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

2014 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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TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES CONTINUED

LIST OF FIGURES

LIST OF FIGURES CONTINUED

LIST OF FIGURES CONTINUED

LIST OF APPENDICES

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 31 March and 14 July 2014. Drainages containing riparian habitat suitable for vireos were surveyed two to four times. Six hundred and thirty-four male vireos and 37 transient vireos were detected. An additional 83 male vireos were initially detected within the perimeter of a wildfire that burned vireo habitat mid-May 2014 and perished or were displaced by the wildfire. Territorial vireos were detected on 20 out of the 23 drainages/sites surveyed. Ninety-two percent of all vireo territories occurred on the six most populated drainages, with the Santa Margarita River containing 65% of all territories on Base. Sixty-nine percent of male vireos were confirmed as paired.

The number of documented Least Bell's Vireo territories on MCBCP (634) decreased 12% from 2013 to 2014. The number of territories on 30% (7/23) of drainages surveyed increased by 1-3 territories from 2013, while 30% of drainages (7/23) decreased by three or more territories, and 39% of drainages (9/23) showed no change or decreased by two or fewer territories.

The decrease in vireo numbers on MCBCP (12%) was inconsistent with population changes in surrounding areas, including the lower San Luis Rey River (decreased by 3%), the middle San Luis Rey River (increased by 53%), and MCAS (increased by 13%) suggesting local conditions specific to MCBCP influenced the MCBCP population. The most likely negative influence on the MCBCP population was wildfire that occurred in May 2014. The vireos that were detected within the wildfire perimeter before the fire either perished or were displaced to other vireo habitat, thereby contributing to increases in vireo numbers in surrounding areas. The immediate negative influence of wildfire on vireos within the wildfire perimeter will likely be temporary as early successional vegetation responds to winter rainfall, revegetating the burned landscape and providing suitable breeding habitat for vireos in spring 2015.

The majority of vireo territories occurred in habitat characterized as willow riparian, with 76% of males in the study area found in this habitat. An additional 15% of birds occupied willow (*Salix* spp.) habitat co-dominated by sycamores (*Platanus racemosa*) or cottonwoods (*Populus fremontii*). Five percent of territories were found in riparian scrub dominated by mule fat (*Baccharis salicifolia*) and/or sandbar willow (*S. exigua*). Two percent or fewer vireos used drier habitats characterized by a mix of sycamores and oaks (*Quercus agrifolia*), upland scrub, and non-native vegetation.

In October 2013, a wildfire burned a large section of the upper Santa Margarita River and De Luz Creek. 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. Exotic and herbaceous species comprised > 50% of the vegetation under 1 m and almost 35% 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), the fire was

less severe at Las Flores Creek as documented by lower burn severity indices, and also demonstrated by greater vegetation cover at all height categories.

Two hundred and seven Least Bell's Vireos were banded for the first time during the 2014 season. These included 59 adult vireos and 148 hatch-year vireos. All adult vireos and seven hatch-year birds were banded with unique color combinations. The remaining 141 hatch-year vireos (all nestlings) were banded with a single gold numbered federal band on the left leg.

Ninety-nine Least Bell's Vireos banded prior to the 2014 breeding season were resighted and identified on Base in 2014. Sixteen of these were originally banded on the San Luis Rey River, two were originally banded at Marine Corps Air Station, Camp Pendleton (MCAS), and the remaining birds were banded at MCBCP. Adult birds of known age ranged from 1-8 years old. Adult survivorship, or the proportion of individuals known to survive from 2013 to 2014, was 53% (79/149). Survivorship of first-year birds that fledged from MCBCP in 2013 and were documented on Base or elsewhere in 2014 was 8% (14/181), based on the number of uniquely banded individuals detected. Of the 14 first-year vireos detected in 2014, ten were male and four were female.

The majority of returning adult vireos showed strong between-year site fidelity. Overall vireo territory fidelity between 2013 and 2014 was 68% (41/60). The average between-year movement for returning adult vireos was 0.6 ± 3.3 km (standard deviation [SD]). The 14 first-year vireos detected in 2014 that fledged from known nests on MCBCP in 2013 dispersed 4.1 ± 2.6 km to their 2014 breeding locations.

We monitored Least Bell's Vireo nests to evaluate the effects of giant reed removal on survivorship, nest success, and productivity. Vireos were monitored at two sites where giant reed (*Arundo donax*) was removed in 2008 (Removal sites) and two sites where giant reed was removed 15-17 years ago (Reference sites). Most of one of the Reference sites burned in mid-May 2014; however, we continued to use the occupied habitat within this site as a Reference. In a secondary study, we began monitoring Least Bell's Vireo nests in 2014 at two additional sites that were burned in the October 2013 wildfire (Post-fire sites) and compared them to the Reference sites described above. Survivorship calculations for Post-fire sites will be presented in subsequent years. We also compared nest success and productivity at the Above Hospital South site before and after it burned in the October 2013 wildfire.

Adult survivorship of vireos at Removal sites and Reference sites was 72% and 54%, respectively. First-year survivorship was 8% and 10%, respectively. One hundred percent of adults from Removal sites that were detected in both 2013 and 2014 returned in 2014 to the same territory occupied in 2013. Eighty percent (12/15) of adult vireos detected in 2013 Reference sites returned to the same site (five to Below Hospital East and seven to Above Hospital South). One male nestling from a 2013 Removal site returned to occupy a breeding territory at a Reference site in 2014. One female nestling from a Reference site in 2013 returned to occupy a Post-fire site in 2014. The remaining 12 vireos that fledged from Removal and Reference sites in 2013 dispersed to areas outside of monitoring sites.

Three vireos (all females) that originated at MCBCP moved off-Base and were detected elsewhere in 2014. All three of these vireos were banded originally as nestlings in 2013 on MCBCP and were re-detected on the San Luis Rey River in 2014.

Nesting activity was monitored between 1 April and 24 July in 76 territories within the Removal, Post-fire, and Reference monitoring sites. Sixty-nine territories were "fully" monitored, 68 of which were occupied by pairs and one of which was occupied by a single male. One hundred and seventy-two nests (68 in Removal sites, 57 in Post-fire sites, and 47 in Reference sites) were monitored during the monitoring period.

Completed nests at Removal sites were no less likely to be successful than nests at Reference sites in 2014. Twenty-nine percent (17/58) of Removal nests and 23% (10/44) of Reference nests successfully fledged young. Predation was believed to be the primary source of nest failure at both sites. Predation accounted for 73% (30/41) and 62% (21/34) of nest failures at Removal and Reference sites, respectively. Of the remaining 24 nests that failed, causes of failure were attributed to burned nests, human disturbance, inviable eggs, collapse of host plant, and other unknown reasons. No nest parasitism of Least Bell's Vireos by Brown-headed Cowbirds (*Molothrus ater*) was documented in 2014.

Productivity per pair was low for both Removal and Reference sites and did not differ between sites (1.4 versus 1.5 young per pair). Similarly, of the proportion of Removal pairs that successfully fledged at least one young did not differ from the proportion of Reference pairs in 2014 (58% versus 50%).

Over the past 5 years, the average clutch size at Removal and Reference sites ranged from 3.1 to 3.7, and was significantly greater over all sites in 2010 than in 2012 and 2014, and also greater in 2013 than 2014. The average number of young fledged per pair ranged from 1.4 to 4.2 at Removal sites and 1.5 to 3.0 at Reference sites. The average number of young fledged per pair differed between sites and between years, with Removal sites fledging more young per pair than Reference sites, and significantly more young fledged per pair in 2010 and 2013 than in 2014. Similarly, nests at Removal sites were more likely to successfully fledge young than nests at Reference sites.

Breeding productivity was lower in 2014 than in previous years at both Removal and Reference sites. Low vireo breeding productivity in 2014 may be attributed potential low prey numbers as a result of a multi-year drought in San Diego County.

Completed nests at Post-fire sites were no less likely to be successful than nests at Reference sites in 2014. Twenty-one percent (10/48) of Post-fire nests and 23% (10/44) of Reference nests successfully fledged young. Predation was believed to be the primary source of nest failure at both sites. Predation accounted for 74% (28/38) and 62% (21/34) of nest failures at Post-fire and Reference sites, respectively. Of the remaining ten nests that failed, causes of failure were attributed collapse of host plant and other unknown reasons. No nest parasitism of Least Bell's Vireos by Brown-headed Cowbirds was documented in 2014.

Productivity per pair was low for both Post-fire and Reference sites and did not differ between sites (1.2 versus 1.5 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 2014 (42% versus 50%).

Clutch size, the proportion of hatchlings that fledged, the number of fledglings per pair, the proportion of nests that were successful, and the proportion of pairs that successfully fledged young did not differ at the Above Hospital South site in the years before the October 2013 wildfire compared to 2014 (after the wildfire). However, the proportion of eggs that hatched was lower after the wildfire. Before the wildfire, 13 nests failed for reasons other than predation, one of which (8%) failed as a result of collapsed nest host plant. After the fire, all four of the nests that failed for reasons other than predation (100%) were built in poison hemlock (*Conium maculatum*) and failed when the host plant desiccated and collapsed.

In 2014, successful and unsuccessful nests within Removal and Reference sites were similar in placement. Vireo nests at Removal sites were placed higher in the host plants, in taller host plants, further from the edge of the host plant, and further from the edge of the riparian vegetation than nests in Reference sites. Twelve plant species were used as hosts for vireo nests in 2014. Seventy-nine percent of all nests were placed in arroyo willow (*S. lasiolepis*), sandbar willow, or mule fat.

Over the past 5 years, vireos at Removal sites consistently built nests higher in host plants, in taller host plants, further from the edge of the host plant, and further from the edge of the vegetation clump surrounding the host plant than vireos at Reference sites.

In 2014, successful nests at Post-fire sites were placed in taller host plants and further from the edge of the host plant than unsuccessful nests. Vireo nests at Post-fire sites were similar in placement to nests at Reference sites except nests at Post-fire sites were placed lower in host plants than nests at Reference sites. Fourteen plant species were used as hosts for vireo nests at Post-fire and Reference sites in 2014. Fifty-eight percent of these nests were placed in arroyo willow, sandbar willow, or mule fat.

Vireo nest placement at the Above Hospital South site was similar before and after the October 2013 wildfire except the average height of the nest host plant was lower post-fire than it was pre-fire.

The density of vireo territories increased at Removal and Reference sites from 2013 to 2014, although territory density at Reference sites remained below the highest density recorded in 2009. Territory density at the Removal sites increased almost to the highest recorded density observed in 2010. Vireo territory density at the Post-fire sites was significantly lower than at the Reference sites, and did not change significantly from before the fire.

Strong site fidelity by adult vireos continued in 2014 at Removal and Reference sites, including the Above Hospital South site that burned in October 2013. Most of the adults returned to their 2013 breeding territories at the burned site, with two others re-detected just upstream and just downstream of the site.

Over the 5 years of the giant reed removal study, Removal sites had higher breeding productivity than Reference sites. This suggests that vireo habitat continues to improve at the Removal sites and that vireos have responded positively. The difference between Removal and Reference sites disappeared in 2014 when productivity was low across all sites. Low productivity may be a result of continued drought conditions in San Diego County.

A high proportion of nests that failed in the Post-fire site failed as a result of nest host plant collapse. Exotic and native herbaceous vegetation comprised a high proportion of the vegetation structure below 2 m, where vireos typically build their nests. During dry years, these annual plants are prone to desiccation as the season progresses. The preponderance of exotic annuals at burned and disturbed sites may create a short-term ecological sink for species such as the vireo that readily use these plants as support substrates for their nests. However, these annual plants also provide a temporary refuge for birds early in the breeding season while the native, traditional nest host plants develop to accommodate later, more successful nests.

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 wildfire events occurred on MCBCP since the end of the 2013 breeding season. One occurred during 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, and burned 8,906 ha on MCBCP. Eight hundred and thirty-seven ha of riparian habitat burned, much of which was occupied during the 2014 vireo breeding season. 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 the October 2013 wildfire and an analysis and discussion of vireo response to the May 2014 wildfires as possible.

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 short-term effects of giant reed removal on vireo fecundity, nest success, and productivity by intensively monitoring vireos within established nest monitoring sites that had recently undergone giant reed removal (2008) and at reference sites in which giant reed had been removed 15-17 years earlier, between 1997 and 1999, (5) assess the effects of the wildfires on vireos by measuring vireo fecundity, nest success, and productivity by intensively monitoring vireos within newly established nest monitoring sites that burned in October 2013 (sections of the Santa Margarita River and De Luz Creek) compared to the reference sites used to achieve goal 4, and (6) document the vegetation structure and plant composition during the first 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 31 March and 14 July 2014 (Fig. 1). Field work was conducted by USGS biologists Katie Allen, Lisa Allen, PJ Falatek, Aaron Gallagher, Jonathan Gunther, Scarlett Howell, Angela Johnson, Barbara Kus, Suellen Lynn, Melanie Madden, Brandon Miller, Eric Nolte, Jason Pietrzak, Devin Taylor, Anne Winters, and Ben Zyla. 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. 19, Fig. 20).
   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. 19).

2. ***De Luz Creek,*** between the confluence of the Santa Margarita River with the Base boundary (Appendix A, Fig. 19).

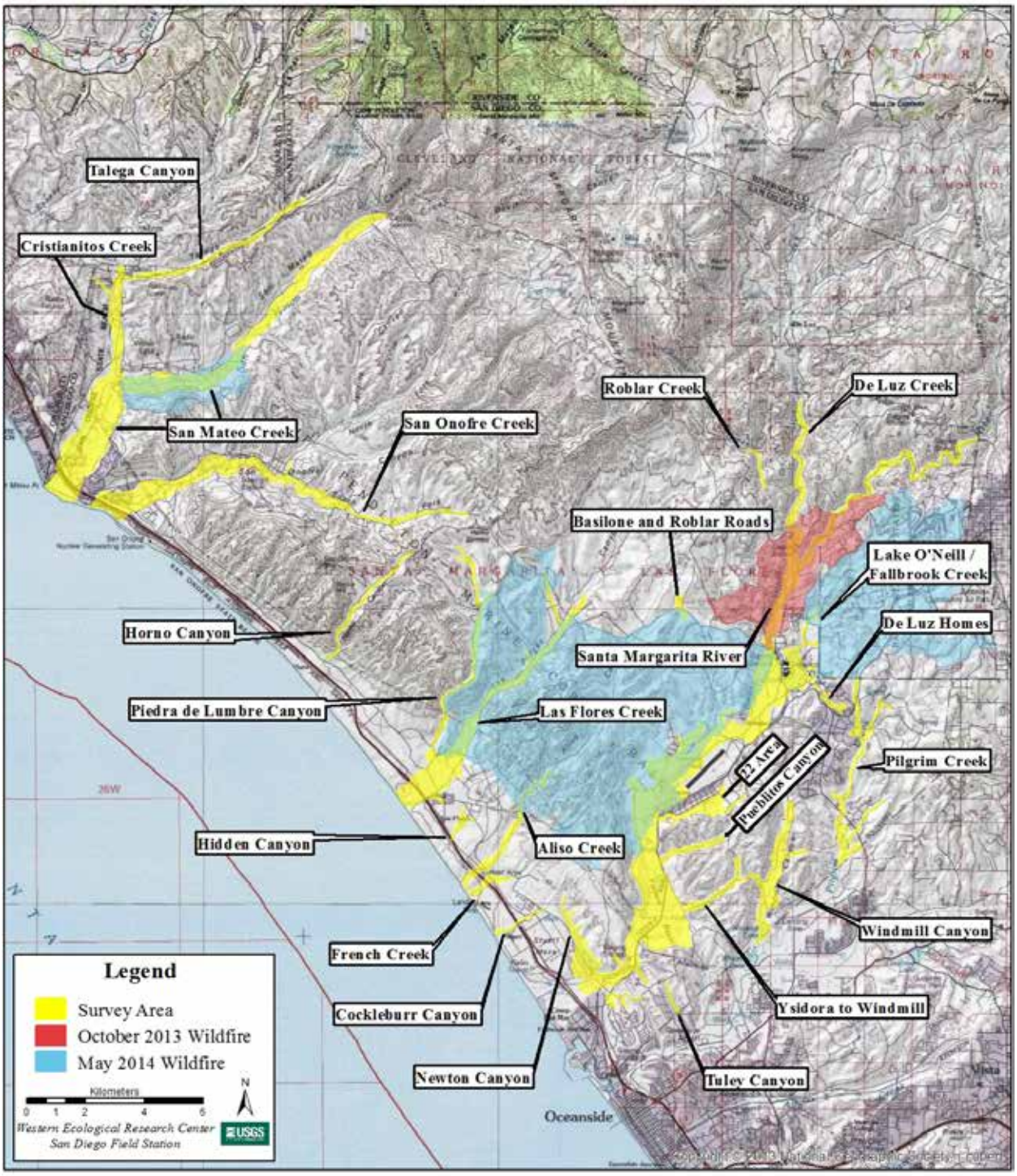

Fig. 1. Least Bell's Vireo survey areas at Marine Corps Base Camp Pendleton, 2014.

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. 19).

4. ***Lake O'Neill/Fallbrook Creek:***
   a. All riparian habitat around Lake O'Neill (Appendix A, Fig. 19).
   b. Between Lake O'Neill and the Base boundary with FNWS (Appendix A, Fig. 19).

5. ***Basilone and Roblar Roads,*** a small patch of habitat straddling Basilone Road at the intersection of Basilone and Roblar Roads (Appendix A, Fig. 19).

6. ***22 Area,*** all riparian habitat within the 22 Area, east of Vandegrift Road and the Supply Depot (Appendix A, Fig. 20).

7. ***Pueblitos Canyon,*** between Vandegrift Road and a point approximately 2.5 km upstream (Appendix A, Fig. 20).

8. ***Tuley Canyon,*** between the Base boundary and a point approximately 1.1 km upstream (Appendix A, Fig. 20).

9. ***Newton Canyon,*** between the confluence with the Santa Margarita River and the upstream limit of riparian habitat (Appendix A, Fig. 20).

10. ***Cockleburr Canyon,*** between the Pacific Ocean and a point 0.25 km east of Interstate 5 (Appendix A, Fig. 20).

11. ***French Creek,*** between the Pacific Ocean and the Edson Range Impact Area (Appendix A, Fig. 20).

12. ***Aliso Creek,*** between the Pacific Ocean and 0.5 km upstream of the electrical transmission lines (Appendix A, Fig. 20).

13. ***Hidden Canyon,*** between Interstate 5 and Stuart Mesa Road (Appendix A, Fig. 21).

14. ***Las Flores Creek (within Las Pulgas Canyon):***
   a. Between Stuart Mesa Road and the high voltage electrical transmission lines (Appendix A, Fig. 21).
   b. Between the Pacific Ocean and Stuart Mesa Road (Appendix A, Fig. 21).
   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. 21).

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. 21).

16. Horno Canyon, between Old Highway 101 and the upstream limit of riparian habitat (Appendix A, Fig. 21).

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. 21, Fig. 22).
b. From Basilone Road upstream to the access road to Range 219 (Appendix A, Fig. 21).

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. 22).
b. From San Mateo Road upstream to the Base boundary (Appendix A, Fig. 22, Fig. 23).

19. Cristianitos Creek, between the confluence with San Mateo Creek and the Base boundary (Appendix A, Fig. 22).

20. Talega Canyon, between the confluence with Cristianitos Creek and a point approximately 6.5 km upstream (Appendix A, Fig. 22).

21. Pilgrim Creek:

a. Between the southern Base boundary and Vandegrift Boulevard, including the two side drainages east of Pilgrim Creek (Appendix A, Fig. 24).
b. From Vandegrift Boulevard upstream to the limit of riparian habitat (Appendix A, Fig. 24).

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. 24).

23. Ysidora Basin to Windmill Canyon, between Upper Ysidora Basin and Windmill Canyon/ Pueblitos Canyon (Appendix A, Fig. 24).

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

The majority of drainages were surveyed from 3-4 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/Fallbrook Creek (4a), Cockleburr Canyon, Aliso Creek, Las Flores Creek, San Onofre Creek (17a), San Mateo Creek (18a), Cristianitos Creek, Talega Canyon, and Pilgrim Creek (21a). Sites surveyed three times were: Basilone and Roblar Roads, 22 Area, Pueblitos Canyon, Tuley Canyon, Newton Canyon, French Creek, Hidden Canyon, Horno Canyon, Piedra de Lumbre Canyon, San Onofre Creek (17b), San Mateo Creek (18b), 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. Generally, birds were considered transients if they were not detected on two or more consecutive surveys after an initial detection. However, vireos that occupied territories that burned during the May 2014 wildfires (see below) and were not detected again after the fire were considered transients because it is possible that they were displaced by the fire and detected elsewhere in subsequent surveys. To indicate that these territories were affected by fire, the breeding status of these territories was recorded as "fire-displaced" transient. 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 March 2014 and in August 2014 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 canopy height 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. In 2014, canopy height was measured for the tallest vegetation (alive or dead) and for live vegetation to differentiate between standing burned snags (presumably near the pre-fire canopy height) and actual live foliage canopy height post-fire. 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).

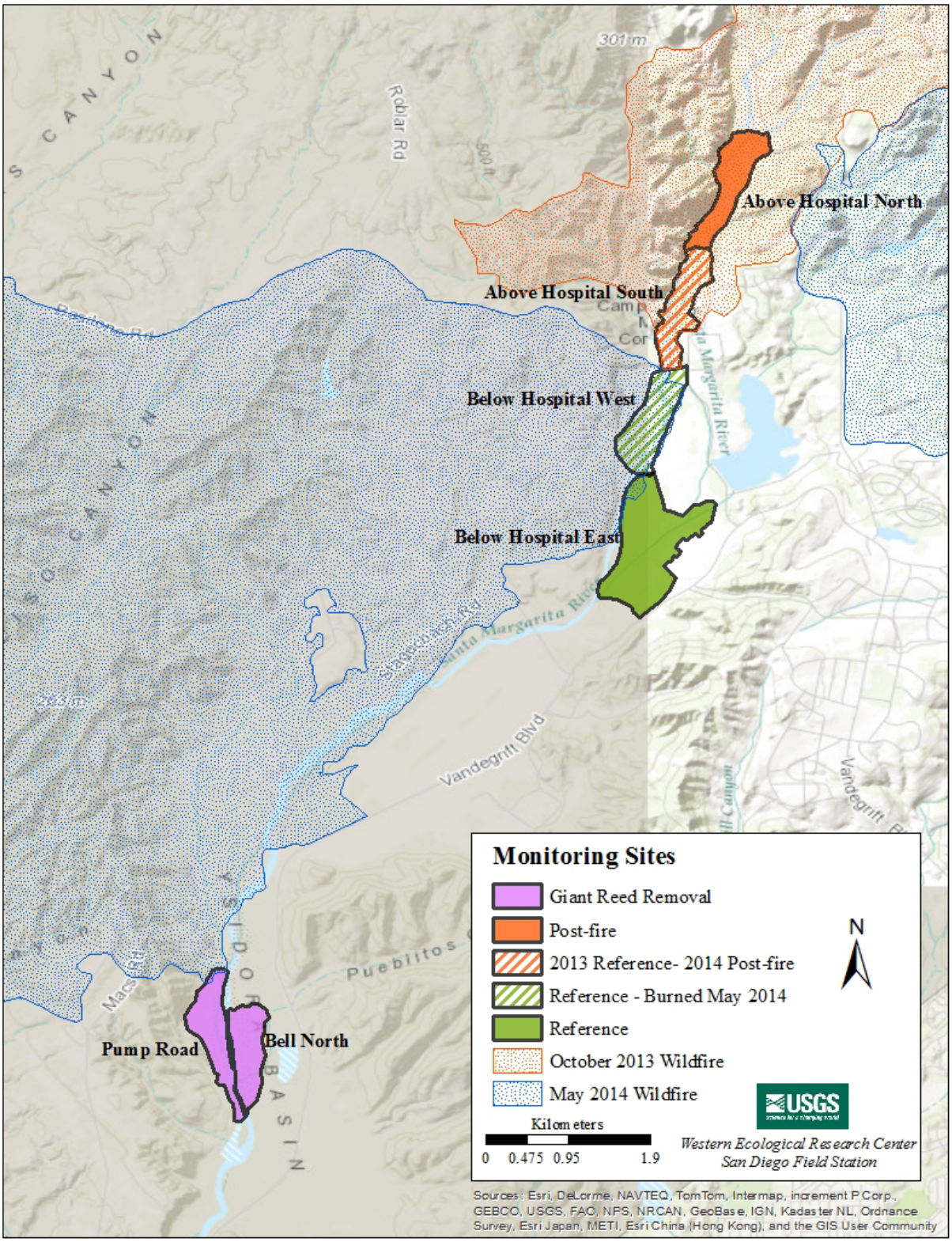
Above Hospital North
Above Hospital South
Below Hospital West
Below Hospital East
Pump Road
Bell North
Monitoring Sites
Giant Reed Removal
Post-fire
2013 Reference- 2014 Post-fire
Reference - Burned May 2014
Reference
October 2013 Wildfire
May 2014 Wildfire
N
Kilometers
0 0.475 0.95 1.9
USGS
Western Ecological Research Center
San Diego Field Station
Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), and the GIS User Community

Fig. 2. Location of Least Bell's Vireo giant reed Removal, Post-fire, and Reference study sites at Marine Corps Base Camp Pendleton, 2014.

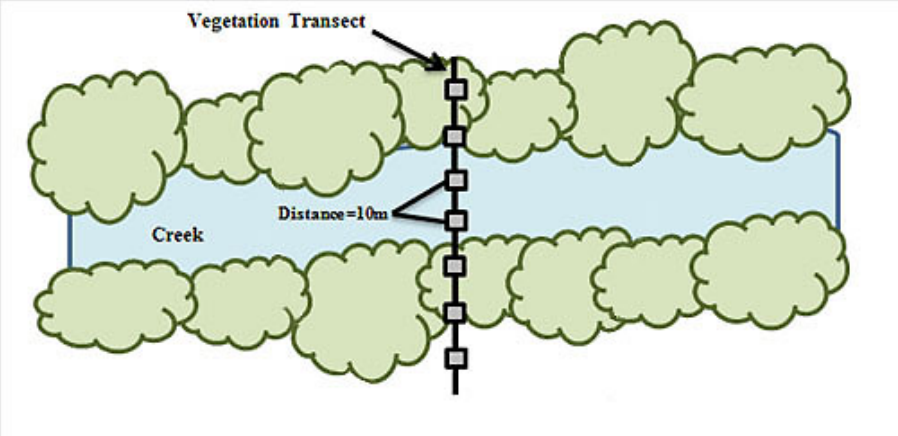

Fig. 3. Schematic diagram of a vegetation sampling transect.

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

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

Burn Severity[a]:	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.

[a] Famolaro 2008.

We compared BSI and vegetative cover at the Post-fire site with vegetation data collected at Las Flores Creek August 2008, following a wildfire that burned in October 2007 (Ferree et al. 2012b).

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 giant reed removal and wildfire affect 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 Removal, 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. 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 2013-2014 was calculated for known individuals that were: (1) adults in 2013 on Base and were resighted anywhere on Base in 2014; (2) adult vireos that held territories in Removal or Reference sites in 2013 and were resighted anywhere on Base in 2014; (3) first-year vireos that were banded as nestlings or juveniles anywhere on Base in 2013 and were resighted anywhere in 2014 (including off-Base); and (4) first-year vireos that were banded as nestlings or juveniles in Removal or Reference sites in 2013 and were resighted anywhere in 2014. 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 Removal 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 2013 and the center of the same vireo's breeding territory in 2014. Vireos exhibited site fidelity if they returned to within 100 m of their 2013 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 2014 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 twofold: to evaluate how vireo nest success and productivity were affected by (1) giant reed removal and the recovery of riparian habitat in those areas over 5 years (2010-2014), and (2) alteration of vireo habitat by the October 2013 wildfires. Therefore, we monitored vireo nests at three categories of sites: (1) giant reed removal sites (Removal sites), (2) post-October 2013-fire sites (Post-fire sites), and (3) reference sites (Reference sites) which were compared with both Removal sites and Post-fire sites. As a result of the 2013 and 2014 wildfires, some of our study sites changed categories between (and within) years (see Table 2).

Table 2. Least Bell's Vireo study site categories from 2005 to 2014, Marine Corps Base Camp Pendleton.

	Study Years		
Site Location	**2005-2009**	**2010-2013**	**2014**
Below Hospital West	-	-	Reference, burned in May 2014[a]
Below Hospital East	Reference	Reference	Reference
Bell	-	Giant reed Removal	Giant reed Removal
Pump Road	-	Giant reed Removal	Giant reed Removal
Above Hospital North	-	-	Post-fire
Above Hospital South	Reference	Reference	Post-fire

[a] Seven Least Bell's Vireo territories that remained active after the mid-May 2014 wildfire were included in Reference site data.

Giant Reed Removal

Giant reed is a highly invasive, non-native plant within riparian systems in southern California. Originally introduced for bank stabilization in the 1800s, giant reed has become a major component of many riparian systems, becoming the dominant vegetation within streams and rivers. As part of a riparian restoration effort, MCBCP has been removing large quantities of giant reed on the Santa Margarita River. Areas that have recently undergone giant reed removal tend to consist of patches of native woody plants surrounded by areas of bare earth. These open areas are typically populated by native and non-native herbaceous plants until the appropriate

conditions arise that allow for the establishment of native woody species, such as mule fat, sandbar willow, black willow, arroyo willow, and red willow.

In Fall 2008, giant reed was cleared in an area within the Santa Margarita River drainage downstream of Marine Corps Air Station, Camp Pendleton (MCAS; Fig. 2). In 2010, we began monitoring vireos within two monitoring areas inside this extensive clearing (hereafter "Removal" sites; Fig. 2).

October 2013 Wildfire

In October 2013, wildfires burned approximately 1350 ha encompassing the upper Santa Margarita River and the lower section of De Luz Creek on MCBCP (Fig. 2). Approximately 350 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 breeding habitat for Least Bell's Vireo. We used this opportunity to evaluate the response of vireos to the recovery of riparian vegetation after wildfire.

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

Reference Sites

Our vireo monitoring reference sites for 2014 included one site that has been used as a Reference site since 2005 (Below Hospital East, Table 2, Fig. 2). We established a new Reference site in 2014 at Below Hospital West (Fig. 2) to replace the Above Hospital South Reference site that burned in the October 2013 fire. In May 2014, approximately 90% of the new Below Hospital West Reference site burned. Because the new Below Hospital West Reference site burned during the breeding season, the territories that were abandoned after the fire were considered "fire-displaced" and only a subset of their data were included in analyses.

We compared vireo breeding productivity and factors that potentially influence productivity (1) between Removal and Reference sites in 2014, (2) between Post-fire and Reference sites in 2014, and (3) between previous years and the current year (2014) at the Above Hospital South site (2013 Reference site that burned and became a 2014 Post-fire site), to determine whether giant reed removal and wildfires influenced vireo productivity. For ease of interpretation, data from Reference sites are presented twice, once when comparing with Removal site data and once when comparing with Post-fire site data. The following parameters were examined: clutch size, hatching rate, fledging rate, nest success, re-nesting rate, total number of fledglings per pair, nest placement, predation rate, and cowbird parasitism rate.

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

Finally, we compiled annual density within the Removal, Post-fire, and Reference sites by delineating the boundary surrounding all monitored nests at each site (Fig. 2), then counting the number of vireo territories that occurred within those boundaries each year from 1997 through 2014. We examined these data to look for trends in local population size and density, particularly in response to the recovery of native habitat following giant reed removal and the alteration of habitat by wildfire.

We monitored vireo nesting activity at 24 territories in Removal sites, 25 territories at Post-fire sites, and 27 territories in Reference sites between 31 March and 24 July 2014. 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, to the edge of the vegetation clump in which they were placed, and to the edge of the riparian vegetation 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 used Chi-square or Fisher's Exact tests to determine if there were differences between Removal and Reference sites, between Post-fire and Reference sites, and between pre- and post-fire periods at the Above Hospital South site 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 the number of nesting attempts, clutch size, the number of pairs that fledged young, 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 Removal and Reference sites, between Post-fire and Reference sites, and between pre- and post-fire periods at the Above Hospital South site, to determine if there were differences in nest placement characteristics between successful and failed nests within Removal, Post-fire, and Reference sites, and differences in vireo territory density between Removal and Reference sites, Post-fire and Reference sites, and pre- and post-fire periods at the Above Hospital South site. 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. We used Analysis of Variance (ANOVA) and Tukey's post-hoc pairwise comparisons to determine if there were differences in clutch size by year and young fledged per pair by year between Removal and Reference sites. Because our monitoring effort was disrupted in 2011 and 2012, we were not able to monitor all territories for the entire length of the season and therefore our nesting records for those 2 years are incomplete and not included in the 5-year analyses of number of young fledged per pair._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, and 2012 used in comparisons with current data can be found in Rourke and Kus 2006a, 2007a, 2008, and Lynn and Kus 2009, 2010a, 2010c, 2011c, and 2012b. See Griffith Wildlife Biology 2004 for data prior to 2005.

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

a logit link to build models. First, we generated a constant survival model to serve as a reference for the effect of treatment and habitat variables on DSR. We then modeled the treatment covariate and evaluated support for the model in relation to the constant survival model.

RESULTS

Population Size and Distribution

A total of 754 male Least Bell's Vireos were detected during Base-wide surveys (Table 3; Appendix C, Figs. 25-44). This number was likely inflated as it included vireos in 83 territories that were occupied prior to the May 2014 fire which were abandoned post-fire. Many of these vireos were probably displaced into unburned areas as we detected 111 new territories in unburned areas after the fire. This probability was demonstrated by the detection of three banded males that were originally identified in territories that subsequently burned and were then resighted after the fire in areas that did not burn (Fig. 4). All three of these males were detected within or near their burned territories for a short time (2-3 weeks) before they moved to areas that had not burned. These three males were only counted once (all as territorial males prior to the wildfire). Therefore we removed the 83 abandoned territories from the total number detected, yielding 671 territories.

Of the remaining 671 vireos detected in 2014, 634 were territorial males, 69% of which were confirmed as paired, and 37 were transients. Transient vireos were observed on 9 of the 23 (39%) drainages/sites surveyed. Ninety-two percent of all vireo territories occurred on the six most populated drainages/sites (Santa Margarita River, San Onofre Creek, Las Flores Creek, De Luz Creek, San Mateo 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.

Of the 634 vireo territories documented in 2014, 48 (7.6%) were located within the October 2013 wildfire perimeter. In 2013, 59 of 724 territories (8.1%) were recorded within the same area prior to the fire.

