Least Bell's Vireos and Southwestern Willow Flycatchers at the San Luis Rey River Flood Control Project Area in San Diego County, California: Breeding Activities and Habitat Use

2007 Annual Data Summary

Prepared for:

RECON Environmental, Inc.

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

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By Kimberly Ferree and Barbara E. Kus

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EXECUTIVE SUMMARY

Surveys for the endangered least Bell's vireo (*Vireo bellii pusillus*) were conducted at the San Luis Rey River Flood Control Project area in the city of Oceanside, San Diego County, California, between 1 April and 15 July 2007. Three protocol surveys were conducted during the breeding season and supplemented by weekly territory monitoring visits. One hundred and eight least Bell's vireo territorial males were identified; all but three males were paired.

The vireo population in the project area declined by 9% (11 territories) from 2006, the largest drop observed in five years. Overall there was a net increase of five territories in the channel where exotic and native vegetation removal has occurred (Treated) and a net loss of 16 territories in the Untreated sites where vegetation removal will not occur (Untreated), suggesting that factors other than vegetation removal may have contributed to the 2007 decline. Factors contributing to the vireo decline may include drier conditions, reduced habitat quality, and human disturbance.

The majority of vireo territories (70%) occurred in habitat characterized as Willow Riparian. Ten percent of birds occupied habitat co-dominated by willows (*Salix* spp.) and cottonwoods (*Populus fremontii*), and 20% of territories were found in Riparian Scrub, dominated by mule fat (*Baccharis salicifolia*) and/or sandbar willow (*S. exigua*). Most vireo territories (63%) were established in habitat where 50 to 95% of the vegetation cover was native species while 37% of the territories were in habitat vegetated almost entirely (>95%) by native species. Giant reed (*Arundo donax*) was the most common exotic species within territories followed by black mustard (*Brassica nigra*), poison hemlock (*Conium maculatum*) and tamarisk (*Tamarix ramosissima*).

Nesting activity was monitored in 97 territories. Pair success from both treatments was comparable; 82% (50/61) of Treated pairs vs. 87% (27/31) of Untreated pairs were successful in fledging young from at least one nest. Nest success (number of nests fledging at least one young/total number of nests found) of pairs breeding in the channel (Treated) did not differ statistically from that of pairs breeding in the Untreated sites (49%; 60/122 vs. 59%; 32/54). Successful and failed nests within Treated and Untreated sites did not differ statistically in average nest height, height of the host plant, or the distance the nest was placed from the edge of the host plant. Eighty to ninety percent of nests were placed in arroyo willow (*S. lasiolepis*), *B. salicifolia* and *S. exigua*. Predation was believed to be the primary source of nest failure.

Two hundred and fifty-four least Bell's vireos were banded during the 2007 season. These included seven adult vireos that were target netted and banded with a unique color combination, 236 hatch-year birds banded as nestlings, and ten first-year birds that were banded as nestlings in 2006. Adult survivorship was high; of 61 uniquely color banded adult vireos present during the 2006 breeding season, 69% (42/61) returned to the San Luis Rey River Project area in 2007. Territory site fidelity was strong among the banded vireos; 80% (33/41) of adults returned to breed in the same territory as the previous year and the remaining eight vireos

returned to an adjacent territory (within 200 m) of the territory they occupied in 2006. First year survivorship was 7% (16/220).

We conducted three protocol surveys for the endangered southwestern willow flycatcher (*Empidonax traillii extimus*) in the project area between 14 May and 13 July 2007. We detected ten willow flycatcher transients of unknown sub-species in the river channel and one resident pair in the Whelan Lake area. We documented one unsuccessful nest attempt for the breeding pair. The nest was abandoned one week after hatching was estimated to occur. We detected one banded female flycatcher during the 2007 season that returned to breed in the same territory as 2006. She was originally banded in 2005 as an adult. We were unable to confirm the band status of the male.

A total of 46 vegetation transects (526 points) were sampled at the San Luis Rey River Flood Control Project area in 2007. Seventy-two percent (378/526) of points were located in the Channel site while the remaining 28% (148/526) were located at Upper Pond and Whelan Mitigation. One hundred and twelve of the 526 points, all within the Channel site, were located in areas cleared of vegetation (64%, 72 points), *A. donax* (21%, 23 points) or both (15%, 17 points). Points in cleared areas made up 30% (112/378) of the points in the Channel and 21% (112/526) of all points sampled in these sites.

We did not detect large changes in vegetation structure or composition from 2006 to 2007 largely because vegetation removal did not occur prior to the 2007 breeding season. The small to moderate changes that we documented appeared to be a result of low rainfall during the 2007 winter and spring. Total foliage cover decreased across sites, but was especially apparent in the sites outside of the Channel, where the greatest changes in foliage cover occurred at heights below 3 m. Differences in overall vegetation cover from 2006 to 2007 were attributed to a decrease in herbaceous cover, indicating that the low rainfall was a key factor explaining the observed loss in foliage cover.

Forty-four vireo nests and 44 random plots (352 sampling points in total) were sampled following the 2007 breeding season. Just as in 2006, habitat use by vireos was non-random, particularly with regard to nest site selection. Vireos favored as nest sites locations within territories with higher foliage density and canopy height than that in the territory as a whole. In contrast to 2006, when vegetation structure within vireo territories did not differ from that in the site as a whole, in 2007 vireos appeared to favor territories with dense canopy compared to what was available throughout the site. Thus territory placement may have been more critical as vireos responded to the drier conditions present in 2007.

INTRODUCTION

Least Bell's Vireo

The least Bell's vireo (*Vireo bellii pusillus*) 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 1900's as a result of habitat loss and alteration associated with urbanization and conversion of land adjacent to rivers to agriculture (Franzreb 1989, U.S. Fish and Wildlife Service 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 (U.S. Fish and Wildlife Service 1986; Franzreb 1989; Brown 1993; Kus 1998, 1999), and the introduction of invasive exotic plant species such as giant reed (*Arundo donax*) into riparian systems. By 1986 the vireo population in California numbered just 300 territorial males (U.S. Fish and Wildlife Service 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, with the U.S. Fish and Wildlife Service (USFWS) following 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 2004, the statewide vireo population was estimated to be approximately 2,500 territories (U.S. Geological Survey, unpublished data) of which approximately 10% occur along the San Luis Rey River between Interstate 15 and Interstate 5.

