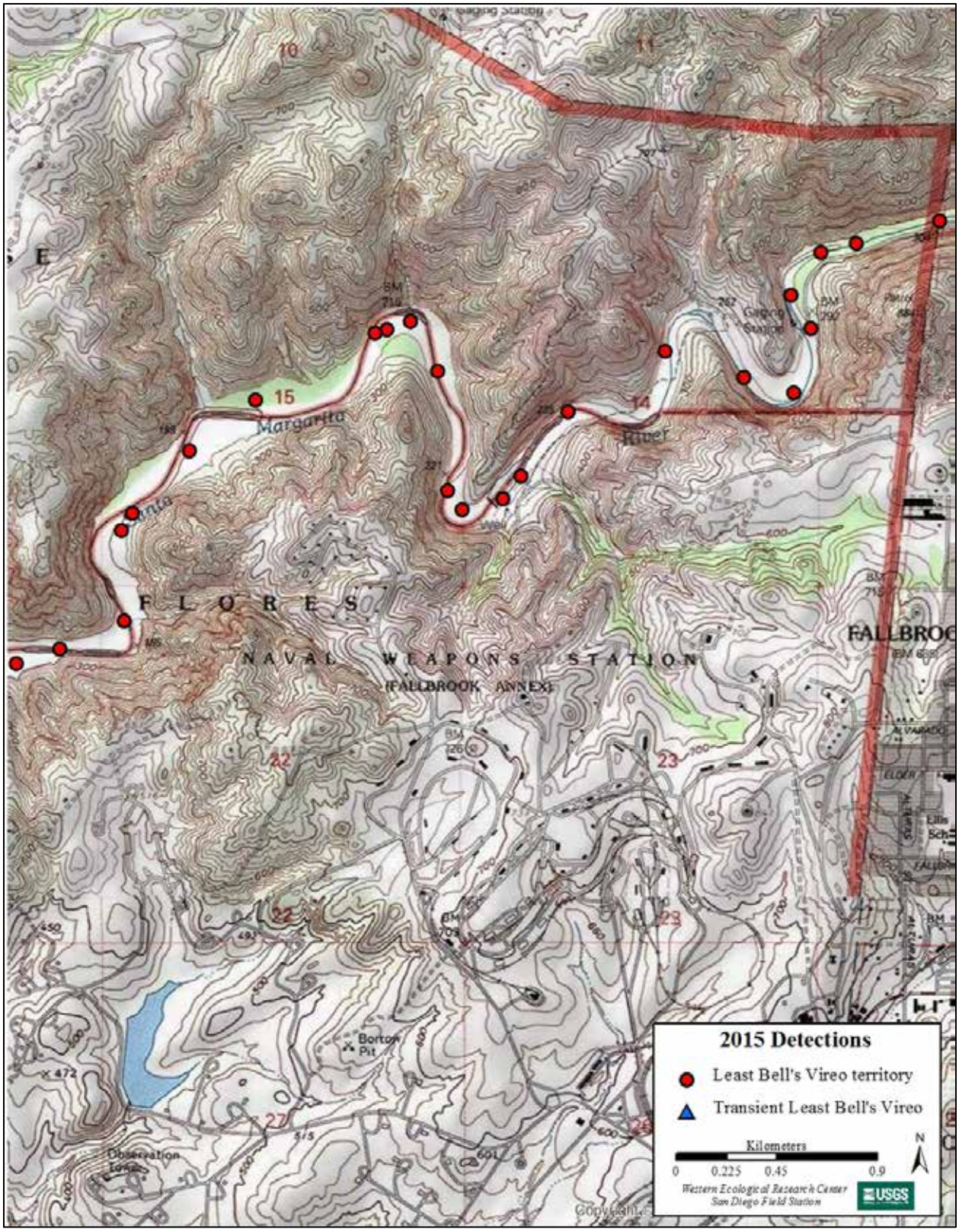


Fig. 20. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2015: Upper Santa Margarita River.

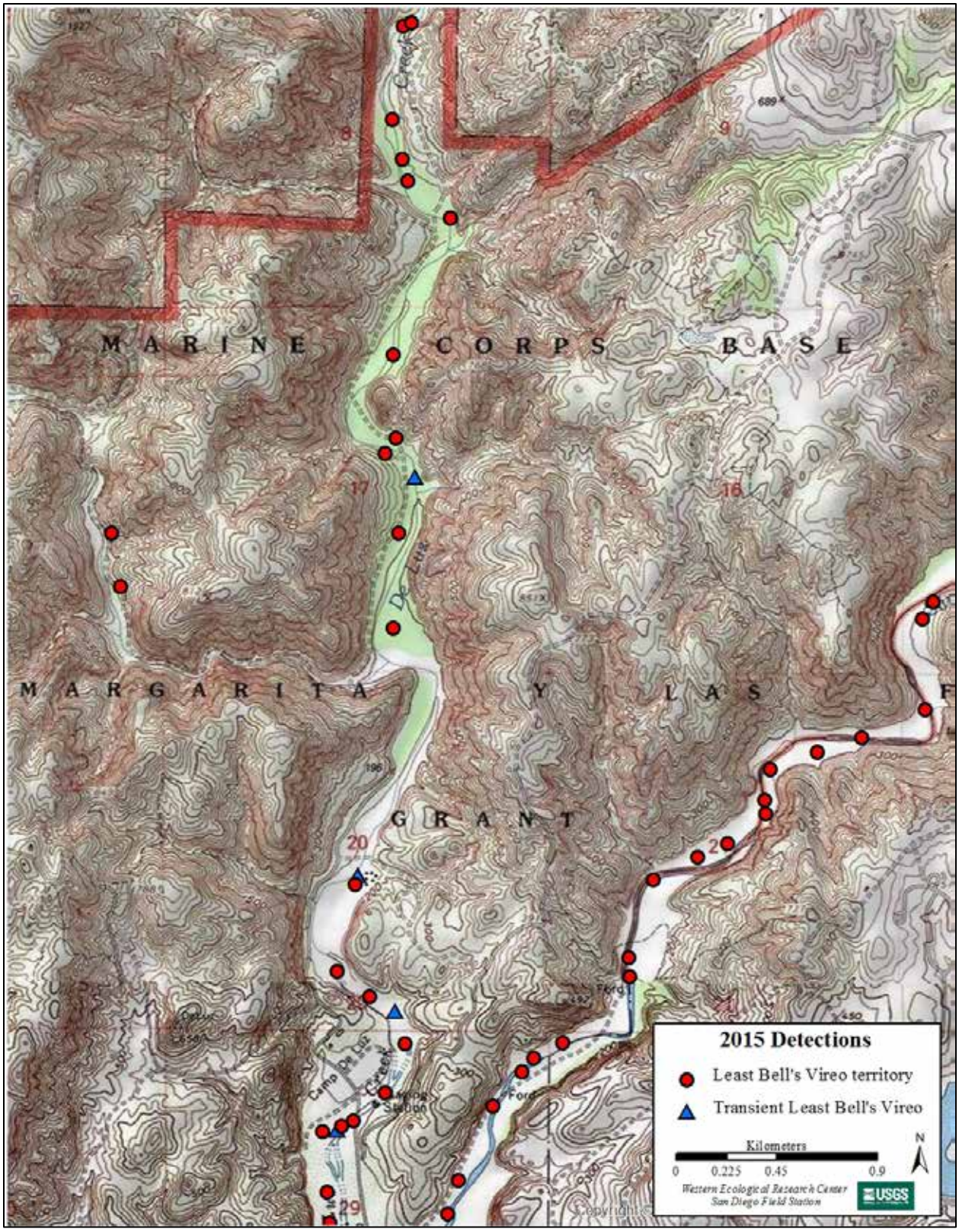


Fig. 21. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2015: Upper Santa Margarita River, De Luz Creek, and Roblar Creek.

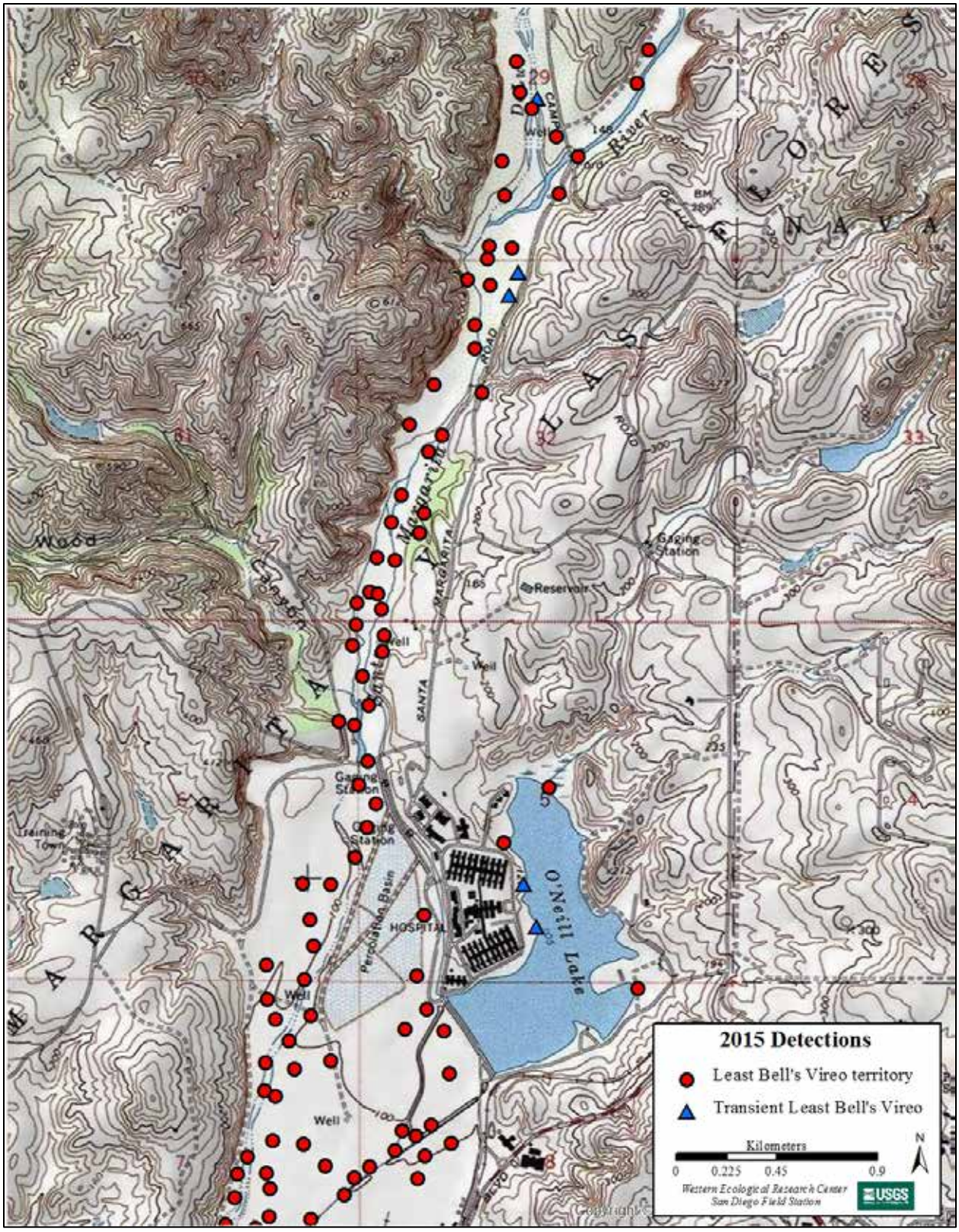


Fig. 22. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2015 Santa Margarita River, Lake O'Neill, and Fallbrook Creek.