The distribution of Least Bell's Vireo territories documented on Base in 2014 did not change significantly compared to 2013 (Table 4). Ten survey areas have fluctuated between zero and five territories over the past 8 years. Four of these (Basilone and Roblar Roads, Pueblitos Canyon, Hidden Canyon, and Ysidora Basin to Windmill Canyon) gained 1-3 territories between 2013 and 2014 and six remained the same as in 2013 (Roblar Creek, Cockleburr Creek, French Canyon, Horno Canyon, Talega Canyon, and Tuley Canyon). The five most heavily populated drainages on MCBCP contained 89% of all vireo territories in 2013 and 88% of all territories in 2014. In 2014, the vireo population increased in 30% of drainages surveyed (7/23). Nine drainages (39%) showed no change or decreased by two or fewer territories between 2013 and 2014 and seven drainages (30%) decreased by 3 or more territories. The drainages with the largest numeric increases in vireo territories were Basilone and Roblar Roads, San Onofre Creek, and Fallbrook Creek/Lake O'Neill, increasing by 2-3 territories each (300%, 4%, and 40%, respectively). The sites with the largest numeric loss in vireo numbers were the Santa Margarita

River, Las Flores Creek, and San Mateo Creek, losing 43, 22, and 15 territories, respectively (10%, 34%, and 37%, respectively). Overall, the vireo population on Base decreased by 12% from 2013 to 2014 (Fig. 5).

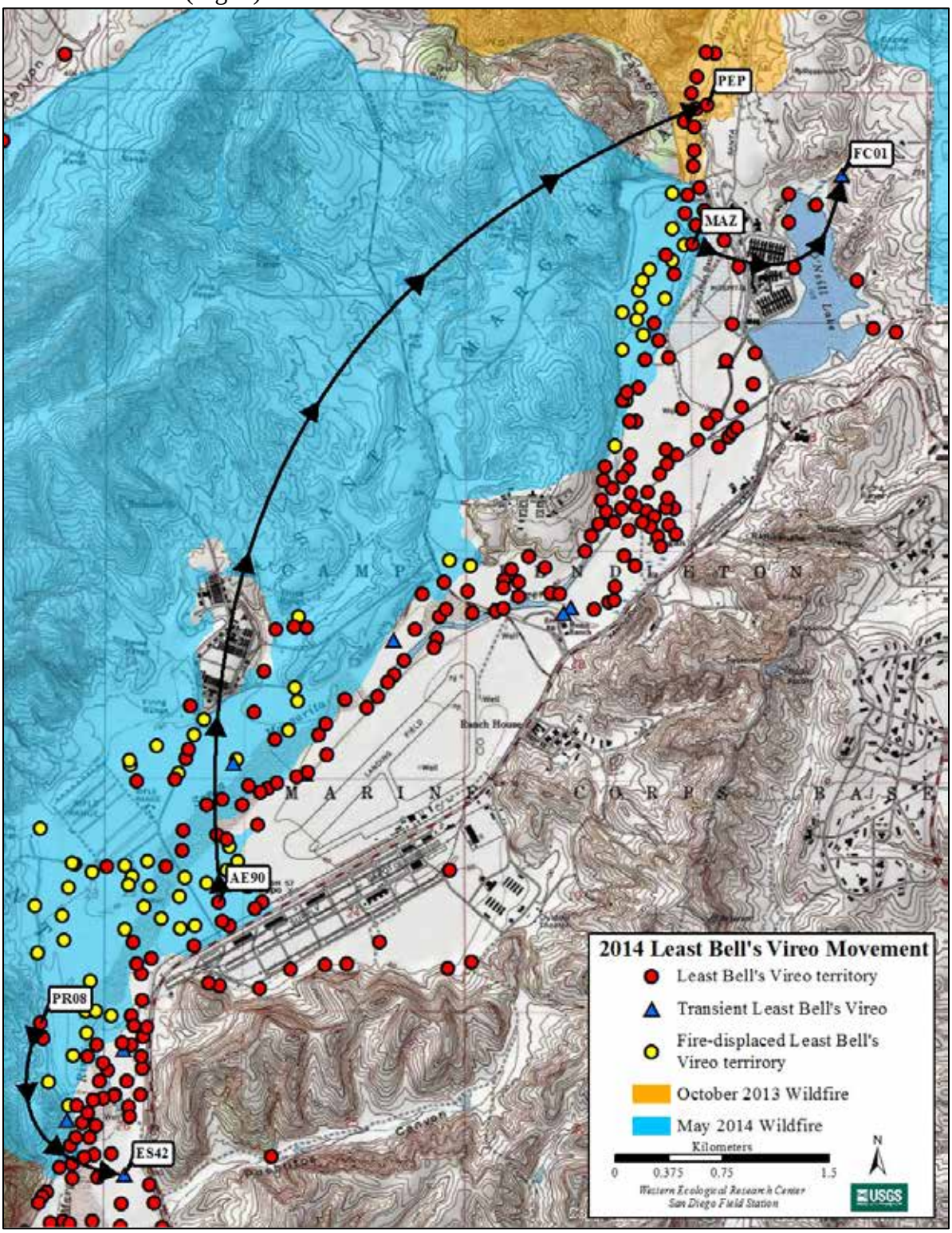

Fig. 4. Movements of three banded Least Bell's Vireos that were detected during the 2014 breeding season before and after the May 2014 wildfire on Marine Corps Base Camp Pendleton.

Table 3. Number and distribution of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2014.

Drainage/Survey Site	Known Pairs	Single/ Status Undetermined	Transient	Fire-displaced Transient	Total Territories
Santa Margarita River:					
I-5 to De Luz Creek	260	97	18[a]	61	357
De Luz Creek to Base Boundary	22	21	0	0	43
22 Area	5	5	0	0	10
De Luz Creek	25	2	1	0	27
Roblar Creek	2	0	0	0	2
Lake O'Neill/Fallbrook Creek	4	3	0[a]	0	7
Basilone-Roblar Roads	2	1	0	0	3
Pueblitos Canyon	0	1	0	0	1
Newton Canyon	4	1	0	0	5
Cockleburr Creek	0	0	0	0	0
French Canyon	1	2	0	0	3
Aliso Creek	1	5	0	0	6
Hidden Canyon	2	2	0	0	4
Las Flores Creek:					
Pacific Ocean to Stuart Mesa Rd	3	1	0	0	4
Stuart Mesa Rd to Power Lines	18	6	1	6	24
Power Lines to Zulu Impact Area	11	4	0	16	15
Piedra de Lumbre Canyon	3	0	0	0	3
Horno Canyon	1	0	0	0	1
San Onofre Creek:					
Pacific Ocean to Basilone Rd	23	18	4	0	41
Basilone Rd to Access Rd to Range 219	11	2	0	0	13
San Mateo Creek					
Pacific Ocean to San Mateo Road	16	10	6	0	26
San Mateo Road to Yankee Training Area	0	0	0	0	0
Cristianitos Creek	6	0	2	0	6
Talega Canyon	0	0	0	0	0
Tuley Canyon	0	0	0	0	0
Pilgrim Creek:					
Base Boundary upstream to Vandegrift Blvd	4	12	2	0	16
Vandegrift Blvd to upstream riparian limit	7	0	0	0	7
Windmill Canyon	6	0	0	0	6
Ysidora Basin to Windmill Canyon	0	2	1	0	2
De Luz Homes	1	1	2	0	2
Total	438	196	37	83	634

[a] Does not include two banded vireos on the Santa Margarita and one banded vireo at Fallbrook Creek that were identified as territory-holding males prior to the May 2014 wildfires.

Table 4. Number of territorial male Least Bell's Vireos at Marine Corps Base Camp Pendleton, by drainage, 2004-2014. Numeric change is the positive or negative change in the number of vireo territories between 2013 and 2014.

	Number of Territorial Males											
Drainage	**2004[a]**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**Numeric Change**
Santa Margarita River[b]	440	472	417	423	463	599	678	467	382	453	410	-43
De Luz Creek	26	18	25	24	25	39	34	27	28	31	27	-4
Roblar Creek	1	0	0	0	0	2	1	1	1	2	2	0
Lake O'Neill/Fallbrook Creek	16	20	10	9	11	11	15	6	5	5	7	2
Basilone-Roblar Roads	-	2	0	0	0	5	4	2	4	0	3	3
Pueblitos Canyon	3	5	3	2	2	1	0	0	0	0	1	1
Newton Canyon	9	8	8	5	4	6	7	6	4	6	5	-1
Cockleburr Creek	0	2	2	2	1	2	0	0	1	0	0	0
French Canyon	5	6	4	2	2	2	2	2	2	3	3	0
Aliso Creek	21	21	11	9	11	21	16	9	8	9	6	-3
Hidden Canyon	5	8	5	4	4	2	4	3	3	3	4	1
Las Flores Creek	84	85	76	81	70	107	124	92	61	65	43	-22
Piedra de Lumbre Cyn	5	8	9	6	3	5	6	3	5	3	3	0
Horno Canyon	0	1	0	0	0	1	1	4	1	1	1	0
San Onofre Creek	56	52	43	44	41	62	54	57	46	52	54	2
San Mateo Creek	68	56	59	46	53	83	71	56	45	41	26	-15
Cristianitos Creek	8	6	8	8	4	13	10	11	10	11	6	-5
Talega Canyon	0	1	0	0	0	1	0	0	0	0	0	0
Tuley Canyon	2	-	0	0	0	0	0	0	0	0	0	0
Pilgrim Creek	37	36	23	26	26	27	24	25	20	30	23	-7
Windmill Canyon	20	12	7	8	12	13	10	7	6	5	6	1
Ysidora Basin-Windmill Cyn	8	4	6	5	4	5	2	1	1	1	2	1
De Luz Homes	5	4	2	3	2	6	5	5	3	3	2	-1
Total	819	827	718	707	738	1,013	1,068	784	636	724	634	-90

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

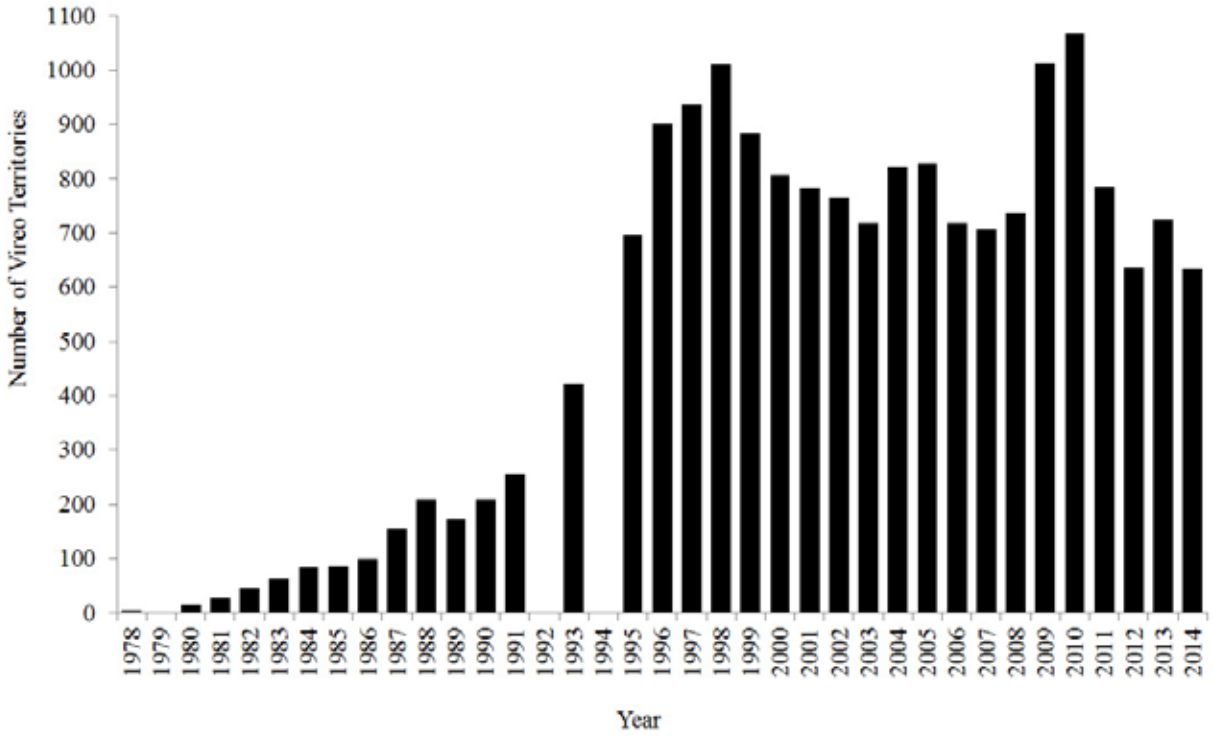

Fig. 5. Number of Least Bell's Vireo territories at Marine Corps Base Camp Pendleton, 1978–2014.

Least Bell's Vireos began arriving on Base during the last week of March 2014 (Fig. 6), with 115 territories (18% of all territories) established by the end of the first week of April. By the end of the third week of April, 45% of territories had been established, and by the first week of May, 57% of vireos had been detected on their territories. There was an increase in vireo territory establishment rate between mid- and late May corresponding with the movement of fire-displaced vireos from their initial points of detection (where they were considered transient and therefore not included in the graph) to their final established territories.

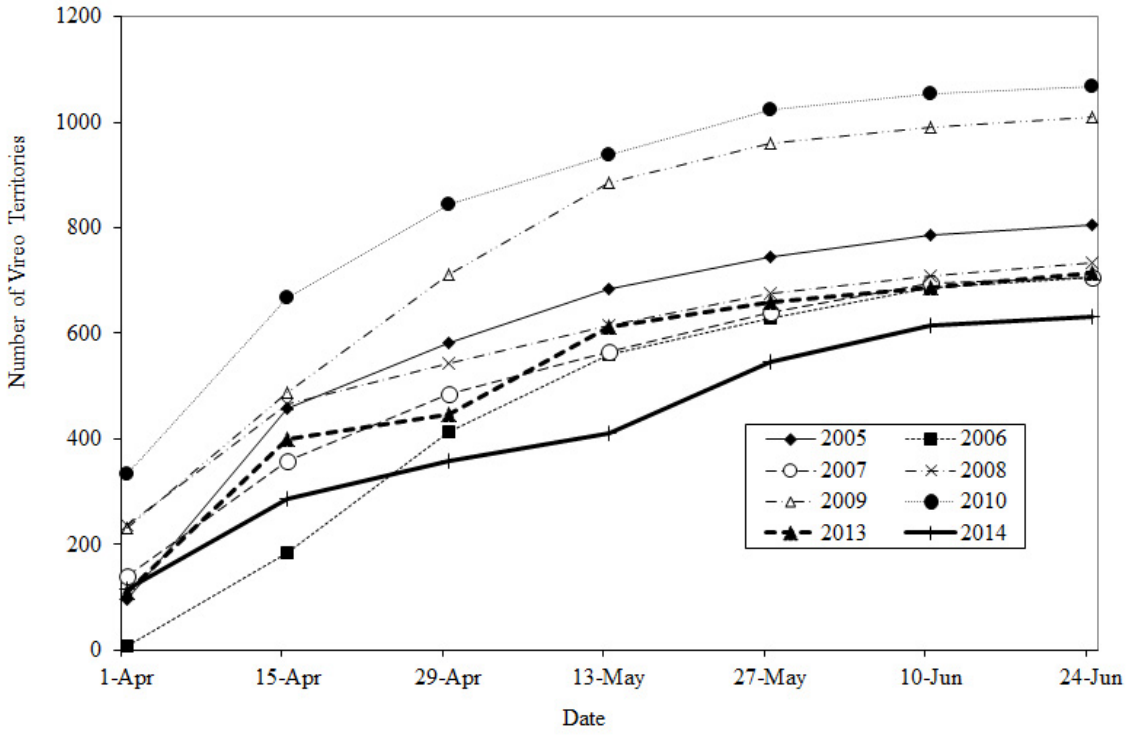

Fig. 6. Territory establishment of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2005-2014. Surveys began late in 2011 and 2012; therefore, arrival dates for these years are not included.

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 76% of males in the study area found in this habitat. An additional 15% of birds occupied willow habitat co-dominated by cottonwoods or sycamores. Five percent of territories were found in riparian scrub, dominated by mule fat and/or sandbar willow. Two percent of vireos occupied drier habitats characterized by a mix of sycamore and oaks or upland scrub, and < 1% of territories occurred in non-native vegetation.

Table 5. Habitat types used by Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2014.

	Number of Territories			
Habitat Type	**>50% Native**	**>50% Exotic**	**Total**	**Percent of Total**
Mixed Willow	466	14	480	76%
Willow/Sycamore	87	6	93	15%
Riparian Scrub	30	0	30	5%
Oak/Sycamore	14	1	15	2%
Upland Scrub	12	1	13	2%
Willow/Cottonwood	2	0	2	<1%
Non-native	0	1	1	<1%
Total	611	23	634	100%

The same proportion of vireo territories were documented in exotic vegetation in 2014 as in 2013 (Table 6). Four percent (23/634) of vireo territories in 2014 and 2013 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. Five drainages contained territories dominated by non-native vegetation in 2014, compared to three in 2013. Two of these drainages (the Santa Margarita River and San Onofre Creek) also contained territories dominated by non-native vegetation in 2013. The proportion of vireo territories dominated by exotic vegetation has decreased over the past 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, 2005-2014. Numbers in parentheses are the number of territories on the drainage.

	Proportion of Territories																			
Drainage	**2005**		**2006**		**2007**		**2008**		**2009**		**2010**		**2011**		**2012**		**2013**		**2014**	
Basilone-Roblar Roads	0	(2)	-	-	-	-	-	-	0	(5)	0	(3)	0	(2)	**0.25**	**(4)**	-	-	**0.33**	**(3)**
Newton Canyon	**0.63**	**(8)**	**0.13**	**(8)**	0	(5)	**0.50**	**(4)**	**0.20**	**(6)**	0	(4)	**0.17**	**(6)**	**0.25**	**(4)**	0	(6)	**0.20**	**(5)**
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)**
Santa Margarita River[a]	**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)**
San Onofre Creek	**0.23**	**(52)**	0	(43)	0	(44)	**0.13**	**(41)**	**0.21**	**(62)**	**0.11**	**(54)**	**0.07**	**(57)**	0	(46)	**0.04**	**(52)**	**0.02**	**(54)**
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)
French Canyon	0	(6)	0	(4)	0	(2)	0	(2)	0	(2)	0	(2)	0	(2)	**0.50**	**(2)**	0	(3)	0	(3)
Windmill Creek	**0.67**	**(12)**	**0.14**	**(7)**	**0.13**	**(8)**	**0.67**	**(12)**	**0.92**	**(13)**	**0.60**	**(10)**	**0.71**	**(7)**	**0.33**	**(6)**	0	(5)	0	(6)
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)
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)
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)
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)
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)
Ysidora Basin to Windmill Canyon	**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)
Hidden Canyon	0	(8)	0	(5)	0	(4)	0	(4)	**0.50**	**(2)**	0	(4)	0	(3)	0	(3)	0	(3)	0	(4)
Pueblitos Canyon	0	(5)	0	(3)	0	(2)	**0.50**	**(2)**	0	(1)	-	-	-	-	-	-	-	-	0	(1)
Lake O'Neill/ Fallbrook Creek	**0.15**	**(20)**	0	(10)	**0.11**	**(9)**	0	(11)	0	(11)	0	(15)	0	(6)	0	(5)	0	(5)	0	(7)
De Luz Homes	0	(4)	0	(2)	0	(3)	0	(2)	0	(6)	0	(5)	0	(5)	0	(3)	0	(3)	0	(2)
Horno Canyon	**1.00**	**(1)**	-	-	-	-	-	-	0	(1)	0	(1)	0	(4)	0	(1)	0	(1)	0	(1)
Roblar Creek	-	-	-	-	-	-	-	-	0	(2)	0	(1)	0	(1)	0	(1)	0	(2)	0	(2)
Cockleburr Canyon	0	(2)	0	(2)	0	(2)	0	(1)	0	(2)	-	-	-	-	0	(1)	-	-	-	-
Talega Canyon	0	(1)	-	-	-	-	-	-	0	(1)	-	-	-	-	-	-	-	-	-	-
Total	0.19	(827)	0.06	(718)	0.03	(707)	0.09	(703[b])	0.10	(1,009[b])	0.10	(1,059[b])	0.12	(784)	0.07	(636)	0.04	(722[b])	0.04	(634)

[a] Includes vireo territories detected within the 22 Area.
[b] 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. Vegetation cover in height categories over 4 m was < 3% (Fig. 7) and consisted primarily of burned snags, re-sprouted wild grape (*Vitis* spp.), and trees that crown-sprouted after the fire (white alder [*Alnus rhombifolia*], California walnut [*Juglans californica*], California sycamore, and Fremont cottonwood). Exotic and herbaceous species comprised more than half of the vegetation cover <1 m and almost 35% of the cover between 1 and 2 m. The remaining cover < 2 m consisted mostly of stump-sprouted red and arroyo willow, 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% was unburned (Ferree et al. 2012b). The pattern of vegetation cover at the Above Hospital site in 2014 was similar to that at Las Flores Creek in 2008 following the October 2007 wildfires, with the bulk of vegetation growth below 4 m (Fig. 7). However, vegetation cover was greater at all height categories at Las Flores Creek than at the Above Hospital site. Also, exotic herbaceous cover comprised a higher proportion of the cover in all height categories where it was present at Las Flores Creek than it did at the Above Hospital site.

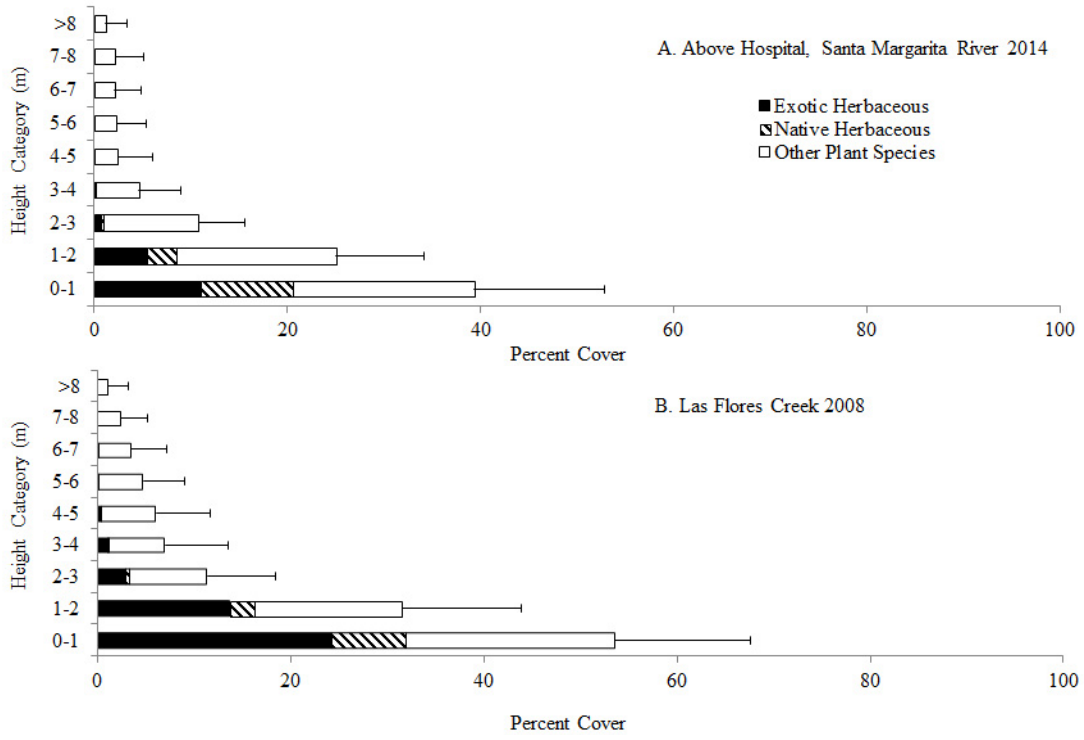

Fig. 7. Average total percent cover by height class (m) and plant type at A. Above Hospital, Santa Margarita River, in 2014, which burned in the October 2013 wildfire and B. Las Flores Creek, in 2008, which burned in the October 2007 wildfire (Ferree et al. 2012b), Marine Corps Base Camp Pendleton.

Banded Birds

Returning Banded Birds

We were able to observe 1,023 adult Least Bell's Vireos (685 males, 91% of all males, 327 females, 68% of all females, and 11 vireos of unknown sex, 100% of all unknown sex) on Base well enough to determine banding status in 2014, although not all banded vireos were observed well enough to conclusively identify the individual. One hundred and twelve of these had been banded prior to the 2014 breeding season, 13 of which we could not identify because band combinations were not confirmed (eight) or because the vireos were banded with only a single numbered metal federal band as nestlings and not recaptured ("natal"; five total; Table 7). Therefore, we were able to identify 99 vireos on Base that were banded with unique color band combinations in 2014 (Table 7, Appendix D). Of these, 80 vireos had been banded on Base and 19 vireos were originally banded off-Base (16 on the San Luis Rey River, Ferree and Kus 2008b, Ferree et al. 2010b, Ferree et al. 2011, 2012a, 2013; and three on MCAS, Allen and Kus 2013; Table 8). Adult birds of known age ranged from 1-8 years old.

Table 7. Banding status of Least Bell's Vireos detected on Marine Corps Base Camp Pendleton and those that emigrated off-Base in 2014.

	Detected on Base[a]			Total on	Emigrants		
Banding Status	**Male**	**Female**	**Unknown Sex**	**Base**	**Male**	**Female**	**Total**
Uniquely banded prior to 2014	59	15	3	77	-	-	77
Natal[b] recaptured in 2014	17	5	-	22	-	3	25
Subtotal of known identity vireos	76	20	3	99	0	3	102
Unidentified (Partial resights)	4	4	-	8	-	-	8
Natal[b], not recaptured	2	3	-	5	-	-	5
Grand total	82	27	3	112	0	3	115

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

Five natal vireos (two males and three females) were resighted on Base in 2014 (Table 7). Four (one male and three females) were banded as nestlings on Base or at MCAS. The fifth natal vireo was banded on the San Luis Rey River. Efforts to recapture and identify these vireos were unsuccessful.

Three vireos that were originally banded on Base in 2013 (with gold numbered metal federal bands) were detected off-Base in San Diego County in 2014 (Table 7). All three were 1-year-old females that were recaptured on the San Luis Rey River (Ferree et al. 2015).

Table 8. Number of banded adult Least Bell's Vireos at Marine Corps Base Camp Pendleton in 2014, 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		
Year Originally Banded	Age in 2014	Male	Female	Unk[a]	Male	Female	Male	Female	Total
2006	8 yrs.	0	1	0	0	0	0	0	1
2007	≥ 8 yrs.	1	0	0	0	0	0	0	1
	7 yrs.	0	1	0	3	0	0	0	4
2008	≥ 7 yrs.	1	0	0	0	0	0	0	1
	6 yrs.	0	2	0	0	0	0	0	2
2009	≥ 6 yrs.	0	1	0	0	0	0	0	1
	5 yrs.	3	1	0	0	0	0	0	4
2010	≥ 6 yrs.	1	0	0	0	0	0	0	1
	≥ 5 yrs.	5	1	0	0	0	0	0	6
	≥ 4 yrs.	1	0	0	0	0	0	0	1
	4 yrs.	1	0	0	1	0	0	0	2
2011	≥ 4 yrs.	4	0	0	0	1	0	0	5
	3 yrs.	2	0	0	2	1	0	0	5
2012	≥ 3 yrs.	16	0	0	0	0	0	0	16
	2 yr.	4	1	0	3	0	1	0	9
2013	≥ 3 yrs.	1	0	1	0	0	0	0	2
	≥ 2 yrs.	11	7	2	0	0	0	0	20
	1 yr.	10	1	0	3	2	2	0	18
Subtotal		61	16	3	12	4	3	0	99
Unknown[b]	≥ 1 yr.	1	3	0	1	0	0	0	5
Total		62	19	3	13	4	3	0	104

[a] Vireos of unknown sex were banded at one of two MAPS stations at Marine Corps Base Camp Pendleton and not detected breeding in 2014.

[b] Natal vireos banded with single numbered metal federal band or identity unknown because of inadequate resight, so natal year is not known. Four 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. The fifth was seen with a metal dark blue numbered band, indicating that it was originally banded on the San Luis Rey River.

New Banded Birds

A total of 207 Least Bell's Vireos were captured and banded for the first time during 2014 (Table 9). These included 59 adult vireos caught for the first time and banded with a unique color combination and 148 hatch-year birds (141 of which were banded as nestlings with a single gold numbered federal band and 7 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 2014.

Age Banded	Males	Females	Unknown Sex	Total
Adult	39	12	8	59
Juvenile			7[a]	7
Nestling			141	141
Total	39	12	156	207

[a] Incidentally captured post-fledging and given unique color band combinations.

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 2014. 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 2013-2014

Of 144 uniquely color banded adult vireos detected on Base during the 2013 breeding season, 51% (74/144) returned in 2014 (Table 10). Five additional adult vireos identified in 2014 but not detected on Base in 2013 were added to the calculations to yield an adjusted annual survivorship of 53% (79/149; Table 10). Fifty-nine of the 99 adult male vireos known to be alive in 2013 were resighted in 2014, an over-winter survivorship rate of 60%. Seventeen of the 38 adult female vireos known to be alive in 2013 were resighted in 2014, an over-winter survivorship rate of 45%. The remaining 40 males and 21 females were not resighted in 2014.

Table 10. Number of banded adult Least Bell's Vireos detected in 2013 at giant reed (*Arundo donax*) Removal sites, Reference sites, and other areas on Marine Corps Base Camp Pendleton, and where those that returned were detected in 2014. Numbers in parentheses include the adjustments resulting from vireos that were identified in 2014 but not in 2013.

	Study Site Name and Type for each Year[a]						
Year / Sex	**Bell, Pump Road**	**Above Hospital South**	**Below Hospital East**	**Above Hospital North**	**Below Hospital West**		
2013	**Removal**	**Reference**	**Reference**	**Other**	**Other**	**Other**	**Total**
Male	22	11	11	1	2	49	96 (99)
Female	7	5	1		1	22	36 (38)
Unknown						12	12 (12)
Total	29	16	12	1	3	83	144 (149)
2014	**Removal**	**Post-fire**	**Reference**	**Post-fire**	**Reference**	**Other**	
Male	19[b]	7[c]	5[d]		2[e]	23	56 (59)
Female	6[f]			1[g]	1[g]	7	15 (17)
Unknown						3	3 (3)
Total	25	7	5	1	3	33	74 (79)

[a] See Table 1. "Other" includes all areas outside of study sites.
[b] All occupied territories at Removal sites in 2013.
[c] All occupied territories at Above Hospital South in 2013.
[d] All occupied territories at Below Hospital East in 2013.
[e] One occupied a territory at Above Hospital South in 2013, the other occupied a territory outside of any study area in 2013.
[f] Two occupied territories at Removal sites in 2013 and four others occupied territories outside of our monitoring area in 2013.
[g] Occupied a territory at Above Hospital South in 2013.

First-year Survivorship from 2013-2014

Of the 181 hatch-year vireos banded in 2013 that survived to fledge, 14 (ten males and four females) were resighted with or captured and given unique color band combinations in 2014 (Table 11). This yields a conservative first-year survivorship of 8% (14/181) (Table 11, Table 12). Assuming an equal sex ratio of banded juveniles, first-year survivorship of males was 11% (10/90.5) and females was 4% (4/90.5).

Table 11. Number of Least Bell's Vireos banded as nestlings or fledglings at giant reed (*Arundo donax*) Removal sites, Reference sites, and other areas on Marine Corps Base Camp Pendleton in 2013, and where those that returned were detected in 2014.

Year/Sex	Study Site Name and Type for each Year[a]					
	Bell, Pump Road	Above Hospital South	Below Hospital East	Above Hospital North		
2013	**Removal**	**Reference**	**Reference**	**Other**	**Other**	**Total**
Unknown	98	36	34	0	13	181
2014	**Removal**	**Post-fire**	**Reference**	**Post-fire**	**Other**	
Male	0	0	1[b]	0	9[c]	10
Female	0	0	0	1[d]	3[e]	4
Total	0	0	1	1	12	14

[a] See Table 1. "Other" includes all areas outside of study sites.
[b] Banded as a nestling at a Removal site.
[c] Three were banded as nestlings in 2013 at a Removal site, four were banded as nestlings in 2013 at Above Hospital South, and two were banded as nestlings in 2013 at Below Hospital East.
[d] Banded as a nestling in 2013 at Above Hospital South.
[e] All were banded at a Removal site in 2013 and emigrated to the San Luis Rey River in 2014.

Adjusted Annual Survivorship

Five adult banded vireos (three males and two females) that were detected in 2014 were not observed in 2013 (Table 10). These detections were used to adjust estimates of annual survivorship for previous years (see Methods: Banding). Incorporating these detections into calculations did not change first-year survivorship estimates but increased adult survivorship 1-9% over the previous estimate in 2011, 2012, and 2013 (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, 2010c, 2011c, 2012b, and 2013.

Years	First-year Survivorship			Adult Survivorship		
	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%	15%	53%	61%	-
2009-2010	7%	10%	10%	50%	56%	56%
2010-2011	5%	12%	-	27%	39%	40%
2011-2012	10%	15%	-	54%	66%	67%
2012-2013	16%	-	-	76%	-	85%
2013-2014	-	-	8%	-	-	53%

Survivorship at Removal and References Sites

Of the 29 banded adult vireos of known sex (22 males and 7 females) that were detected within Removal sites in 2013, 21 (19 males and 2 females) were resighted in 2014 for 72% survival rate (86% for males and 29% for females; Table 10 and Appendix E). All adult vireos that were detected in Removal sites in 2013 were re-detected in Removal sites in 2014. Of the 28 banded adult vireos of known sex (22 males and 6 females) that were detected within 2013 Reference sites in 2013, 15 (13 males and 2 females) were resighted in 2014 for a 54% survival rate (59% for males and 33% for females). Seven adult male vireos were detected in 2013 in the Above Hospital South site, and were re-detected in this same site in 2014 (this site burned in October 2007). One adult male vireo that was detected in the Above Hospital South site was re-detected in 2014 in Below Hospital West, the new Reference site. Five adult male vireos were detected in 2013 and 2014 in Below Hospital East Reference site. Of the two females that were detected in Reference sites in 2013, one was re-detected in Below Hospital West, the new Reference site in 2014, and one was re-detected in Above Hospital South, the new Post-fire site in 2014. Over-winter survival rate did not differ between vireos that occupied Removal or Reference sites in 2013 ($\chi^2 = 2.174$, $P = 0.14$).