Male least Bell's vireos typically arrive on breeding grounds in southern California in mid-March. Male vireos are vocally conspicuous, and sing their diagnostic primary song throughout the breeding season from exposed perches. 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. Typical clutch size for least Bell's vireos averages 3-4 eggs. Typically, the female and male incubate the eggs for 14 days with young fledging 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. 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.

Southwestern Willow Flycatcher

The southwestern willow flycatcher (*Empidonax traillii extimus*) is one of four subspecies of willow flycatcher in the United States with a breeding range including southern California, Arizona, New Mexico, extreme southern portions of Nevada and Utah, and western Texas (Hubbard 1987, Unitt 1987). Restricted to riparian habitat for breeding, the southwestern willow flycatcher has declined in recent decades in response to widespread habitat loss throughout its range and, possibly, cowbird parasitism (Wheelock 1912; Willett 1933; Grinnell and Miller 1944; Remson 1978; Garrett and Dunn 1981; Unitt 1984, 1987; Gaines 1988; Schlorff 1990; Whitfield and Sogge 1999, Kus and Whitfield 2005). By 1993, the species was believed to number approximately 70 pairs in California (U.S. Fish and Wildlife Service 1993) in small disjunct populations. The southwestern willow flycatcher was listed as endangered by the State of California in 1992 and by the USFWS in 1995.

Willow flycatchers in southern California co-occur with the least Bell's vireo. However, unlike the vireo which has increased six-fold since the mid-1980's in response to management efforts, willow flycatcher numbers have remained low. Currently, the majority of southwestern willow flycatchers in California are concentrated in three sites: the South Fork of the Kern River in Kern County (Whitfield 2002), the Upper San Luis Rey River, including a portion of the Cleveland National Forest in San Diego County (Varanus Biological Services 2001), and Marine Corps Base Camp Pendleton in San Diego County (Rourke *et al.* 2008). Outside of these sites, southwestern willow flycatchers occur as small, isolated populations of one to half a dozen pairs (Kus *et al.* 2003).

San Luis Rey River Flood Control Project

The San Luis Rey River Flood Control Project encompasses approximately 576 acres (233 ha) of the lower San Luis Rey River in northwestern San Diego County, California (Figure 1). Authorized in 1970 and constructed during the late 1980’s and early 1990’s, the flood control project area includes single- and double-levee reaches and six out-of-channel detention ponds, five of which also serve as mitigation sites for impacts to biological resources within the channel. Operation and maintenance of the flood control project includes periodic vegetation clearing, exotic plant removal, and sediment removal to ensure that sufficient conveyance capacity is maintained (U.S. Fish and Wildlife Service 2006).

Riparian vegetation communities in the project area included willow (*Salix* spp.) dominated riparian, mixed mule fat (*Baccharis salicifolia*) and sandbar willow (*S. exigua*) riparian scrub, freshwater marsh, and areas dominated by non-native giant reed (*Arundo donax*). Dominant plants included arroyo willow (*S. lasiolepis)*, black willow (*S. gooddingii*), Fremont cottonwood (*Populus fremontii*), *S. exigua*, *B. salicifolia*, and *A. donax*. Adjacent habitat and land use types included coastal sage scrub, nonnative grassland, and urban housing and commercial developments. Human-induced disturbances such as homeless camps, recreation, illegal dumping, and invasive exotic plants were pervasive throughout the project area.

Prior to the 2006 least Bell’s vireo breeding season, the U.S. Army Corps of Engineers (Corps) began two project activities: (1) *A. donax* eradication and (2) channel vegetation clearing. In December of 2005, they mowed large stands of *A. donax* using a bull dozer. The vegetation was then mulched by a masticator and was left on site. In March 2006, the Corps cleared and mulched an approximately 30–m swath of vegetation in the flood channel from Benet Road to College Boulevard, overlapping when possible with the *A. donax* eradication areas. Both activities resulted in a loss of approximately 15-20% of the riparian vegetation in the river channel. No vegetation removal activities were conducted following the 2006 breeding season.