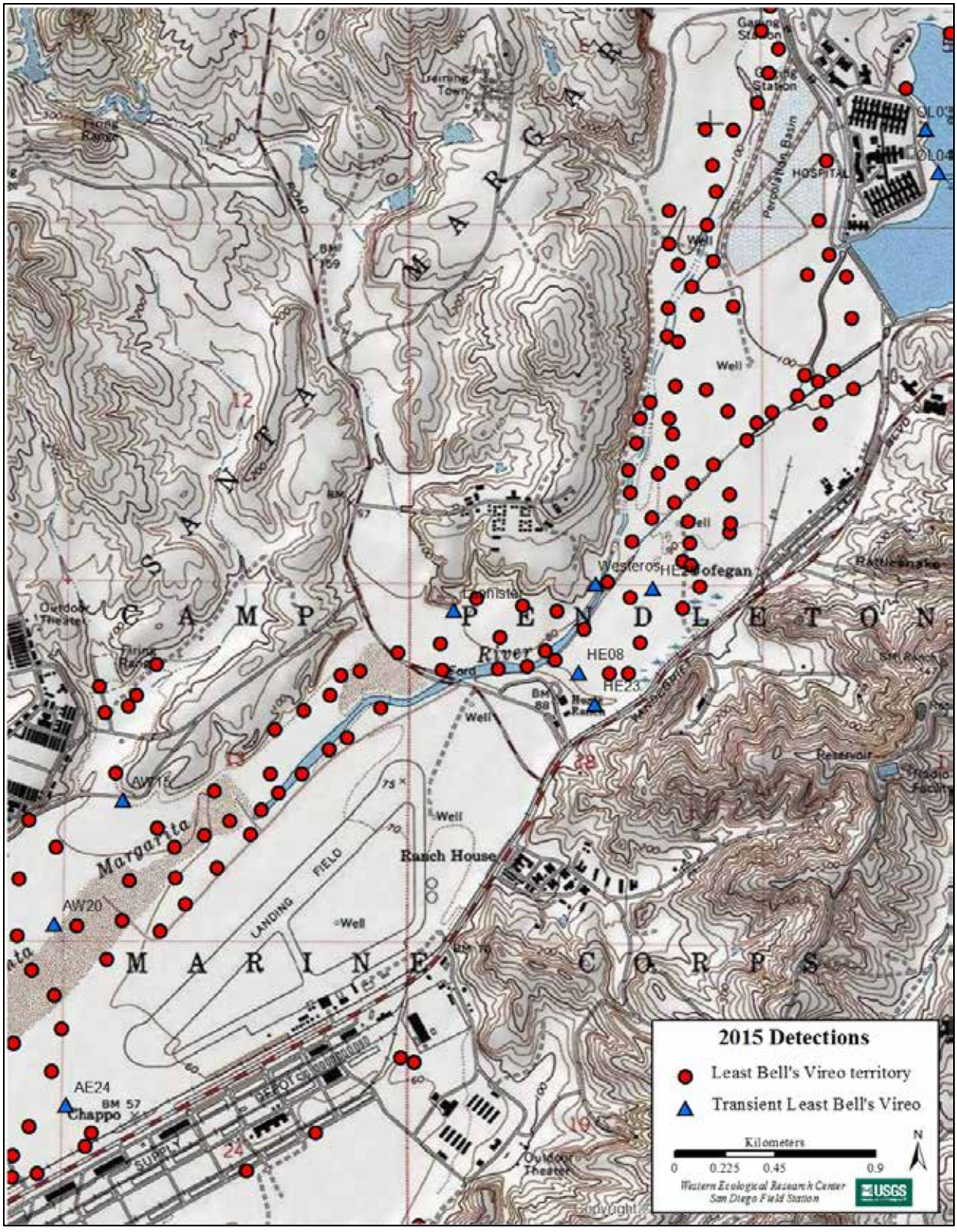


Fig. 23. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2015: Santa Margarita River.

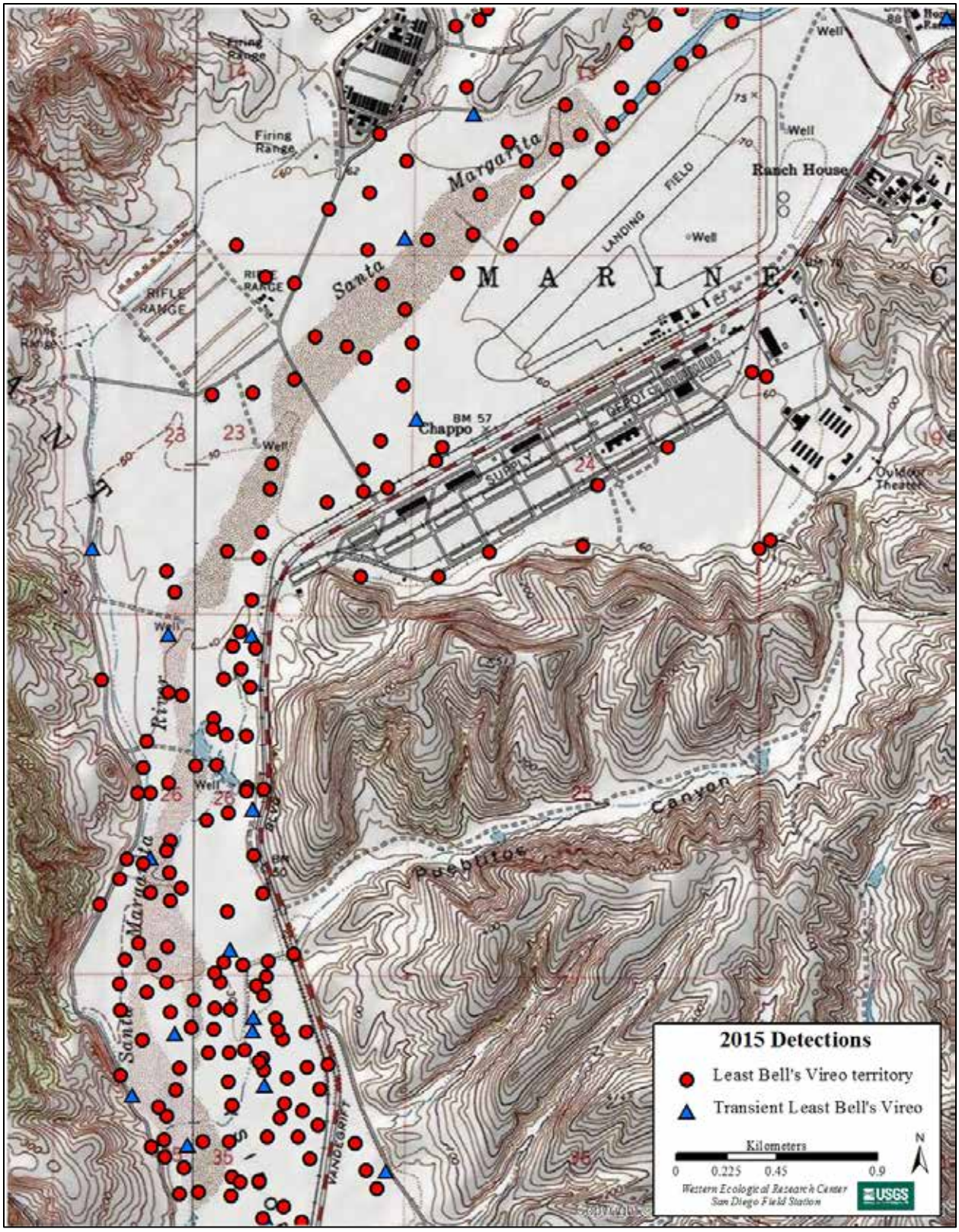


Fig. 24. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2015: Santa Margarita River, 22 Area, and Pueblitos Canyon.

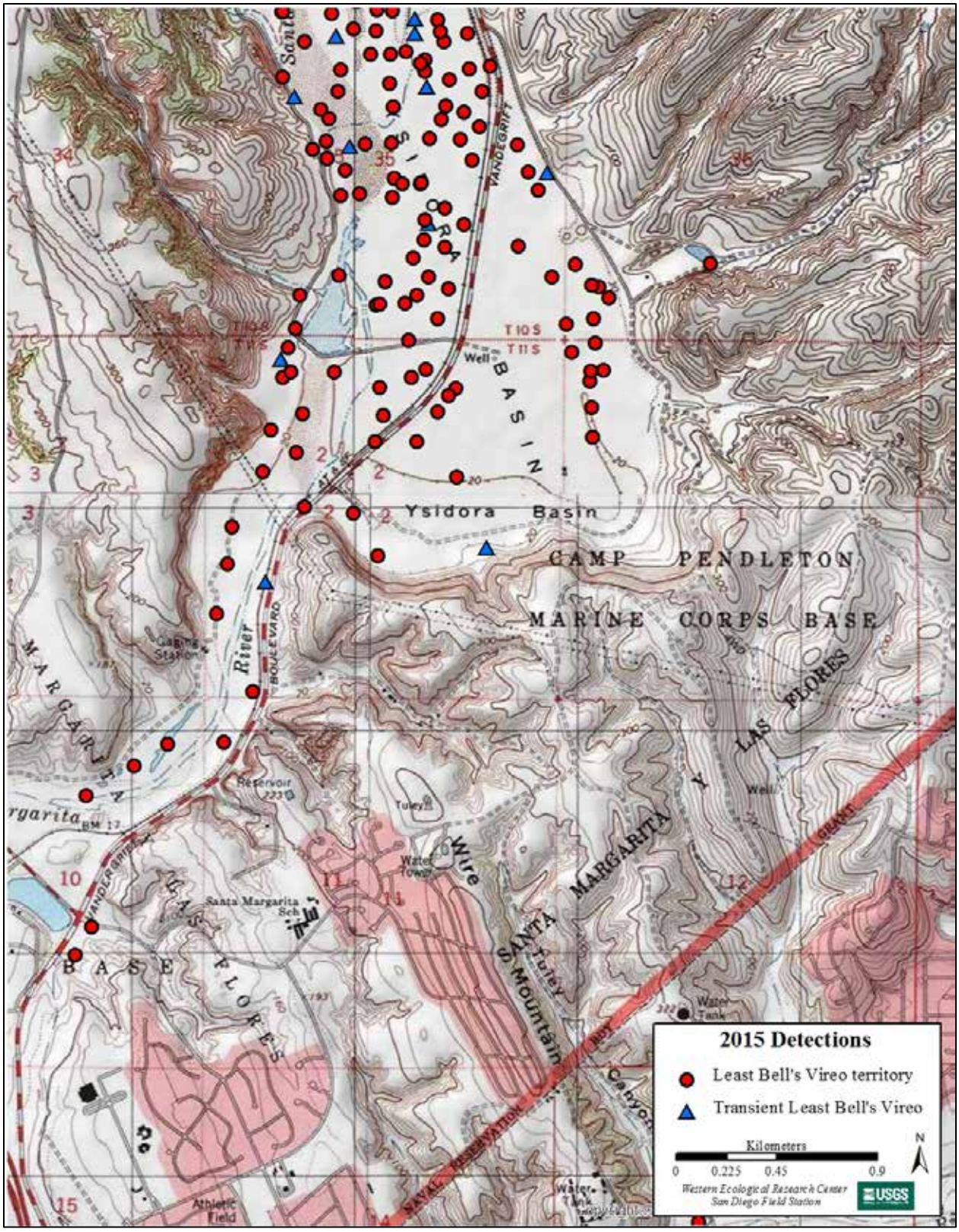


Fig. 25. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2015: Santa Margarita River, Ysidora Basin, and Ysidora Basin to Windmill Canyon.

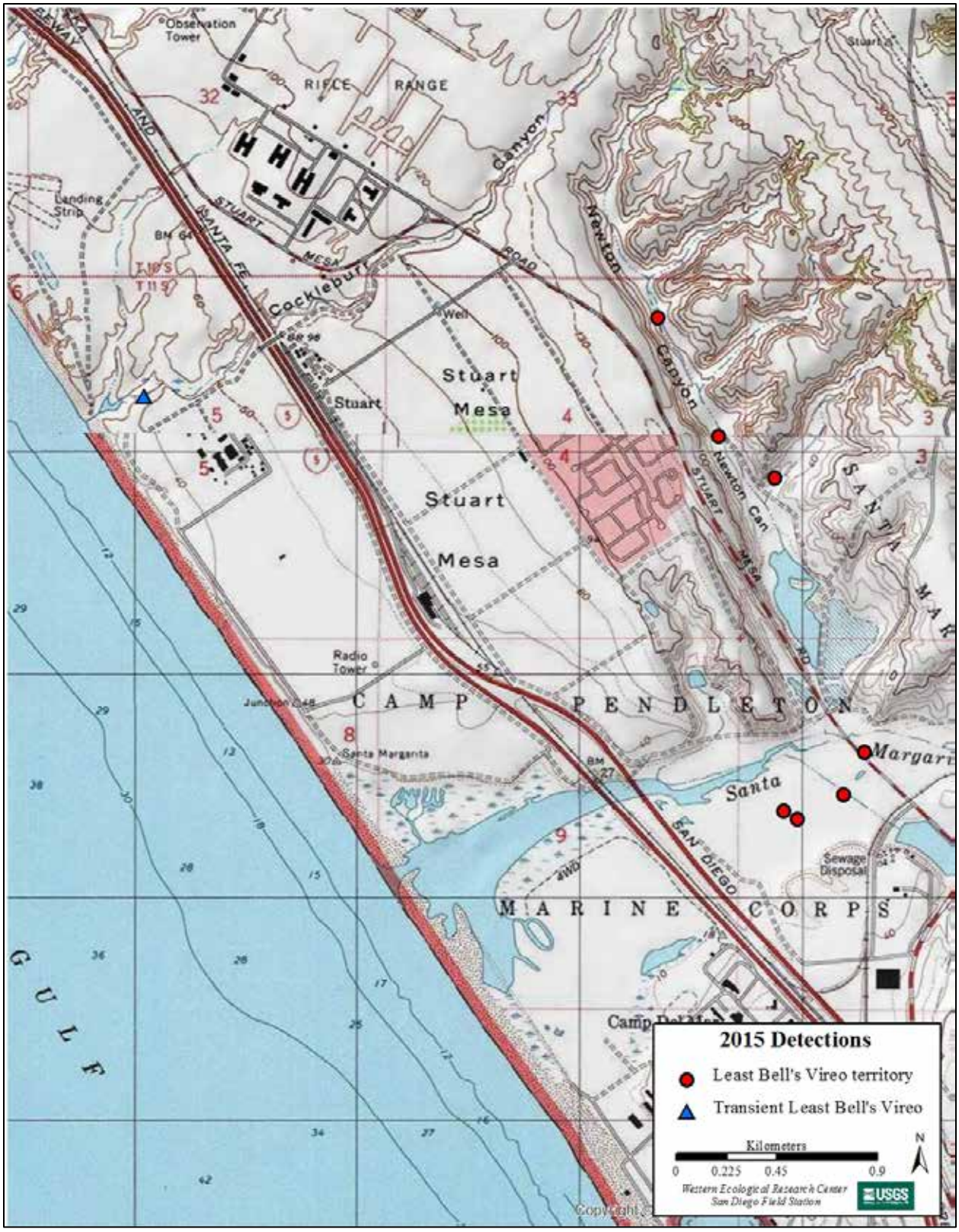


Fig. 26. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2015: Lower Santa Margarita River, Newton Canyon, and Cockleburr Canyon.