One hundred and sixty-eight of the 181 banded juveniles that were known to fledge in 2013 were banded on a Removal or Reference site (98 at Removal sites and 70 at Reference sites). Of these, 14 (seven from Removal sites, two from Below Hospital East Reference site, and five from the Above Hospital South site) were recaptured on MCBCP and given unique color band combinations in 2014 for an overall first-year survival rate of 8% for fledglings from Removal sites and 10% 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-four adult vireos (56 males, 15 females, and 3 vireos of unknown sex) that were identified in 2013 were resighted in 2014, 60 of which occupied known territories both years. The majority of returning adult vireos showed strong between-year site fidelity. Of the 60 returning territorial adults, 41 (39 males and 2 females; 68% of all territorial vireos; 76% of males and 22% of females) occupied a breeding site in 2014 that they had defended in 2013 (within 100 m). Ten additional vireos (eight males and two females; 17% of all vireos, 16% of males and 22% of females) returned to sites adjacent to their previous territories (within 300 m). The average distance moved by returning adult vireos was 0.6 ± 3.3 km (standard deviation [SD]; 0.6 ± 3.5 km (SD) for males and 0.7 ± 0.9 km (SD) for females).

Fourteen first-year vireos that were banded as a nestling in 2013 on MCBCP were resighted in 2014 and occupied a known territory. Eleven of these returned to MCBCP and three emigrated to the San Luis Rey River (Ferree et al. 2015). The 11 first-year vireos that returned to MCBCP dispersed 3.5 ± 2.7 km (SD) from their 2013 natal site (3.8 ± 2.7 km (SD) for ten males, 0.6 km for the one female; Table 13). Including the three vireos that were banded as nestlings on MCBCP in 2013 and were re-detected off-Base in 2014, the average dispersal distance was 4.1 ± 2.6 km (SD) (3.8 ± 2.7 km (SD) for males, 4.7 ± 2.7 km (SD) for females).

Seven other first-year vireos that were originally banded as nestlings along the San Luis Rey River (three males and two females) and on MCAS (two males) in 2013 dispersed an average 4.2 ± 2.5 km (SD) to MCBCP.

Table 13. Between-year dispersal into or out of Marine Corps Base Camp Pendleton by Least Bell's Vireos banded as juveniles in 2013 and detected in 2014.

Year Last Detected	Drainage / Territory / Treatment[a]		Dispersal Distance (km)	Band Combination[b]		Sex[c]
	2013	2014		Left Leg	Right Leg	
2013	SMR / CAR / REM	SMR / OCM / REF	7.5	WHDP	DPDP/Mgo	M
2013	SMR / ONX / REF-PF	SMR / 2206	7.7	WHDP	BKBK/Mgo	M
2013	SMR / HOL / REF	SMR / HW18	1.0	ORPU	YEYE/Mgo	M
2013	SMR / POE / REM	SMR / BS11	2.5	PUOR	ORPU/Mgo	M
2013	SMR / TOP / REM	SMR / PR08	1.6	LPBK	WHPU/Mgo	M
2013	SMR / ONX / REF-PF	SMR / GNU / PF	0.6	BKBK	OROR/Mgo	F
2013	SMR / QIN / REF-PF	SMR / HE12	2.7	DGOR	PUYE/Mgo	M
2013	SMR / QIN / REF-PF	SMR / HE59	2.2	BKBK	PUOR/Mgo	M
2013	SMR / FAU / REF-PF	SMR / HW19	3.3	PUOR	PUPU/Mgo	M
2013	SMR / TRP / REM	LF / LL17	7.6	WHDP	LPBK/Mgo	M
2013	SMR / HOL / REF	FC / OL04	2.0	ORPU	BYST/Mgo	M
2013	SMR / FLN / REM	SLR / BLAS	5.6	PUOR/gogo	Mgo	F
2013	SMR / POE / REM	SLR / BRAT	6.6	DPWH	BKLP/Mgo	F
2013	SMR / ICE / REM	SLR / BBOA	5.7	DPWH	BYST/Mgo	F
2013	SLR / WOLD	SMR / PO12	4.1[d]	DPWH	WHPU/Mdb	M
2013	SLR / CLOT	SMR / YB13	5.3[d]	DBDP/gogo	Mdb	M
2013	SLR / CNED	SMR / YB11	6.8[d]	WHDB/gogo	Mdb	F
2013	SLR / DCAL	SMR / FLN / REM	5.8[d]	BKBK	YEYE/Mdb	M
2013	SLR / WMAN	PC / PS07	6.3[d]	DPWH	DBDP/Mdb	F
2013	MCAS / EDG	SMR / AW07	0.6[e]	WHDP	OROR/Mgo	M
2013	MCAS / VIC	SMR / AE90	0.4[e]	DPWH	DPWH/Mgo	M

[a] Drainage Codes: FC = Fallbrook Creek; LF = Las Flores Creek; MCAS = Marine Corps Air Station, Camp Pendleton; PC = Pilgrim Creek; SLR = San Luis Rey River; SMR = Santa Margarita River. Treatment Codes: PF = Post-fire site; REF = Reference site in 2013 and 2014; REF-PF = Reference site in 2013 that became a Post-fire site in 2014; REM = Removal.

[b] Band colors: Mdb = dark blue numbered federal band; Mgo = gold numbered federal band; gogo = metal gold; BKBK = plastic black; BKLP = plastic black-light pink split; BYST = plastic black-yellow striped; DBDP = plastic dark blue-dark pink split; DGOR = plastic dark green-orange split; DPWH = plastic dark pink-white split; DPDP = plastic dark pink; LPBK = plastic light pink-black split; OROR = plastic orange; ORPU = plastic orange-purple split; PUOR = plastic purple-orange split; PUPU = plastic purple; PUYE = plastic purple-yellow split; WHDB = plastic white-dark blue split; WHDP = plastic white-dark pink split; WHPU = plastic white-purple split; YEYE = plastic yellow.

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

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

[e] Immigrant to MCBCP from the Marine Corps Air Station, Camp Pendleton.

Site Fidelity and Movement – Removal and Reference Sites

Fidelity to Removal sites was 100% (21/21) as all adults that were detected in Removal sites in 2013 were re-detected in Removal sites in 2014, although not necessarily in the same Removal site. Fifteen vireos were detected at Reference sites in 2013. Five adult vireos showed fidelity to the Below Hospital East site. The remaining ten adult vireos were detected in 2013 in the Above Hospital South site. Seven of these (70%) returned to the Above Hospital South site, one (10%) was re-detected in 2014 at the Above Hospital North site, and two (20%) were re-detected at the Below Hospital West site (Appendix E).

One male vireo detected in 2014 fledged from a Removal site in 2013 and returned to occupy a breeding territory at a Reference site in 2014. One female vireo detected in 2014 fledged from the Above Hospital South site in 2014 and returned to occupy a breeding territory at the Above Hospital North site in 2014. The remaining 12 vireos that fledged from Removal and Reference sites in 2013 dispersed to territories outside of our monitoring areas.

Nest Monitoring

Nesting activity was monitored in a total of 76 territories within the Removal, Post-fire, and Reference monitoring areas (Table 14, Fig. 8 -13, Appendix F). One of these territories was known to be occupied by a single male and was therefore excluded from reproductive analyses. Sixty-nine of the territories (including the single male) were considered "fully" monitored, meaning that all nests within the territory were found and documented during the breeding season. The seven other territories were at the Reference site that burned in the May 2014 wildfire and were abandoned post-fire. These territories were categorized as "fire-displaced" (analogous to "partially" monitored) and were only included in analyses where their breeding parameters could be considered comparable to territories that were not abandoned as a result of the wildfires. No nests were found at one of the fully monitored territories at a Post-fire site. A total of 172 nests were monitored during the breeding season; 22 of these were not completed (coded as "INC" or "FAL" in Appendix F) and have been excluded from calculations of nest success and productivity. Of the remaining 150 nests, 142 were in fully monitored territories.

Table 14. Number of Least Bell's Vireo territories and nests monitored at giant reed (*Arundo donax*) Removal, October 2013 Post-fire, and Reference sites on Marine Corps Base Camp Pendleton, 2014.

	Nest Monitoring Area Type		
	Removal	**Post-fire**	**Reference**
Territories fully monitored	24	25	20
Nests in fully monitored territories (# complete)	68 (58)	57 (48)	39 (36)
Completed nests per pair[a] (fully monitored territories)	2.4 ± 0.9 (SD)	2.1 ± 0.8 (SD)	1.8 ± 0.9 (SD)
Total number of nests per pair[a] (includes incomplete nests fully monitored territories only)	2.8 ± 1.0 (SD)	2.5 ± 1.0 (SD)	2.0 ± 0.9 (SD)
Fire-displaced territories[b]	0	0	7
Nests in fire-displaced territories[b] (# complete)	0	0	8 (8)
Total # of nests monitored	68	57	47

[a] Does not include the territory occupied by a single male.
[b] Territories that were monitored before the May 2014 wildfire and were subsequently abandoned post-fire.

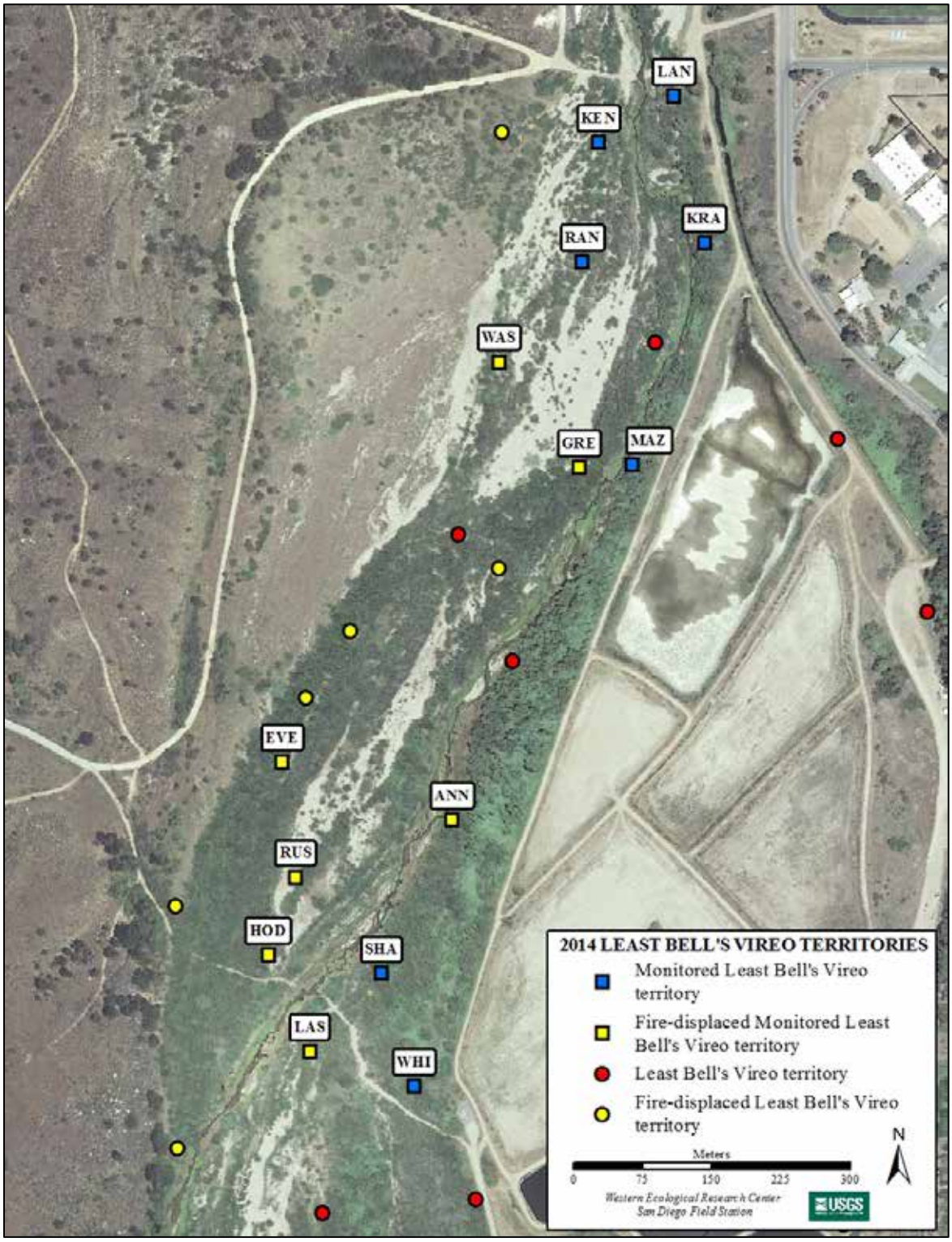

Fig. 8. Locations of monitored Least Bell's Vireo territories at the Below Hospital West Reference site, Marine Corps Base Camp Pendleton, 2014. This was a new Reference site in 2014 and most of the site burned in the May 2014 wildfire.

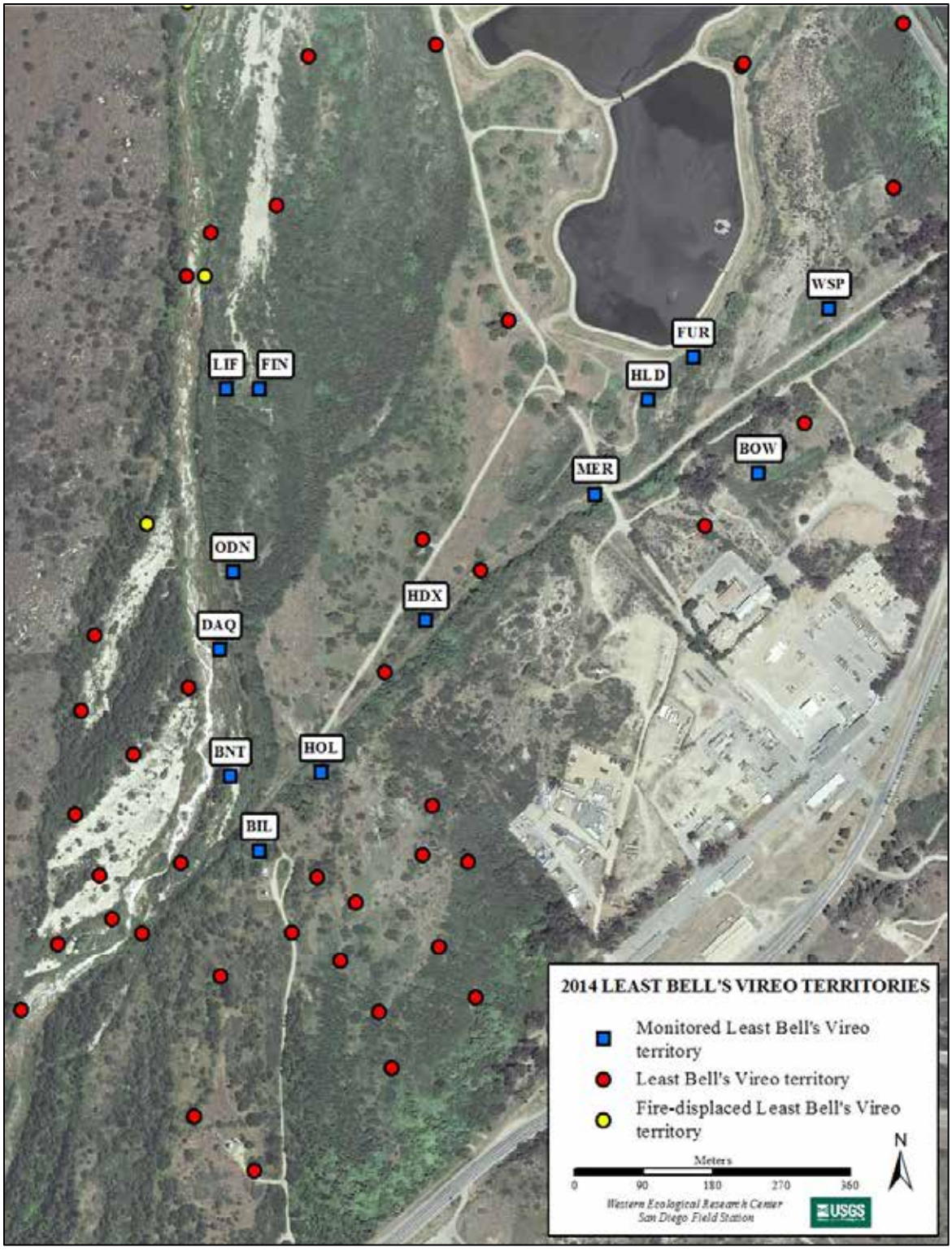

Fig. 9. Locations of monitored Least Bell's Vireo territories at the Below Hospital East Reference site, Marine Corps Base Camp Pendleton, 2014. This has been a Reference site since 2005 and remained a Reference site in 2014.

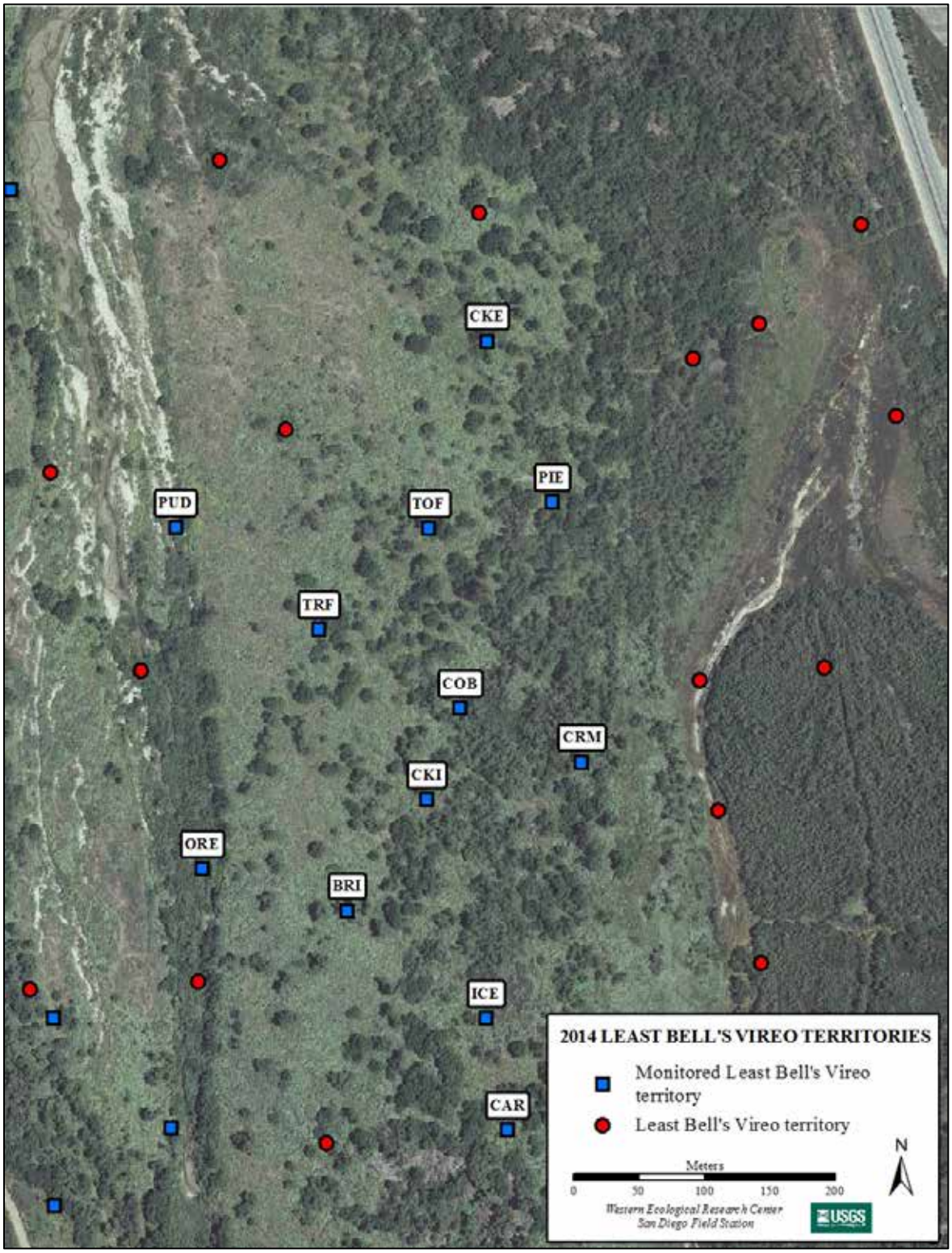

Fig. 10. Locations of monitored Least Bell's Vireo territories at the Bell giant reed (*Arundo donax*) Removal site, Marine Corps Base Camp Pendleton, 2014. This has been a Removal site since 2010 and remained a Removal site in 2014.

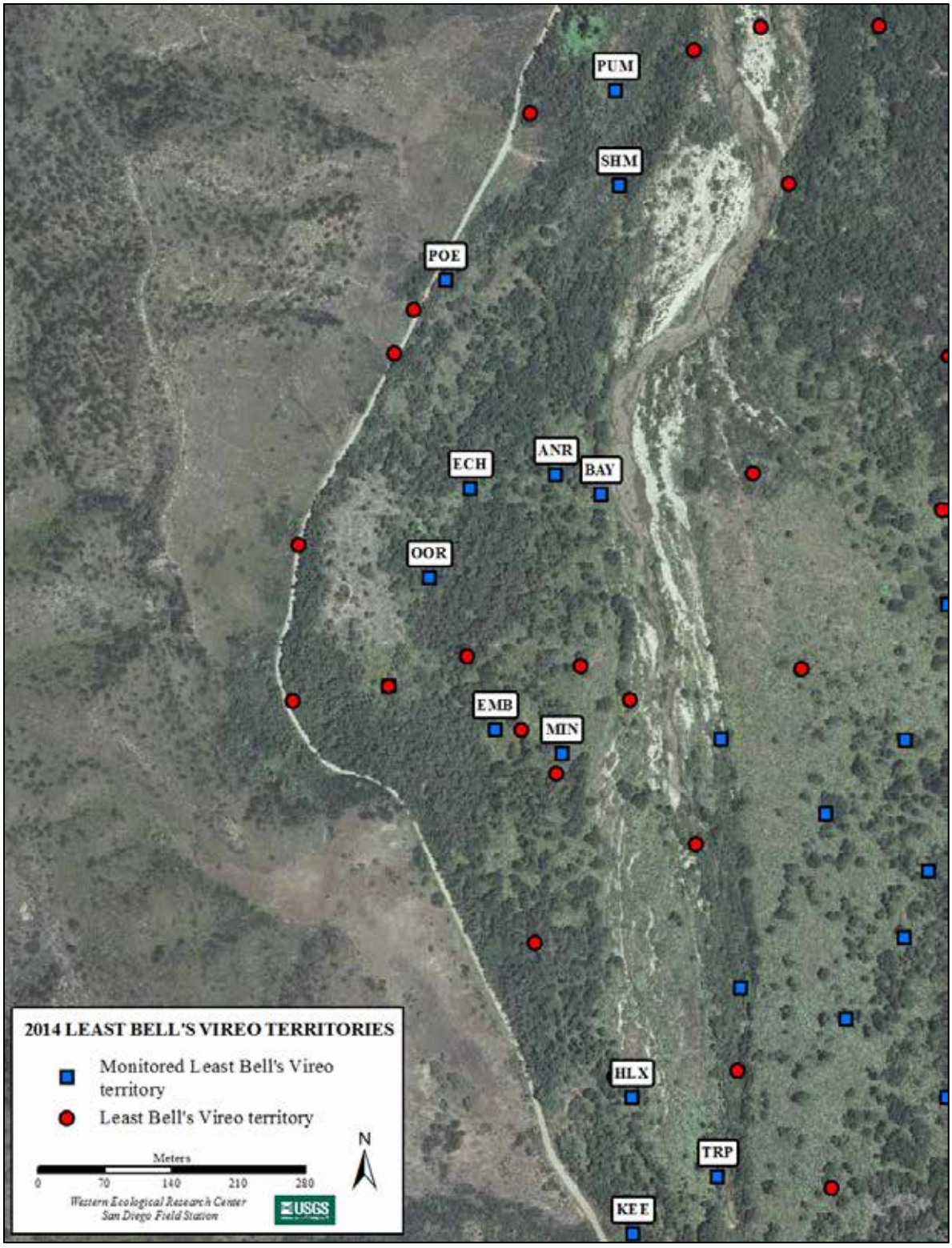

Fig. 11. Locations of monitored Least Bell's Vireo territories at the Pump Road giant reed (*Arundo donax*) Removal site, Marine Corps Base Camp Pendleton, 2014. This has been a Removal site since 2010 and remained a Removal site in 2014.

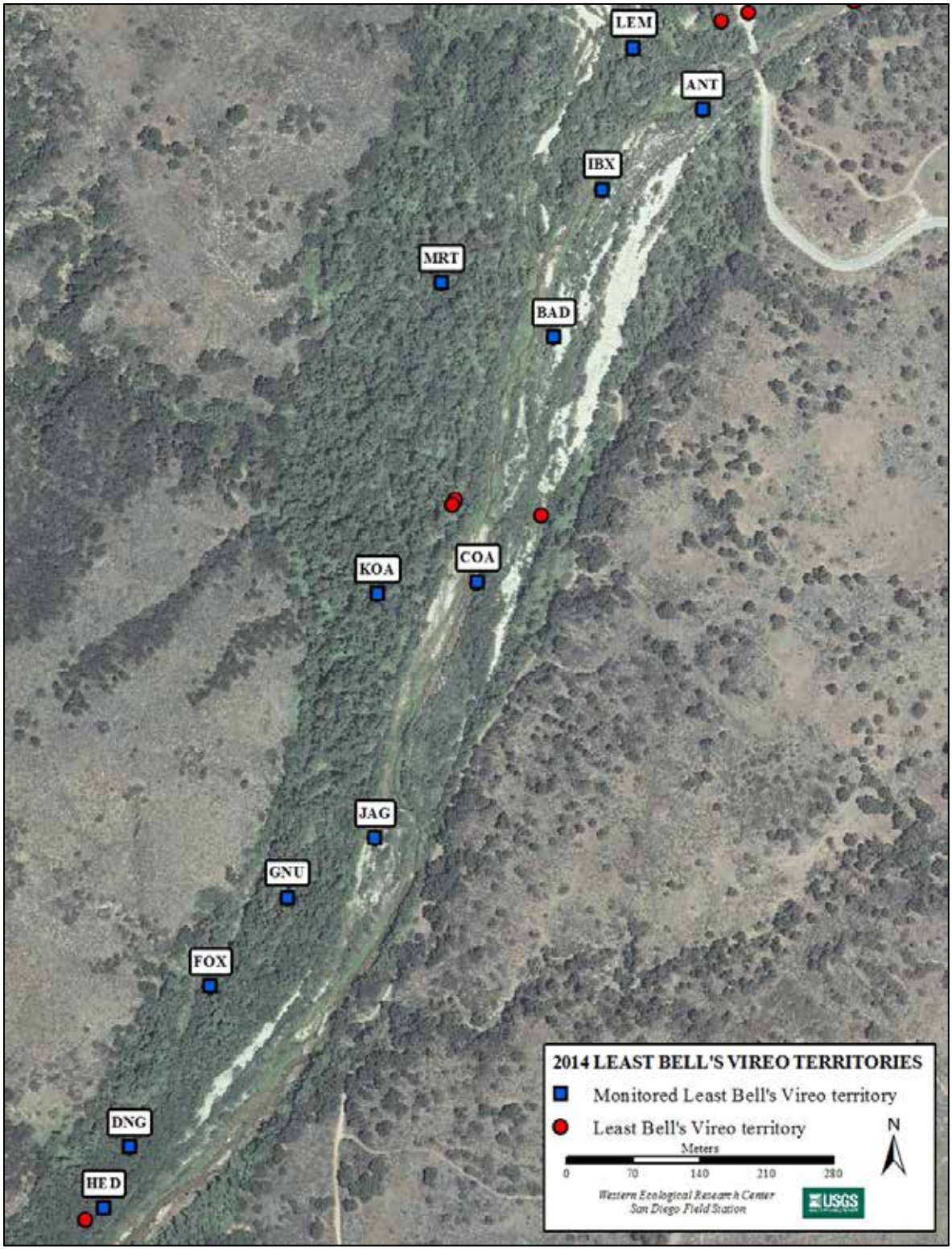

Fig. 12. Locations of monitored Least Bell's Vireo territories at the Above Hospital North Post-fire site, Marine Corps Base Camp Pendleton, 2014. This was a new Post-fire site in 2014.

Fig. 13. Locations of monitored Least Bell's Vireo territories at the Above Hospital South Post-fire site, Marine Corps Base Camp Pendleton, 2014. This was a Reference site from 2005 until 2013, when it burned in the October 2013 wildfire. An asterisk (*) indicates second location of vireo detected first elsewhere.

Giant Reed Removal versus Reference Sites

Nesting Attempts

Pairs at Removal sites had significantly more nesting attempts (including incomplete nests) than pairs at Reference sites over the course of the 2014 breeding season (Table 14; t = 2.98, $P < 0.01$). Pairs at Removal sites were more likely to re-nest after their initial attempt than pairs at Reference sites (Fisher's Exact $P = 0.015$), as 96% of Removal pairs and 65% of Reference pairs initiated a second attempt. Incidence of re-nesting after a failed first nesting attempt was higher at Removal sites (100%; 19/19) than Reference sites (80%; 12/15; Fisher's Exact $P = 0.08$). Re-nesting rate after a successful first nesting attempt did not differ between Removal sites (80%; 4/5) and Reference sites (20%; 1/5; Fisher's Exact $P = 0.26$) likely because of low sample size. However, vireos were more likely to re-nest after a failed first nesting attempt than after a successful first nesting attempt (Fisher's Exact $P = 0.01$). Overall, 91% (31/34) of vireo pairs attempted to re-nest after a failed first nesting attempt in 2014, similar to the average proportion that attempted to re-nest after a failed first nesting attempt in previous years (Fig. 14). The rate of re-nesting attempts following a successful nesting attempt in 2014 (50%; 5/10) was also similar to the average of previous years (51%; Fig. 14). Fourteen pairs at Removal sites and four pairs at Reference sites attempted three or more nests in 2014. Seven pairs at Removal sites and two pairs at Reference sites initiated four nesting attempts and one pair at a Removal site initiated five nesting attempts in 2014.

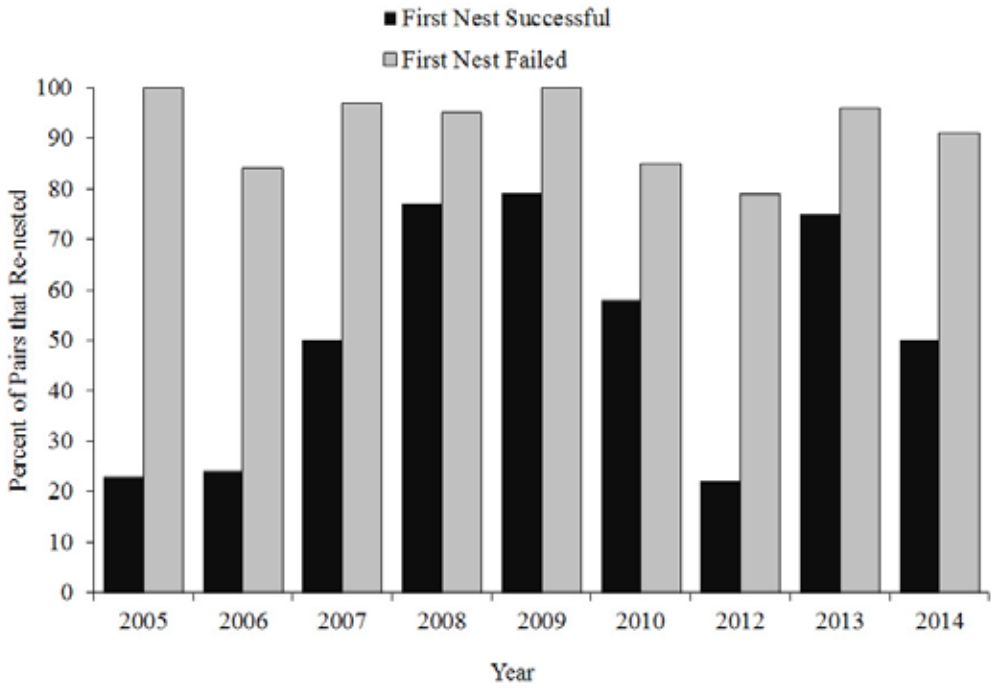

Fig. 14. Percent of Least Bell's Vireo pairs that re-nested after a successful or failed first nesting attempt on Marine Corps Base Camp Pendleton, 2005-2010 and 2012-2014.

Nest Success

Completed nests in Removal sites were as likely to be successful as completed nests in Reference sites ($\chi^2 = 0.27$, $P = 0.60$), as 29% (17/58) of nests in Removal sites successfully fledged young and 23% (10/44) of those in Reference sites successfully fledged young (Table 15).

Table 15. Fate of Least Bell's Vireo nests in fully and fire-displaced monitored territories at giant reed (*Arundo donax*) Removal and Reference sites, Marine Corps Base Camp Pendleton, 2014. Numbers in parentheses are proportions of total nests.

	Number of Nests		
Nest Fate	**Removal**	**Reference**	**Total**
Successful	17	10	27 (0.26)
Failed			
Predation	30	21	51 (0.50)
Parasitism	0	0	0 (0.00)
Other/Unknown	11	13	24 (0.24)
Total Completed Nests	58	44	102 (1.00)

Causes of nest failure were similar at Removal and Reference sites. Predation was believed to be the primary source of nest failure at both types of sites, although no predation events were witnessed (Table 15). Predation accounted for 73% (30/41) of nest failures at Removal sites and 62% (21/34) of nest failures at Reference sites. We also documented 24 nests that failed for other known and unknown reasons at our study sites. Five nests at a Reference site were burned in the May 2014 wildfire. One nest at a Reference site was abandoned after the adults were banded, possibly as a result of disturbance in the area. One nest at a Removal site was incubated well beyond the normal incubation period and likely had inviable eggs. Two nests, one at a Removal site and one at a Reference site, failed when the structure supporting the nest collapsed. A third nest (at a Removal site) may have also failed when the supporting structure collapsed, but may have been abandoned for other, unknown reasons prior to the support collapse. Nine nests (three at Removal sites and six at Reference sites) failed between nest-building and egg-laying from unknown causes. The nestlings in two nests at Removal sites were found dead or covered in ants, possibly starved when the adults abandoned the nests. Three nests at Removal sites were abandoned with eggs for unknown reasons. Overall, 71% and 77% of completed vireo nests at Removal and Reference 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 2014.