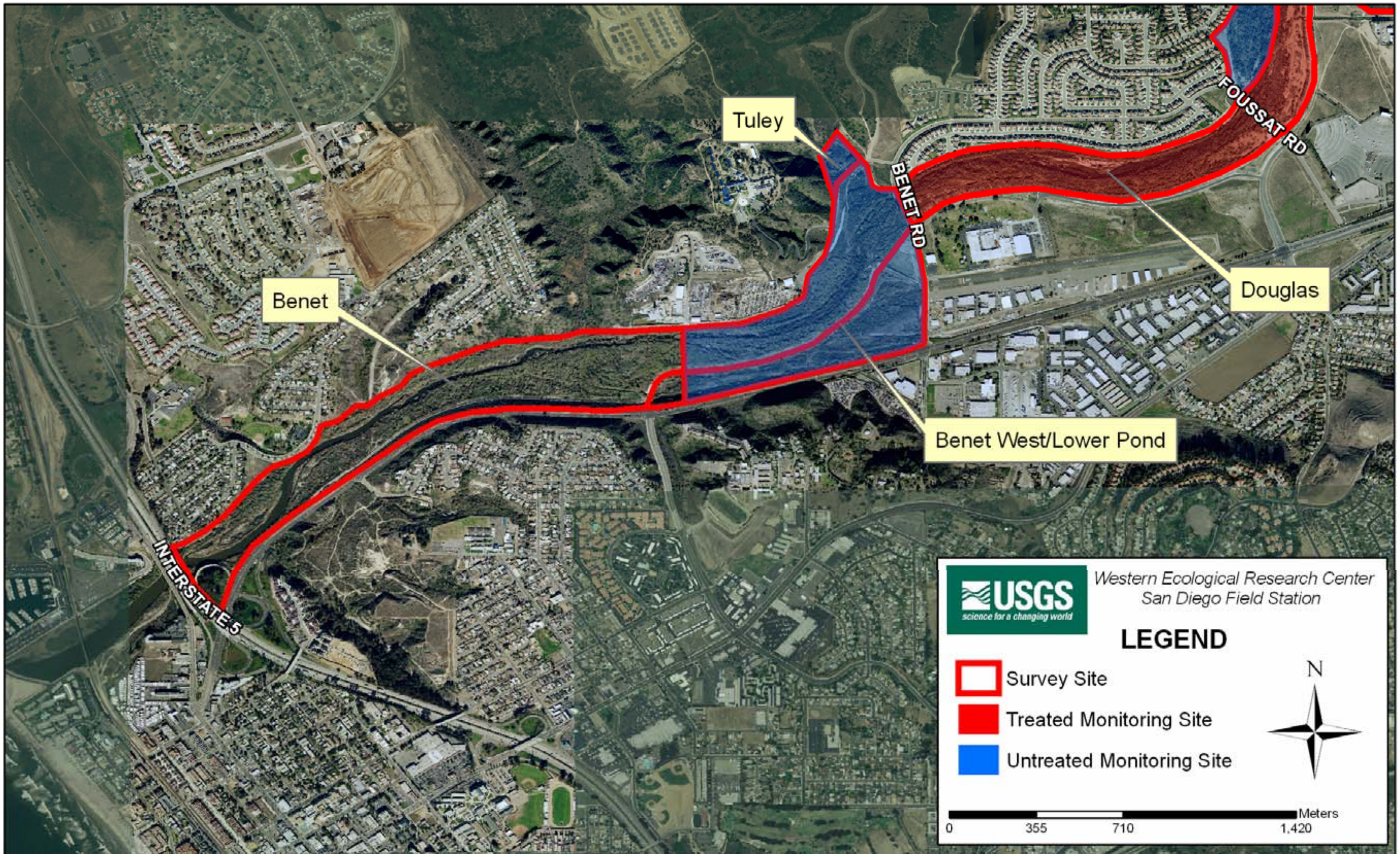

Figure 1. (a) Least Bell's vireo and southwestern willow flycatcher survey and monitoring sites at the San Luis Rey River Flood Control Project area, California in 2007.

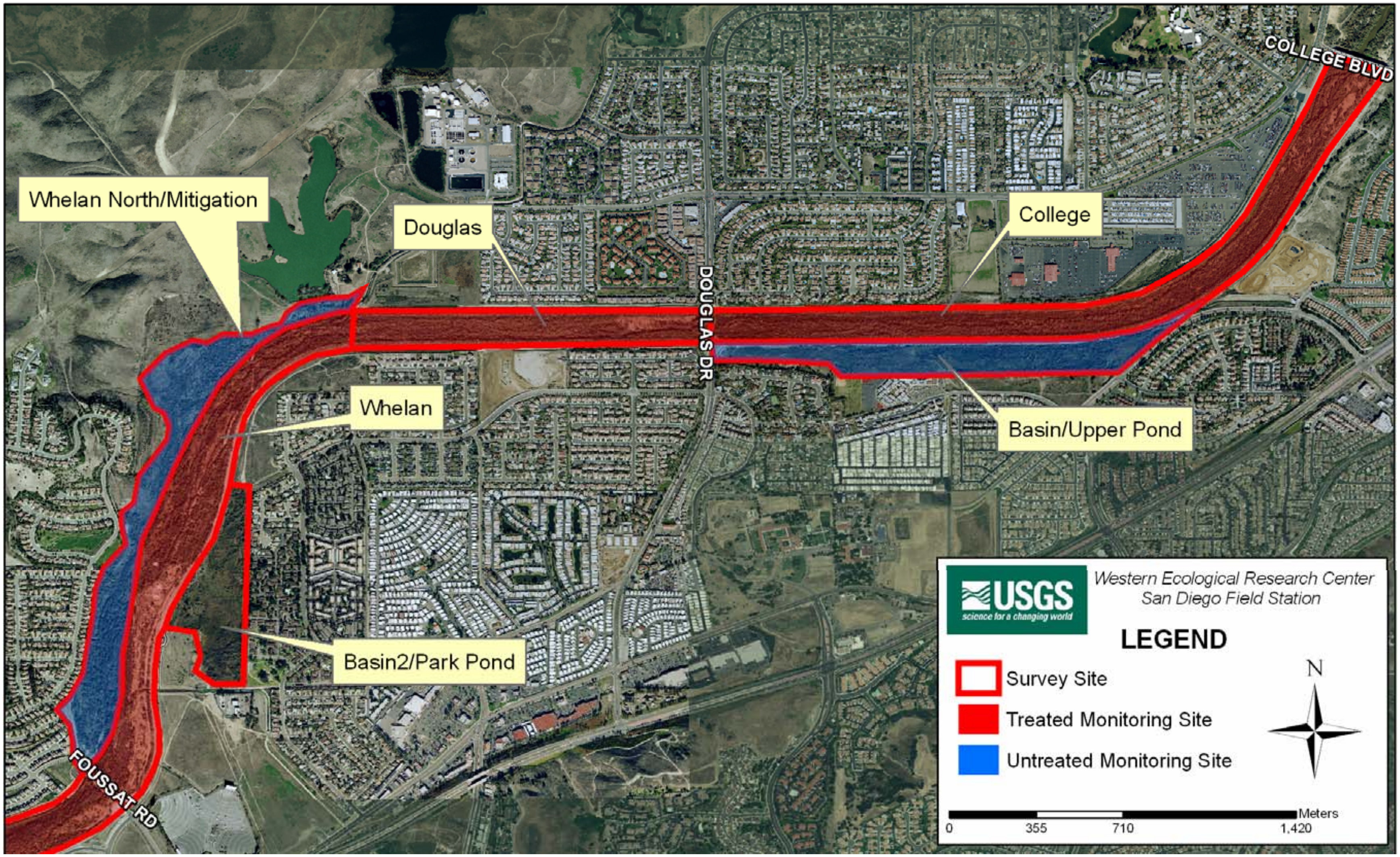

Figure 1. (b) Least Bell's vireo and southwestern willow flycatcher survey and monitoring sites at the San Luis Rey River Flood Control Project area, California in 2007