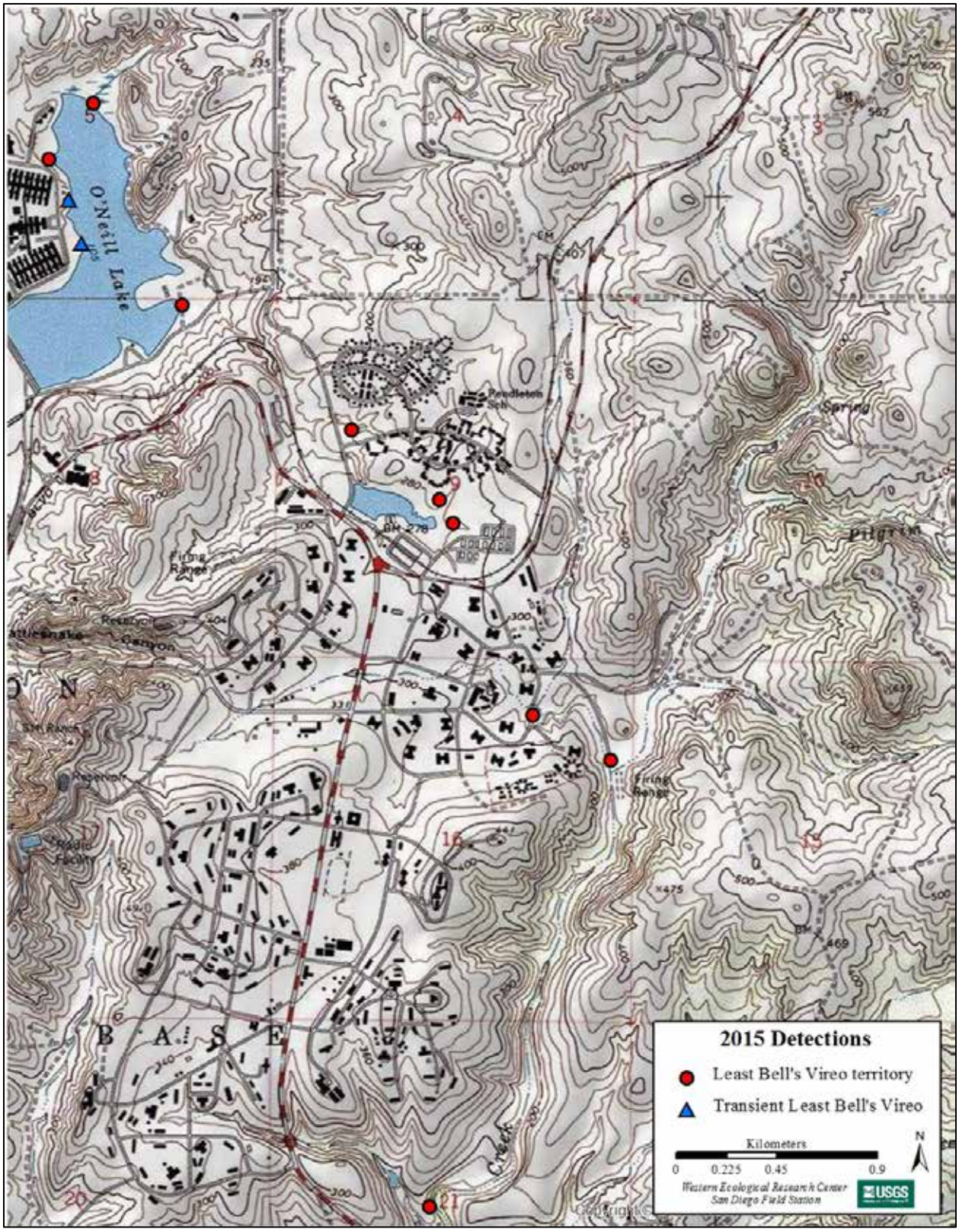


Fig. 27. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2015: Upper Pilgrim Creek, De Luz Homes Habitat, and Lake O'Neill.

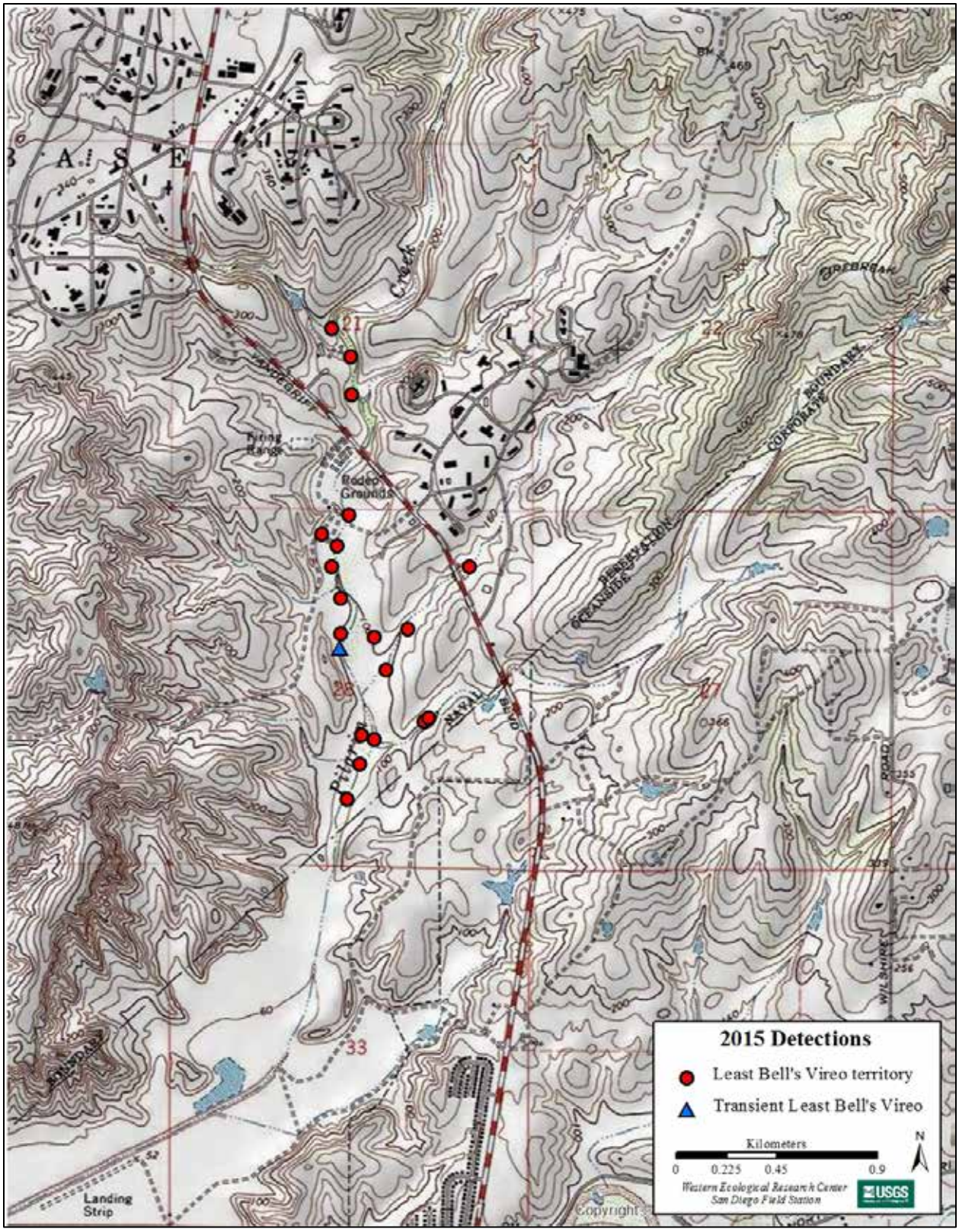


Fig. 28. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2015: Upper and Lower Pilgrim Creek.

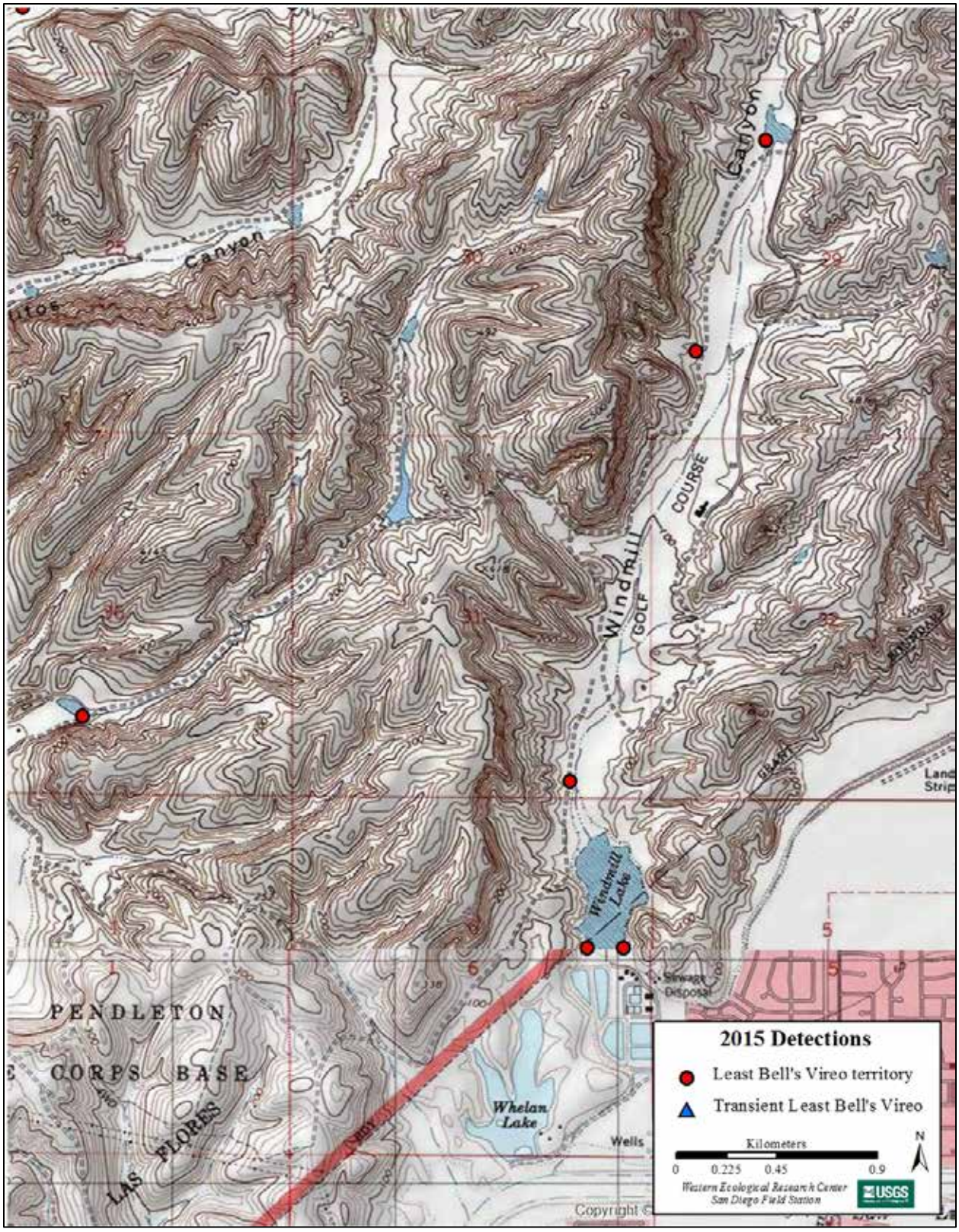


Fig. 29. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2015: Windmill Canyon and Ysidora Basin to Windmill Canyon.