Productivity

Clutch size did not differ between Removal and Reference sites (Table 16). Measures of hatching success were higher at Removal sites but fledging success was higher at Reference sites. Overall productivity per pair was low and did not differ between Removal and Reference sites (1.4 versus 1.5 young fledged per pair, respectively; Table 16). Fifty-eight percent of pairs at Removal sites and 50% of pairs at Reference sites were ultimately successful in fledging young from at least one nest. Three pairs at Removal sites (13%) and no pairs at Reference sites successfully double-brooded, fledging young from two nests during the 2014 breeding season. Vireo pairs at Removal and Reference sites combined fledged 1.4 vireo young per pair, and 55% of monitored pairs were successful in fledging at least one young in 2014.

Table 16. Reproductive success and productivity of nesting Least Bell's Vireos at giant reed (*Arundo donax*) Removal and Reference sites, Marine Corps Base Camp Pendleton, 2014.

Parameter	Removal Sites	Reference Sites	Total
Nests with eggs	49	36	85
Eggs laid	134	107	241
Average clutch size[a]	3.0 ± 0.5 (SD)	3.1 ± 0.6 (SD)	3.1 ± 0.5 (SD)
Hatchlings	86	53	139
Nests with hatchlings	33	19	52
Hatching success:			
Eggs[b]	64%	50%	58%
Nests[c]	67%	53%	61%
Fledglings	34	29	63
Nests with fledglings	17	10	27
Fledging success:			
Hatchlings[d]	40%	55%	45%
Nests[e]	52%	53%	52%
Fledglings per egg	0.3	0.3	0.3
Fledglings per nest	0.7	0.8	0.7
Average number of young fledged per pair[f]	1.4 ± 1.5 (SD)	1.5 ± 1.5 (SD)	1.4 ± 1.5 (SD)
Pairs fledging ≥ 1 young[f]	14 (58%)	10 (50%)	24 (55%)

[a] Based on 39 Removal and 29 Reference non-parasitized nests with a full clutch ($t = 0.58$; $P = 0.57$).
[b] Percent of all eggs that hatched.
[c] Percent of all nests with eggs in which at least one egg hatched.
[d] Percent of all nestlings that fledged.
[e] Percent of all nests with nestlings in which at least one young fledged.
[f] Based on 24 Removal and 20 Reference pairs ($t = 0.07$, $P = 0.94$).

5-Year Analysis

From 2010-2014, there were no statistical differences in average clutch size between Removal and Reference sites when analyzed on an annual basis (Fig. 15A). However, when data from Removal and Reference sites were combined, significant differences in average clutch size between years became apparent (Table 17, Fig. 15B), with the average clutch size in 2010 significantly higher than 2012 and 2014, and the average clutch size in 2013 significantly higher than in 2014. Mean clutch size ranged from 3.1 (2014) to 3.7 (2010).

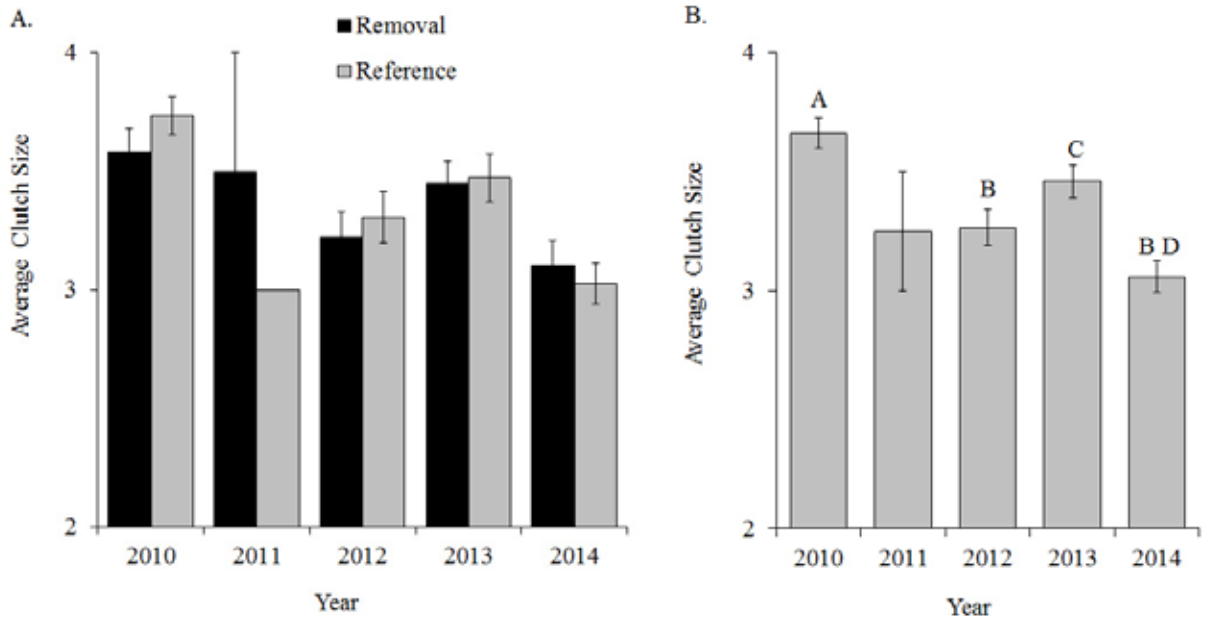

Fig. 15. Average annual Least Bell's Vireo clutch size (± SE) of nests (A) at giant reed (*Arundo donax*) Removal and Reference sites and (B) summarized by year across both sites at Marine Corps Base Camp Pendleton, 2010-2014. Significant differences are indicated by letter pairs (A different from B, C different from D).

Table 17. Results from two-way ANOVA testing for differences in average clutch size of Least Bell's Vireos nesting at giant reed (*Arundo donax*) Removal and Reference sites at Marine Corps Base Camp Pendleton, 2010-2014.

Source	Sum of Squares	df	Mean Squares	*F*	*P*
Treatment	0.020	1	0.020	0.066	0.80
Year	12.855	4	3.214	10.361	< 0.01
Treatment x Year	0.488	4	0.122	0.393	0.81
Error	79.407	256	0.310		

From 2010-2014, we found the average number of young fledged per pair differed significantly between Removal and Reference sites as well as between years (Fig. 16, Table 18). The average number of young fledged per pair was higher at Removal sites than at Reference sites and the number of young fledged per pair was significantly lower in 2014 than in 2010 and 2013.

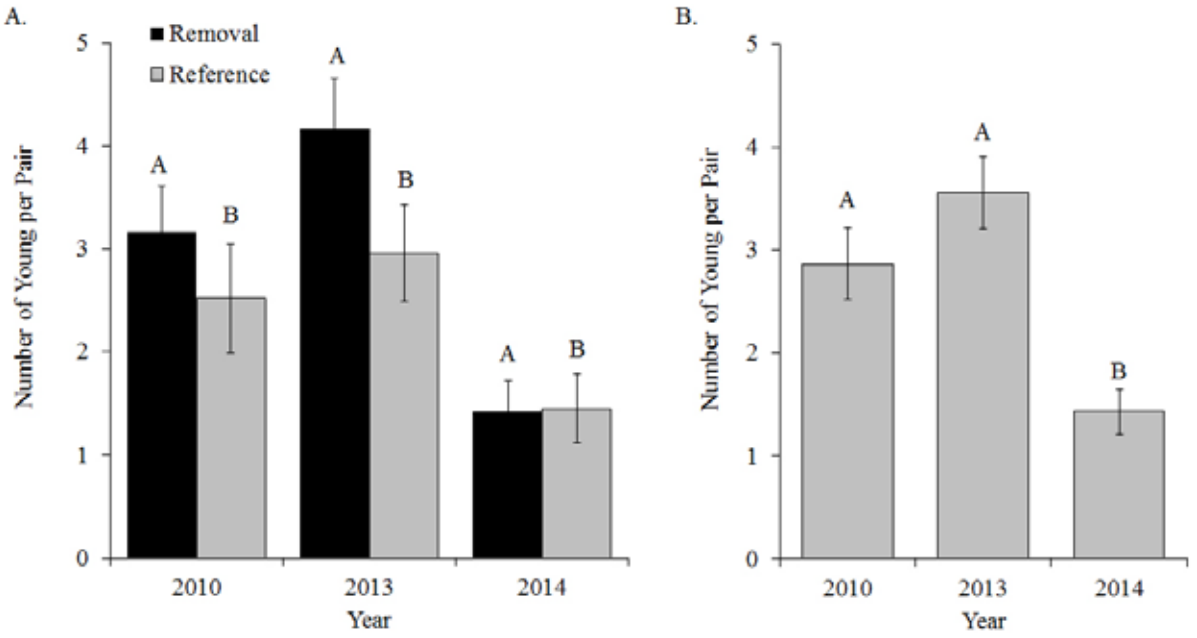

Fig. 16. Average number of Least Bell's Vireo young fledged per pair (± SE) (A) at giant reed (*Arundo donax*) Removal and Reference sites per year, and (B) summarized by year across both site types at Marine Corps Base Camp Pendleton, 2010-2014. Significant differences are indicated by letter pairs (A different from B).2011 and 2012 were excluded because disruption in monitoring prevented collecting a complete record of nesting those years.

Table 18. Results from two-way ANOVA testing for differences in the average number of young fledged per pair of Least Bell's vireos nesting at giant reed (*Arundo donax*) Removal and Reference sites at Marine Corps Base Camp Pendleton, 2010-2014.

Source	Sum of Squares	df	Mean Squares	*F*	*P*
Treatment	12.491	1	12.491	2.787	0.10
Year	106.241	2	53.120	11.851	< 0.01
Treatment x Year	8.813	2	4.406	0.983	0.38
Error	591.673	132	4.482		

Analysis of DSR showed that type of monitoring site (Removal or Reference) was a good predictor of vireo nest survival (Table 19). This means that nests at Removal sites were 1.9 times more likely to fledge young than nests at Reference sites (Fig. 17,Table 20). The best supported model had a lower AIC than the next best model, and the odds ratios for the type of

monitoring site had confidence intervals that did not include 1, which indicates that it was a significant contributing factor to the model (Table 20). The models containing year and the interaction between treatment and year also performed well as indicated by the AICc weight (26, which indicates a 26% likelihood of being the correct model), although when these covariates were examined separately they did not significantly contribute to the model.

Table 19. Logistic regression models for the effect of Treatment (whether a nest was in a Removal or Reference site) on nest survival of Least Bell's Vireos on Marine Corps Base Camp Pendleton, 2010-2014. Models are ranked from best to worst based on Akaike's Information Criteria for small samples (AIC_C), ΔAIC_C, and Akaike weights (w). AIC_C is based on -2 x $\log_e$ likelihood (L) and the number of parameters (K) in the model.

Model	Deviance	# Parameters	AIC_C	ΔAIC_C	AIC_C Weight
Treatment	1062.17	2	1066.17	0.00	0.42
Treatment + Treatment x Year	1061.14	3	1067.15	0.98	0.26
Treatment + Year + Treatment x Year	1059.94	4	1067.95	1.78	0.17
Treatment + Year	1062.13	3	1068.14	1.97	0.16
Constant	1081.07	1	1083.07	16.90	0.00

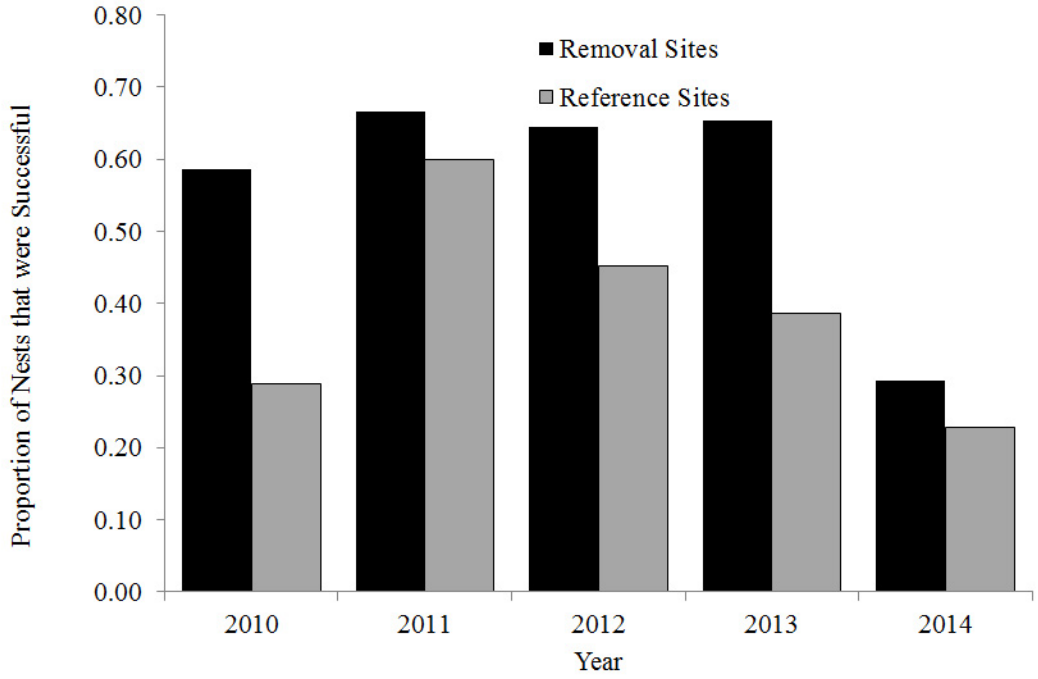

Fig. 17. Proportion of nests that survived to fledge young at Removal and Reference sites, Marine Corps Base Camp Pendleton, 2010-2014.

Table 20. Parameter estimate (β), standard error (SE), odds ratios and 95% confidence intervals (CI) for the best supported model explaining daily survival rate of Least Bell's Vireos at Removal and Reference sites on Marine Corps Base Camp Pendleton, 2010-2014.

Effect	β	SE	Odds Ratio	95% CI
Treatment	0.65	0.15	1.92	1.43 – 2.59
Constant	3.20	0.10	24.43	20.22 – 29.53

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 2014 breeding season (Table 21; $t = 1.36$, $P = 0.18$). There was no difference in re-nesting rate after an initial attempt between Post-fire sites (83%) and Reference sites (65%; Fisher's Exact $P = 0.29$). Similarly, incidence of re-nesting after a failed first nesting attempt did not differ between Post-fire sites (89%, 17/19) and Reference sites (80%, 12/15; Fisher's Exact $P = 0.63$). Re-nesting rate after a successful first nesting attempt also did not differ between Post-fire sites (50%) and Reference sites (20%; Fisher's Exact $P = 0.82$). However, vireos were more likely to re-nest after a failed first nesting attempt in 2014 than after a successful nesting attempt (Fisher's Exact $P = 0.004$). Overall, 85% (29/34) of vireo pairs attempted to re-nest after a failed first nesting attempt and 33% (3/9) pairs attempted to re-nest after a successful first nesting attempt. Eleven pairs at Post-fire sites and four pairs at Reference sites attempted three or more nesting attempts. Four pairs at Post-fire sites and two pairs at Reference sties initiated four nesting attempts in 2014.

Table 21. Fate of Least Bell's Vireo nests in fully and fire-displaced monitored territories at Post-fire and Reference sites, Marine Corps Base Camp Pendleton, 2014. Numbers in parentheses are proportions of total nests.

	Number of Nests		
Nest Fate	Post-fire	Reference	Total
Successful	10	10	20 (0.22)
Failed			
Predation	28	21	49 (0.53)
Parasitism	0	0	0 (0.00)
Other/Unknown	10	13	23 (0.25)
Total Completed Nests	48	44	92 (1.00)

Nest Success

Completed nests in Post-fire sites were no more likely to be successful than completed nests in Reference sites ($\chi^2 = 0.05$, $P = 0.83$), as 21% (10/48) of nests in Post-fire sites successfully fledged young and 23% (10/44) of those in Reference sites successfully fledged young (Table 21). First nesting attempts were also no more likely to be successful at Post-fire sites (24%) than at Reference sites (20%; $\chi^2 = 0.14$; $P = 0.71$) in 2014. Overall, 21% of first detected nesting attempts were successful in 2014.

The majority of nest failures at both Post-fire and Reference sites were caused by predation, although no predation events were witnessed (Table 21). Predation accounted for 74% (28/38) of nest failures at Post-fire sites. We documented ten nests that failed for other known and unknown reasons at the Post-fire sites. Six nests at the Post-fire sites failed when the structure supporting the nest collapsed. Three nests at the Post-fire sites failed between nest-building and egg-laying from unknown causes and one nest was abandoned with eggs for unknown reasons. Overall, 79% of completed vireo nests at Post-fire sites were lost to predation or other causes.

Productivity

Clutch size was significantly greater at Post-fire sites than at Reference sites (Table 22). Measures of hatching and fledging success were higher at Reference sites. Overall productivity per pair was low relative to Reference sites in previous years (Fig. 16) and did not significantly differ between Post-fire and Reference sites (1.2 versus 1.5 young fledged per pair, respectively; Table 22). Forty-two percent of pairs at Post-fire sites and 50% of pairs at Reference sites were ultimately successful in fledging young from at least one nest. No pairs at either type of site successfully double-brooded during the 2014 breeding season. Vireo pairs at Post-fire and Reference sites combined fledged 1.3 vireo young per pair, and 55% of monitored pairs were successful in fledging at least one young in 2014.

Table 22. Reproductive success and productivity of nesting Least Bell's Vireos at Post-fire and Reference sites, Marine Corps Base Camp Pendleton, 2014.

Parameter	Post-fire Sites	Reference Sites	Total
Nests with eggs	46	36	82
Eggs laid	133	107	240
Average clutch size[a]	3.3 ± 0.5 (SD)	3.1 ± 0.6 (SD)	3.2 ± 0.5 (SD)
Hatchlings	57	53	110
Nests with hatchlings	19	19	38
Hatching success:			
Eggs[b]	43%	50%	46%
Nests[c]	41%	53%	46%
Fledglings	29	29	58
Nests with fledglings	10	10	20
Fledging success:			
Hatchlings[d]	51%	55%	53%
Nests[e]	53%	53%	53%
Fledglings per egg	0.2	0.3	0.2
Fledglings per nest	0.6	0.8	0.7
Average number of young fledged per pair[f]	1.2 ± 1.5 (SD)	1.5 ± 1.5 (SD)	1.3 ± 1.5 (SD)
Pairs fledging ≥ 1 young[f]	10 (42%)	10 (50%)	24 (55%)

[a] Based on 30 Post-fire and 29 Reference non-parasitized nests with a full clutch ($t = 1.70$; $P = 0.09$).
[b] Percent of all eggs that hatched.
[c] Percent of all nests with eggs in which at least one egg hatched.
[d] Percent of all nestlings that fledged.
[e] Percent of all nests with nestlings in which at least one young fledged.
[f] Based on 24 Post-fire and 20 Reference pairs ($t = 0.53$, $P = 0.60$).

Pre-fire versus Post-fire Comparisons

Most breeding and productivity parameters were similar at the Above Hospital South site vireo nests before and after the site burned in October 2013. We did not see clutch size change from before to after the October 2013 wildfire (3.5 ± 0.6 pre-fire versus 3.5 ± 0.5 post-fire; $t = 0.11$, $P = 0.91$). However, the percent of eggs that hatched decreased after the wildfire (70% to 38%; Fisher's Exact $P < 0.01$). There was no difference in the number of fledglings produced per pair (2.6 ± 2.2 pre-fire versus 1.5 ± 1.7 post-fire; $t = 1.41$, $P = 0.16$), the percent of nests that were successful (30% pre-fire versus 21% post-fire; Fisher's Exact $P = 0.46$), and the percent of pairs that were successful in fledging young before and after the wildfire (71% versus 50%, respectively; Fisher's Exact $P = 0.27$).

Prior to the October 2013 wildfire, 13 vireo nests were unsuccessful for reasons other than depredation. One of these nests failed as a result of collapsing nest support structure. Two nests were abandoned with pierced eggs and one nest was abandoned with eggs for no known reason. No eggs were observed in the remaining nine nests. In 2014 (after the October 2013 wildfire), four vireo nests were unsuccessful for reasons other than depredation, all of which failed when the nest support structure collapsed. All four of these nests were built in poison hemlock, a non-native annual herb that typically responds quickly to the understory clearing characteristically caused by wildfires.

Nest Characteristics

Giant Reed Removal versus Reference Sites

Least Bell's Vireos used 12 plant species for nesting at Removal and Reference sites in 2014, although not all were used within each treatment (Table 23). Vireos used eight species at Removal sites and ten species at Reference sites. Seventy-nine percent of all nests (87% at Removal sites and 65% at Reference sites) were placed in arroyo willow, mule fat, or sandbar willow. Three vireo nests were built in an exotic plant species (one in poison hemlock and two in salt cedar).

In 2014, successful and unsuccessful nests within Removal and Reference sites were similar in placement (Table 24). However, vireo nests at Removal sites were placed higher in the host plants, in taller host plants, further from the edge of the host plant, and further from the edge of the host nest clump than nests in Reference sites.

Table 23. Host plant species used by Least Bell's Vireos at giant reed (*Arundo donax*) Removal and Reference sites, Marine Corps Base Camp Pendleton, 2014. Numbers in parentheses are proportions of total nests within treatment types.

	Number of Nests	
Host Species	**Removal**	**Reference**
Arroyo or red willow	42 (0.61)	6 (0.15)
Mule fat	14 (0.20)	10 (0.25)
Sandbar willow	4 (0.06)	10 (0.25)
Wild grape	-	4 (0.10)
Poison hemlock	-	1 (0.03)
California blackberry (*Rubus ursinus*)	1 (0.01)	4 (0.10)
Mexican elderberry (*Sambucus nigra*)	4 (0.06)	1 (0.03)
California sycamore	-	1 (0.03)
Poison oak (*Toxicodendron diversilobum)*	1 (0.01)	2 (0.05)
Mugwort (*Artemisia douglasiana*)	-	1 (0.03)
Salt cedar	2 (0.03)	-
Black willow	1 (0.01)	-

Table 24. Least Bell's Vireo nest characteristics and results of Student's *t*-tests of successful versus unsuccessful nesting attempts at giant reed (*Arundo donax*) Removal and Reference sites, Marine Corps Base Camp Pendleton, 2014.

	Nest Fate				
Nest Characteristic	**Successful**	**Unsuccessful**	***n*[a]**	***t*[b]**	***P*[c]**
Removal Site					
Average nest height (m)	0.97	0.95	17, 49	0.21	0.83
Average host height (m)	6.09	5.62	17, 52	0.60	0.55
Average distance to edge of host (m)	1.22	1.17	17, 51	0.19	0.85
Average distance to edge of clump (m)	2.35	2.61	17, 51	0.34	0.73
Reference Site					
Average nest height (m)	0.75	0.78	10, 29	0.31	0.76
Average host height (m)	2.88	3.23	10, 30	0.41	0.68
Average distance to edge of host (m)	0.47	0.49	10, 29	0.12	0.90
Average distance to edge of clump (m)	1.83	1.37	10, 29	0.80	0.43
Removal and Reference Sites	**Removal**	**Reference**	***n*[d]**	***t*[b]**	***P*[c]**
Average nest height (m)	0.96	0.78	66, 39	3.10	**< 0.01**
Average host height (m)	5.74	3.14	69, 40	5.04	**<0.01**
Average distance to edge of host (m)	1.18	0.48	68, 39	5.02	**< 0.01**
Average distance to edge of clump (m)	2.54	1.49	68, 39	2.24	**0.03**

[a] *n* = number of nests in sample (Successful, Unsuccessful).
[b] *t* = Student's *t* statistic.
[c] *P* = *P*-value.
[d] *n* = number of nests in sample (Removal, Reference).

Over the past 5 years, results of analyses of nest placement characteristics between Removal and Reference sites consistently showed greater values at Removal sites than at Reference sites when the differences were significant. Removal site nests were placed higher in the host plant, in taller nest plants, further from the edge of the host plant (closer to the center), and further from the edge of the vegetation clump surrounding the nest than were nests at Reference sites (Table 25).

Table 25. 5-year summary of Least Bell's Vireo nest placement comparisons using *t*-tests between Removal and Reference sites, Marine Corps Base Camp Pendleton, 2010-2014. Statistical differences ($P \leq 0.1$) are indicated by ">" if Removal site values were significantly higher than Reference site values or "<" if Reference site values were significantly higher.

	Year				
Analysis	**2010**	**2011**	**2012**	**2013**	**2014**
Average nest height (m)	>		>	>	>
Average host height (m)			>	>	>
Average distance to edge of host (m)	>	>		>	>
Average distance to edge of clump (m)		>		>	>

Post-fire versus Reference Sites

Least Bell's Vireos used 14 plant species for nesting at Post-fire and Reference sites in 2014, although not all were used within each treatment (Table 26). Vireos used 13 species at Post-fire sites and 10 species at Reference sites. One nest (at a Post-fire site) was placed in an unknown species of plant. Fifty-eight percent of all nests (53% at Post-fire sites, and 65% at Reference sites) were placed in arroyo willow, mule fat, or sandbar willow. Twelve vireo nests were built in an exotic plant species (ten in poison hemlock and two in black mustard). Eleven of the 14 nests that were built in exotic vegetation were located in the Post-fire sites.

In 2014, successful nests at Post-fire sites were placed in taller host plants and were placed further from the edge (closer to the center) of the host plant than unsuccessful nests (Table 27). Vireo nests at Post-fire sites were similar in placement to those at Reference sites, except nests in Post-fire sites were placed lower in host plants than nests at Reference sites.

Table 26. Host plant species used by Least Bell's Vireos at Post-fire (October 2013) and Reference sites, Marine Corps Base Camp Pendleton, 2014. Numbers in parentheses are proportions of total nests within treatment types.

	Number of Nests	
Host Species	**Post-fire**	**Reference**
Arroyo or red willow	24 (0.44)	6 (0.15)
Mule fat	4 (0.07)	10 (0.25)
Sandbar willow	1 (0.02)	10 (0.25)
Wild grape	6 (0.11)	4 (0.10)
Poison hemlock	9 (0.16)	1 (0.03)
California blackberry	1 (0.02)	4 (0.10)
Mexican elderberry	1 (0.02)	1 (0.03)
California sycamore	3 (0.05)	1 (0.03)
Poison oak	-	2 (0.05)
Mugwort	1 (0.02)	1 (0.03)
Black mustard	2 (0.04)	-
Black willow	1 (0.02)	-
Coastal live oak	1 (0.02)	-
Unknown species	1 (0.02)	-

Table 27. Least Bell's Vireo nest characteristics and results of Student's *t*-tests of successful versus unsuccessful nesting attempts at Post-fire (October 2013) and Reference sites, Marine Corps Base Camp Pendleton, 2014.

	Nest Fate				
Nest Characteristic	**Successful**	**Unsuccessful**	***n*[a]**	***t*[b]**	***P*[c]**
Post-fire Site					
Average nest height (m)	0.70	0.69	10, 44	0.21	0.84
Average host height (m)	3.72	2.55	10, 45	1.85	**0.07**
Average distance to edge of host (m)	0.85	0.46	10, 44	3.50	< **0.01**
Average distance to edge of clump (m)	1.39	1.21	10, 44	0.76	0.45
Reference Site					
Average nest height (m)	0.75	0.78	10, 29	0.31	0.76
Average host height (m)	2.88	3.23	10, 30	0.41	0.68
Average distance to edge of host (m)	0.47	0.49	10, 29	0.12	0.90
Average distance to edge of clump (m)	1.83	1.37	10, 29	0.80	0.43
Post-fire and Reference Sites	**Post-fire**	**Reference**	***n*[d]**	***t*[b]**	***P*[c]**
Average nest height (m)	0.69	0.78	54, 39	1.80	**0.08**
Average host height (m)	2.77	3.14	55, 40	0.88	0.38
Average distance to edge of host (m)	0.53	0.48	54, 39	0.62	0.54
Average distance to edge of clump (m)	1.24	1.49	54, 39	1.03	0.31

[a] *n* = number of nests in sample (Successful, Unsuccessful).
[b] *t* = Student's *t* statistic.
[c] *P* = *P*-value.
[d] *n* = number of nests in sample (Post-fire, Reference).

Pre-fire versus Post-fire Comparisons

Vireo nest characteristics at the Above Hospital South site after the October 2013 wildfire were similar to nest characteristics before the fire (2010-2013; Table 28). The only significant difference in vireo nest placement was that the average height of the nest host plant was less post-fire than it was pre-fire.

Table 28. Comparison of Least Bell's Vireo nest characteristics at the Above Hospital South site, pre-fire (2010-2013) versus post-fire (2014), Marine Corps Base Camp Pendleton.

Nest Characteristic	**Pre-fire (2010-2013)**	**Post-fire (2014)**	***n*[a]**	***t*[b]**	***P*[c]**
Average nest height (m)	0.70	0.70	92, 23	0.11	0.91
Average host height (m)	3.30	2.28	93, 23	1.76	**0.08**
Average distance to edge of host (m)	0.65	0.54	91, 23	0.93	0.35
Average distance to edge of clump (m)	1.29	1.12	91, 23	0.91	0.37

[a] *n* = number of nests in sample (Pre-fire, Post-fire).
[b] *t* = Student's *t* statistic.
[c] *P* = *P*-value.

Population Density

Giant Reed Removal versus Reference Sites

The density of the vireo population increased at Removal and Reference sites in 2014 (Fig. 18). Vireo density at the Reference sites remained below the highest density recorded in 2009, although density at the Removal sites increased almost to the highest recorded density observed in 2010. In 2014, density at Reference sites did not differ from density at Removal sites (t = 0.996, P = 0.42, df = 1). Vireo density at Removal sites increased 10-fold during the first year following treatment, and doubled to match that of Reference sites by the second post-treatment year, and thereafter has remained higher than the Reference sites.

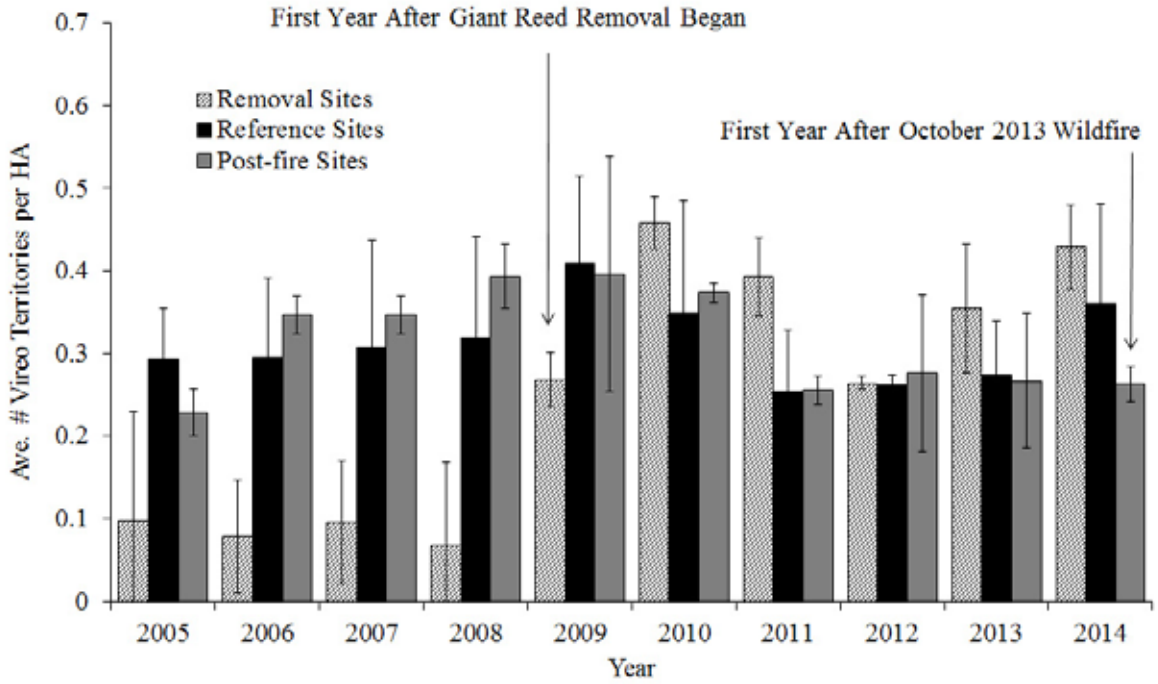

Fig. 18. Annual density of Least Bell's Vireo territories (± SD) at giant reed (*Arundo donax*) Removal, Post-fire, and Reference sites by year, averaged across sites, Marine Corps Base Camp Pendleton, 1997-2014.

Post-fire versus Reference Sites

Vireo territory density at the Post-fire sites was significantly lower than at the Reference sites in 2014 (t = 6.21, P = 0.02, df = 1). Additionally, vireo territory density at the Post-fire sites did not change significantly from the density before the fire (t = 0.057, P = 0.96, df = 1; Fig. 18) while territory density at the Reference sites significantly increased during the same time period (t = 8.60, P = 0.01, df = 1).

Pre-fire versus Post-fire Comparisons

Vireo territory density from 2010 through 2013 at the Above Hospital South site ranged from 0.31 territories/ha to 0.69 territories/ha. After the October 2013 wildfire, vireo territory density at the same site was 0.46 territories/ha, almost exactly the pre-fire average.

DISCUSSION

In 2014, the number of documented Least Bell's Vireo territories (634) on MCBCP decreased by 12% from 2013. This follows one year of vireo population increase on MCBCP, and is not consistent with trends seen elsewhere in San Diego County where vireo populations only decreased slightly or continued to increase for the third year. Vireo populations decreased slightly from 2013 to 2014 on the lower San Luis Rey River (3%; Ferree et al. 2015), increased on the middle San Luis Rey River (53%; Houston and Kus 2014), and increased at MCAS (13%; Allen and Kus 2014). The population decrease on MCBCP is likely a response to wildfires in May 2014 that burned large sections of riparian habitat on the Santa Margarita River and Las Flores Creek. The vireos that were detected prior to the wildfire within its perimeter either perished or were displaced to other vireo habitat, either elsewhere on MCBCP or surrounding drainages off-Base such as the San Luis Rey River. Three banded vireos that were originally documented within the wildfire perimeters prior to the fire were re-detected post-fire in other, unburned parts of MCBCP, demonstrating that at least some territory-holding vireos did survive the fire and moved to more hospitable habitat. Displacement of vireos from MCBCP wildfire areas and from wildfires that occurred during the same period in other areas in northern San Diego County may have exaggerated the discrepancy in population trajectory between MCBCP and surrounding populations in that the surrounding populations may have increased as a result of absorbing fire-displaced vireos in addition to inherent increases in the local populations.