The purpose of this study was to document the status of least Bell's vireos and southwestern willow flycatchers at the San Luis Rey River Flood Control Project area and characterize habitat structure and composition within the project area (Figure 1). Specifically, our goals for least Bell's vireos were to (1) determine the size and composition of the vireo population, (2) characterize habitat used by vireos, (3) band a subset of vireos to facilitate the estimation of vireo survivorship and movement in future years, and (4) assess the short-term effects of vegetation removal on vireo reproductive success and productivity by monitoring established nest monitoring plots in treated and untreated sites. Our goals for southwestern willow flycatchers were to (1) determine the size and composition of the willow flycatcher population in the project area, (2) document and monitor nesting activities of resident flycatchers, and (3) band and resight all flycatchers to facilitate the estimation of flycatcher turnover and movement. The purpose of the habitat component of the study was (1) to provide post-treatment data on the habitat composition and structure of the study area including areas that underwent vegetation removal in 2005-2006 and (2) characterize habitat use by least Bell's vireos at the San Luis Rey River Flood Control Project area. These data, when combined with data from other years, will inform natural resource managers about the status of these endangered species in the Corps project area, and guide modification of land use and management practices as appropriate to ensure the species' continued existence.

This work was funded by the U.S. Army Corps of Engineers and RECON Environmental, Inc.

STUDY AREA AND METHODS

Vireo and Flycatcher Surveys

The project area included a channelized 10.7-km section of the lower San Luis Rey River from College Boulevard to Interstate 5 and five detention ponds outside of the channel in Oceanside, California (Figure 1). The project area was divided into ten survey sites; five of which were located primarily within the flood control channel and five that were located outside of the flood control channel. The five outside of the flood control channel included one restored site north of the levee and west of Whelan Lake and four in the detention ponds (Figure 1, Table 1).

Vireo surveys were conducted at the San Luis Rey River Flood Control Project area between 1 April and 15 July 2007. Three protocol surveys (U.S. Fish and Wildlife Service 2001) were conducted during the breeding season and followed standard survey techniques described in the California Least Bell's Vireo Working Group and USFWS least Bell's vireo survey guidelines (U.S. Fish and Wildlife Service 2001). We supplemented these protocol surveys with weekly territory monitoring visits; therefore most survey sites were visited >10 times throughout the breeding season resulting in complete coverage of the study area. Vireo field work was conducted by Lisa Allen, Kevin Clark, Cynthia Jones Daverin, Kimberly Ferree, and Barbara Kus.

We conducted three willow flycatcher surveys of the project area, completing one survey during each of three protocol survey periods (Sogge *et al*. 1997, U.S. Fish and Wildlife Service 2000). The first period extended from 14 May through 31 May, the second period from 1 June through 20 June, and the third from 21 June through 13 July. Flycatcher field work was conducted by Kimberly Ferree and Barbara Kus.

For both species, observers moved slowly (1-2 km per hour) through the riparian habitat while searching and listening for vireos or flycatchers. Observers walked along the north and south levees to survey the flood control channel. 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. For each bird encountered, investigators recorded age (adult or juvenile), sex, breeding status (paired, single, undetermined, or transient), and whether the bird was banded. Birds were considered transients if they were not detected on two or more consecutive surveys after an initial detection. Bird locations were mapped on 1":12,000" aerial photographs as well as 1":24,000" USGS topographic maps, using a Garmin 12 Global Positioning System (GPS) unit with 1-15 m positioning accuracy to determine geographic coordinates (WSG84). Distance to the nearest surface water was recorded for each flycatcher location. Dominant native and exotic plants were recorded within each vireo and flycatcher territory, and percent cover of exotic vegetation estimated using cover categories of <5%, 5-50%, 51-95%, and >95%. Overall habitat type was specified according to the following categories:

Mixed willow riparian: Habitat dominated by one or more willow species including *S. gooddingii, S. lasiolepis,* and red willow *(S. laevigata),* with *B. salicifolia* as a frequent co-dominant.

Willow-cottonwood: Willow riparian habitat in which *P. fremontii* is a co-dominant.

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

Sycamore-oak: Woodlands in which *P. racemosa* and coastal live oak (*Quercus agrifolia)* occur as co-dominants.

Riparian scrub: Dry and/or sandy habitat dominated by *S. exigua* or *B. salicifolia,* with few other woody species.

Upland scrub: Coastal sage scrub adjacent to riparian habitat.

Non-native: Areas vegetated exclusively with non-native species such as *A. donax* and *Tamarix ramosissima*.

Table 1. Least Bell's vireo and southwestern willow flycatcher survey sites at the San Luis Rey River Flood Control Project area, California, in 2007.

Survey Site	Description
Channel Sites	
College	From College Boulevard to Douglas Drive
Douglas	From Douglas Drive to Whelan canal including a small section of habitat north of the levee and east of Whelan canal
Whelan	From Whelan canal to Foussat Road
Foussat	From Foussat Road to Benet Road
Benet	From Benet Road to the Pacific Ocean
Non-channel Sites	
Upper Pond	Detention pond with restored habitat located south of levee between College Boulevard and Douglas Drive
Whelan Mitigation	Restored habitat north of levee, between Whelan canal and Foussat Road
Park Pond	Detention ponds with restored habitat, located south of the levee, between Douglas Drive and Foussat Road
Lower Pond	Detention pond with restored habitat, west of Benet Road and south of the levee
Tuley Canyon	Detention pond with restored habitat, west of Benet Road and north of the levee

Vireo Nest Monitoring

We monitored least Bell's vireo nests to evaluate the effects of native and exotic vegetation removal on nest success and productivity. Work was conducted within four established monitoring sites; four adjacent sites in the flood control channel where both exotic and native vegetation removal has occurred and three sites, one in the flood control channel and two adjacent to the channel, where vegetation removal will not occur (Table 2). The treated river channel (hereafter "Channel") extended from Benet Road to College Boulevard and was divided into four sites (from west to east: Foussat, Whelan, Douglas and College); these sites were the focus of recent vegetation removal activities by the Corps and functioned as our treated sites (Figure 1). Two of the untreated sites included detention ponds located outside of the channel. Upper Pond consisted of a detention pond located east of Douglas Drive. We combined two smaller detention ponds, Lower Pond and Tuley Canyon, along with the river channel located between the two detention ponds into one untreated monitoring site (hereafter "Benet West") (Figure 1). The final untreated monitoring site, Whelan Mitigation, encompassed the area beginning at the Whelan Lake Bird Sanctuary and extending west to Foussat Road (Figure 1). All of these sites, except the section of Benet West located in the river channel were riparian restoration sites established by the Corps in the early 1990's.