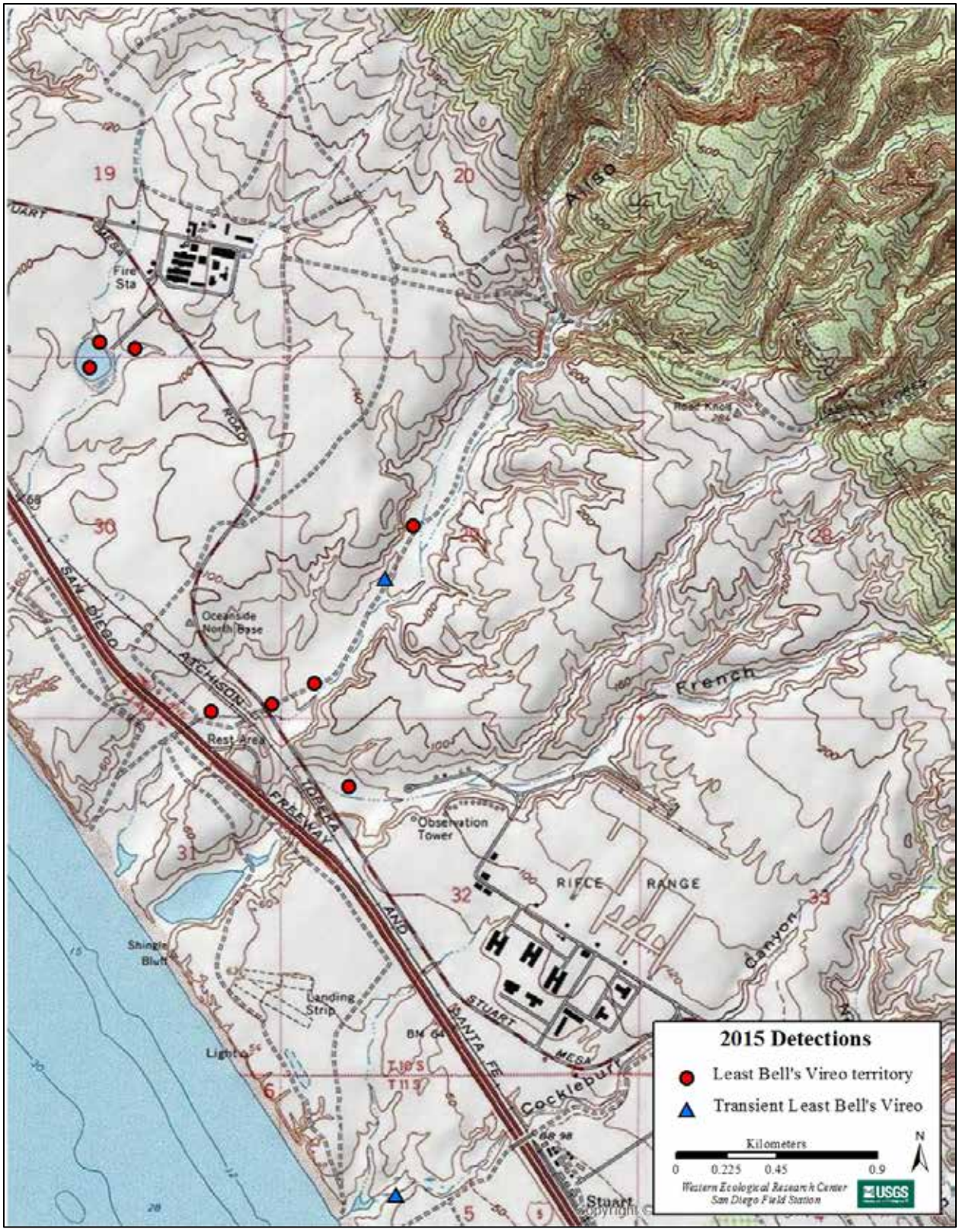


Fig. 30. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2015: French Creek, Aliso Creek, and Hidden Canyon.

Fig. 31. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2015: Basilone and Roblar Roads.

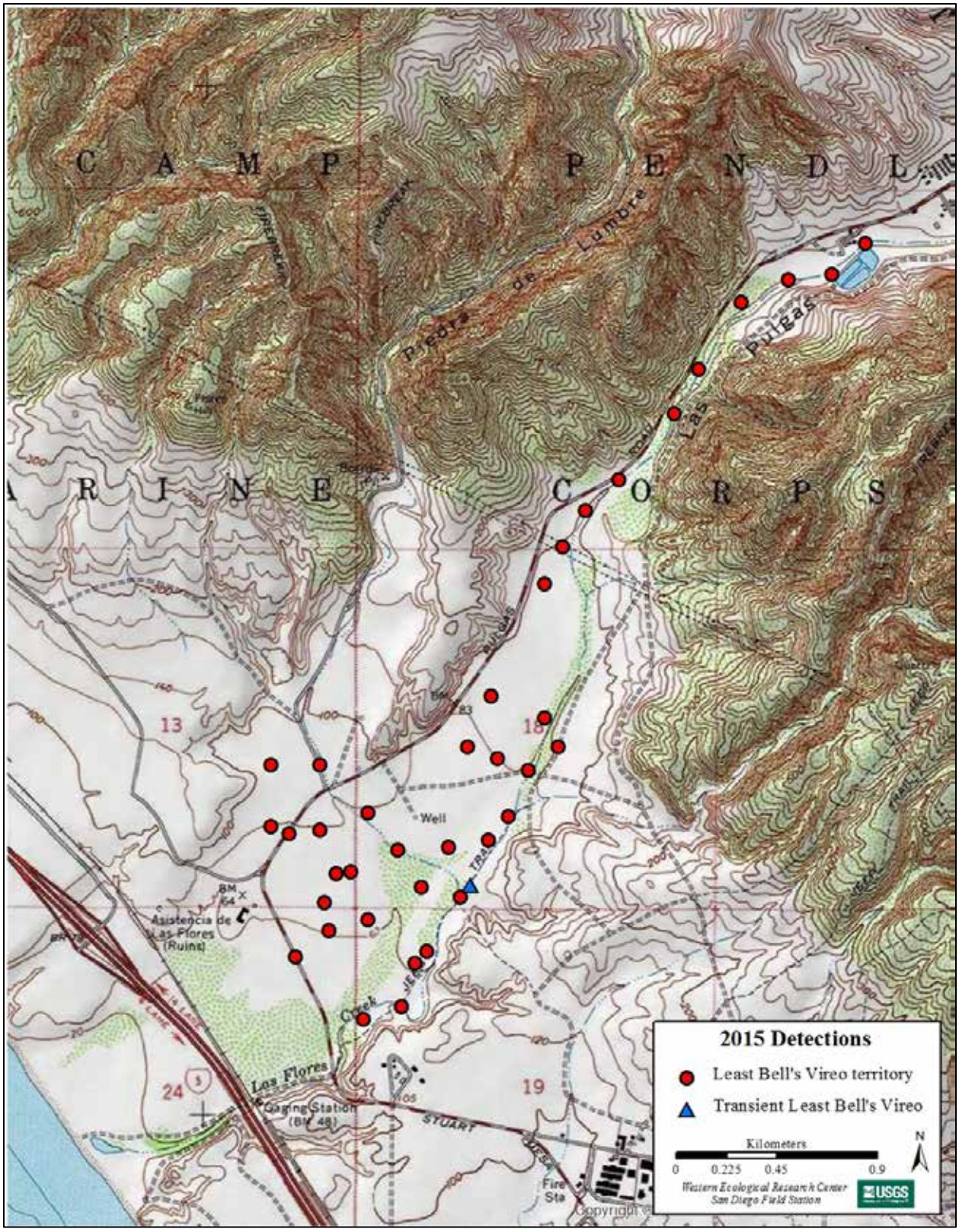


Fig. 32. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2015: Lower Las Flores Creek and Piedra de Lumbre Canyon.

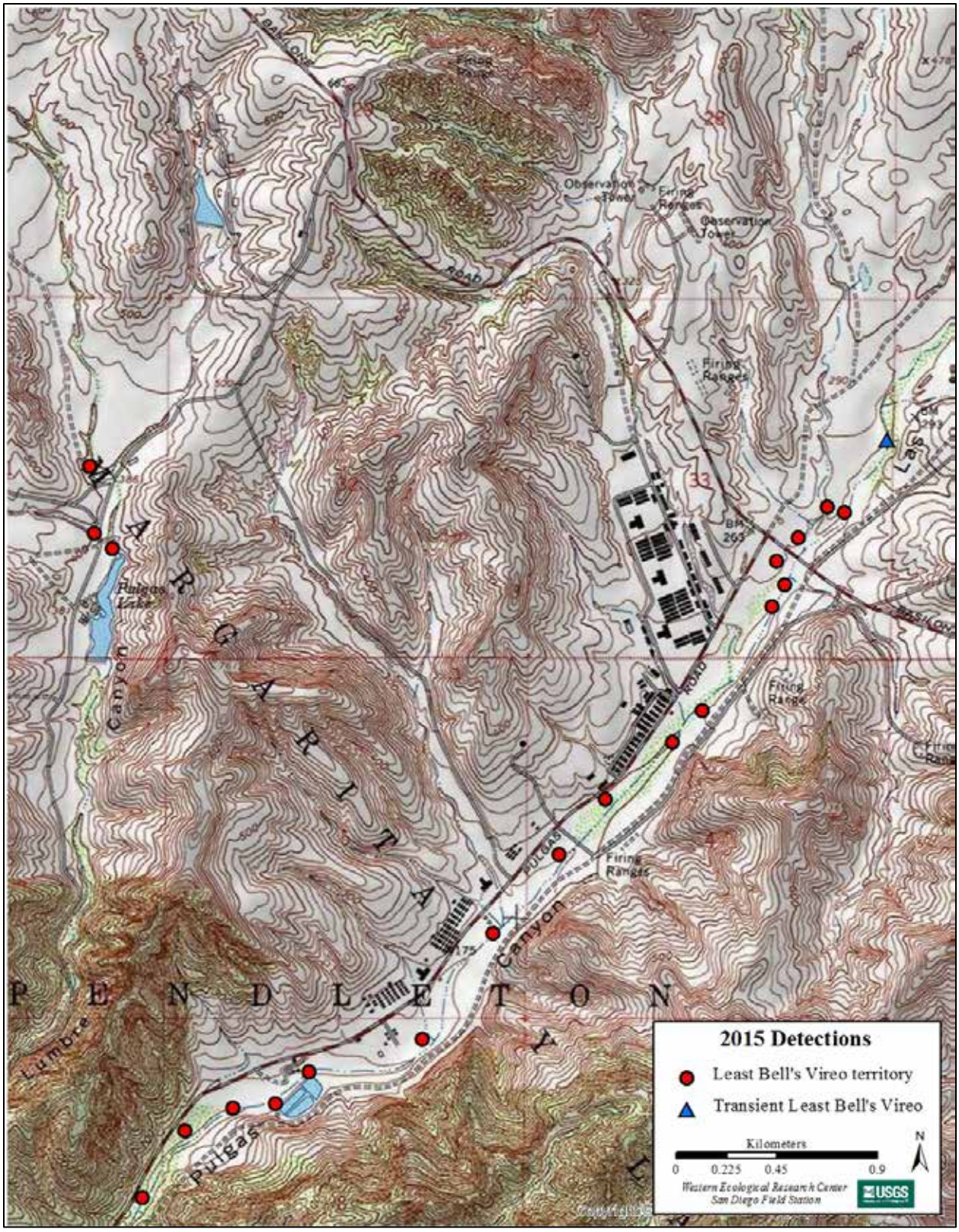


Fig. 33. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2015: Piedra de Lumbre Canyon and Upper Las Flores Creek.

Fig. 34. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2015: Horno Canyon.

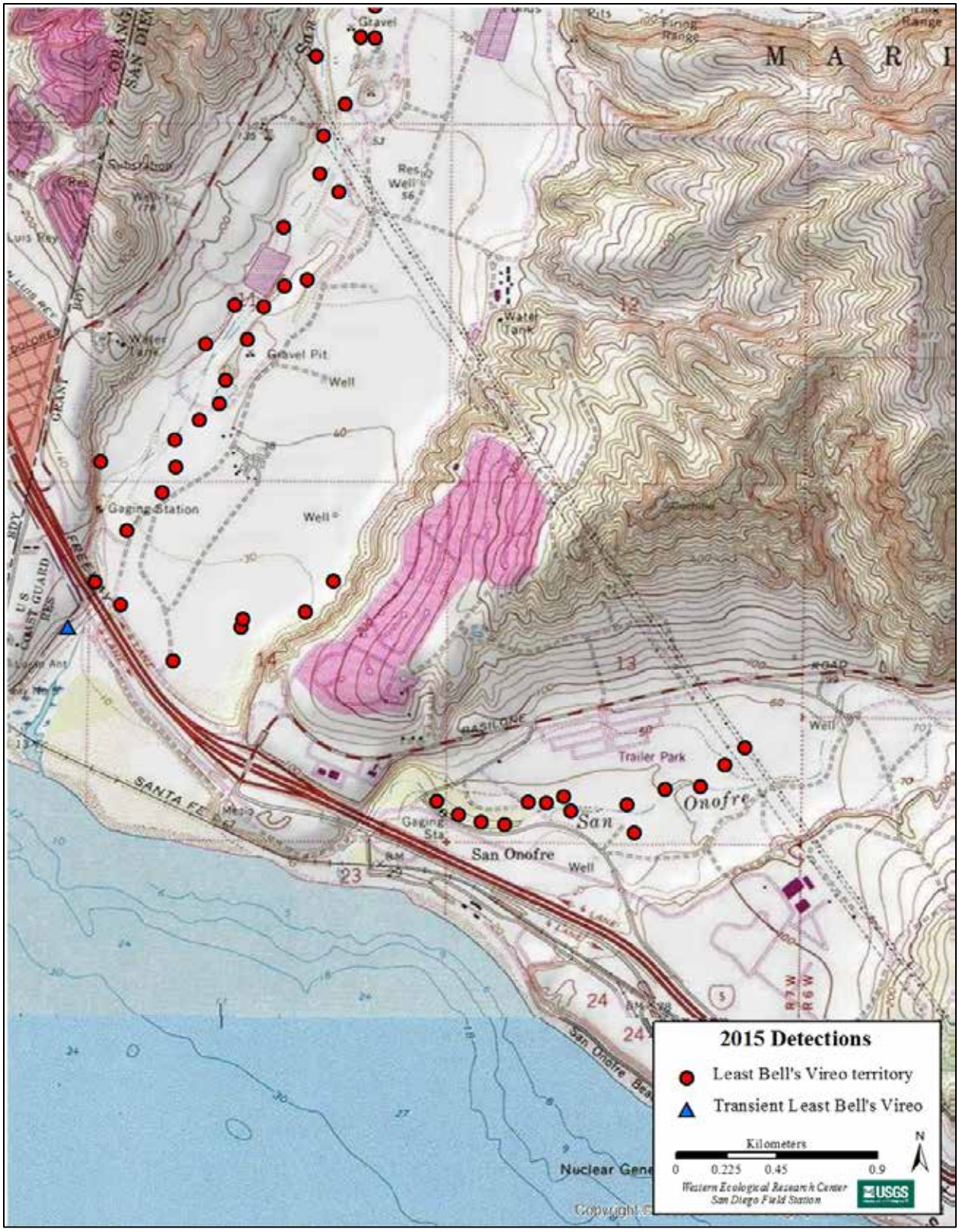


Fig. 35. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2015: Lower San Onofre Creek and Lower San Mateo Creek.