Until 2014, fluctuations in the vireo population over the past several years have been manifested relatively consistently across several study areas in San Diego County, including 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 and then increasing again in 2013 (Ferree and Kus 2007, 2008a, 2008b, Ferree et al. 2010a, 2010b, 2011, 2012a, 2013, Jones 1985; Kus 1988, 1989, 1991a, 1991b, 1994, 1995; Kus and Beck 1998; Peterson et al. 2002; Pottinger and Kus 2013, Rourke and Kus 2006b, 2007b; Lynn and Kus 2008, 2010a, 2010b, 2010d, 2011a, 2011b, 2012a, Lynn et al. 2010, 2012, 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. We expected that the wildfire in May on MCBCP would have an immediate negative effect on vireos as territorial individuals were displaced or died and nests were destroyed. However, vireos re-colonized and had similar breeding productivity in the early successional vegetation growth at the Post-fire sites compared to the Reference sites this year. Therefore the negative effect of habitat destruction during the May 2014 wildfires will likely be temporary as early successional vegetation responds to winter rainfall, revegetating the burned landscape and providing suitable breeding habitat for vireos in spring 2015.

In past years, adult males and females have shown strong fidelity to the Removal and Reference sites, holding the same territories for several years in a row. This continued in 2014 at the Removal sites and the Reference site that has remained consistently a Reference site since 2005. Interestingly, the majority of adult vireos that occupied the other 2013 Reference site that burned in October 2013 returned to the same site, probably because vegetation had regrown substantially by the time they arrived on Base in March and April. Some of the adult vireos that did not return to the same burned site were re-detected just upstream in the other site that burned in October 2013, or just downstream in the new Reference site.

As in past years, in 2014 we detected vireos that originated outside of MCBCP holding territories on drainages on MCBCP, as well as vireos that hatched on MCBCP breeding off-Base on the San Luis Rey River, providing further evidence of the connection between vireo populations in drainages across southern California. 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.

Over the 5-year course of our study, Removal sites had higher breeding productivity than Reference sites as indicated by the greater number of young fledged per pair each year at Removal sites than at Reference sites. These results suggest that vireo habitat continues to improve at Removal sites and vireos have responded quickly and positively to the habitat improvement. This difference disappeared in 2014, when breeding productivity was lowest at both types of sites since 2010. Similarly the proportion of nests that were successful and the percent of pairs that fledged at least one young were at their lowest level in 2014 since monitoring began in 2005. San Diego County has been experiencing a drought since 2012, with precipitation for each bio-year (1 July – 30 June) since July 2011 totaling < 50% of the precipitation for the July 2009 and 2010 bio-years (Weather Underground 2014). Low annual precipitation translates to low primary productivity and a corresponding dearth of prey for vireos. Without an adequate prey-base, vireos were likely unable to amass sufficient energy reserves to provide for their offspring. Survivorship of adult vireos may also be compromised by reduced prey availability. While nest failure rate and breeding productivity in 2014 did not differ between Removal and Reference sites, more pairs at Removal sites initiated three or more nests than at Reference sites. Pairs at Removal sites may have continued to initiate nesting attempts because resources at those sites were available for longer into the season, or perhaps predator abundance was higher at Removal sites, causing nest failures and stimulating new nest construction post-failure. We did not measure prey availability or predator abundance to ascertain whether these were contributing factors.

Over the past 5 years, vireos nest placement has consistently differed between Removal and Reference sites. Because we did not measure vegetation in this study, we cannot attribute the differences in nest placement to differences in available vegetation versus other factors such

as habitat selectivity. However, at Post-fire sites, vireos placed their nests in shorter trees than they did in the same sites prior to the fire, suggesting that fire may have damaged or destroyed taller trees making them unsuitable for nesting in 2014. As vegetation recovers post-fire and trees grow taller, vireos are likely to place their nests in these taller trees again.

While vireo territory density at the Post-fire sites was lower than at the Reference sites, post-fire territory density did not differ significantly from pre-fire territory density. This suggests that the post-fire vegetation recovered quickly in response to winter rainfall and was at least as suitable for vireo occupation than the habitat was prior to the fire.

Vireo productivity in Reference sites and Post-fire sites was relatively similar in 2014 suggesting that conditions that affected the number of young fledged per pair and the proportion of pairs that fledged at least one young were similar at both types of site. However, a relatively large number of nests failures at the Post-fire site 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, we observed stump-sprouting of red and arroyo willow, mule fat, and sandbar willow at the Post-fire sites which resulted in thick, low branch and leaf cover by the end of the breeding season. This stump-sprouting likely had not progressed far enough by the time the vireos arrived at their breeding territories to provide stable substrates for early nests. Rourke and Kus (2006c) found that Southwestern Willow Flycatchers keyed in on the structural components of poison hemlock that mimicked preferred nesting substrates such as young willow and stinging nettle (*Urtica dioica*), whether or not these traditional substrates were available. The preponderance of exotic annuals at disturbed sites may create an ecological sink during dry years for species such as the vireo and flycatcher that readily use these plants as support substrates for their nests. However, these annuals may also attract birds to recently disturbed sites and provide a short-term refuge while the native vegetation develops to accommodate later nests that might be more successful.

CONCLUSIONS

Until 2014, the vireo population on MCBCP has tracked the overall increase in Least Bell's Vireos in southern California since the late 1970s (USFWS 2006). 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 2014. Cowbird control has a demonstrably positive effect on vireo productivity (Kus 1999, Kus and Whitfield 2005), but must be consistently practiced to maintain the desired reduction in parasitism. The population decline in 2014 was likely anomalous, resulting from mid-season wildfires that displaced territorial vireos. However, given the low number of fledglings produced per pair in 2014, the population overall may experience a decline in 2015. 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 the additive effect, especially in years like 2014, place the vireo population in a position vulnerable to future decline.

Control of giant reed and other invasive riparian plant species has increased vireo breeding habitat, also contributing to increases in the vireo population. We expected short-term negative responses by vireos to the removal of the understory at giant reed Removal sites. Vireos did experience a short-term dip in population density immediately following the removal of giant reed at Removal sites, but there was little evidence that vireo reproductive indices experienced a similar dip. In fact, it is evident that although there may not have been as many vireos breeding at Removal sites immediately following giant reed removal, vireo reproductive success was never lower at Removal sites (after removal of giant reed) than at Reference sites, indicating that over the long term, giant reed removal did not negatively impact vireo breeding productivity. However, it is worth noting that the method and timing of giant reed removal are important factors to consider when weighing the proximate costs and benefits to native bird species of removing giant reed, especially when such activities overlap with the breeding season. Further investigation into habitat, prey, and predation pressures as associated with vireo breeding productivity would identify variables that directly affect vireo productivity and may be subject to management actions to help augment vireo populations.

The growth of exotic annual vegetation in burned or disturbed areas can provide short-term nesting substrate for vireos, as long as rainfall is sufficient to keep the herbaceous vegetation from drying out and collapsing. Complete replacement of exotic annuals by native willows and mule fat could be problematic because native vegetation such as willows and mule fat take time to become established, creating a net loss habitat for vireos in the short-term. Replacement of exotic annuals by native willows and mule fat in stages would 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. 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 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. Aside from wildfire, direct human impacts to vireo habitat were not documented in 2014, 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 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 vegetation clearing will minimize impacts to active territories by either arranging these activities outside of the vireo breeding season or in areas with less potential to impact breeding birds. 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, 2014

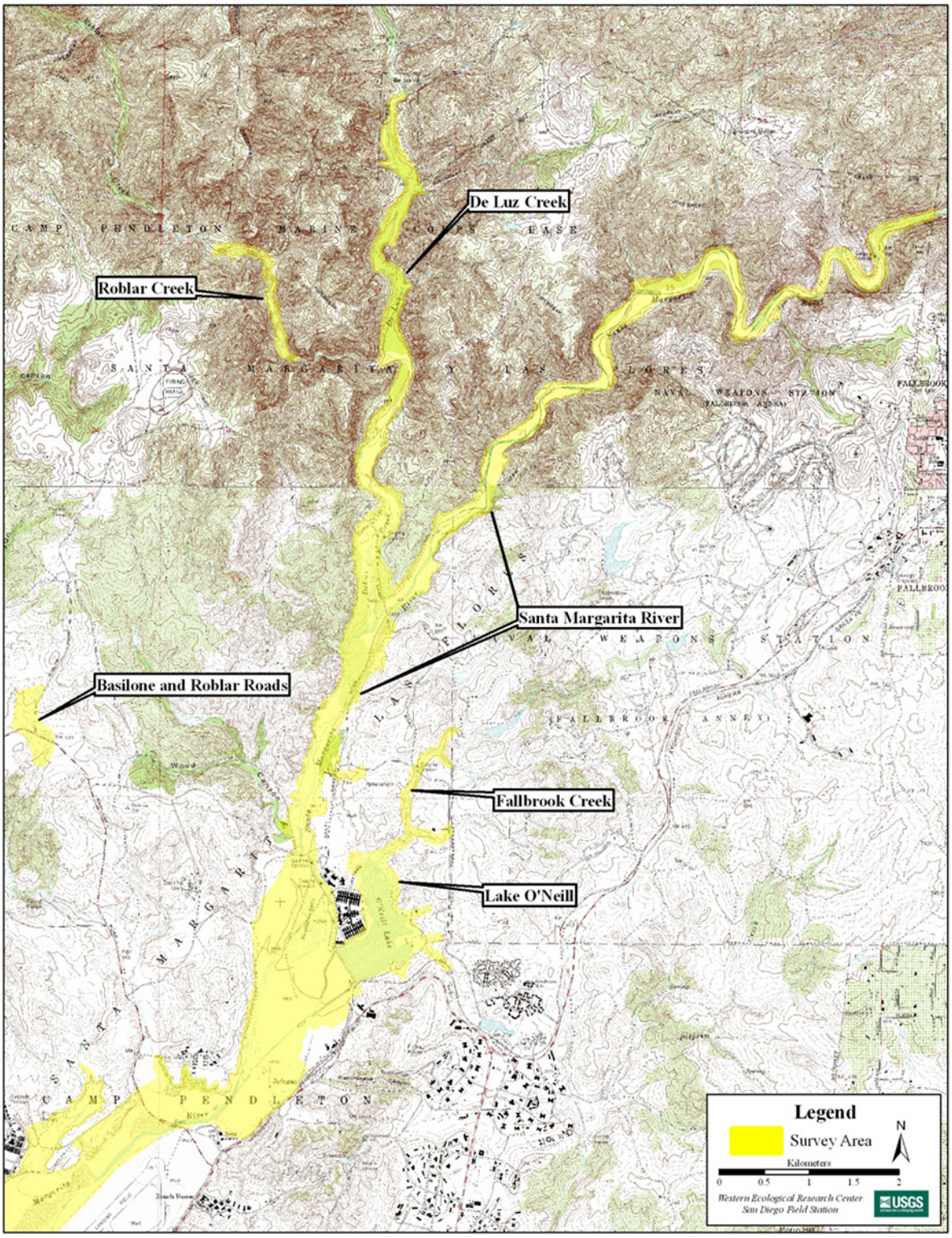

Fig. 19. Least Bell's Vireo survey areas at Marine Corps Base Camp Pendleton, 2014: Upper Santa Margarita River, Fallbrook Creek, Lake O'Neill, De Luz Creek, Roblar Creek, and Basilone and Roblar Roads.

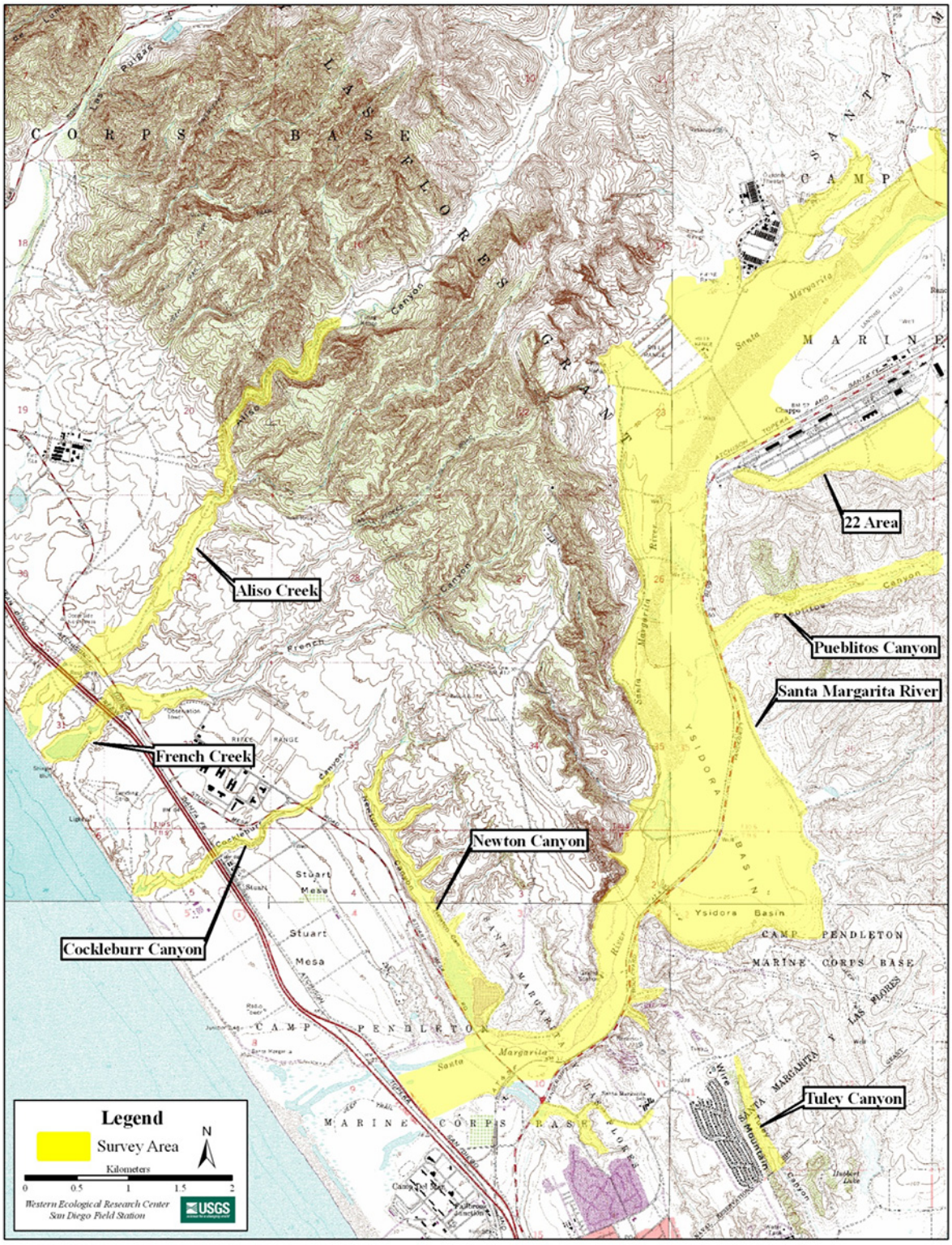

Fig. 20. Least Bell's Vireo survey areas at Marine Corps Base Camp Pendleton, 2014: Lower Santa Margarita River, 22 Area, Pueblitos Canyon, Tuley Canyon, Newton Canyon, Cockleburr Canyon, French Creek, and Aliso Creek.

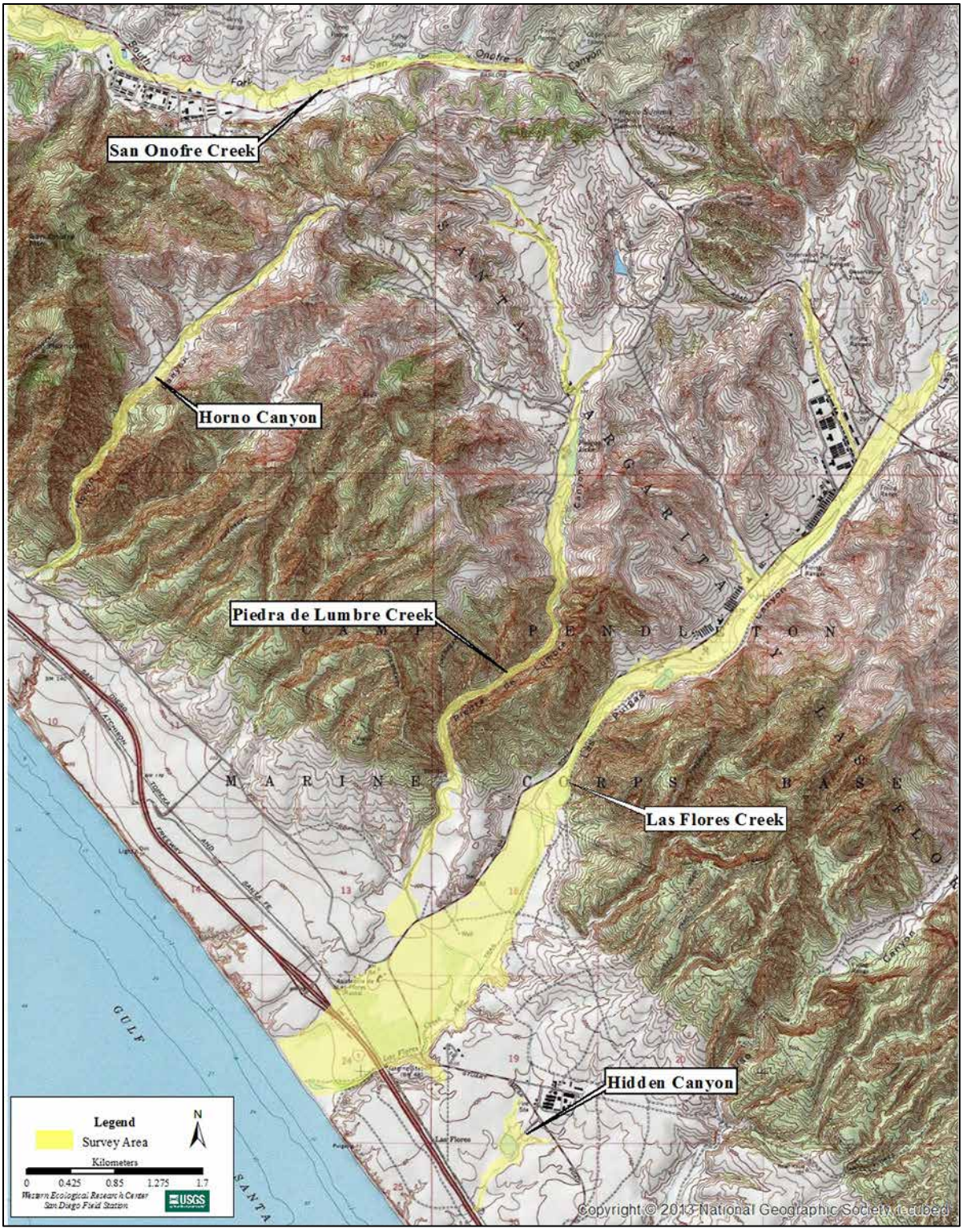

Fig. 21. Least Bell's Vireo survey areas at Marine Corps Base Camp Pendleton, 2014: San Onofre Creek South Fork, Ammunition Supply Point, Horno Canyon, Piedra de Lumbre Creek, Las Flores Creek, and Hidden Canyon.

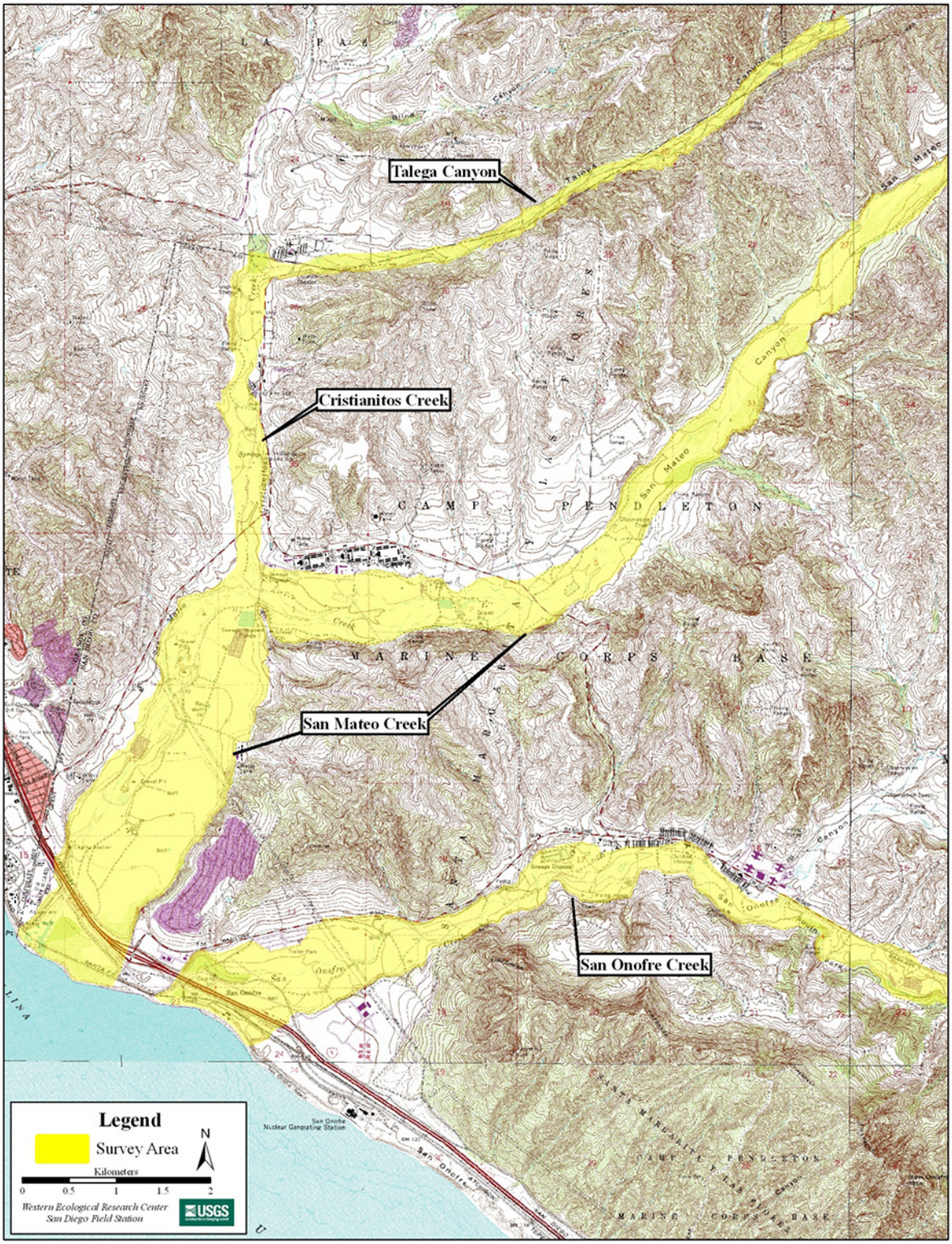

Fig. 22. Least Bell's Vireo survey areas at Marine Corps Base Camp Pendleton, 2014: Talega Canyon, Cristianitos Creek, San Mateo Creek, and San Onofre Creek.

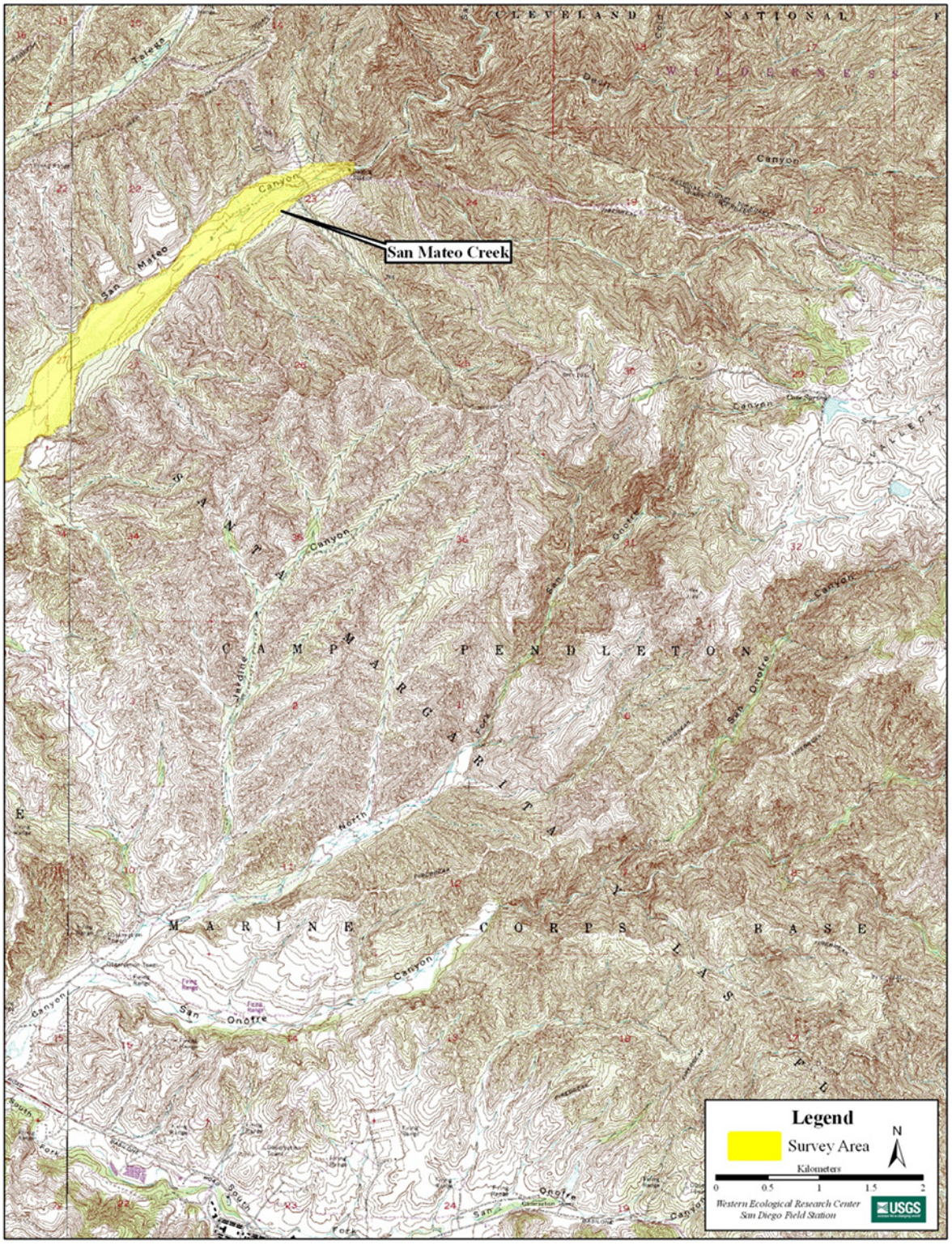

Fig. 23. Least Bell's Vireo survey areas at Marine Corps Base Camp Pendleton, 2014: Upper San Mateo Creek.

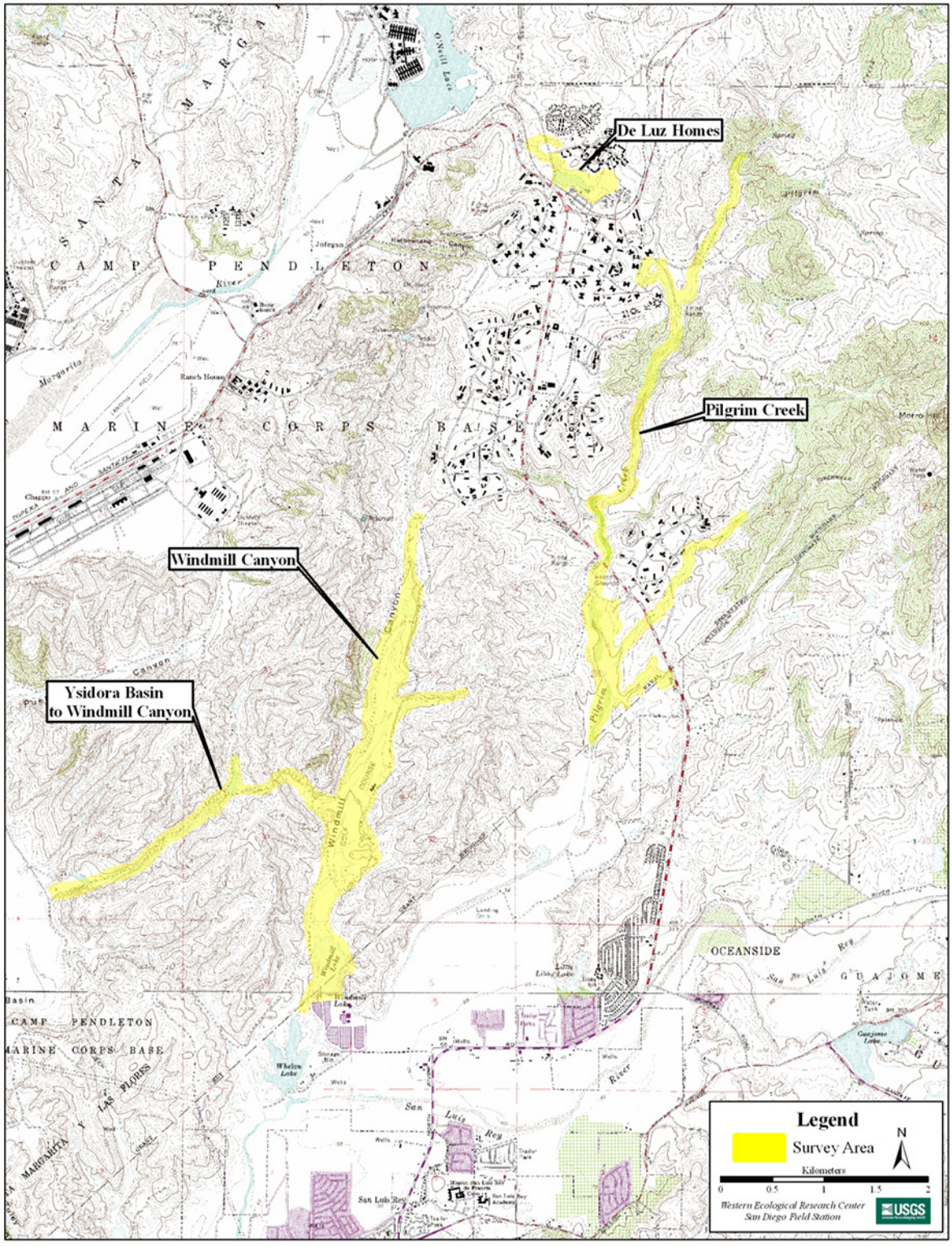

Fig. 24. Least Bell's Vireo survey areas at Marine Corps Base Camp Pendleton, 2014: Windmill Canyon, Ysidora Basin to Windmill Canyon, Pilgrim Creek, and De Luz Homes Habitat.

Appendix B. Photographs of Post-Fire Vegetation Transects Taken From the Beginning of each Transect and Oriented along the Bearing of the Transect, March 2014 and July 2014, Marine Corps Base Camp Pendleton. All photographs were taken by L. Allen.

Photographs Taken 25 March 2014	Photographs Taken 31 July 2014
	
Transect 1	
	
No photograph taken in March 2014.	
Transect 2	

Photographs Taken 25 March 2014	Photographs Taken 31 July 2014
	
Transect 3	
	
Transect 4	
	
Transect 5	

Photographs Taken 25 March 2014	Photographs Taken 31 July 2014
	
Transect 6	
	
No photograph taken in March 2014.	
Transect 7	

Photographs Taken 25 March 2014	Photographs Taken 31 July 2014
	
Transect 8	
	
Transect 9	

Photographs Taken 25 March 2014	Photographs Taken 31 July 2014
	
Transect 10	
	
Transect 11	

Photographs Taken 25 March 2014	Photographs Taken 31 July 2014
	
Transect 12	
	
Transect 13	
	
Transect 14	

Photographs Taken 25 March 2014	Photographs Taken 31 July 2014
	
Transect 15	
	
Transect 16	

Photographs Taken 25 March 2014	Photographs Taken 31 July 2014
	
Transect 17	
	
Transect 18	

Photographs Taken 25 March 2014	Photographs Taken 31 July 2014
	
Transect 19	
	
Transect 20	
	
Transect 21	

Photographs Taken 25 March 2014	Photographs Taken 31 July 2014
	
Transect 22	
	
Transect 23	
	
Transect 24	

Appendix C. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2014

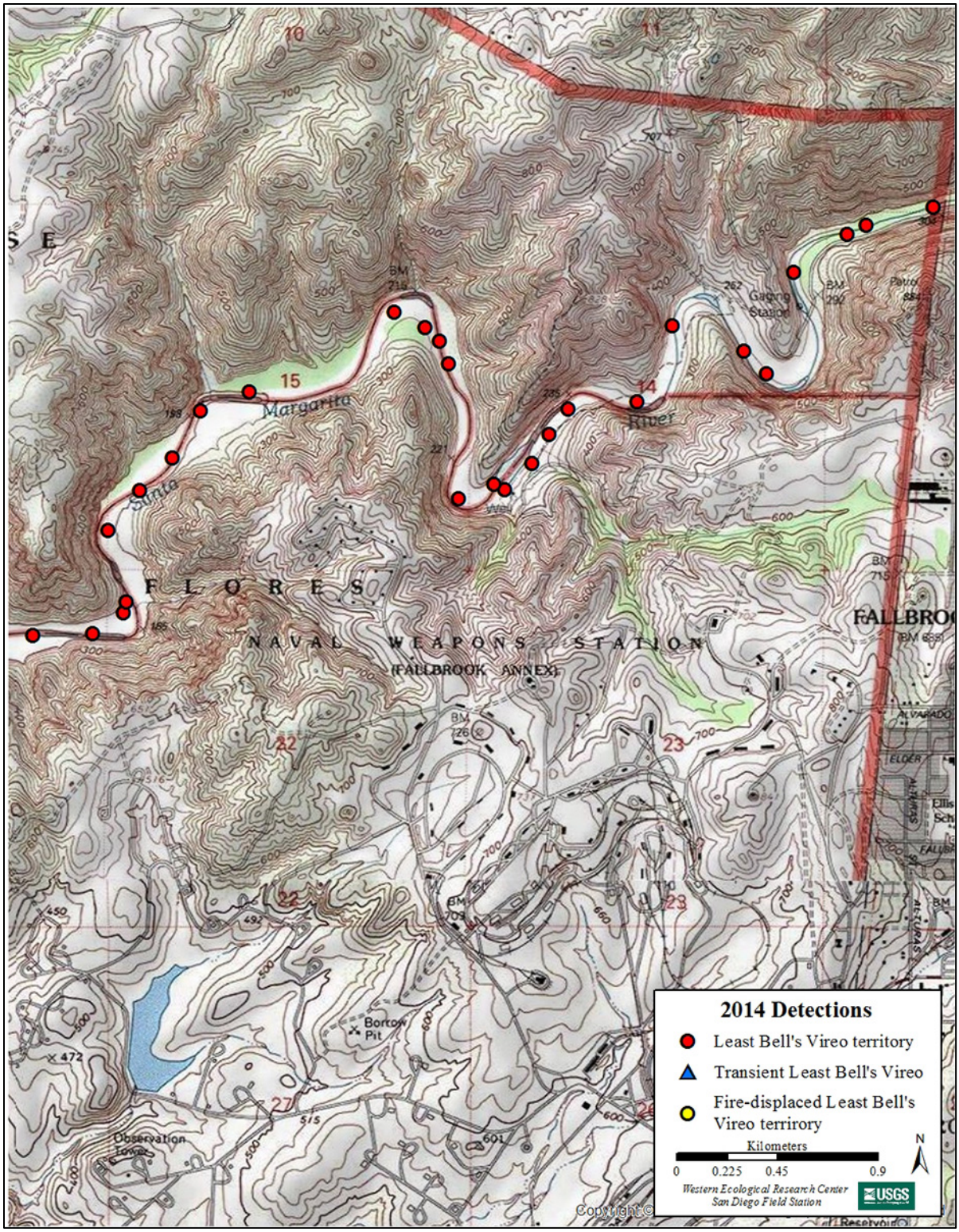

Fig. 25. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2014: Upper Santa Margarita River.