Table 2. Site attributes of Treated (Channel) and Untreated (Benet West, Upper Pond, and Whelan Mitigation) monitoring sites at the San Luis Rey River Flood Control Project area, California, in 2007.

	Treated	**Untreated**		
Attribute	Channel	Upper Pond	Benet West	Whelan Mitigation
Size: acres (ha)	295.5 (119.6)	42.5 (17.2)	69.2 (28.0)	55.4 (22.4)
Habitat Type[a]	Mixed Willow	Riparian Scrub/Mixed Willow	Mixed Willow	Mixed Willow/Riparian Scrub
Dominant Canopy Species[a]	*S. lasiolepis, S. gooddingii*	*S. exigua, B. salicifolia, S. lasiolepis, S. gooddingii*	*S. gooddingii, S. lasiolepis*	*S. gooddingii, B. salicifolia, S. lasiolepis*
Dominant Exotic Species[a]	*A. donax*	*A. donax, T. ramosissima, Cortaderia* spp.	*A. donax*	*Conium maculatum, Brassica nigra, A. donax*
Disturbance[a]	Homeless camps; moderate human use	Homeless camps, pets, recreation; heavy human use	Homeless camps, pets; heavy human use	Some human use
Restoration	<25 acres (10 ha)	yes	yes[b]	yes

[a] Listed in order of dominance.
[b] Park Pond and Tuley Canyon outside of the river channel.

64 pairs in the Treated site and 33 pairs in the Untreated sites were monitored during the breeding season. Pairs were observed for evidence of nesting, and their nests were located. Nests were visited as infrequently as possible to minimize the chances of leading predators or brown-headed cowbirds to nest sites; typically, there were three to four visits per nest. The first visit was timed to determine the number of eggs laid, the next visits to determine hatching and age of young, and the last to band nestlings (see below). Cowbird eggs were removed from nests by monitors when found. Fledging was determined through direct observation of fledglings in the territory or in some rare cases inferred from an accumulation of feather dust and fecal material in the nest indicative of vireo fledging. Characteristics of nests, including height, host species, and host height were recorded following abandonment or fledging of nests.

Data Analysis

We conducted statistical tests to determine whether there were differences in nest success, productivity, or vegetation characteristics between pairs nesting at Treated and Untreated sites. Chi-square analysis was used to test for differences in nest success between sites. Depending on the dispersion of the data, either equal or unequal variance two-sample t-tests were used to test for differences in average clutch size, average brood size, and the number of young fledged per pair. Two-sample t-tests were also used to test for differences in vegetation characteristics between successful and unsuccessful nests within and between Treated and Untreated sites. Analysis of Variance (ANOVA) was used to test for differences in: 1) reproductive success of vireos by year (2006 and 2007) and treatment (with vegetation removal, without vegetation removal) and 2) foliage cover at each site by height class and year. We used $P \leq 0.10$ to evaluate significance for all statistical tests. Analyses were conducted using Systat 11.0 (Systat 2004).

We used MARK (White and Burnham 1999) to model the effects of treatment and habitat variables (see below) on daily survival rate (DSR) of vireo nests (Dinsmore *et al.* 2002). Nest survival was calculated across a 30-day cycle length (4 days 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, laying, or hatching. We used an information-theoretic approach (Burnham and Anderson 2002) to evaluate support for models reflecting *a priori* hypotheses regarding the effect of treatment and habitat variables on DSR. We hypothesized that DSR would be lower in treated than in untreated sites, and that DSR would increase with increasing foliage cover at nest sites, particularly understory cover within 2 m of the ground where vireos place their nests. 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 and habitat covariates individually and evaluated support for each model in relation to the constant survival model and each other. In addition, we modeled the effect of year on DSR to search for any temporal differences across our study.

Flycatcher Nest Monitoring

We monitored southwestern willow flycatchers in the vicinity of Whelan Lake as part of an ongoing demographic study initiated in 2000 (Kus unpubl. data). Procedures followed Rourke *et al.* 1999 and were similar to those described in the previous section for least Bell's vireo.

Vireo and Flycatcher Banding

The primary goals of banding least Bell's vireos were: 1) to better understand adult vireo site fidelity, 2) to investigate natal dispersal, and 3) to understand how vegetation removal and alteration affects vireo productivity and survivorship. Nestlings from monitored nests were banded at 6-7 days of age with a single blue anodized numbered federal band on the right leg. A subset of adult male vireos was targeted for banding at three of the monitoring sites (Channel, Whelan Mitigation, and Upper Pond). We banded all adults with a unique combination of colored plastic and anodized metal bands. Adults previously banded with a single numbered federal band were target netted to determine their identity, and their original band was supplemented with other bands to generate a unique color combination. These data will supplement banding data currently being gathered by USGS on nearby vireo populations on the upper San Luis Rey River and Santa Margarita River on Camp Pendleton.

The primary goals of banding southwestern willow flycatchers were: 1) to better understand adult flycatcher site fidelity and population turnover and 2) to investigate natal dispersal. Unbanded flycatcher adults were captured in mist nets within their territories, and were banded with a unique combination of a silver numbered federal band on one leg and a bi-colored metal band on the other. Nestlings were banded at 7-9 days of age with a silver numbered federal band on the right leg. These data will supplement banding data currently being gathered by USGS on Camp Pendleton and upstream on the San Luis Rey River.