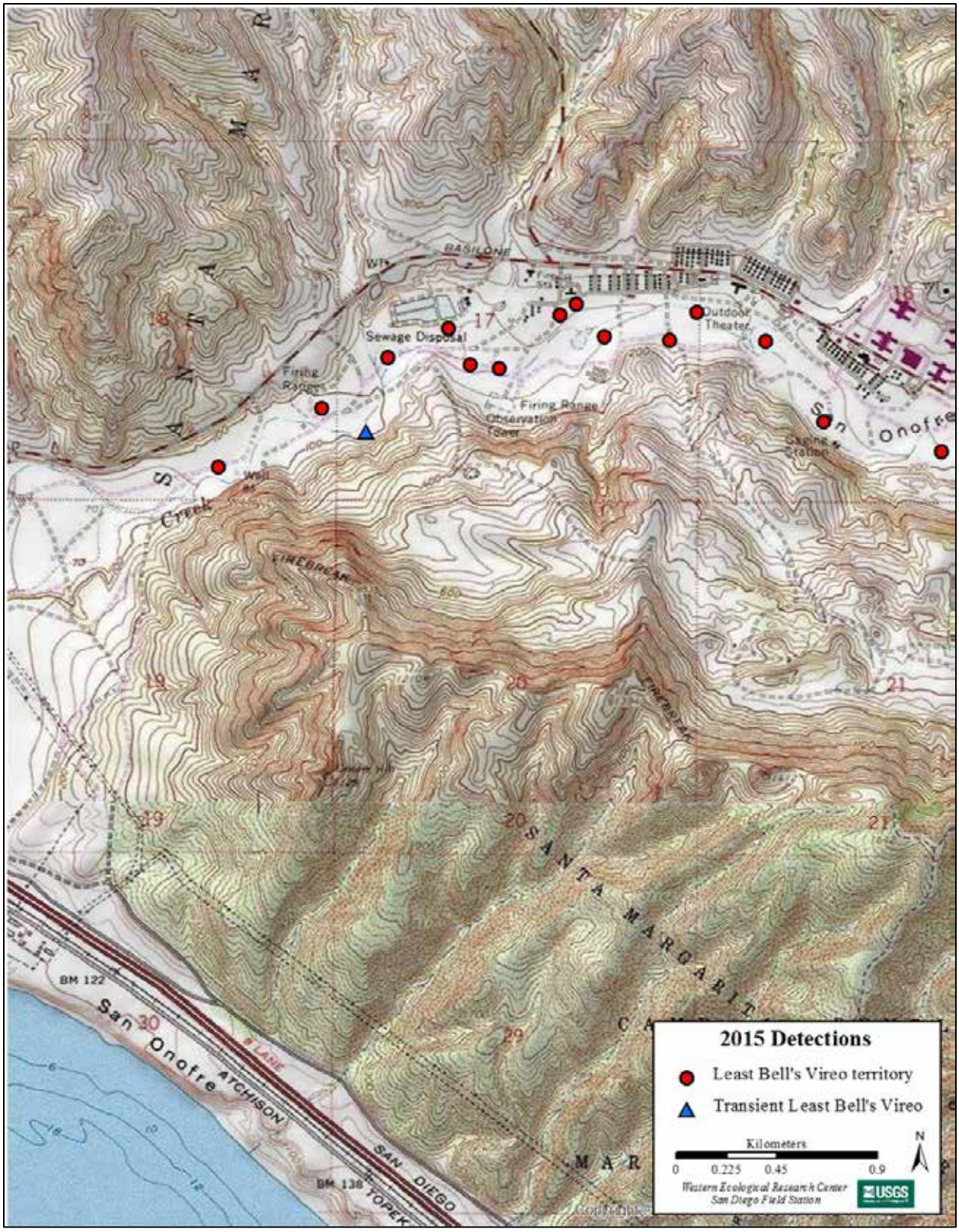


Fig. 36. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2015: San Onofre Creek.

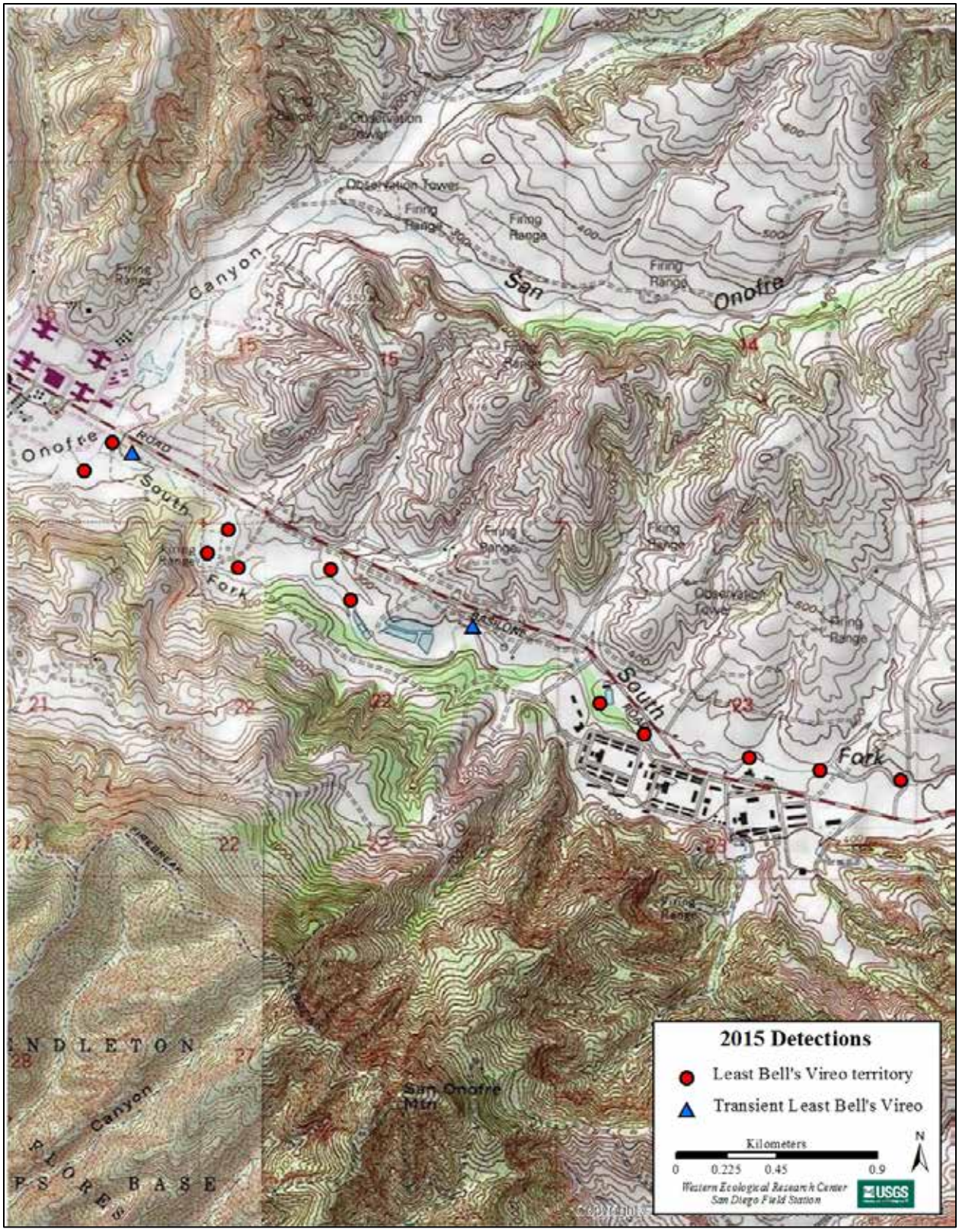


Fig. 37. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2015: South Fork San Onofre Creek.

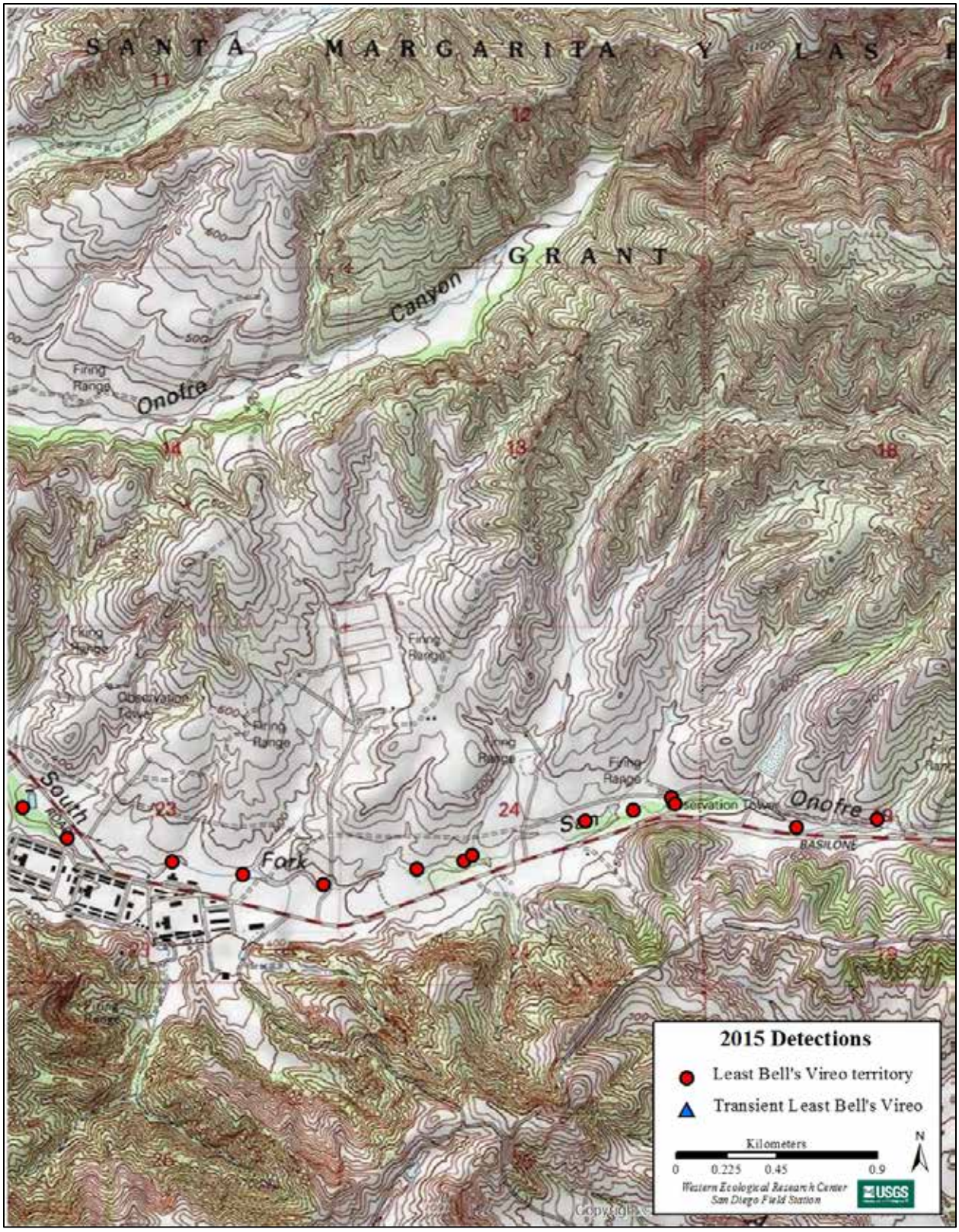


Fig. 38. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2015: San Onofre Creek.