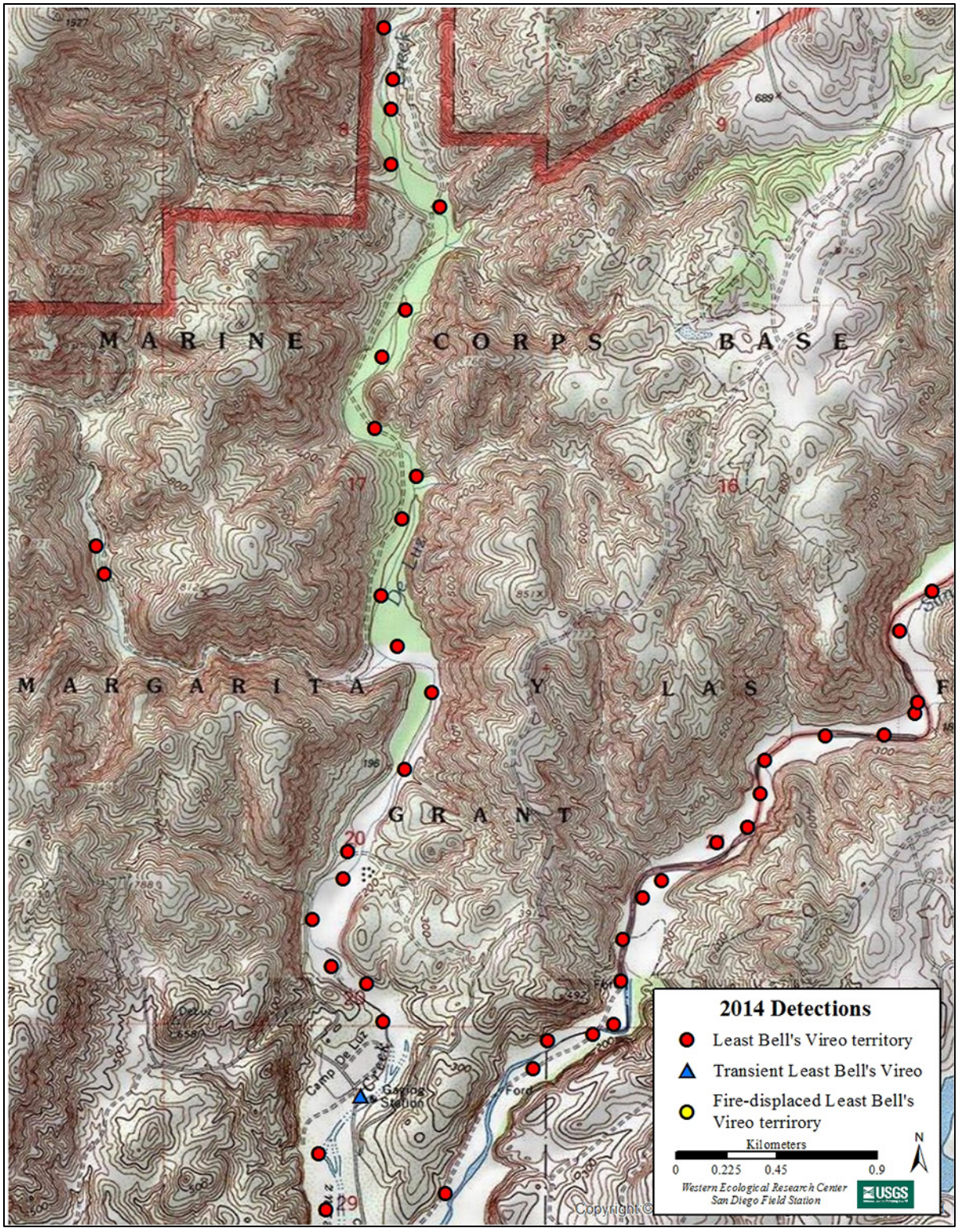

Fig. 26. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2014: Upper Santa Margarita River, De Luz Creek, and Roblar Creek.

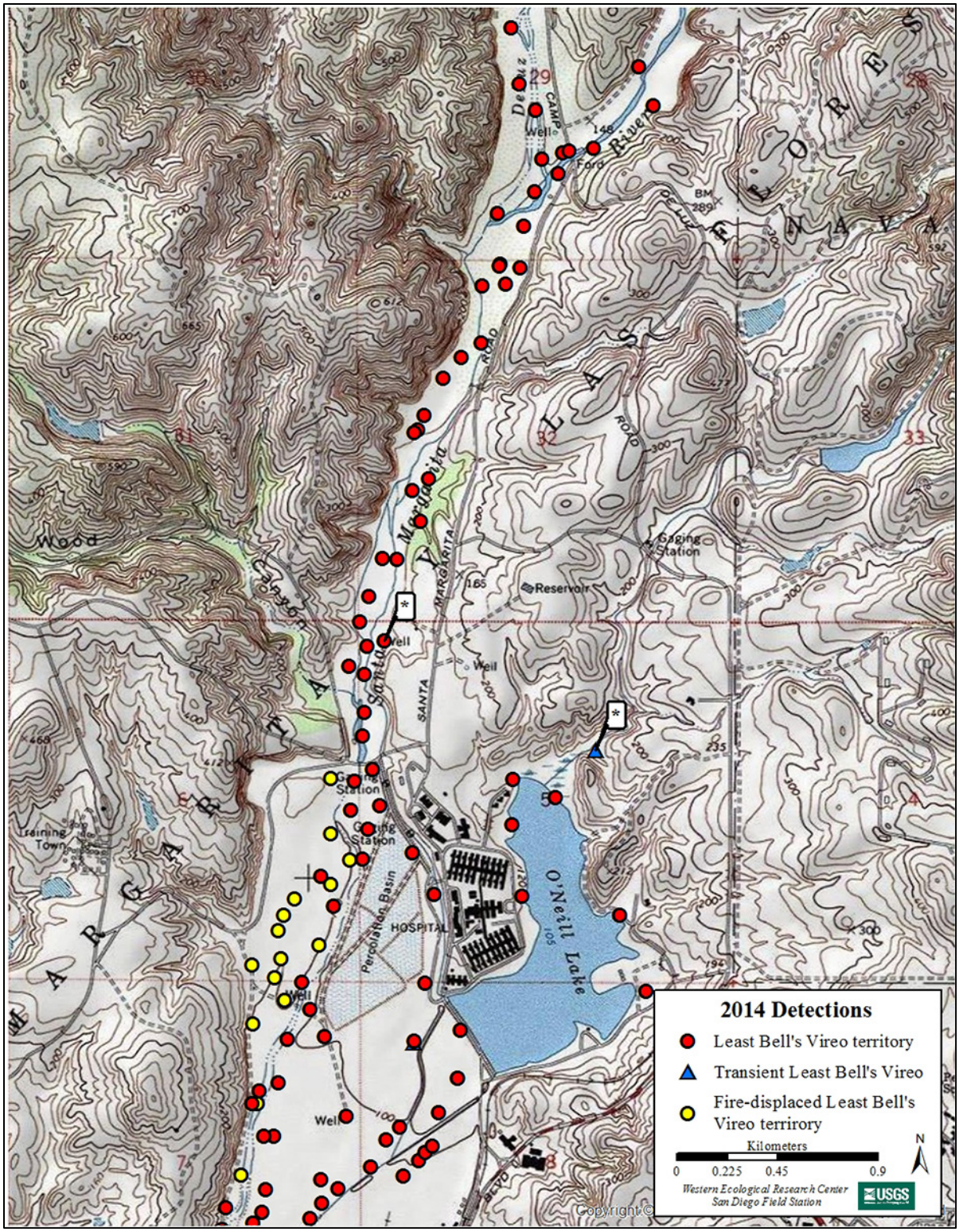

Fig. 27. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2014 Santa Margarita River, Lake O'Neill, and Fallbrook Creek. An asterisk (*) indicates second location of vireo detected and counted first elsewhere.

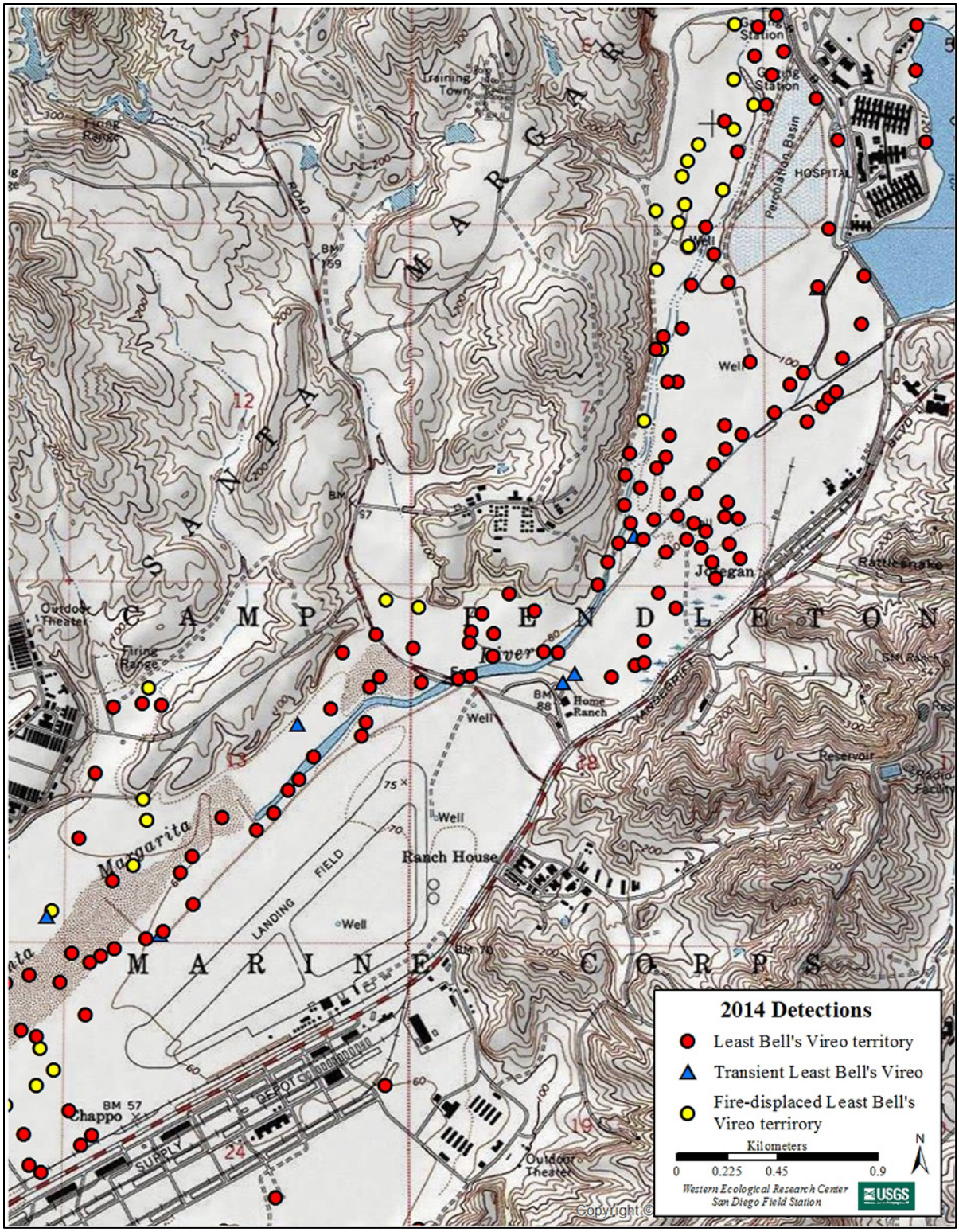

Fig. 28. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2014: Santa Margarita River.

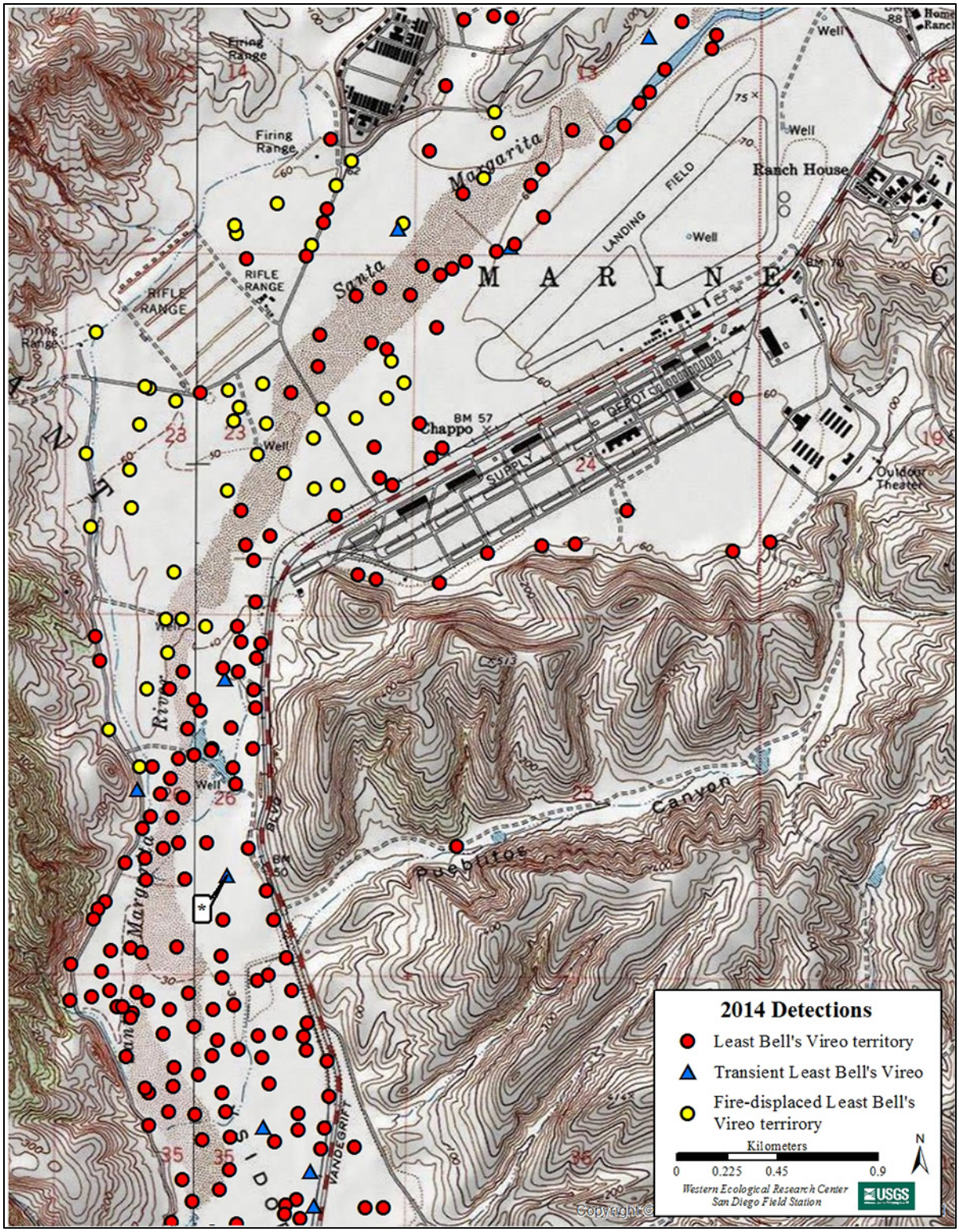

Fig. 29. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2014: Santa Margarita River, 22 Area, and Pueblitos Canyon. An asterisk (*) indicates second location of vireo detected and counted first elsewhere.

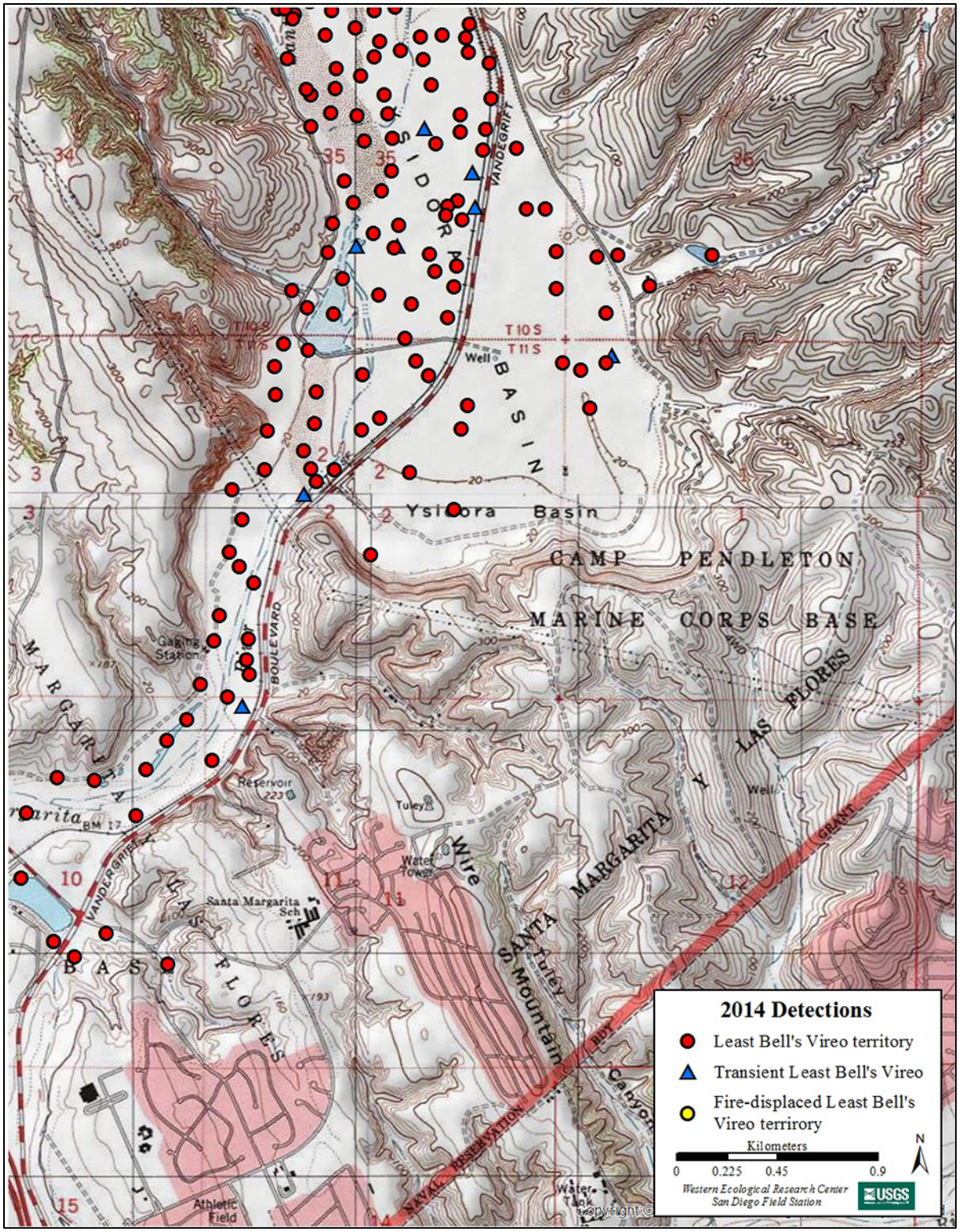

Fig. 30. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2014: Santa Margarita River, Ysidora Basin, and Ysidora Basin to Windmill Canyon.

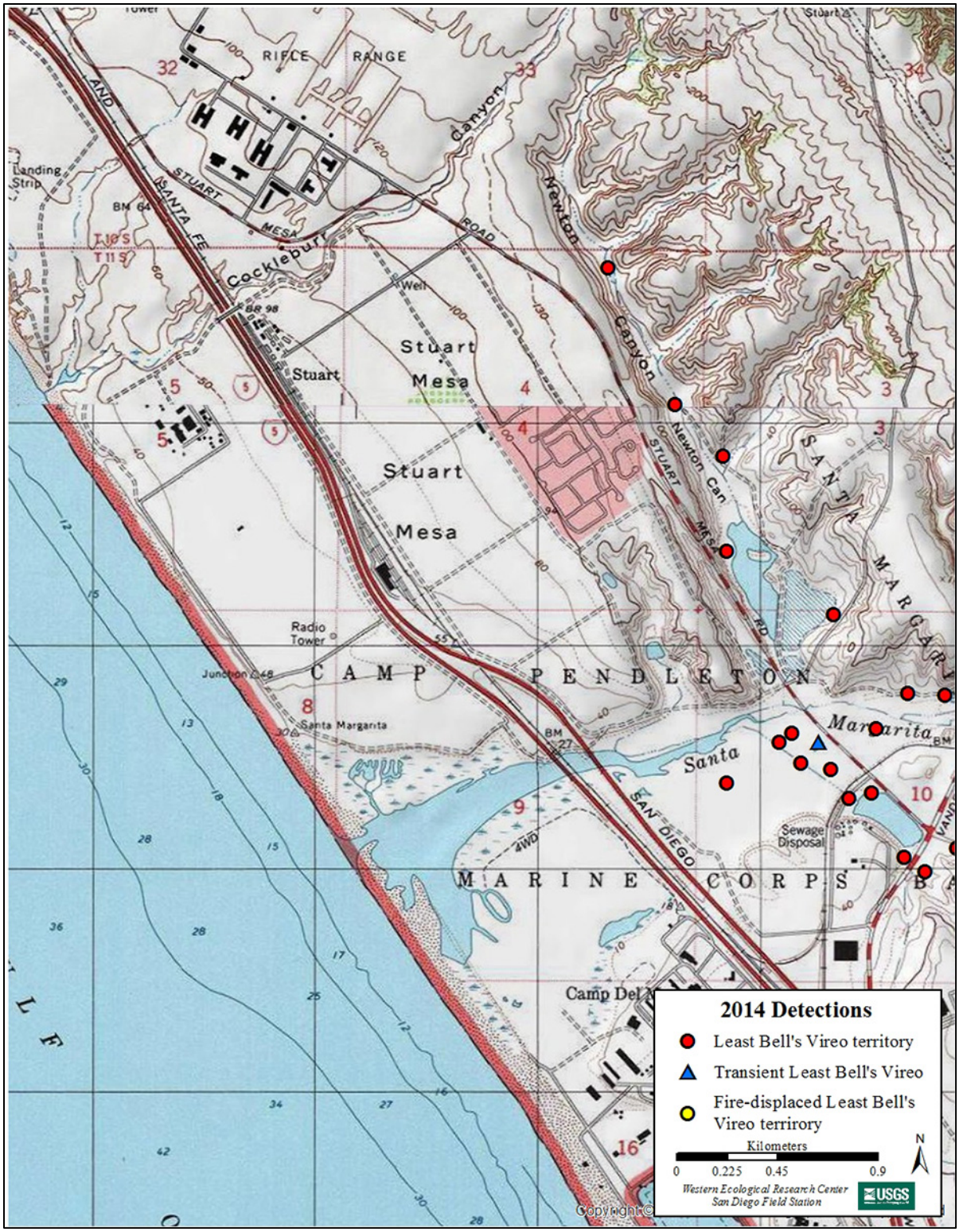

Fig. 31. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2014: Lower Santa Margarita River, Newton Canyon, and Cockleburr Canyon.

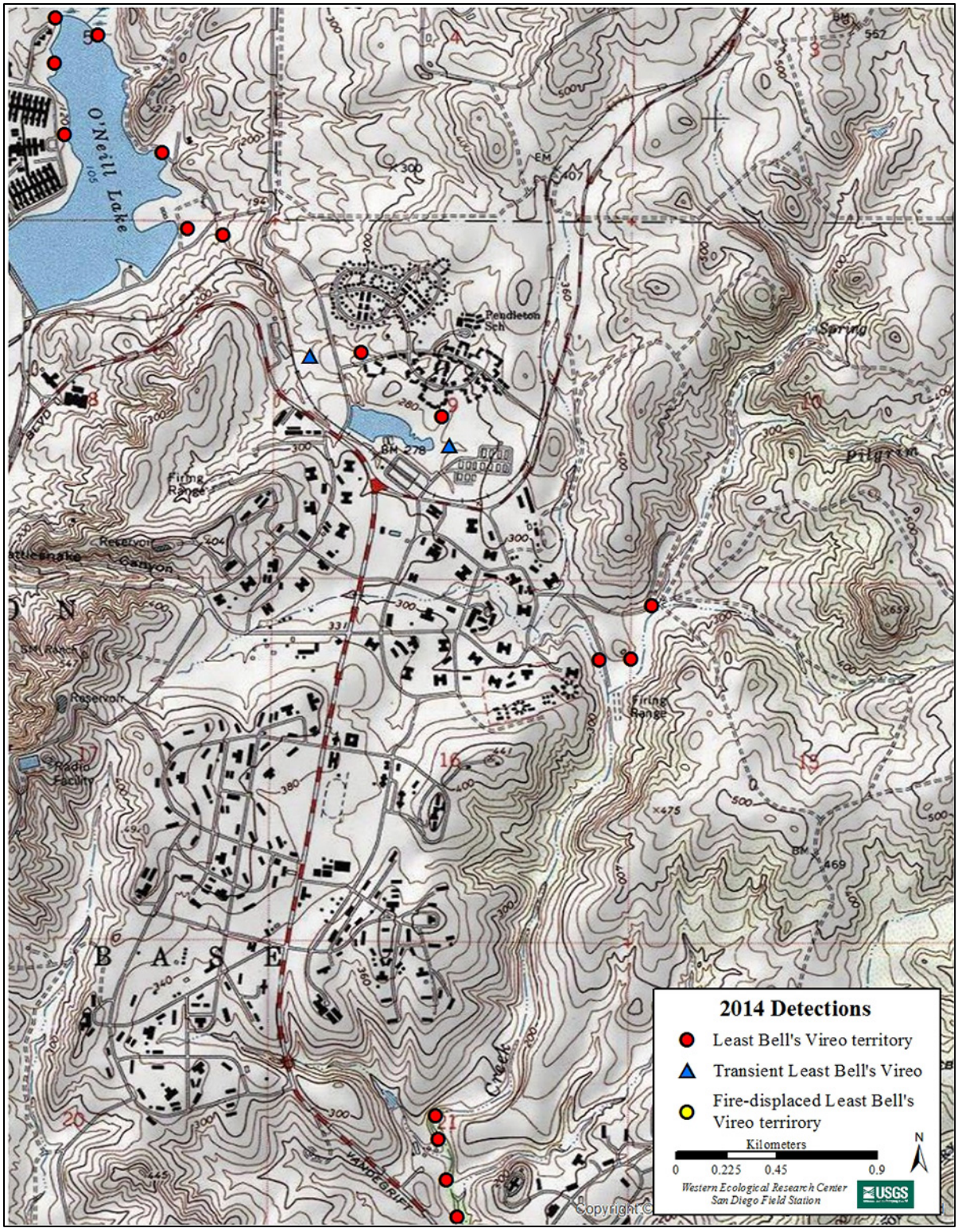

Fig. 32. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2014: Upper Pilgrim Creek, De Luz Homes Habitat, and Lake O'Neill.

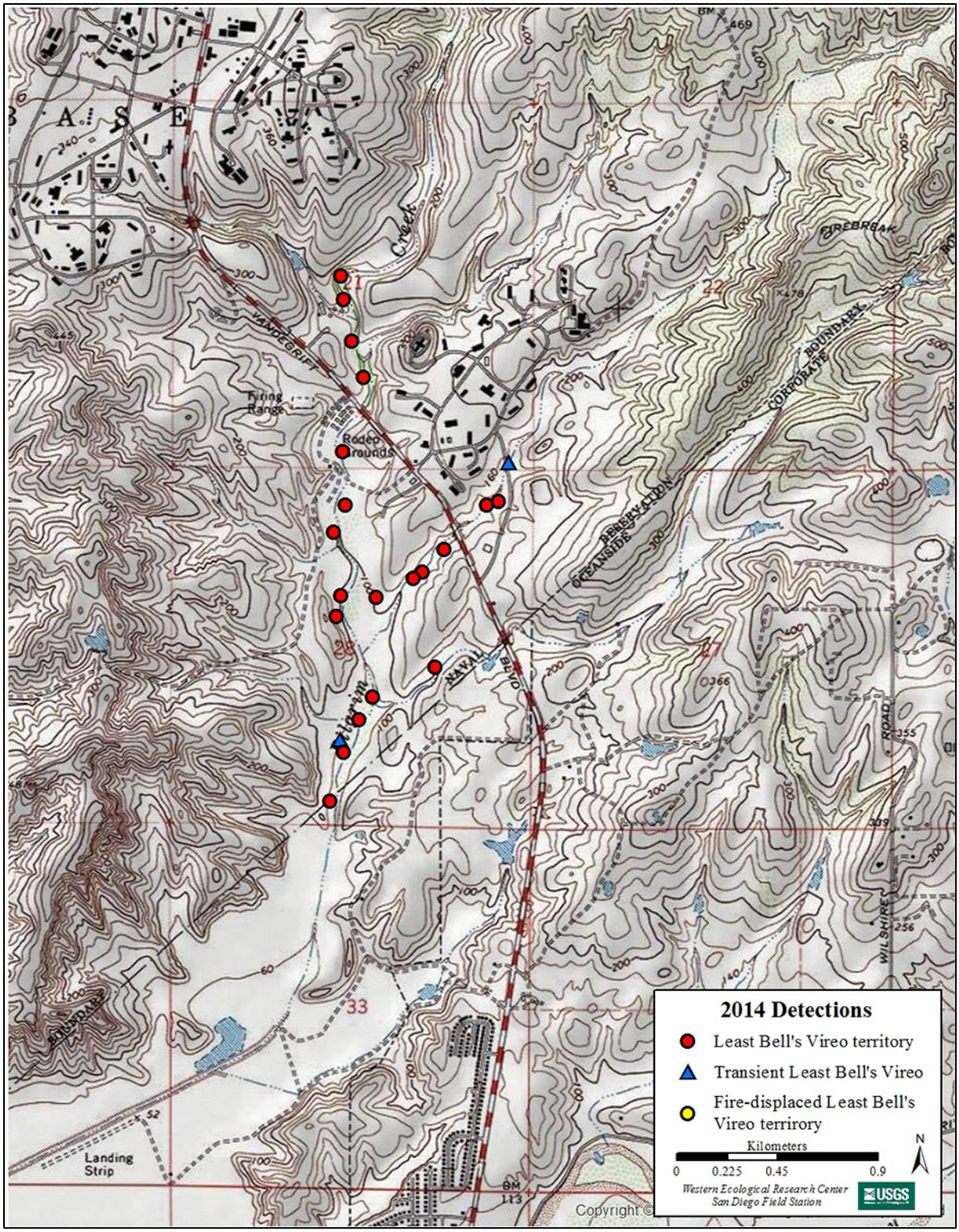

Fig. 33. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2014: Upper and Lower Pilgrim Creek.

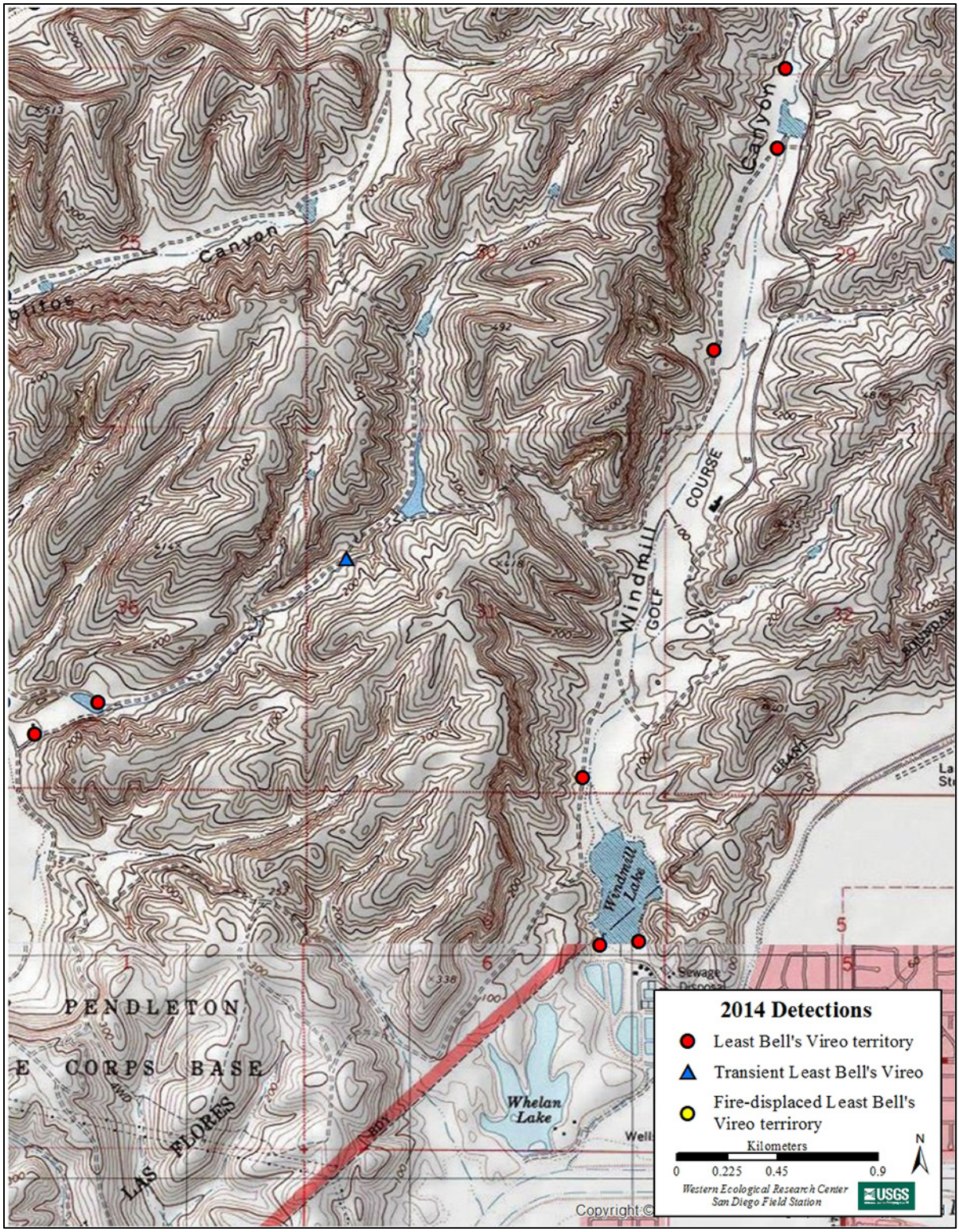

Fig. 34. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2014: Windmill Canyon and Ysidora Basin to Windmill Canyon.