Baseline Vegetation Study Design

Vegetation was sampled along permanent linear transects within two of the least Bell's vireo monitoring sites (Channel and Upper Pond). Transects were originally established in 2006 using a systematic sampling design. Transects located in the flood control channel contained points with vegetation treatment (i.e., removal) (hereafter "treated points") and without vegetation treatment (hereafter "untreated points"), while transects located outside of the channel did not contain vegetation treatment and thus had no treated points. To provide uniform coverage, transects were placed at fixed distances from each other; distances varied with the size of the site. In the Channel, transects were placed at 200- or 400-m intervals depending on the width of the river. In the Upper Pond, transects were placed every 100 m. To capture the range of variability of riparian vegetation structure and composition, we positioned transects perpendicular to the river channel. In addition, we re-sampled two 350-m transects at Whelan Mitigation that were surveyed from 1991-1993 to monitor riparian restoration by the Corps (Kus 1998). The Whelan Mitigation transects were located 75 m apart and oriented approximately parallel (320 degrees) to the flood control channel. 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 (Figure 2).

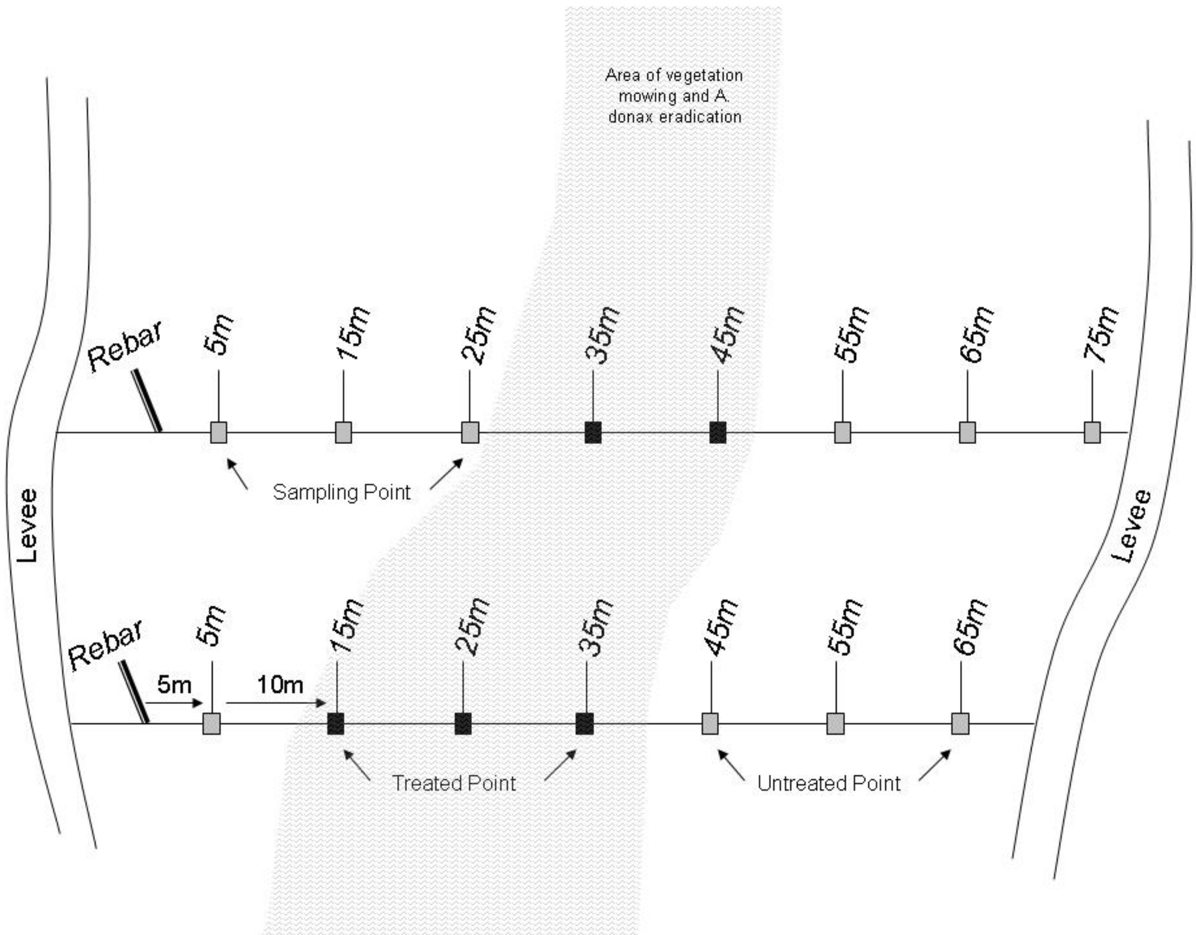

Figure 2. Schematic of vegetation transects in the Channel site at the San Luis Rey River Flood Control Project area, California, in 2007.

We used a number of permanent and semi-permanent methods to ensure that transects could be re-sampled in future years. First, a metal 1.5-m rebar was used to indicate the start of each transect. We spray-painted the rebar pink or orange and placed them at the intersection of the south levee and the river bed. From the rebar, using a compass and tape measure, two field personnel measured the distances between sampling points. A numbered, wooden stake, spray painted pink or orange, was placed in the ground and colored plastic flagging was tied nearby to aid in locating the points. Finally, we obtained geographic coordinates for each rebar and point.