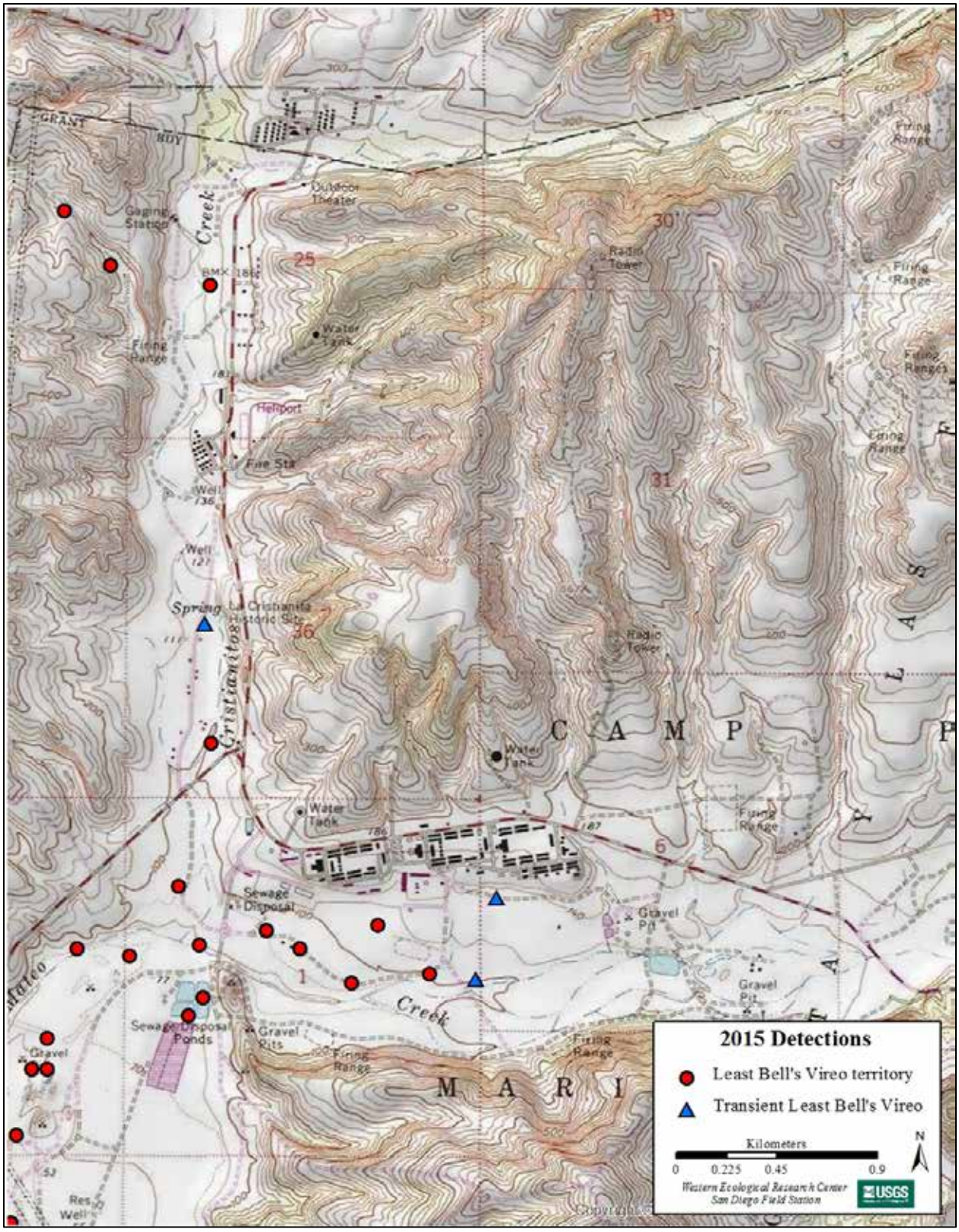


Fig. 39. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2015: San Mateo Creek and Cristianitos Creek.

Appendix D. Banded Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2015

Drainage / Sex[2]	Band Combination[1] Left Leg	Right Leg	Age	Comments[3]
De Luz Creek				
F	Mgo	PUPU/gogo	≥ 7 yrs.	Banded as an adult at DL MAPS in 2009.
F	PUWH/Mgo	PUWH	≥ 2 yrs.	Banded as an adult at DL MAPS in 2014.
M	WHDP/Mgo	WHWH	≥ 7 yrs.	Banded as an adult at DL MAPS in 2010.
M	DGOR/Mgo	PUWH	≥ 3 yrs.	Banded as an adult at DL MAPS in 2013.
M	LPBK	YEPU/Mgo	≥ 3 yrs.	Banded as an adult at DL MAPS in 2013.
M	DPDP	WHWH/Mgo	≥ 2 yrs.	Banded as an adult on DL Creek in 2014.
U	YEPU	WHPU/Mgo	HY	Banded as a juvenile at DL MAPS in 2015.
Las Flores Creek				
M	PUYE/Mdb	WHDB	1 yr.	Banded as a nestling on the SLR in 2014.
Piedra de Lumbre Canyon				
M	PUWH/Mdb	YEYE	1 yr.	Banded as a nestling on the SLR in 2014.
San Mateo Creek				
F	Mdb		≥ 1 yrs.	Banded as a nestling on the SLR prior to 2015.
M	WHDP	DGOR/Mgo	2 yrs.	Banded as a nestling at MCAS in 2013.
Santa Margarita River				
F	YEPU/Mgo	PUPU	9 yrs.	Banded as a nestling on the SMR in 2006.
F	pupu	DGOR/Msi	≥ 7 yrs.	Banded as an adult on the SMR in 2009.
F	OROR/Mgo	ORPU	7 yrs.	Banded as a nestling on the SMR in 2008.
F	DGOR	OROR/Mgo	≥ 3 yrs.	Banded as an adult on the SMR in 2013.
F	PUWH	PUOR/Mgo	≥ 3 yrs.	Banded as an adult at SM MAPS in 2013.
F	OROR/Mgo	PUPU	3 yrs.	Banded as a nestling on the SMR in 2012.
F	LPBK/Mgo	PUPU	3 yrs.	Banded as a nestling on the SMR in 2012.
F	BKLP/Mgo	WHDP	3 yrs.	Banded as a nestling on the SMR in 2012.
F	PUYE/Mgo	DPDP	≥ 2 yrs.	Banded as an adult at DL MAPS in 2014.
F	BKBK/Mgo	LPBK	≥ 2 yrs.	Banded as an adult at DL MAPS in 2014.
F	LPBK	BKLP/Mgo	≥ 2 yrs.	Banded as an adult on the SMR in 2014.
F	LPBK	LPBK/Mgo	2 yrs.	Banded as a juvenile at SM MAPS in 2013.
F	PUOR	BKLP/Mgo	2 yrs.	Banded as a nestling at MCAS in 2013.
F	WHDP	PUPU/Mgo	2 yrs.	Banded as a nestling on the SMR in 2013.
F	ORDG	WHPU/Mgo	2 yrs.	Banded as a nestling on the SMR in 2013.
F	WHDP	BKLP/Mgo	2 yrs.	Banded as a nestling on the SMR in 2013.
F	ORDG	OROR/Mgo	2 yrs.	Banded as a nestling on the SMR in 2013.
F	WHDP	PUOR/Mgo	≥ 1 yrs.	Banded as an adult at SM MAPS in 2015.
F	OROR/Mgo	BKBK	≥ 1 yrs.	Banded as an adult at SM MAPS in 2015.
F	ORDG/Mgo	BKBK	≥ 1 yrs.	Banded as an adult on the SMR in 2015.
F	PUOR/Mgo	BKBK	≥ 1 yrs.	Banded as an adult on the SMR in 2015.
F	PUYE/Mgo	ORDG	≥ 1 yrs.	Banded as an adult on the SMR in 2015.
F		Mgo	≥ 1 yrs.	Banded as a nestling on the SMR or at MCAS prior to 2014.
F	?	?/Mgo	≥ 1 yrs.	Banded as unknown age on the SMR prior to 2015.
F	?/Mgo	PUWH	≥ 1 yrs.	Banded as unknown age on the SMR prior to 2015.
F	ORDG/Mgo	ORPU	1 yr.	Banded as a nestling at MCAS in 2014.
M	DGOR/Mgo	ORDG	7 yrs.	Banded as a nestling on the SMR in 2008.
M	ORPU	OROR/Mgo	≥ 6 yrs.	Banded as an adult on the SMR in 2010.
M	WHPU	Mgo	≥ 6 yrs.	Banded as an adult on the SMR in 2010.
M	Mgo	WHDP	≥ 6 yrs.	Banded as an adult on the SMR in 2010.
M	YEPU/Mgo	DPDP	≥ 6 yrs.	Banded as an adult on the SMR in 2010.

Appendix D. Continued.

Drainage / Sex[2]	Band Combination[1] Left Leg	Right Leg	Age	Comments[3]
Santa Margarita River continued				
M	DPDP	YEYE/Mgo	≥ 6 yrs.	Banded as an adult on the SMR in 2010.
M	WHWH	OROR/Mgo	≥ 5 yrs.	Banded as an adult on the SMR in 2011.
M	WHWH/Mdb	WHDB	≥ 5 yrs.	Banded as an adult on the SMR in 2011.
M	PUPU	BKBK/Mdb	≥ 5 yrs.	Banded as an adult on the SLR in 2011.
M	BYST/Mgo	WHWH	≥ 4 yrs.	Banded as an adult on the SMR in 2012.
M	PUPU	BKLP/Mgo	≥ 4 yrs.	Banded as an adult on the SMR in 2012.
M	WHWH	PUWH/Mgo	≥ 4 yrs.	Banded as an adult on the SMR in 2012.
M	DPWH/Mgo	WHWH	≥ 4 yrs.	Banded as an adult on the SMR in 2012.
M	OROR/Mgo	WHWH	≥ 4 yrs.	Banded as an adult on the SMR in 2012.
M	PUPU	PUWH/Mgo	≥ 4 yrs.	Banded as an adult on the SMR in 2012.
M	ORPU	PUYE/Mgo	≥ 4 yrs.	Banded as an adult on the SMR in 2012.
M	PUPU	ORDG/Mgo	≥ 4 yrs.	Banded as an adult on the SMR in 2012.
M	DPDP/Mgo	PUPU	≥ 4 yrs.	Banded as an adult on the SMR in 2012.
M	BKBK	ORDG/Mgo	≥ 4 yrs.	Banded as an adult on the SMR in 2012.
M	YEPU	ORPU/Mgo	4 yrs.	Banded as a juvenile on the SMR in 2011.
M	WHWH	DBWH/Mdb	4 yrs.	Banded as a nestling on the SLR in 2011.
M	DGOR	LPBK/Mgo	≥ 3 yrs.	Banded as an adult on the SMR in 2013.
M	LPBK/Mgo	ORPU	≥ 3 yrs.	Banded as an adult on the SMR in 2013.
M	DGOR	ORPU/Mgo	≥ 3 yrs.	Banded as an adult on the SMR in 2013.
M	YEYE/Mgo	DPWH	≥ 3 yrs.	Banded as an adult on the SMR in 2013.
M	DGOR/Mgo	ORPU	≥ 3 yrs.	Banded as an adult on the SMR in 2013.
M	PUWH	ORDG/Mgo	≥ 3 yrs.	Banded as an adult at DL MAPS in 2013.
M	PUPU/Mgo	ORPU	3 yrs.	Banded as a nestling on the SMR in 2012.
M	DGOR	WHPU/Mgo	3 yrs.	Banded as a nestling at MCAS in 2012.
M	BYST/Mdb	DBDP	3 yrs.	Banded as a nestling on the SLR in 2012.
M	BYST/Mgo	PUPU	≥ 2 yrs.	Banded as an adult on the SMR in 2014.
M	PUYE/Mgo	PUWH	≥ 2 yrs.	Banded as an adult on the SMR in 2014.
M	PUWH	ORPU/Mgo	≥ 2 yrs.	Banded as an adult at SM MAPS in 2014.
M	BKBK	LPBK/Mgo	≥ 2 yrs.	Banded as an adult at SM MAPS in 2014.
M	BKLP/Mgo	PUPU	≥ 2 yrs.	Banded as an adult on the SMR in 2014.
M	PUOR	DGOR/Mgo	≥ 2 yrs.	Banded as an adult on the SMR in 2014.
M	PUOR	WHPU/Mgo	≥ 2 yrs.	Banded as an adult on the SMR in 2014.
M	OROR/Mgo	DGOR	≥ 2 yrs.	Banded as an adult on the SMR in 2014.
M	DGOR	BKLP/Mgo	≥ 2 yrs.	Banded as an adult on the SMR in 2014.
M	DGOR/Mgo	OROR	≥ 2 yrs.	Banded as an adult on the SMR in 2014.
M	YEYE/Mgo	PUWH	≥ 2 yrs.	Banded as an adult on the SMR in 2014.
M	LPBK	WHDP/Mgo	≥ 2 yrs.	Banded as an adult on the SMR in 2014.
M	BKBK	BYST/Mgo	≥ 2 yrs.	Banded as an adult on the SMR in 2014.
M	DPDP/Mgo	LPBK	≥ 2 yrs.	Banded as an adult on the SMR in 2014.
M	OROR	PUWH/Mgo	≥ 2 yrs.	Banded as an adult on the SMR in 2014.
M	LPBK/Mgo	LPBK	≥ 2 yrs.	Banded as an adult on the SMR in 2014.
M	OROR	BYST/Mgo	≥ 2 yrs.	Banded as an adult on the SMR in 2014.
M	PUPU/Mgo	LPBK	≥ 2 yrs.	Banded as an adult on the SMR in 2014.
M	DPDP	PUWH/Mdb	≥ 2 yrs.	Banded as an adult on the SLR in 2014.
M	DPWH/Mgo	WHDP	≥ 2 yrs.	Banded as an adult on the SMR in 2014.

Appendix D. Continued.