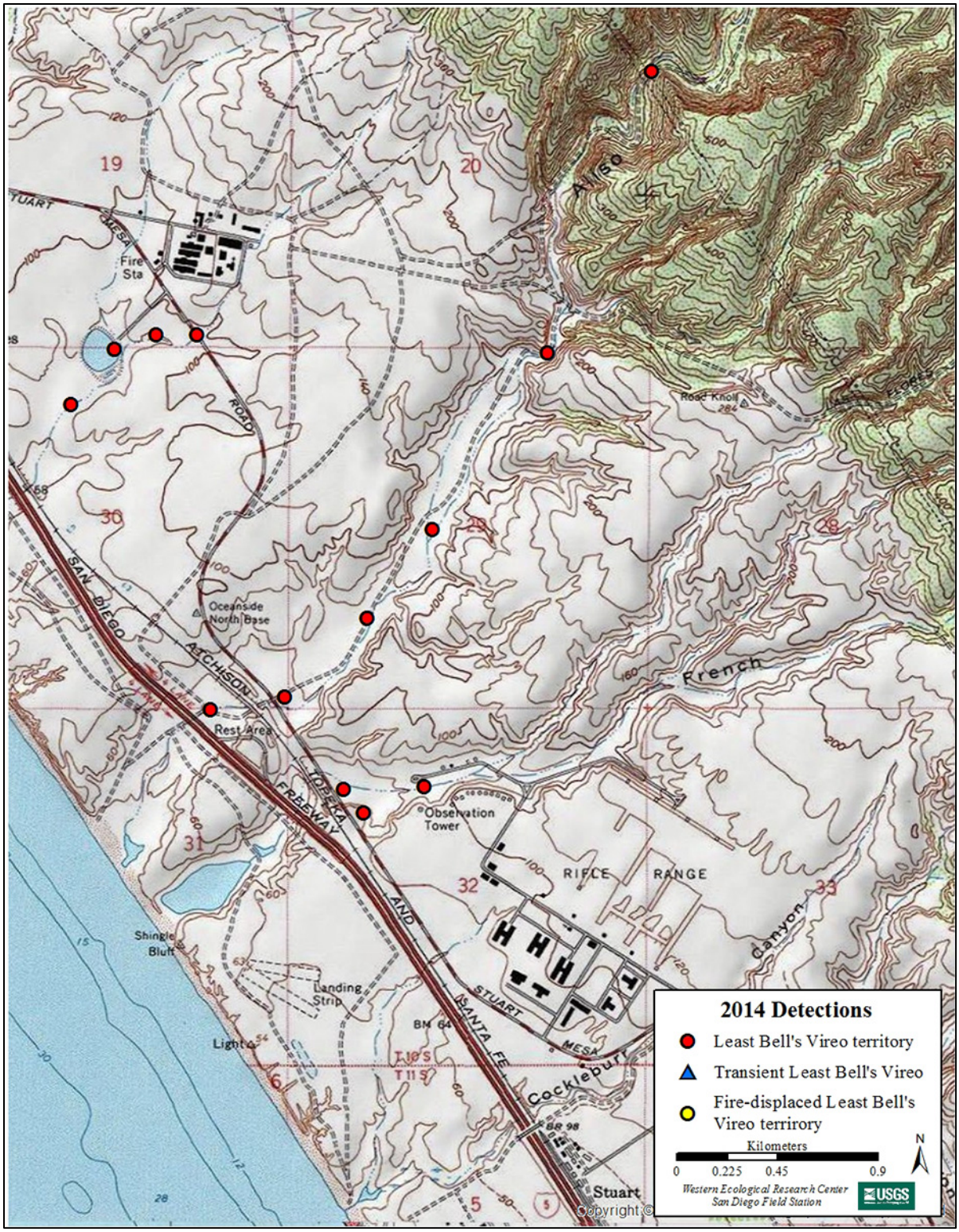

Fig. 35. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2014: French Creek, Aliso Creek, and Hidden Canyon.

Fig. 36. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2014: Basilone and Roblar Roads.

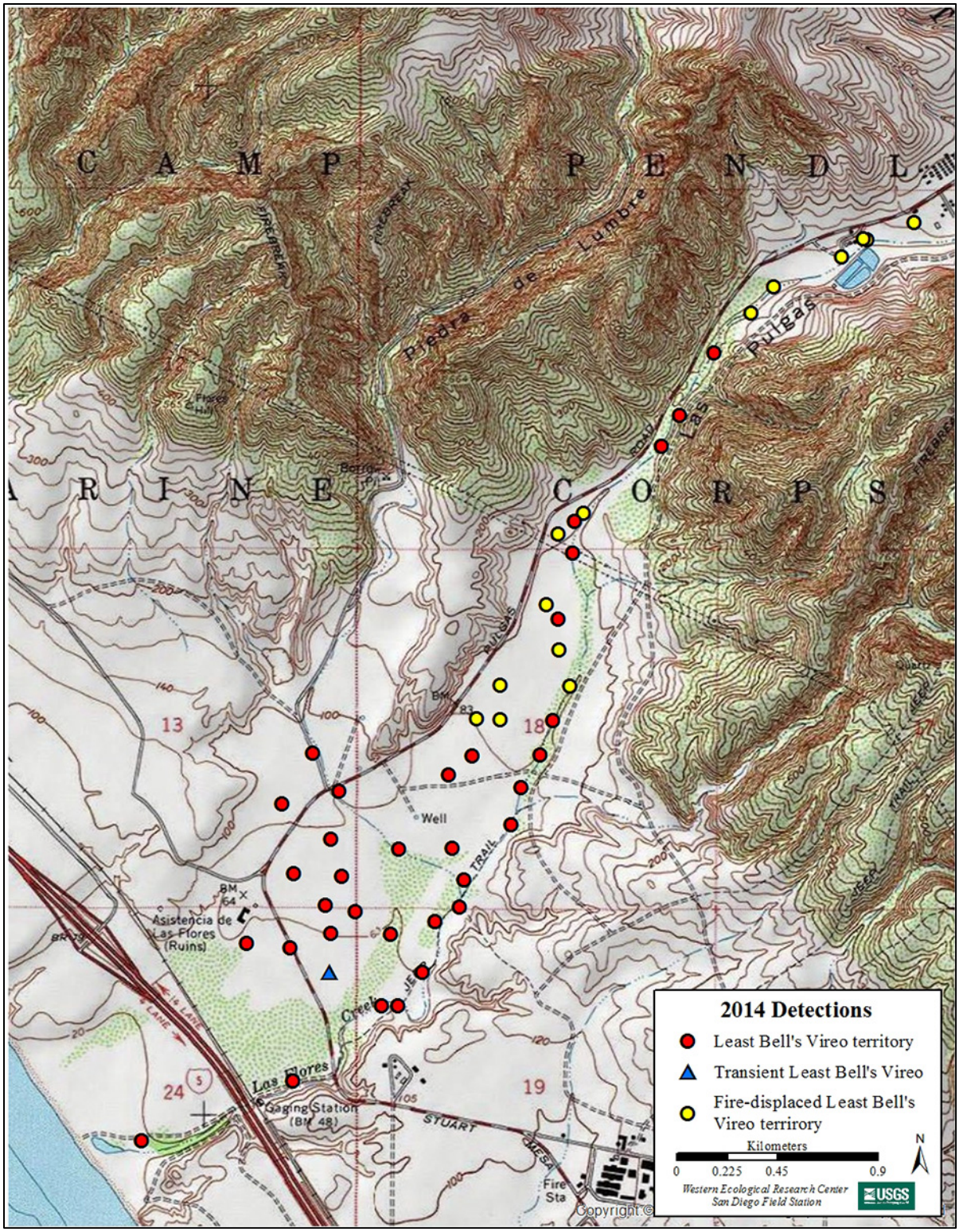

Fig. 37. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2014: Lower Las Flores Creek and Piedra de Lumbre Canyon.

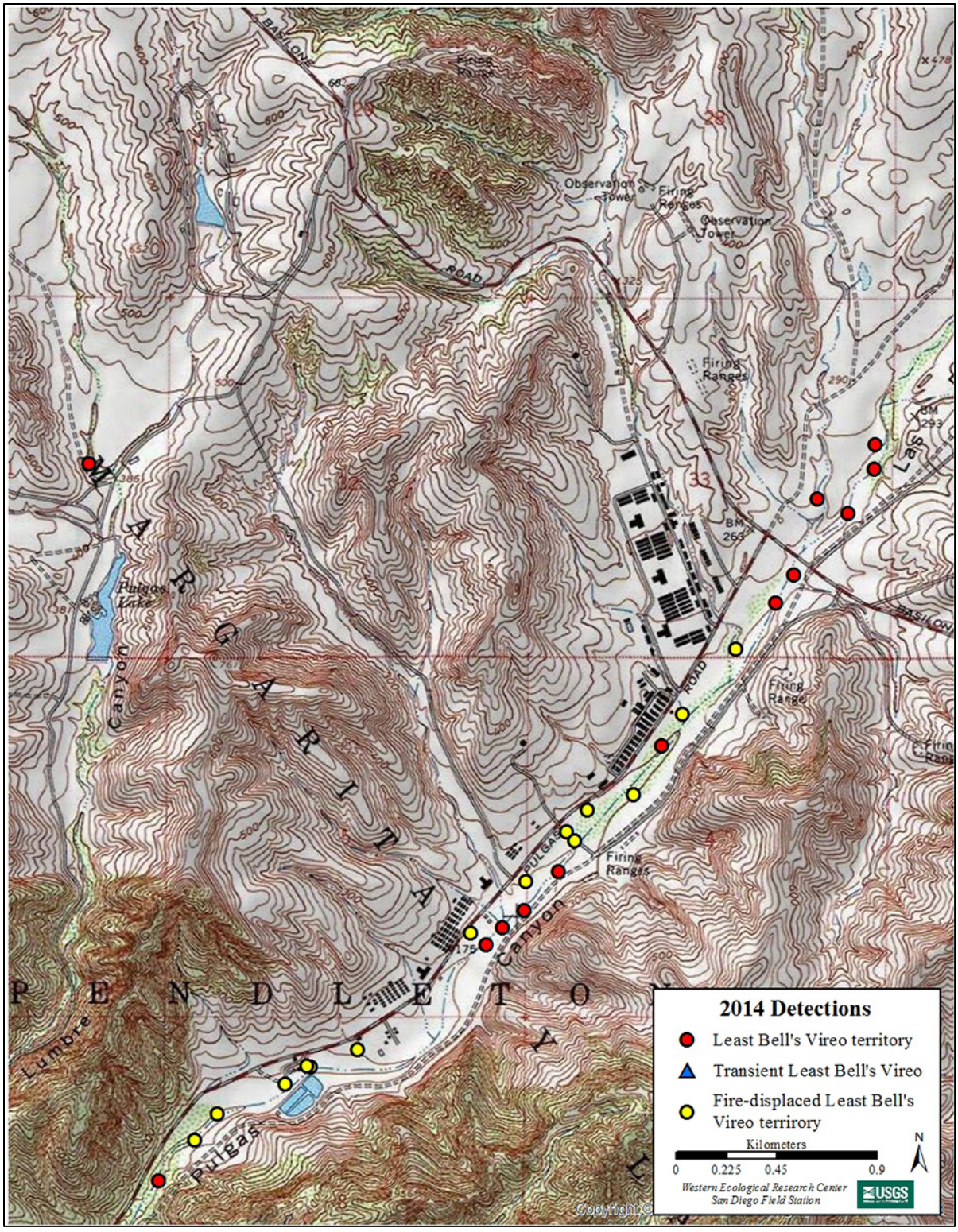

Fig. 38. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2014: Piedra de Lumbre Canyon and Upper Las Flores Creek.

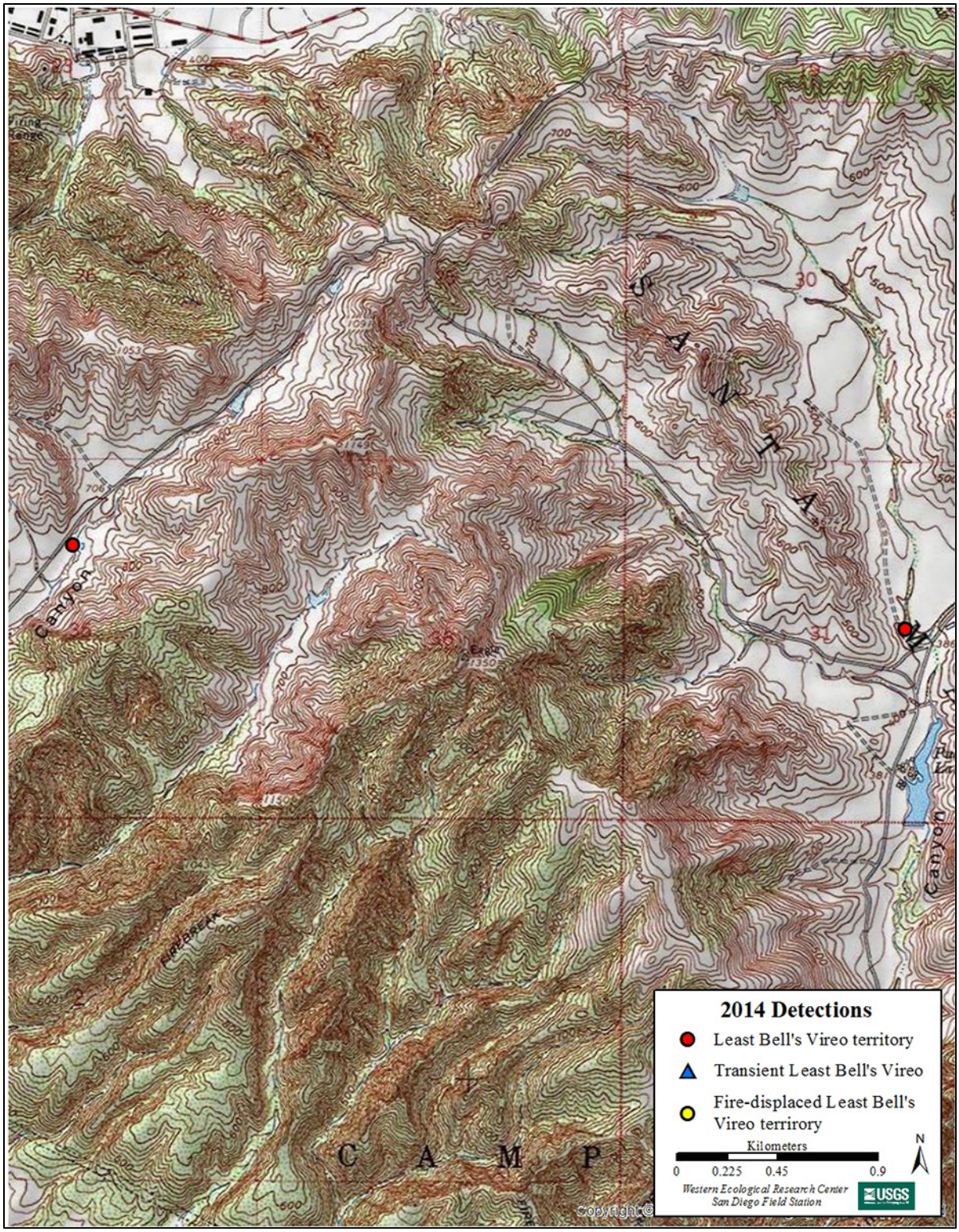

Fig. 39. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2014: Horno Canyon.

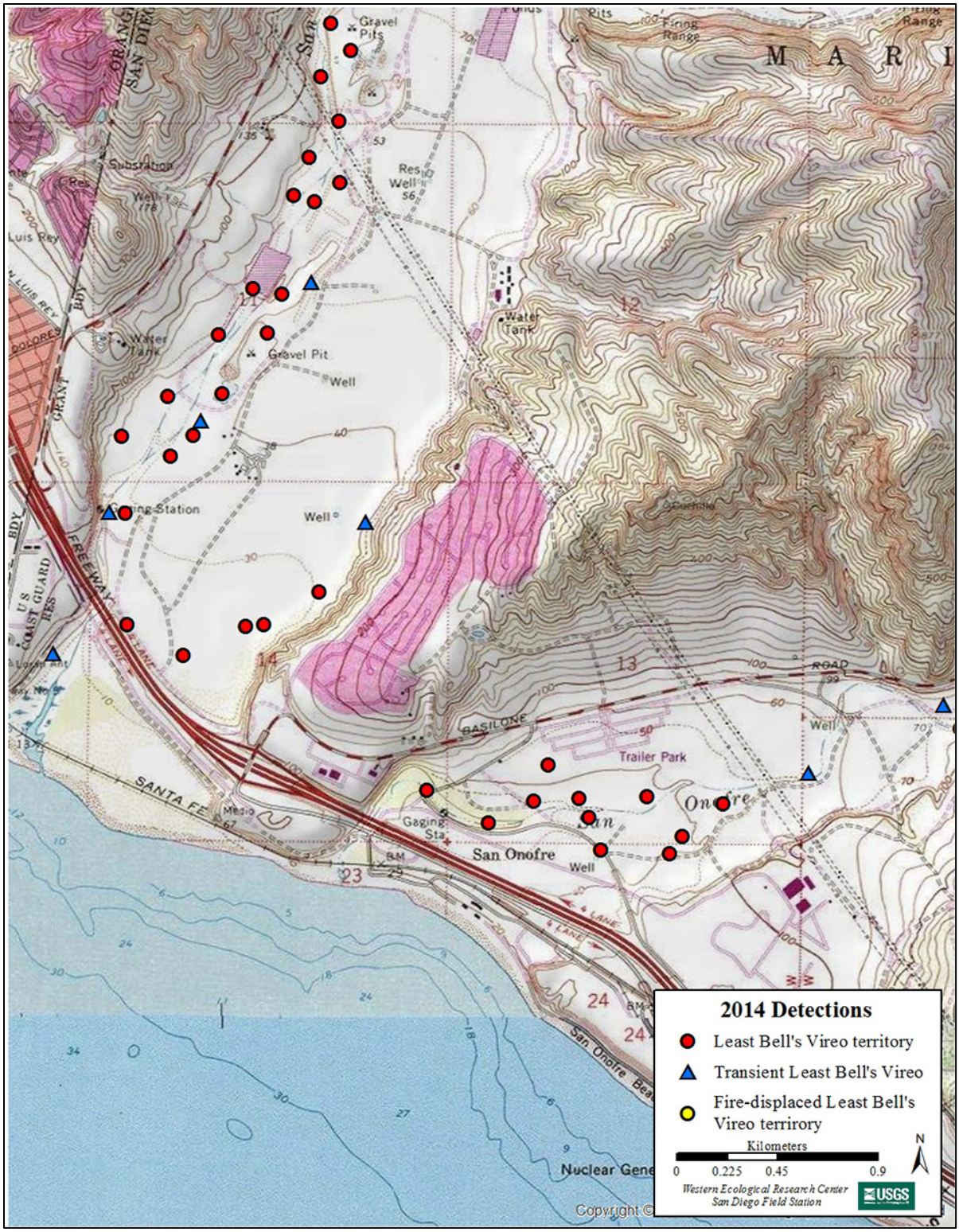

Fig. 40. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2014: Lower San Onofre Creek and Lower San Mateo Creek.

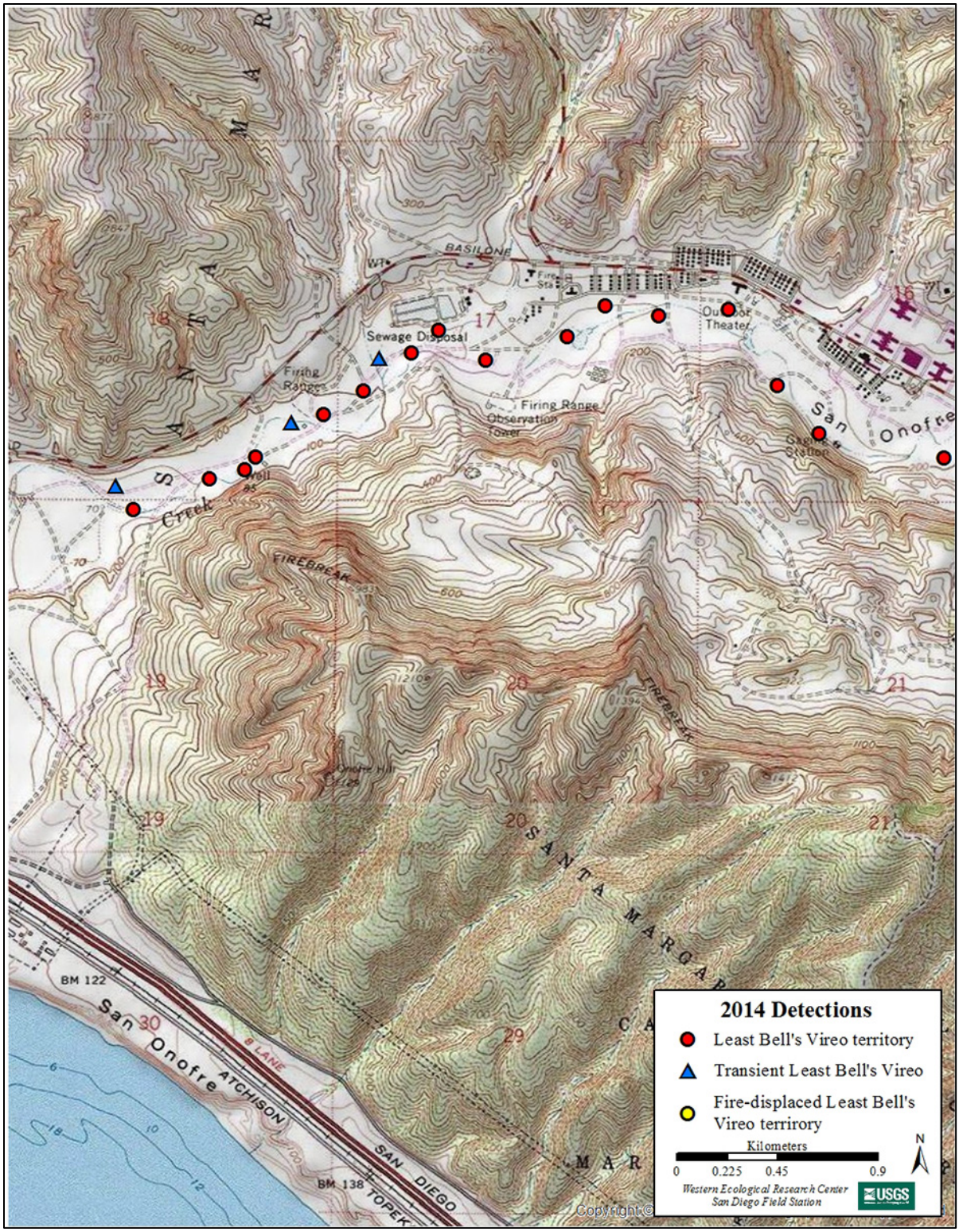

Fig. 41. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2014: San Onofre Creek.

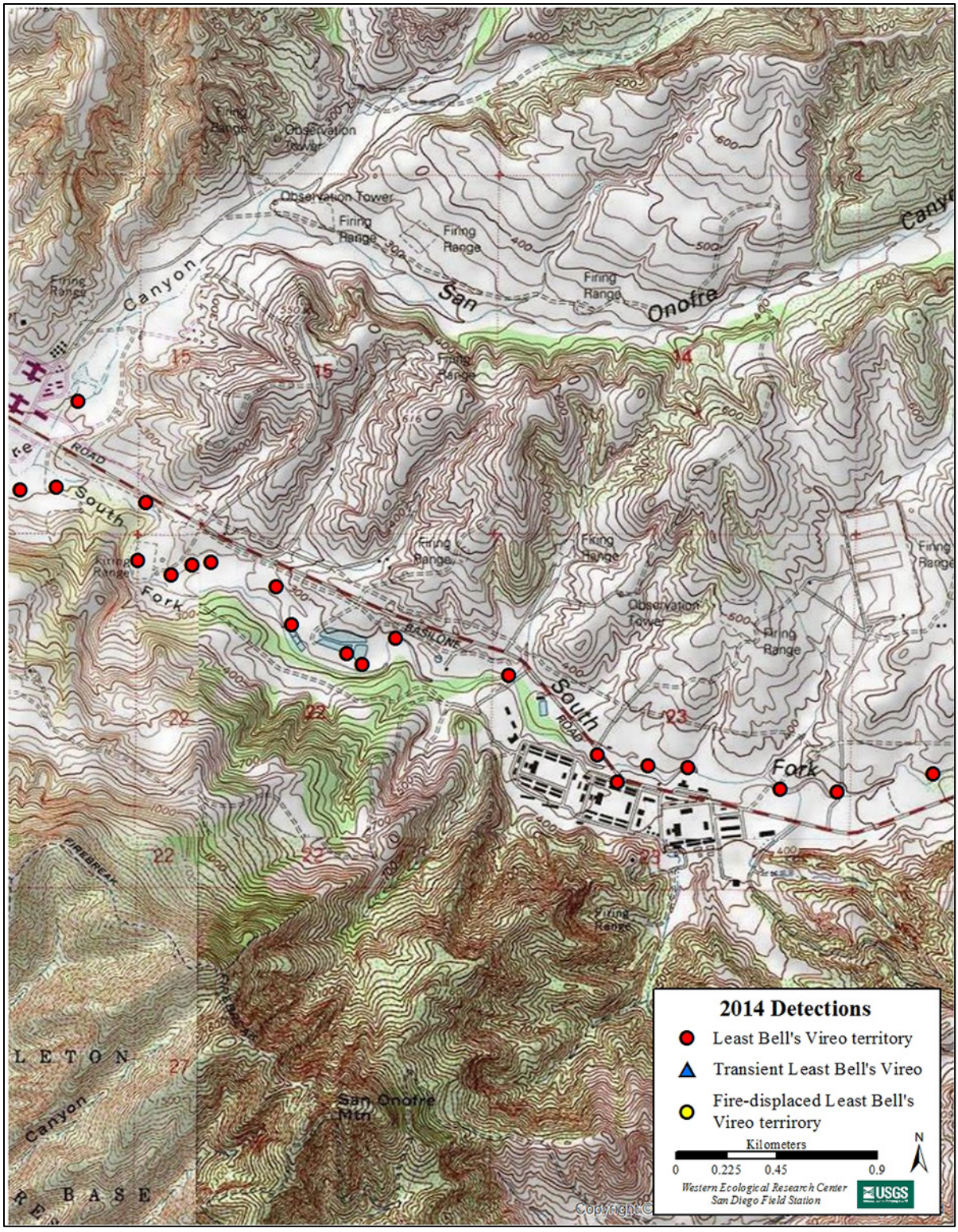

Fig. 42. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2014: South Fork San Onofre Creek.

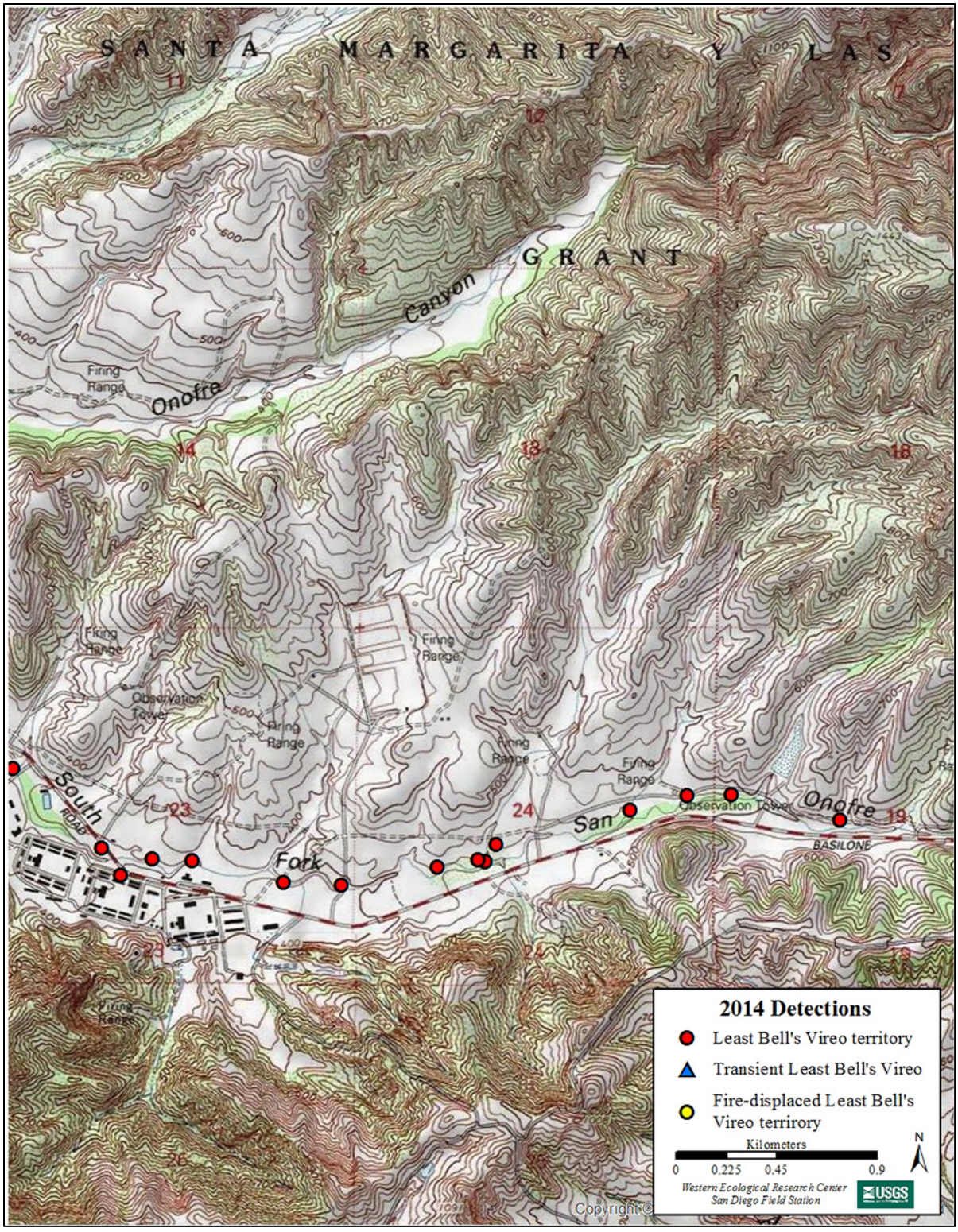

Fig. 43. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2014: San Onofre Creek.

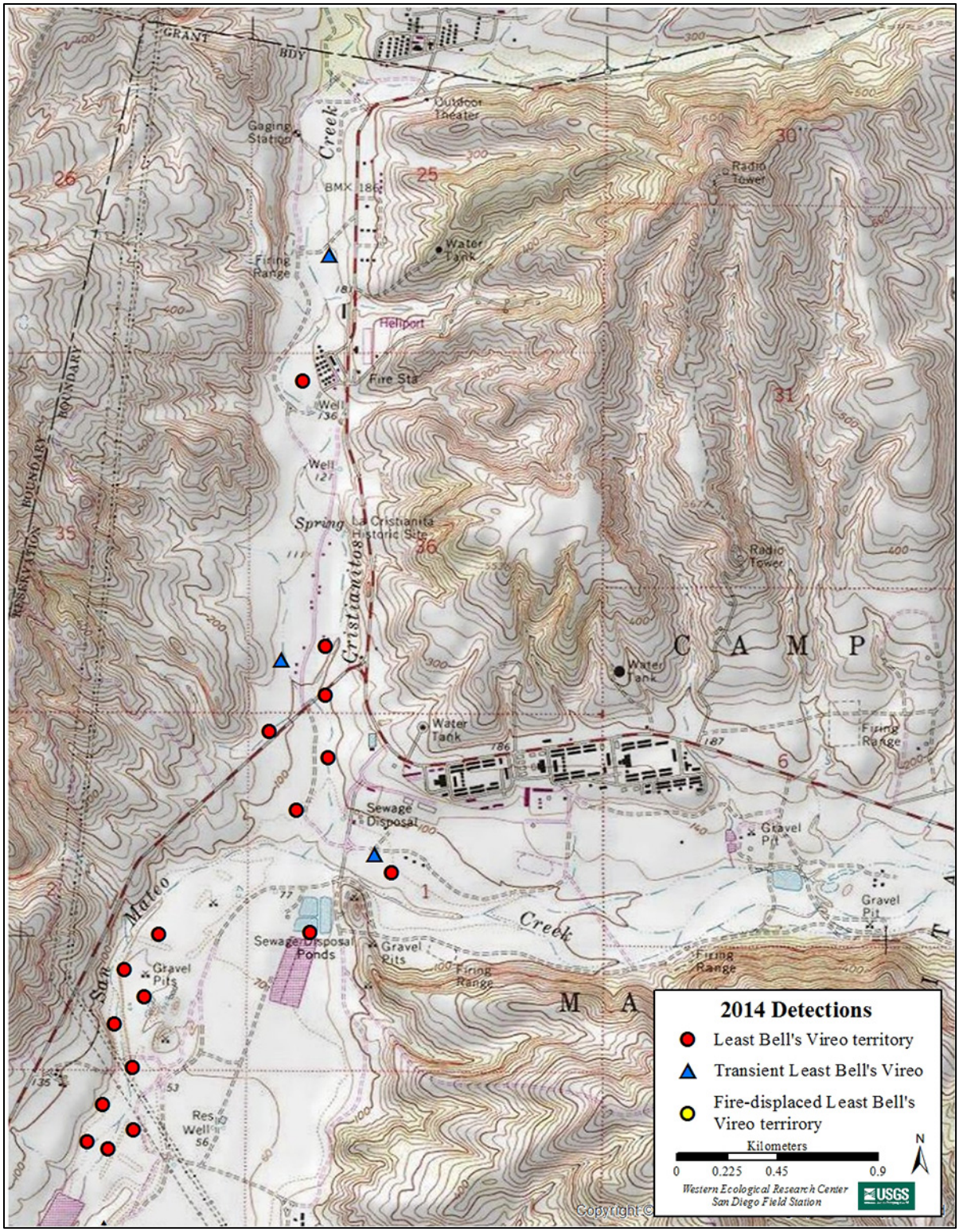

Fig. 44. Locations of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2014: San Mateo Creek and Cristianitos Creek.