Vireo Habitat Use Study Design

We collected vegetation data at the nest and a paired random location (hereafter "nest plot" and "random plot") within the territory for a subset of monitored vireos. Prior to data collection, vireo nests were chosen randomly, and only one nest per pair was sampled. Nest and

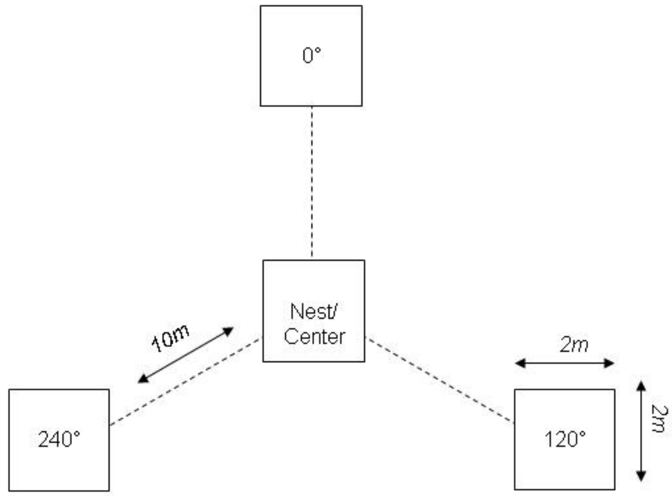

Figure 3. Schematic of nest-centered and random vegetation plots sampled at the San Luis Rey River Flood Control Project area, California in 2007.

random plots consisted of four 2 x 2 m quadrats; one quadrat centered on the nest (or center for random plots) with the remaining three quadrats located 10 m from the nest/center and oriented at 0, 120, and 240 degrees from it (Figure 3). Random plot locations were selected using a random compass bearing and distance from a nest. Distances generated were ≥20 m to avoid overlap in plots and ≤50 m to ensure that random plots remained within the territory of the corresponding pair.

Vegetation Sampling and Analysis

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 point along a vegetation transect or nest/random plot 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 percent. 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 fiberglass telescoping pole, 7.5 m tall, demarcated in 1-m intervals was used to determine height class and canopy height. Vegetation data were collected by USGS and RECON field 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 each transect 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 means across transects for each site. For the Channel, we analyzed treated and untreated points separately. We examined percent cover for species that occurred at >5% of the sampling points (>25 points). Species that were less common (<5%) were grouped together by plant life form. These groups included: tree, shrub, herbaceous, dead woody species, and fresh-water marsh. We used $P \leq 0.10$ to evaluate significance for all statistical tests. Analyses were conducted using Systat 11.0 (Systat 2004).

RESULTS

Least Bell's Vireos

Population Size and Distribution

Compared to the unusually late arrival of least Bell's vireos in 2006 when vireos were documented 2-4 weeks later than usual throughout their breeding range (Rourke and Kus 2007a, Rourke and Kus 2007b, Peter Famolaro, personal comm.), vireo arrival in 2007 followed more typical patterns. We detected several singing males during site visits to the San Luis Rey River in late March and by 1 April, 17 males were observed during the first survey (Figure 4). Peak arrival was observed during the first two weeks of April; in contrast, just one vireo male was documented during the first two weeks of April in 2006 (Figure 4). By 15 April, 70% of vireo territories were established, two weeks earlier than in 2006 (Figure 4).

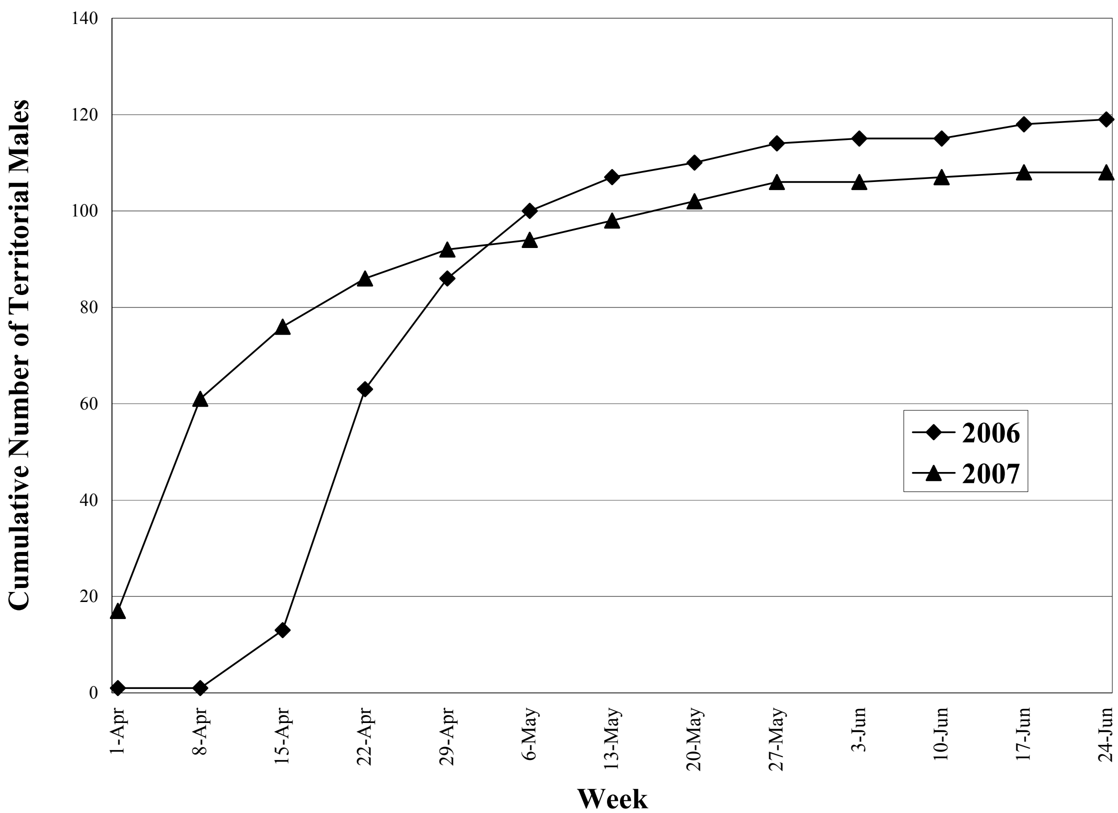

Figure 4. Cumulative number of territorial least Bell's vireo males detected by week at the San Luis Rey River Flood Control Project area, California, during 2006-2007.

A total of 108 least Bell's vireo territories were identified during surveys and weekly territory monitoring (Table 3, Figures 5-8). Of the 108 territorial males, 105 (97%) were confirmed as paired, one (1%) was confirmed as a single male that arrived in late June and two

(2%) territorial males which were present throughout the season were not confirmed as paired. Seventy-one percent of the territories (77/108) were located along the San Luis Rey River within the flood control channel. The remaining 29% of the territories (31/108) were located outside of the channel. Vireo density was highest in the Upper Pond site where 17 pairs were detected (1 pair/2.5 acres (1 pair/ha)). Two territories were detected in detention ponds south of the levee (Park Pond) and one territory was detected north of the levee and east of the Whelan canal (Figure 7b). Two territories were located in Lower Pond and one territory was located in Tuley Canyon (Figure 5b). We detected one transient vireo during these surveys.