Drainage	Band Combination[1]			
Sex[2]	Left Leg	Right Leg	Age	Comments[3]
Santa Margarita River continued				
M	DPWH/Mgo	LPBK	≥ 2 yrs.	Banded as an adult on the SMR in 2014.
M	BKBK	YEYE/Mgo	≥ 2 yrs.	Banded as an adult on the SMR in 2014.
M	DGOR	WHDP/Mgo	≥ 2 yrs.	Banded as an adult on the SMR in 2014.
M	BKBK	WHPU/Mgo	≥ 2 yrs.	Banded as an adult on the SMR in 2014.
M	DGOR	PUOR/Mgo	≥ 2 yrs.	Banded as an adult on the SMR in 2014.
M	DPWH	YEYE/Mdb	2 yrs.	Banded as a nestling on the SLR in 2013.
M	PUOR	ORDG/Mgo	2 yrs.	Banded as a nestling on the SMR in 2013.
M	WHDP	DPDP/Mgo	2 yrs.	Banded as a nestling on the SMR in 2013.
M	WHDP	WHDP/Mgo	2 yrs.	Banded as a nestling on the SMR in 2013.
M	BYST	BKBK/Mgo	2 yrs.	Banded as a nestling on the SMR in 2013.
M	WHDP	ORDG/Mgo	2 yrs.	Banded as a nestling at MCAS in 2013.
M	DPWH	DPWH/Mgo	2 yrs.	Banded as a nestling at MCAS in 2013.
M	PUOR	ORPU/Mgo	2 yrs.	Banded as a nestling on the SMR in 2013.
M	DPWH	WHPU/Mdb	2 yrs.	Banded as a nestling on the SLR in 2013.
M	DGOR	PUYE/Mgo	2 yrs.	Banded as a nestling on the SMR in 2013.
M	BKBK	PUOR/Mgo	2 yrs.	Banded as a nestling on the SMR in 2013.
M	PUPU/Mgo	WHDP	≥ 1 yrs.	Banded as an adult at SM MAPS in 2015.
M	ORDG/Mgo	WHDP	≥ 1 yrs.	Banded as an adult at SM MAPS in 2015.
M	WHDP	WHPU/Mgo	≥ 1 yrs.	Banded as an adult at SM MAPS in 2015.
M	WHDP	ORDG/Mgo	≥ 1 yrs.	Banded as an adult at SM MAPS in 2015.
M	ORDG	DPDP/Mgo	≥ 1 yrs.	Banded as an adult on the SMR in 2015.
M	ORPU/Mgo	ORPU	≥ 1 yrs.	Banded as an adult on the SMR in 2015.
M	ORDG	PUPU/Mgo	≥ 1 yrs.	Banded as an adult on the SMR in 2015.
M	ORDG	BYST/Mgo	≥ 1 yrs.	Banded as an adult on the SMR in 2015.
M	PUWH/Mgo	PUOR	≥ 1 yrs.	Banded as an adult on the SMR in 2015.
M	ORDG	PUOR/Mgo	≥ 1 yrs.	Banded as an adult on the SMR in 2015.
M	PUYE/Mgo	ORPU	≥ 1 yrs.	Banded as an adult on the SMR in 2015.
M	PUWH/Mgo	ORDG	≥ 1 yrs.	Banded as an adult on the SMR in 2015.
M	PUPU/Mgo	DGOR	≥ 1 yrs.	Banded as an adult on the SMR in 2015.
M	DGOR/Mgo	WHDP	≥ 1 yrs.	Banded as an adult on the SMR in 2015.
M	BYST/Mgo	ORDG	≥ 1 yrs.	Banded as an adult on the SMR in 2015.
M	YEPU/Mgo	WHDP	≥ 1 yrs.	Banded as an adult on the SMR in 2015.
M	BKBK/Mgo	PUOR	≥ 1 yrs.	Banded as an adult on the SMR in 2015.
M	-	Mgo	≥ 1 yrs.	Banded as a nestling on the SMR or at MCAS prior to 2015.
M	Mgo	-	≥ 1 yrs.	Banded as a nestling on the SMR or at MCAS prior to 2015.
M	?	?/Mgo	≥ 1 yrs.	Banded as unknown age on the SMR prior to 2015.
M	?	?	≥ 1 yrs.	Banded as unknown age prior to 2015.
M	?	?/Mgo	≥ 1 yrs.	Banded as unknown age on the SMR prior to 2015.
M	?/Mgo	?	≥ 1 yrs.	Banded as unknown age on the SMR prior to 2015.
M	?	?	≥ 1 yrs.	Banded as unknown age prior to 2015.
M	DPDP/Mdb	YEYE	1 yr.	Banded as a nestling on the SLR in 2014.
M	DPWH/Mdb	YEYE	1 yr.	Banded as a nestling on the SLR in 2014.
M	WHDP/Mgo	BKBK	1 yr.	Banded as a juvenile at SM MAPS in 2014.
M	DPWH/Mgo	ORDG	1 yr.	Banded as a nestling on the SMR in 2014.
U	LPBK	PUWH/Mgo	4 yrs.	Banded as a nestling on the SMR in 2011.

Appendix D. Continued.

Drainage / Sex[2]	Band Combination[1] Left Leg	Right Leg	Age	Comments[3]
Santa Margarita River continued				
U	DGOR/Mgo	DPDP	≥ 3 yrs.	Banded as an adult on the SMR in 2013.
U	PUWH	DPDP/Mgo	≥ 1 yrs.	Banded as an adult on the SMR in 2015.
U	PUYE/Mgo	WHDP	≥ 1 yrs.	Banded as an adult on the SMR in 2015.
U	DPWH	LPBK/Mgo	HY	Banded as a juvenile on the SMR in 2015.
U	PUYE/Mgo	BKBK	HY	Banded as a juvenile at SM MAPS in 2015.
U	YEPU	BKLP/Mgo	HY	Banded as a juvenile at SM MAPS in 2015.
U	YEYE/Mgo	YEPU	HY	Banded as a juvenile at SM MAPS in 2015.
U	YEPU	YEYE/Mgo	HY	Banded as a juvenile at SM MAPS in 2015.
U	BKLP/Mgo	BKBK	HY	Banded as a juvenile at SM MAPS in 2015.
Windmill Creek				
F	BWST	PUYE/Mdb	4 yrs.	Banded as a nestling on the SLR in 2011.
M	-	Mdb	≥ 1 yrs.	Banded as a nestling on the SLR in prior to 2014.

[1] Band colors: Mdb = dark blue numbered federal band; Mgo = gold numbered federal band; Msi = silver numbered federal band; gogo = metal gold; pupu = metal purple; 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; 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] DL = De Luz; MCAS = Marine Corps Air Station, Camp Pendleton; MCBCP = Marine Corps Base 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, 2015

Year Last Det.	Drainage / Territory / Treatment[1]		Dist. Moved (km)	Band Combination[2]		Age in 2015 (yrs.)	Sex[3]
	Last Seen	2015		Left Leg	Right Leg		
2014	DL / DL MAPS	SMR / ES49	13.52	PUYE/Mgo	DPDP	≥ 2 yrs.	F
2014	DL / DL MAPS	SMR / AE22	10.78	BKBK/Mgo	LPBK	≥ 2 yrs.	F
2014	SMR / ES37	WC / WC03	4.64	BWST	PUYE/Mdb	4 yrs.	F
2014	SMR / AW12	SMR / MOR / REF	1.42	OROR/Mgo	ORPU	7 yrs.	F
2014	SMR / MAZ / 14REF	SMR / DEU / PF	1.36	DGOR	OROR/Mgo	≥ 3 yrs.	F
2014	SMR / SM MAPS	SMR / BN16	0.98	PUWH	PUOR/Mgo	≥ 3 yrs.	F
2014	SMR / PIK / PF	SMR / HED / PF	0.82	LPBK	BKLP/Mgo	≥ 2 yrs.	F
2014	DL / DL MAPS	DL / DS03	0.64	PUWH/Mgo	PUWH	≥ 2 yrs.	F
2014	SMR / HED / PF	SMR / JSP / PF	0.38	OROR/Mgo	PUPU	3 yrs.	F
2014	DL / DL MAPS	DL / DS14	0.36	Mgo	PUPU/gogo	≥ 7 yrs.	F
2014	SMR / RR03	SMR / RR01	0.19	YEPU/Mgo	PUPU	9 yrs.	F
2014	SMR / MOU / PF	SMR / PRS09	10.39	DGOR	LPBK/Mgo	≥ 3 yrs.	M
2014	SMR / TOP	SMR / HED / PF	10.25	ORPU	OROR/Mgo	≥ 6 yrs.	M
2014	SMR / CED / PF	SMR / LNS / REF	3.94	DGOR	ORPU/Mgo	≥ 3 yrs.	M
2014	SLR / BSAV	SMR / SE03	3.76	DPDP	PUWH/Mdb	≥ 2 yrs.	M
2014	SMR / ES24	SMR / RR06	2.56	PUWH	ORPU/Mgo	≥ 2 yrs.	M
2014	SMR / ANN / 14REF	SMR / CED / PF	1.76	ORPU	PUYE/Mgo	≥ 4 yrs.	M
2014	FC / FC01	SMR / HW04 / REF	1.08	PUPU/Mgo	ORPU	3 yrs.	M
2014	DL / DS10	DL / DS03	0.88	DGOR/Mgo	PUWH	≥ 3 yrs.	M
2014	SMR / BNT / REF	SMR / FUR / REF	0.82	DPDP/Mgo	LPBK	≥ 2 yrs.	M
2014	SMR / ONX / PF	SMR / PEP / PF	0.74	LPBK/Mgo	ORPU	≥ 3 yrs.	M
2014	DL / LEM / PF	DL / DS10	0.72	DPDP	WHWH/Mgo	≥ 2 yrs.	M
2014	SMR / IBX / PF	SMR / KOA / PF	0.46	PUYE/Mgo	PUWH	≥ 2 yrs.	M
2014	DL / DS08	DL / DS15	0.41	LPBK	YEPU/Mgo	≥ 3 yrs.	M
2014	DL / DS04	DL / DS09	0.17	WHDP/Mgo	WHWH	≥ 7 yrs.	M
2014	SMR / PEP / PF	SMR / DAT / PF	0.14	DPWH	DPWH/Mgo	2 yrs.	M
2014	SMR / ZAM / PF	SMR / ZAM / PF	0.11	PUOR	WHPU/Mgo	≥ 2 yrs.	M
2014	SMR / HED / PF	SMR / TEN / PF	0.11	DPWH/Mgo	LPBK	≥ 2 yrs.	M
2014	SMR / BAD / PF	SMR / BAD / PF	0.11	DGOR	WHDP/Mgo	≥ 2 yrs.	M
2014	SMR / YB09	SMR / YB09	0.10	WHWH	DBWH/Mdb	4 yrs.	M
2014	SMR / AXE / PF	SMR / AXE / PF	0.10	WHWH	PUWH/Mgo	≥ 4 yrs.	M
2014	SMR / ANT / PF	SMR / ANT / PF	0.09	BKBK	WHPU/Mgo	≥ 2 yrs.	M
2014	SMR / TOF	SMR / ES51	0.09	WHWH	OROR/Mgo	≥ 5 yrs.	M
2014	SMR / HE12 / REF	SMR / HE21 / REF	0.08	DGOR	PUYE/Mgo	2 yrs.	M
2014	SMR / HDX / REF	SMR / HDX / REF	0.08	DGOR	BKLP/Mgo	≥ 2 yrs.	M
2014	SMR / ODN / REF	SMR / ODN / REF	0.07	YEYE/Mgo	DPWH	≥ 3 yrs.	M
2014	SMR / BAY	SMR / PRS07	0.07	PUPU/Mgo	LPBK	≥ 2 yrs.	M
2014	SMR / HE59 / REF	SMR / TYT / REF	0.07	BKBK	PUOR/Mgo	2 yrs.	M
2014	SMR / PO12	SMR / PO13	0.07	DPWH	WHPU/Mdb	2 yrs.	M
2014	SMR / HLD / REF	SMR / HLD / REF	0.07	DGOR/Mgo	OROR	≥ 2 yrs.	M
2014	SMR / WSP / REF	SMR / WSP / REF	0.06	YEPU	ORPU/Mgo	4 yrs.	M
2014	SMR / OCM / REF	SMR / ZPR / REF	0.06	WHDP	DPDP/Mgo	2 yrs.	M
2014	SMR / PIK / PF	SMR / OCE / PF	0.06	BKBK	YEYE/Mgo	≥ 2 yrs.	M
2014	SMR / ES37	SMR / ES03	0.06	PUPU	PUWH/Mgo	≥ 4 yrs.	M
2014	SMR / BIL / REF	SMR / BIL / REF	0.06	BKBK	BYST/Mgo	≥ 2 yrs.	M
2014	SMR / SM MAPS	SMR / ES44	0.05	BKBK	LPBK/Mgo	≥ 2 yrs.	M

Appendix E. Continued.