Appendix D. Banded Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2014

Drainage	Band Combination[a]			
Sex[b]	Left Leg	Right Leg	Age	Comments[c]
De Luz Creek				
F	Mgo	PUPU/gogo	≥ 6 yrs.	Banded as an adult at DL MAPS in 2009.
F	PUWH/Mgo	PUWH	≥ 1 yrs.	Banded as an adult on DL in 2014.
F	LPBK	ORDG/Mgo	≥ 1 yrs.	Banded as an adult on DL in 2014.
F	LPBK	PUYE/Mgo	≥ 1 yrs.	Banded as an adult on DL in 2014.
F	OROR	LPBK/Mgo	≥ 1 yrs.	Banded as an adult on DL in 2014.
M	WHDP/Mgo	WHWH	≥ 6 yrs.	Banded as an adult at DL MAPS in 2010.
M	DPWH	YEPU/Mgo	5 yrs.	Banded as a nestling on the SMR in 2009.
M	DGOR/Mgo	PUWH	≥ 3 yrs.	Banded as an adult at DL MAPS in 2013.
M	LPBK	DPWH/Mgo	≥ 2 yrs.	Banded as an adult at DL MAPS in 2013.
M	LPBK	YEPU/Mgo	≥ 2 yrs.	Banded as an adult at DL MAPS in 2013.
M	Mgo		≥ 1 yrs.	Banded as a nestling at MCBCP or MCAS prior to 2014.
M	DPDP	WHWH/Mgo	≥ 1 yrs.	Banded as an adult on DL in 2014.
M	DPWH/Mgo	PUWH	≥ 1 yrs.	Banded as an adult on DL in 2014.
U	DPDP	PUYE/Mgo	≥ 3 yrs.	Banded as an adult at DL MAPS in 2013.
U	PUYE/Mgo	DPDP	≥ 1 yrs.	Banded as an adult on DL in 2014.
U	PUWH	YEPU/Mgo	≥ 1 yrs.	Banded as an adult on DL in 2014.
U	BKBK/Mgo	LPBK	≥ 1 yrs.	Banded as an adult on DL in 2014.
Fallbrook Creek				
M	ORPU	BYST/Mgo	1 yr.	Banded as a nestling on the SMR in 2013.
Las Flores Creek				
M	PUWH/pupu	Mdb	7 yrs.	Banded as a nestling on the SLR in 2007.
M	PUYE/Mgo	WHWH	4 yrs.	Banded as a juvenile at DL MAPS in 2010.
M	WHDP	LPBK/Mgo	1 yr.	Banded as a nestling on the SMR in 2013.
Newton Canyon				
F	?	?	≥ 1 yrs.	Banded as unknown age prior to 2014.
Pilgrim Creek				
F	DPWH	DBDP/Mdb	1 yr.	Banded as a nestling on the SLR in 2013.
M	WHDB/Mdb	gogo	2 yrs.	Banded as a nestling on the SLR in 2012.
San Onofre Creek				
M	LPBK	DBWH/Mdb	7 yrs.	Banded as a nestling on the SLR in 2007.
Santa Margarita River				
F	YEPU/Mgo	PUPU	8 yrs.	Banded as a nestling on the SMR in 2006.
F	BKBK	PUPU/Mgo	7 yrs.	Banded as a nestling on the SMR in 2007.
F	OROR/Mgo	ORPU	6 yrs.	Banded as a nestling on the SMR in 2008.
F	PUWH/Mgo	PUPU	6 yrs.	Banded as a nestling on the SMR in 2008.
F	WHPU/Mgo	WHWH	≥ 5 yrs.	Banded as an adult at SM MAPS in 2010.
F	PUOR	BKBK/Mgo	5 yrs.	Banded as a nestling on the SMR in 2009.
F	DPWH/Mdb	DBDP	≥ 4 yrs.	Banded as an adult on the SLR in 2011.
F	BWST	PUYE/Mdb	3 yrs.	Banded as a nestling on the SLR in 2011.
F	DGOR	OROR/Mgo	≥ 2 yrs.	Banded as an adult on the SMR in 2013.
F	YEPU/Mgo	ORPU	≥ 2 yrs.	Banded as an adult on the SMR in 2013.
F	BKBK	PUWH/Mgo	≥ 2 yrs.	Banded as an adult at SM MAPS in 2013.
F	DPDP/Mgo	BKBK	≥ 2 yrs.	Banded as an adult at SM MAPS in 2013.
F	YEPU	DGOR/Mgo	≥ 2 yrs.	Banded as an adult on the SMR in 2013.
F	PUWH	PUOR/Mgo	≥ 2 yrs.	Banded as an adult at SM MAPS in 2013.
F	ORDG/Mgo	DPDP	≥ 2 yrs.	Banded as an adult at SM MAPS in 2013.

Appendix D. Continued.

Drainage / Sex[b]	Band Combination[a] Left Leg	Right Leg	Age	Comments[c]
Santa Margarita River continued				
F	OROR/Mgo	PUPU	2 yrs.	Banded as a nestling on the SMR in 2012.
F	PUWH	OROR/Mgo	≥ 1 yrs.	Banded as an adult on the SMR in 2014.
F	WHWH/Mgo	PUWH	≥ 1 yrs.	Banded as an adult on the SMR in 2014.
F	YEPU/Mgo	LPBK	≥ 1 yrs.	Banded as an adult on the SMR in 2014.
F	ORPU/Mgo	PUPU	≥ 1 yrs.	Banded as an adult on the SMR in 2014.
F	LPBK/Mgo	PUOR	≥ 1 yrs.	Banded as an adult on the SMR in 2014.
F	OROR	BKBK/Mgo	≥ 1 yrs.	Banded as an adult on the SMR in 2014.
F	WHDP/Mgo	OROR	≥ 1 yrs.	Banded as an adult on the SMR in 2014.
F	LPBK	BKLP/Mgo	≥ 1 yrs.	Banded as an adult on the SMR in 2014.
F	WHDB/gogo	Mdb	1 yr.	Banded as a nestling on the SLR in 2013.
F	BKBK	OROR/Mgo	1 yr.	Banded as a nestling on the SMR in 2013.
F		Mgo	≥ 1 yrs.	Banded as a nestling at MCBCP or MCAS prior to 2014.
F		Mgo	≥ 1 yrs.	Banded as a nestling at MCBCP or MCAS prior to 2014.
F		Mgo	≥ 1 yrs.	Banded as a nestling at MCBCP or MCAS prior to 2014.
F	?/Mgo	?/BKLP	≥ 1 yrs.	Banded as unknown age prior to 2014.
F	DPDP	?	≥ 1 yrs.	Banded as unknown age prior to 2014.
F	?	PUWH	≥ 1 yrs.	Banded as unknown age prior to 2014.
M	Mgo	DPDP/pupu	≥ 8 yrs.	Banded as an adult at SM MAPS in 2007.
M	DPWH/sisi	Mgo	≥ 7 yrs.	Banded as an adult on the SMR in 2008.
M	WHWH/Mdb	WHDB	7 yrs.	Banded as a nestling on the SLR in 2007.
M	ORPU	OROR/Mgo	≥ 5 yrs.	Banded as an adult on the SMR in 2010.
M	Mgo	WHDP	≥ 5 yrs.	Banded as an adult on the SMR in 2010.
M	YEPU/Mgo	DPDP	≥ 5 yrs.	Banded as an adult on the SMR in 2010.
M	OROR/Mgo	DPDP	≥ 5 yrs.	Banded as an adult on the SMR in 2010.
M	DPDP	YEYE/Mgo	≥ 5 yrs.	Banded as an adult on the SMR in 2010.
M	Mgo	OROR/sisi	5 yrs.	Banded as a juvenile on the SMR in 2009.
M	DGOR	BKBK/Mgo	5 yrs.	Banded as a nestling on the SMR in 2009.
M	WHWH	YEPU/Mgo	≥ 4 yrs.	Banded as an adult on the SMR in 2011.
M	WHWH	LPBK/Mgo	≥ 4 yrs.	Banded as an adult on the SMR in 2011.
M	WHWH	OROR/Mgo	≥ 4 yrs.	Banded as an adult on the SMR in 2011.
M	YEPU	BKBK/Mgo	≥ 4 yrs.	Banded as an adult on the SMR in 2011.
M	PUWH	DGOR/Mgo	≥ 4 yrs.	Banded as unknown age at SM MAPS in 2010.
M	BYST/Mgo	WHWH	≥ 3 yrs.	Banded as an adult on the SMR in 2012.
M	PUPU	BKLP/Mgo	≥ 3 yrs.	Banded as an adult on the SMR in 2012.
M	WHWH	PUWH/Mgo	≥ 3 yrs.	Banded as an adult on the SMR in 2012.
M	DPWH/Mgo	WHWH	≥ 3 yrs.	Banded as an adult on the SMR in 2012.
M	ORPU	BKLP/Mgo	≥ 3 yrs.	Banded as an adult on the SMR in 2012.
M	OROR/Mgo	WHWH	≥ 3 yrs.	Banded as an adult on the SMR in 2012.
M	PUPU	PUWH/Mgo	≥ 3 yrs.	Banded as an adult on the SMR in 2012.
M	ORPU	PUYE/Mgo	≥ 3 yrs.	Banded as an adult on the SMR in 2012.
M	PUPU	ORDG/Mgo	≥ 3 yrs.	Banded as an adult on the SMR in 2012.
M	DPDP/Mgo	PUPU	≥ 3 yrs.	Banded as an adult on the SMR in 2012.
M	LPBK/Mgo	DPWH	≥ 3 yrs.	Banded as an adult on the SMR in 2012.
M	ORDG/Msi	Pupu	≥ 3 yrs.	Banded as an adult on the SMR in 2012.
M	OROR/Mgo	PUWH	≥ 3 yrs.	Banded as an adult on the SMR in 2012.

Appendix D. Continued.

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

Appendix D. Continued.

Drainage / Sex[b]	Band Combination[a] Left Leg	Right Leg	Age	Comments[c]
Santa Margarita River continued				
M	OROR	BYST/Mgo	≥ 1 yrs.	Banded as an adult on the SMR in 2014.
M	PUPU/Mgo	LPBK	≥ 1 yrs.	Banded as an adult on the SMR in 2014.
M	DPWH/Mgo	WHDP	≥ 1 yrs.	Banded as an adult on the SMR in 2014.
M	DGOR/Mgo	BKBK	≥ 1 yrs.	Banded as an adult on the SMR in 2014.
M	LPBK/Mgo	BKBK	≥ 1 yrs.	Banded as an adult on the SMR in 2014.
M	DPWH/Mgo	LPBK	≥ 1 yrs.	Banded as an adult on the SMR in 2014.
M	DPDP/Mgo	PUWH	≥ 1 yrs.	Banded as an adult on the SMR in 2014.
M	YEPU	WHDP/Mgo	≥ 1 yrs.	Banded as an adult on the SMR in 2014.
M	BKBK	YEYE/Mgo	≥ 1 yrs.	Banded as an adult on the SMR in 2014.
M	DGOR	WHDP/Mgo	≥ 1 yrs.	Banded as an adult on the SMR in 2014.
M	BKBK	PUYE/Mgo	≥ 1 yrs.	Banded as an adult on the SMR in 2014.
M	BKBK	WHPU/Mgo	≥ 1 yrs.	Banded as an adult on the SMR in 2014.
M	PUPU	WHDP/Mgo	≥ 1 yrs.	Banded as an adult on the SMR in 2014.
M	DGOR	PUOR/Mgo	≥ 1 yrs.	Banded as an adult on the SMR in 2014.
M	ORPU/Mgo	BKBK	≥ 1 yrs.	Banded as an adult on the SMR in 2014.
M	WHWH/Mgo	?	≥ 1 yrs.	Banded as unknown age prior to 2014.
M	WHDP/Mgo	?	≥ 1 yrs.	Banded as unknown age prior to 2014.
M	LPLP	?	≥ 1 yrs.	Banded as unknown age prior to 2014.
M	?	WHWH/gogo	≥ 1 yrs.	Banded as unknown age prior to 2014.
M	WHDP	DPDP/Mgo	1 yr.	Banded as a nestling on the SMR in 2013.
M	WHDP	BKBK/Mgo	1 yr.	Banded as a nestling on the SMR in 2013.
M	WHDP	OROR/Mgo	1 yr.	Banded as a nestling at MCAS in 2013.
M	DPWH	DPWH/Mgo	1 yr.	Banded as a nestling at MCAS in 2013.
M	ORPU	YEYE/Mgo	1 yr.	Banded as a nestling on the SMR in 2013.
M	PUOR	ORPU/Mgo	1 yr.	Banded as a nestling on the SMR in 2013.
M	LPBK	WHPU/Mgo	1 yr.	Banded as a nestling on the SMR in 2013.
M	DPWH	WHPU/Mdb	1 yr.	Banded as a nestling on the SLR in 2013.
M	DBDP/gogo	Mdb	1 yr.	Banded as a nestling on the SLR in 2013.
M	BKBK	YEYE/Mdb	1 yr.	Banded as a nestling on the SLR in 2013.
M	DGOR	PUYE/Mgo	1 yr.	Banded as a nestling on the SMR in 2013.
M	BKBK	PUOR/Mgo	1 yr.	Banded as a nestling on the SMR in 2013.
M	PUOR	PUPU/Mgo	1 yr.	Banded as a nestling on the SMR in 2013.
U	WHPU/Mgo	PUWH	≥ 2 yrs.	Banded as an adult at SM MAPS in 2013.
U	BKLP/Mgo	LPBK	≥ 2 yrs.	Banded as an adult at SM MAPS in 2013.
U	PUPU/Mgo	PUWH	≥ 1 yrs.	Banded as an adult on the SMR in 2014.
U	BKBK	LPBK/Mgo	≥ 1 yrs.	Banded as an adult on the SMR in 2014.
U	OROR/Mgo	LPBK	≥ 1 yrs.	Banded as an adult on the SMR in 2014.
U	WHPU/Mgo	BKBK	≥ 1 yrs.	Banded as an adult on the SMR in 2014.
U	BKBK	OROR/Msi	≥ 1 yrs.	Banded as an adult on the SMR in 2014.
Windmill Creek				
M	Mdb	BKLP/gogo	4 yrs.	Banded as a nestling on the SLR in 2010.
M		Mdb	≥ 1 yrs.	Banded as a nestling on the SLR in prior to 2014.

Appendix D. Continued.

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

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

[c] DL = De Luz Creek; DL MAPS = De Luz MAPS Station; 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, 2014

Year Last Det.	Drainage[a] / Territory[a] / Treatment[a]		Dist. Moved (km)	Band Combination[b]		Age in 2014 (yrs.)	Sex[c]
	Last Seen	2014		Left Leg	Right Leg		
2013	SMR / AE04	SMR / BAY / REM	2.62	DPWH/Mdb	DBDP	≥ 4	F
2013	SMR / DEL / REF-PF	SMR / MAZ / 14REF	1.74	DGOR	OROR/Mgo	≥ 2	F
2013	SMR / AE11	SMR / AW12	0.60	OROR/Mgo	ORPU	6	F
2013	SMR / SM MAPS	SMR / BRT / REM	0.41	DPDP/Mgo	BKBK	≥ 2	F
2013	SMR / SM MAPS	SMR / FRIT / REM	0.41	BKBK	PUWH/Mgo	≥ 2	F
2013	SMR / PR04	SMR / ES37	0.39	BWST	PUYE/Mdb	3	F
2013	SMR / ORE / REM	SMR / PUD / REM	0.36	YEPU/Mgo	ORPU	≥ 2	F
2013	SMR / SM MAPS	SMR / ES35	0.26	ORDG/Mgo	DPDP	≥ 2	F
2013	SMR / KEE / REM	SMR / GEL / REM	0.22	YEPU	DGOR/Mgo	≥ 2	F
2013	SMR / MOU / REF-PF	SMR / HED / PF	0.20	OROR/Mgo	PUPU	2	F
2013	SMR / BN09	SMR / SM MAPS	0.16	WHPU/Mgo	WHWH	≥ 5	F
2013	DL / DL MAPS	DL / DL MAPS	0.11	Mgo	PUPU/gogo	≥ 6	F
2013	SMR / PR11	SMR / PUM / REM	0.10	BKBK	PUPU/Mgo	7	F
2013	SMR / SM MAPS	SMR / SM MAPS	0.07	PUWH	PUOR/Mgo	≥ 2	F
2013	SMR / RR02	SMR / RR03	0.03	YEPU/Mgo	PUPU	8	F
2013	CS / CS07	SMR / MAZ / 14REF	25.10	PUPU/Mgo	ORPU	2	M
2013	DL / DN02	DL / DN09	2.11	DPWH	YEPU/Mgo	5	M
2013	DL / DL MAPS	SMR / UM62	1.80	PUWH	PUYE/Mgo	≥ 2	M
2013	SMR / CED / REF-PF	SMR / ANN / 14REF	1.78	ORPU	PUYE/Mgo	≥ 3	M
2013	SMR / ONX / REF-PF	SMR / CED / REF-PF	0.31	DGOR	ORPU/Mgo	≥ 2	M
2013	SMR / PEP / REF-PF	SMR / ARI / REF-PF	0.30	DGOR/Mgo	ORPU	≥ 2	M
2013	SMR / MAC / REM	SMR / ORE / REM	0.27	YEYE/Mdb	LPBK	2	M
2013	SMR / STR / REM	SMR / PUD / REM	0.20	BYST/Mgo	WHWH	≥ 3	M
2013	DL / DL MAPS	DL / DS08	0.17	LPBK	YEPU/Mgo	≥ 2	M
2013	DL / DL MAPS	DL / DS10	0.16	DGOR/Mgo	PUWH	≥ 3	M
2013	DL / DS12	DL / DS04	0.14	WHDP/Mgo	WHWH	≥ 6	M
2013	SMR / YUK / REM	SMR / SHM / REM	0.13	YEPU	BYST/Mgo	≥ 3	M
2013	SMR / TRP / REM	SMR / TRP / REM	0.13	OROR/Mgo	PUWH	≥ 3	M
2013	SMR / QIN / REF-PF	SMR / AXE / REF-PF	0.11	WHWH	PUWH/Mgo	≥ 3	M
2013	SMR / ECH / REM	SMR / ECH / REM	0.10	YEPU	BKBK/Mgo	≥ 4	M
2013	SMR / SM MAPS	SMR / SM MAPS	0.10	Mgo	DPDP/pupu	≥ 8	M
2013	SMR / BY21	SMR / YB07	0.09	BKBK	BYST/Mdb	3	M
2013	SMR / UM22	SMR / UM09	0.09	WHWH/Mdb	WHDB	≥ 4	M
2013	SMR / RR03	SMR / RR02	0.08	WHWH	BKBK/Mgo	3	M
2013	SMR / MER / REF	SMR / MER / REF	0.08	Mgo	WHDP	≥ 5	M
2013	SMR / DEL / REF-PF	SMR / ONX / REF-PF	0.08	LPBK/Mgo	ORPU	≥ 2	M
2013	SMR / AE91	SMR / AE87	0.08	DPWH/Mgo	DPWH	2	M
2013	SMR / AE88	SMR / AE93	0.07	ORPU/Mgo	DPDP	2	M
2013	SMR / YB16	SMR / YB09	0.07	WHWH	DBWH/Mdb	3	M
2013	SMR / UM42	SMR / UM17	0.07	PUWH	ORDG/Mgo	≥ 2	M
2013	SMR / DEU / REF-PF	SMR / DEU / REF-PF	0.07	OROR/Mgo	WHWH	≥ 3	M
2013	SMR / SG01	SMR / SG05	0.07	DGOR	BKBK/Mgo	5	M
2013	SMR / YB15	SMR / YB02	0.06	ORPU	ORDG/Mgo	2	M
2013	SMR / AE85	SMR / AE85	0.05	DGOR	WHPU/Mgo	2	M
2013	SMR / ES08	SMR / ES1	0.05	Mgo	OROR/sisi	5	M

Appendix E. Continued.

Year Last Det.	Drainage[a] / Territory[a] / Treatment[a]		Dist. Moved (km)	Band Combination[b]		Age in 2014 (yrs.)	Sex[c]
	Last Seen	2014		Left Leg	Right Leg		
2013	SMR / RR09	SMR / RR08	0.05	DPWH/sisi	Mgo	≥ 7	M
2013	DL / DL MAPS	DL / DS09	0.05	LPBK	DPWH/Mgo	≥ 2	M
2013	SMR / POE / REM	SMR / POE / REM	0.05	BKBK	ORDG/Mgo	≥ 3	M
2013	SOF / OW06	SOF / OW04	0.04	LPBK	DBWH/Mdb	7	M
2013	SMR / TRF / REM	SMR / TRF / REM	0.04	YEPU/Mgo	DPDP	≥ 5	M
2013	SMR / CKI / REM	SMR / CKI / REM	0.04	DPDP	YEYE/Mgo	≥ 5	M
2013	SMR / TOP / REM	SMR / TOP / REM	0.04	ORPU	OROR/Mgo	≥ 5	M
2013	SMR / HLX / REM	SMR / HLX / REM	0.04	WHWH	LPBK/Mgo	≥ 4	M
2013	SMR / LIF / REF	SMR / LIF / REF	0.03	LPBK/Mgo	DPWH	≥ 3	M
2013	SMR / JSP / REF-PF	SMR / JSP / REF-PF	0.03	PUPU	BKLP/Mgo	≥ 3	M
2013	SMR / ES25	SMR / ES27	0.03	DPWH/Mgo	WHWH	≥ 3	M
2013	SMR / KEE / REM	SMR / KEE / REM	0.03	BKBK/Mgo	DPWH	≥ 2	M
2013	SMR / ES31	SMR / ES11	0.03	DPDP/Mgo	PUPU	≥ 3	M
2013	SMR / MOU / REF-PF	SMR / MOU / REF-PF	0.03	DGOR	LPBK/Mgo	≥ 2	M
2013	SMR / EMB / REM	SMR / EMB / REM	0.03	BYST/Mdb	DBDP	2	M
2013	SMR / GEL / REM	SMR / GEL / REM	0.03	ORPU	BKLP/Mgo	≥ 3	M
2013	SMR / ODN / REF	SMR / ODN / REF	0.02	YEYE/Mgo	DPWH	≥ 2	M
2013	SMR / CKE / REM	SMR / CKE / REM	0.02	ORDG/Msi	pupu	≥ 3	M
2013	SMR / TOF / REM	SMR / TOF / REM	0.02	WHWH	OROR/Mgo	≥ 4	M
2013	LF / LL07	LF / LL16	0.01	PUWH/pupu	Mdb	7	M
2013	SMR / PIE / REM	SMR / PIE / REM	0.01	WHWH	YEPU/Mgo	≥ 4	M
2013	SMR / BAY / REM	SMR / PR51 / REM	0.01	BKBK	WHDP/Mgo	≥ 3	M
2013	SMR / COB / REM	SMR / COB / REM	0.00	BKBK/Mgo	ORPU	≥ 2	M
2013	SMR / HRP / REF	SMR / HRP / REF	0.00	PUPU	ORDG/Mgo	≥ 3	M
2013	SMR / ICE / REM	SMR / ICE / REM	0.00	OROR/Mgo	DPDP	≥ 5	M
2013	SMR / WSP / REF	SMR / WSP / REF	0.00	YEPU	ORPU/Mgo	3	M
2013	SMR / SM MAPS	SMR / SM MAPS	0.24	BKLP/Mgo	LPBK	≥ 2	U
2013	DL / DL MAPS	DL / DL MAPS	0.08	DPDP	PUYE/Mgo	≥ 3	U
2013	SMR / SM MAPS	SMR / SM MAPS	0.05	WHPU/Mgo	PUWH	≥ 2	U
2012	SLR / FO40	PC / PS13	6.98	WHDB/Mdb	gogo	2	M
2012	SMR / ES12	SMR / BN14	0.98	PUWH	DGOR/Mgo	≥ 4	M
2012	LF / FS15	LF / FS06	0.10	PUYE/Mgo	WHWH	4	M
2012	SMR / ES01	SMR / ES37	0.09	PUPU	PUWH/Mgo	≥ 3	M
2010	SLR / WMON	WC / WC02	1.15	Mdb	BKLP/gogo	4	M
2009	SMR / ORN / REM	SMR / ES11	0.29	PUOR	BKBK/Mgo	5	F
2008	SMR / VIC / REM	SMR / ES10	0.23	PUWH/Mgo	PUPU	6	F

Appendix E. Continued.

[a] Drainage Codes: CS = Cristianitos Creek; DL = De Luz Creek; LF = Las Flores Creek; PC = Pilgrim Creek; SLR = San Luis Rey River; SMR = Santa Margarita River; SOF = San Onofre Creek; WC = Windmill Creek; DL MAPS = De Luz MAPS Station; SM MAPS = Santa Margarita MAPS Station; Treatment Codes: 14REF = new Reference in 2014; PF = Post-fire; REF = Reference; REF-PF = Reference in 2013, Post-fire in 2014; REM = Removal;.

[b] Band colors: Mdb = dark blue numbered federal band; Mgo = gold numbered federal band; Msi = silver numbered federal band; gogo = metal gold; pupu = metal purple; sisi = metal silver; BKBK = plastic black; BKLP = plastic black-light pink split; BWST = plastic 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.

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

Appendix F. Status and Nesting Activities of Least Bell's Vireos at Marine Corps Base Camp Pendleton, 2014

Giant Reed (*Arundo donax*) Removal Site Territories					
Territory	**Nest**	**Monitoring[a]**	**Nest Fate[b]**	**# Fledged**	**Comments**
BRI	1	F	INC		Nest not completed.
BRI	2	F	PRE		
CAR	1	F	FAL		Only male seen building, nest not completed.
CAR	2	F	PRE		
CAR	3	F	PRE		
CAR	4	F	PRE		
ICE	1	F	INC		Nest not completed.
ICE	2	F	PRE		
ICE	3	F	PRE		
ICE	4	F	PRE		
ORE	1	F	PRE		
ORE	2	F	SUC	1	
CKE	1	F	PRE		
CKE	2	F	PRE		
CKE	3	F	INC		Nest not completed.
CKE	4	F	PRE		
CKE	5	F	SUC	3	
COB	1	F	INC		Nest not completed.
COB	2	F	UNK		Nest completed, no eggs confirmed.
COB	3	F	SUC	2	
CKI	1	F	PRE		
CKI	2	F	PRE		
CKI	3	F	SUC	2	
CRM	1	F	SUC	2	
CRM	2	F	SUC	2	
PIE	1	F	PRE		
PIE	2	F	SUC	2	
PIE	3	F	SUC	2	
PUD	1	F	SUC	2	
TOF	1	F	PRE		
TOF	2	F	PRE		
TOF	3	F	UNK		Nest abandoned with eggs.
TOF	4	F	OTH		Eggs did not hatch.
TRF	1	F	PRE		
TRF	2	F	SUC	2	
TRF	3	F	INC		Nest not completed.
TRF	4	F	PRE		
ANR	1	F	UNK		Nest abandoned with nestlings.
ANR	2	F	PRE		
BAY	1	F	SUC	3	
BAY	2	F	PRE		
ECH	1	F	SUC	2	
ECH	2	F	SUC	2	
EMB	1	F	INC		Nest not completed.
EMB	2	F	INC		Nest not completed.
EMB	3	F	SUC	2	

Appendix F. Continued.

Territory	Nest	Monitoring[a]	Nest Fate[b]	# Fledged	Comments
Giant Reed (*Arundo donax*) Removal Site Territories					
HLX	1	F	INC		Nest not completed.
HLX	2	F	UNK		Nest completed, no eggs confirmed.
HLX	3	F	PRE		
KEE	1	F	UNK		Nest completed, no eggs confirmed.
KEE	2	F	UNK		Nest abandoned with nestlings.
MIN	1	F	INC		Nest not completed.
MIN	2	F	PRE		
MIN	3	F	PRE		
MIN	4	F	SUC	1	
OOR	1	F	OTH		Nest support failed.
OOR	2	F	PRE		
OOR	3	F	PRE		
OOR	4	F	PRE		
POE	1	F	INC		Nest not completed.
POE	2	F	UNK		Nest may have been depredated or may have failed from support structure collapse.
POE	3	F	PRE		
PUM	1	F	PRE		
PUM	2	F	UNK		Nest abandoned with eggs.
PUM	3	F	PRE		
SHM	1	F	SUC	1	
SHM	2	F	PRE		
TRP	1	F	UNK		Nest abandoned with eggs.
TRP	2	F	SUC	3	
Reference Site Territories					
ANN[c]	1	F	OTH		Nest burned in May 2014 wildfire.
EVE[c]	1	F	OTH		Nest burned in May 2014 wildfire.
GRE[c]	1	F	UNK		Nest completed, no eggs confirmed.
HOD[c]	1	F	UNK		Nest completed, no eggs confirmed.
LAS[c]	1	F	UNK		Nest completed, no eggs confirmed.
LAS[c]	2	F	UNK		Nest completed, no eggs confirmed.
RUS[c]	1	F	PRE		
WAS[c]	1	F	OTH		Nest burned in May 2014 wildfire.
BNT	1	F	SUC	3	
BIL	1	F	PRE		
BIL	2	F	SUC	3	
BOW	1	F	UNK		Nest completed, no eggs confirmed.
BOW	2	F	PRE		
DAQ	1	F	SUC	3	
FIN	1	F	INC		Nest not completed.
FIN	2	F	SUC	3	
FUR	1	F	PRE		
FUR	2	F	PRE		
FUR	3	F	PRE		

Appendix F. Continued.

Reference Site Territories

Territory	Nest	Monitoring[a]	Nest Fate[b]	# Fledged	Comments
HDX	1	F	PRE		
HDX	2	F	SUC	3	
HLD	1	F	PRE		
HOL	1	F	SUC	3	
HOL	2	F	UNK		Nest completed, no eggs confirmed.
HOL	3	F	PRE		
KEN	1	F	PRE		
KEN	2	F	PRE		
KEN	3	F	PRE		
KEN	4	F	OTH		Nest failed from human disturbance.
KRA	1	F	SUC	3	
LAN	1	F	OTH		Nest support failed.
LIF	1	F	INC		Nest not completed.
LIF	2	F	PRE		
MAZ	1	F	OTH		Nest burned in May 2014 wildfire.
MER	1	F	PRE		
MER	2	F	SUC	2	
ODN	1	F	SUC	3	
RAN	1	F	OTH		Nest burned in May 2014 wildfire.
RAN	2	F	PRE		
SHA	1	F	PRE		
SHA	2	F	SUC	3	
WHI	1	F	PRE		
WHI	2	F	INC		Nest not completed.
WHI	3	F	PRE		
WHI	4	F	PRE		
WSP	1	F	PRE		
WSP	2	F	PRE		

Post-fire Site Territories

Territory	Nest	Monitoring[a]	Nest Fate[b]	# Fledged	Comments
ANT	1	F	PRE		
ANT	2	F	PRE		
ARI	1	F	INC		Nest not completed.
ARI	2	F	SUC	3	
ARI	3	F	PRE		
AXE	1	F	SUC	4	
BAD	1	F	SUC	2	
BER	1	F	OTH		Nest support failed.
CED	1	F	SUC	4	
CED	2	F	INC		Nest not completed.
CED	3	F	PRE		
COA	1	F	PRE		
COA	2	F	PRE		
DEU	1	F	PRE		
DEU	2	F	PRE		
DEU	3	F	PRE		

Appendix F. Continued.

Post-fire Site Territories

Territory	Nest	Monitoring[a]	Nest Fate[b]	# Fledged	Comments
DNG	1	F	INC		Nest not completed.
DNG	2	F	PRE		
DNG	3	F	PRE		
DNG	4	F	SUC	3	
DRK	1	F	INC		Nest not completed.
DRK	2	F	PRE		
FOX	1	F	UNK		Nest support failed.
FOX	2	F	PRE		
FOX	3	F	PRE		
FOX	4	F	SUC	3	
GNU	1	F	PRE		
GNU	2	F	PRE		
HED	1	F	PRE		
HED	2	F	PRE		
IBX	1	F	SUC	3	
IBX	2	F	PRE		
JAG	1	F	PRE		
JSP	1	F	INC		Nest not completed.
JSP	2	F	PRE		
JSP	3	F	SUC	2	
KOA	1	F	INC		Nest not completed.
KOA	2	F	UNK		Nest abandoned with eggs.
KOA	3	F	PRE		
MOU	1	F	OTH		Nest support failed.
MOU	2	F	OTH		Nest support failed.
MOU	3	F	INC		Nest not completed.
MOU	4	F	PRE		
ONX	1	F	INC		Nest not completed.
ONX	2	F	OTH		Nest support failed.
ONX	3	F	INC		Nest not completed.
ONX	4	F	SUC	2	
PUC	1	F	PRE		
PUC	2	F	PRE		
PUC	3	F	OTH		Nest support failed.
ZAM	1	F	OTH		Nest support failed.
ZAM	2	F	UNK		Nest completed, no eggs confirmed.
LEM	1	F	PRE		
LEM	2	F	SUC	3	
MRT	1	F	PRE		
MRT	2	F	PRE		
MRT	3	F	UNK		Nest completed, no eggs confirmed.

[a] Monitoring: F = fully monitored territory.

[b] 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.

[c] Territory burned in May 2014 wildfire. Pair not detected post-fire.