Year Last Det.	Drainage / Territory / Treatment[1]		Dist. Moved (km)	Band Combination[2]		Age in 2015 (yrs.)	Sex[3]
	Last Seen	2015		Left Leg	Right Leg		
2014	SMR / FOX / PF	SMR / FOX / PF	0.05	DGOR	PUOR/Mgo	≥ 2 yrs.	M
2014	SMR / DAQ / REF	SMR / DAQ / REF	0.04	OROR	PUWH/Mgo	≥ 2 yrs.	M
2014	SMR / UM17	SMR / UM27	0.04	PUWH	ORDG/Mgo	≥ 3 yrs.	M
2014	SMR / HRP / REF	SMR / KNG / REF	0.04	PUPU	ORDG/Mgo	≥ 4 yrs.	M
2014	SMR / JSP / PF	SMR / JSP / PF	0.04	PUPU	BKLP/Mgo	≥ 4 yrs.	M
2014	SMR / MIN	SMR / PRS16	0.04	OROR	BYST/Mgo	≥ 2 yrs.	M
2014	SMR / BOW / REF	SMR / BOW / REF	0.04	LPBK	WHDP/Mgo	≥ 2 yrs.	M
2014	SMR / KEN / 14REF	SMR / HW06 / REF	0.03	DPWH/Mgo	WHDP	≥ 2 yrs.	M
2014	SMR / WHI / 14REF	SMR / HW01 / REF	0.03	OROR/Mgo	DGOR	≥ 2 yrs.	M
2014	SMR / ES11	SMR / ES02	0.03	DPDP/Mgo	PUPU	≥ 4 yrs.	M
2014	SMR / BS11	SMR / BS05	0.03	PUOR	ORPU/Mgo	2 yrs.	M
2014	SMR / UM09	SMR / UM29	0.03	WHWH/Mdb	WHDB	≥ 5 yrs.	M
2014	SMR / EMB	SMR / PRS11	0.02	BYST/Mdb	DBDP	3 yrs.	M
2014	SMR / POE	SMR / PRS21	0.02	BKBK	ORDG/Mgo	≥ 4 yrs.	M
2014	SMR / ES27	SMR / ES41	0.02	DPWH/Mgo	WHWH	≥ 4 yrs.	M
2014	SMR / FUR / REF	SMR / FUR / REF	0.02	YEYE/Mgo	PUWH	≥ 2 yrs.	M
2014	SMR / AW07	SMR / AW12	0.02	WHDP	OROR/Mgo	2 yrs.	M
2014	SMR / ARI / PF	SMR / ARI / PF	0.02	DGOR/Mgo	ORPU	≥ 3 yrs.	M
2014	SMR / DEU / PF	SMR / DEU / PF	0.02	OROR/Mgo	WHWH	≥ 4 yrs.	M
2014	SMR / SHA / 14REF	SMR / HW02 / REF	0.02	BYST/Mgo	PUPU	≥ 2 yrs.	M
2014	SMR / AE85	SMR / AE22	0.02	DGOR	WHPU/Mgo	3 yrs.	M
2014	SMR / FIN / REF	SMR / FIN / REF	0.02	LPBK/Mgo	LPBK	≥ 2 yrs.	M
2014	SMR / CKI	SMR / ES50	0.02	DPDP	YEYE/Mgo	≥ 6 yrs.	M
2014	SMR / BER / PF	SMR / BER / PF	0.02	PUOR	DGOR/Mgo	≥ 2 yrs.	M
2014	SMR / PUD	SMR / ES36	0.01	BYST/Mgo	WHWH	≥ 4 yrs.	M
2014	SMR / QIN / PF	SMR / QIN / PF	0.01	BKLP/Mgo	PUPU	≥ 2 yrs.	M
2014	SMR / TRF	SMR / ES49	0.01	YEPU/Mgo	DPDP	≥ 6 yrs.	M
2014	SMR / MER / REF	SMR / MER / REF	0.00	Mgo	WHDP	≥ 6 yrs.	M
2013	SMR / STR	SMR / CLE / REF	5.56	WHDP	BKLP/Mgo	2 yrs.	F
2013	MCAS / NEV	SMR / HOL / REF	3.00	PUOR	BKLP/Mgo	2 yrs.	F
2013	SMR / HDX / REF	SMR / AE04	2.00	ORDG	WHPU/Mgo	2 yrs.	F
2013	SMR / SM MAPS	SMR / BN26	0.85	LPBK	LPBK/Mgo	2 yrs.	F
2013	SMR / HOL / REF	SMR / BOW / REF	0.75	WHDP	PUPU/Mgo	2 yrs.	F
2013	SMR / FAU / PF	SMR / DAT / PF	0.22	ORDG	OROR/Mgo	2 yrs.	F
2013	SMR / ES01	SMR / ES02	0.14	LPBK/Mgo	PUPU	3 yrs.	F
2013	SMR / FUR / REF	SAR / PRADO	71.66	LPBK	DGOR/Mgo	2 yrs.	M
2013	MCAS / BEA	SMO / MB01	23.91	WHDP	DGOR/Mgo	2 yrs.	M
2013	SLR / WRAD	SMR / 2202	6.61	DPWH	YEYE/Mdb	2 yrs.	M
2013	SMR / TOF	SMR / PO07	1.65	BYST	BKBK/Mgo	2 yrs.	M
2013	SMR / CKI	SMR / ES25	0.95	WHDP	WHDP/Mgo	2 yrs.	M
2013	SMR / CKE	SMR / PRS22	0.47	PUOR	ORDG/Mgo	2 yrs.	M
2013	SMR / AW12	MCAS / QID	0.39	DPWH	OROR/Mgo	≥ 4 yrs.	M
2013	SMR / AE09	SMR / AE06	0.06	WHPU	Mgo	≥ 6 yrs.	M

Appendix E. Continued.

Year Last Det.	Drainage / Territory / Treatment[1]		Dist. Moved (km)	Band Combination[2]		Age in 2015 (yrs.)	Sex[3]
	Last Seen	2015		Left Leg	Right Leg		
2013	SMR / PR56	SMR / PRS06	0.01	PUPU	BKBK/Mdb	≥ 5 yrs.	M
2013	SMR / SM03	SMR / SM07	0.15	DGOR/Mgo	DPDP	≥ 3 yrs.	U
2013	SMR / SM10	SMR / SM10	0.00	LPBK	PUWH/Mgo	4 yrs.	U
2012	SMR / DRK / PF	SMR / BN38	9.54	BKLP/Mgo	WHDP	3 yrs.	F
2010	SMR / MER / REF	SMR / TEN / PF	3.33	pupu	DGOR/Msi	≥ 7 yrs.	F
2008	SMR / DAQ / REF	SMR / LEM / PF	4.74	DGOR/Mgo	ORDG	7 yrs.	M

[1] Drainage Codes: DL = De Luz Creek; FC = Fallbrook Creek; LF = Las Flores Creek; MCAS = Marine Corps Air Station; PD = Piedra de Lumbre Canyon; SAR = Santa Ana River; SLR = San Luis Rey River; SMR = Santa Margarita River; SMO = San Mateo Creek; WC = Windmill Creek; DL MAPS = De Luz MAPS Station; SM MAPS = Santa Margarita MAPS Station; Treatment Codes: 14REF = Reference in 2014; PF = Post-fire; REF = Reference; .

[2] Band colors: Mdb = dark blue numbered federal band; Mgo = gold numbered federal band; Msi = silver numbered federal band; gogo = metal gold; pupu = metal purple; 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; DPDP = plastic dark pink; DPWH = plastic dark pink-white split; LPBK = plastic light pink-black split; ORDG = plastic orange-dark green split; 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, 2015

Post-fire Site Territories

Territory	Nest	Monitoring[1]	Nest Fate[2]	# Fledged	Comments
ANT	1	F	PRE		
ANT	2	F	PRE		
ARI	1	F	PRE		
ARI	2	F	INC		Nest support failed while still under construction.
ARI	3	F	SUC	3	
AXE	1	F	PRE		Nestlings depredated by ants.
AXE	2	F	SUC	4	
AXE	3	F	PRE		
BAD	1	F	UNK		Nest completed but no eggs confirmed.
BAD	2	F	SUC	4	
BAD	3	F	PRE		
BAD	4	F	PRE		
BER	1	F	PRE		
BER	2	F	PRE		Eggs broken in nest.
BER	3	F	OTH		Nest failed after rain storm. Nest found hanging from branch with one egg on the ground and two eggs in the nest.
BER	4	F	SUC	3	
CED	1	F	SUC	1	One nestling disappeared between hatching and banding.
CED	2	F	INC		
CED	3	F	SUC	2	
CRE	1	F	PRE		One nestling disappeared between hatching and banding. One egg did not hatch.
DAT	1	F	SUC	3	One egg disappeared during incubation.
DAT	2	F	PRE		
DAT	3	F	SUC	3	
DEU	1	F	SUC	3	
DEU	2	F	SUC	3	
DRK	1	F	PRE		Nest failed with one egg in nest and one egg on ground.
DRK	2	F	PRE		
DRK	3	F	INC		
DRK	4	F	UNK		Nest abandoned with nestlings.
FOX	1	F	PRE		Found two dead nestlings, one with head puncture, in nest at failure. One nestling was missing.
FOX	2	F	PRE		
HED	1	F	PRE		
HED	2	F	UNK		Nest completed but no eggs confirmed.
HED	3	F	PRE		
HED	4	F	SUC	2	One egg did not hatch.
JAG	1	F	PRE		
JAG	2	F	INC		
JAG	3	F	SUC	2	One egg did not hatch.
JSP	1	F	SUC	3	
JSP	2	F	PRE		
JSP	3	F	SUC	3	

Post-fire Site Territories (continued)

Territory	Nest	Monitoring[1]	Nest Fate[2]	# Fledged	Comments
KOA	1	F	SUC	2	One egg did not hatch.
KOA	2	F	PRE		
LEM	1	F	SUC	3	
LEM	2	F	SUC	3	
MRT	1	F	PRE		
MRT	2	F	SUC	3	
OCE	1	F	PRE		
JSP	3	F	SUC	3	
PEP	1	F	PRE		
PEP	2	F	PRE		
PEP	3	F	PRE		Adult female dead on ground with a head puncture, and a dead nestling on the ground below the nest at failure.
PIK	1	F	PRE		
PIK	2	F	SUC	2	One egg did not hatch.
PUC	1	F	PRE		
PUC	2	F	UNK		Nest completed but no eggs confirmed.
PUC	3	F	PRE		
QIN	1	F	SUC	3	
QIN	2	F	SUC	2	
SER	1	F	UNK		Nest completed but no eggs confirmed.
SER	2	F	PRE		One egg disappeared during incubation.
SER	3	F	PRE		One egg left in nest on fail date.
TEN	1	F	PRE		One nestling found dead on banding date, One nestling found dead and third nestling missing on fail date. Ants were also predating nest. Likely failed during rain.
TEN	2	F	PRE		
TEN	3	F	PRE		
UNI	1	F	OTH		All three nestlings found dead in nest, probably a result of rainstorm.
UNI	2	F	PRE		
VLE	1	F	PRE		Nest on ground at failure.

Reference Site Territories

Territory	Nest	Monitoring[1]	Nest Fate[2]	# Fledged	Comments
ARY	1	F	UNK		Nest abandoned with one (only) egg.
ARY	2	F	PRE		
ARY	3	F	SUC	3	
BAE	1	F	PRE		
BAE	2	F	PRE		
BAE	3	F	PRE		One egg did not hatch.
BAT	1	F	UNK		Nest completed but no eggs confirmed.
BAT	2	F	PRE		
BAT	3	F	PRE		
BAT	4	F	SUC	3	

Reference Site Territories (continued)

Territory	Nest	Monitoring[1]	Nest Fate[2]	# Fledged	Comments
BIL	1	F	PRE		
BIL	2	F	INC		
BIL	3	F	SUC	2	
BOW	1	F	PRE		Nest on ground at failure.
BOW	2	F	PRE		
BOW	3	F	PRE		Two eggs broken in nest and ants present at failure.
BRA	1	F	OTH		Nest support failed.
CLE	1	F	INC		
CLE	2	F	UNK		Nest completed but no eggs confirmed.
CLE	3	F	SUC	1	One egg did not hatch and one nestling missing on banding day.
CLE	4	F	SUC	3	
DAQ	1	F	PRE		
DAQ	2	F	SUC	2	
DAQ	3	F	INC		
DAQ	4	F	PRE		
DAQ	5	F	SUC	4	
DRO	1	F	OTH		Eggs did not hatch, likely infertile.
DRO	2	F	SUC	2	
FIN	1	F	UNK		Nest completed but no eggs confirmed.
FIN	2	F	PRE		
FIN	3	F	SUC	1	Nest partially depredated during laying and incubation.
FKI	1	F	PRE		
FKI	2	F	INC		
FKI	3	F	PRE		
FUR	1	F	INC		
FUR	2	F	FAL		Male building a nest, no female observed.
HDX	1	F	INC		
HDX	2	F	UNK		Nest completed but no eggs confirmed.
HDX	3	F	SUC	3	
HLD	1	F	PRE		
HLD	2	F	SUC	3	
HOL	1	F	PRE		
HOL	2	F	PRE		Eggshells found on the ground below nest on failure date.
HOL	3	F	PRE		
HOL	4	F	PRE		One egg did not hatch.
HOU	1	F	PRE		
HOU	2	F	PRE		One egg was infertile.
HOU	3	F	PRE		
KHA	1	F	OTH		Eggs did not hatch, likely infertile.
KHA	2	F	SUC	2	One egg did not hatch, likely infertile.
KNG	1	F	SUC	3	
KNG	2	F	SUC	3	
MER	1	F	UNK		Nest abandoned with one (only) egg.

Reference Site Territories (continued)

Territory	Nest	Monitoring[1]	Nest Fate[2]	# Fledged	Comments
MOR	1	F	UNK		Nest completed but no eggs confirmed.
ODN	1	F	INC		
ODN	2	F	SUC	3	
REM	1	F	SUC	3	
SAN	1	F	UNK		Nest completed but no eggs confirmed.
SAN	2	F	UNK		Nest completed but no eggs confirmed.
SAN	3	F	INC		
SAN	4	F	PRE		
SAN	5	F	UNK		Nest abandoned with eggs, mites on eggs.
SAN	6	F	INC		
SAN	7	F	PRE		One egg missing on hatch date. Mites on eggs but hatched successfully.
SNO	1	F	SUC	4	
SNO	2	F	PRE		
TYR	1	F	PRE		Nest branch broken on fail date so likely was predated.
TYR	2	F	UNK		Nest completed but no eggs confirmed.
TYR	3	F	SUC	3	
WIN	1	F	UNK		Nest completed but no eggs confirmed.
WIN	2	F	SUC	3	
WSP	1	F	OTH		Nest abandoned with nestlings likely a result of heavy rains the day before they were expected to fledge.
WSP	2	F	SUC	3	
ZYL	1	F	PRE		
ZYL	2	F	INC		
ZYL	3	F	SUC	3	

[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.