Least Bell's vireo territory numbers declined from 119 territories in 2006 to 108 territories in 2007, a 9% decrease overall (Table 4, Figure 9). Changes in vireo territory numbers and distribution were concentrated in four survey sites, two inside the channel (Benet and Whelan) and two outside the channel (Upper Pond and Whelan Mitigation). The greatest decline occurred in the Benet survey area, where numbers dropped from 13 to 7 territories. Territory distribution did not change from 2006, as most territories were located on the eastern end of the survey site near Benet Road. Only one vireo territory compared to four in 2006 was detected in the remaining 2.2 km from North Canyon Drive to Interstate 5. Whereas numbers in the upland site of Whelan Mitigation decreased from 14 to 9 territories, numbers in the adjacent channel site of Whelan, *increased* from 14 to 19 territories. Furthermore, the distribution of territories in these sites changed significantly; territories that had straddled the channel and upland areas of Whelan Mitigation in 2006 were located primarily in the channel in 2007 (Figure 10). Territory numbers decreased slightly from 20 to 17 territories in the Upper Pond.

Table 3. Number and distribution of least Bell's vireos at the San Luis Rey River Flood Control Project area, California, in 2007.

Survey Site	Known Pairs	Status Undetermined[a]	Transient[b]	Total Territories
Channel Sites				
College	22	0		22
Douglas	12	3[c]	1	15[d]
Whelan	19	0		19
Foussat	14	0		14
Benet	7	0		7
Non-channel Sites				
Upper Pond	17	0		17
Whelan Mitigation	9	0		9
Park Pond	2	0		2
Lower Pond	2	0		2
Tuley Canyon	1	0		1
Total	105	3	1	108

[a] Territorial male observed, female not confirmed.

[b] Transient birds were detected only once during the breeding season.

[c] One territory held by a single male that arrived late during the breeding season (15 June).

[d] One pair was located outside of the flood control channel.

Table 4. Number and distribution of least Bell's vireo territories at the San Luis Rey River Flood Control Project area, California, in 2006-2007.

Survey Site	**2006**	**2007**
Channel Sites		
College	22	22
Douglas	14	15
Whelan	14	19
Foussat	15	14
Benet	13	7
Non-channel Sites		
Upper Pond	20	17
Whelan Mitigation	14	9
Park Pond	3	2
Lower Pond	3	2
Tuley Canyon	1	1
Total	119	108

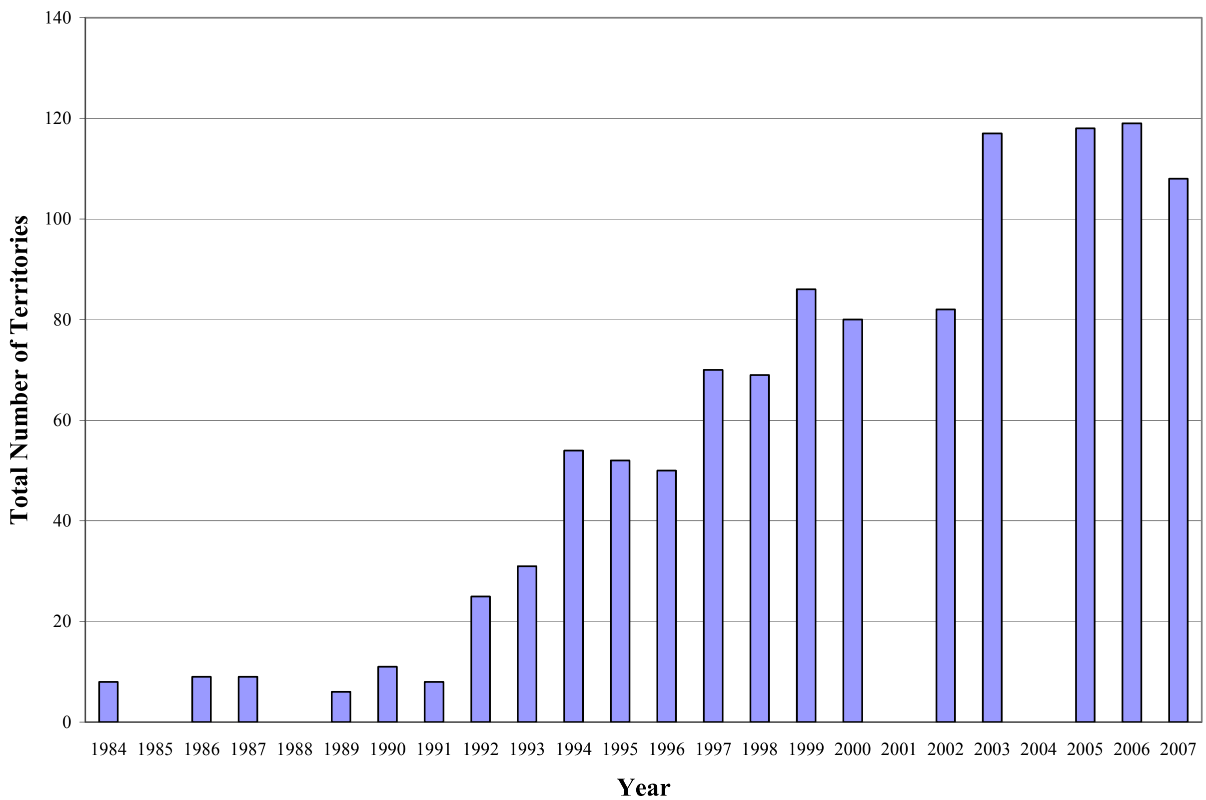

Figure 9. Number of least Bell's vireo territories from 1984-2007 at the San Luis Rey River Flood Control Project area, California. Surveys were not conducted during 1985, 1988, 2001, or 2004.

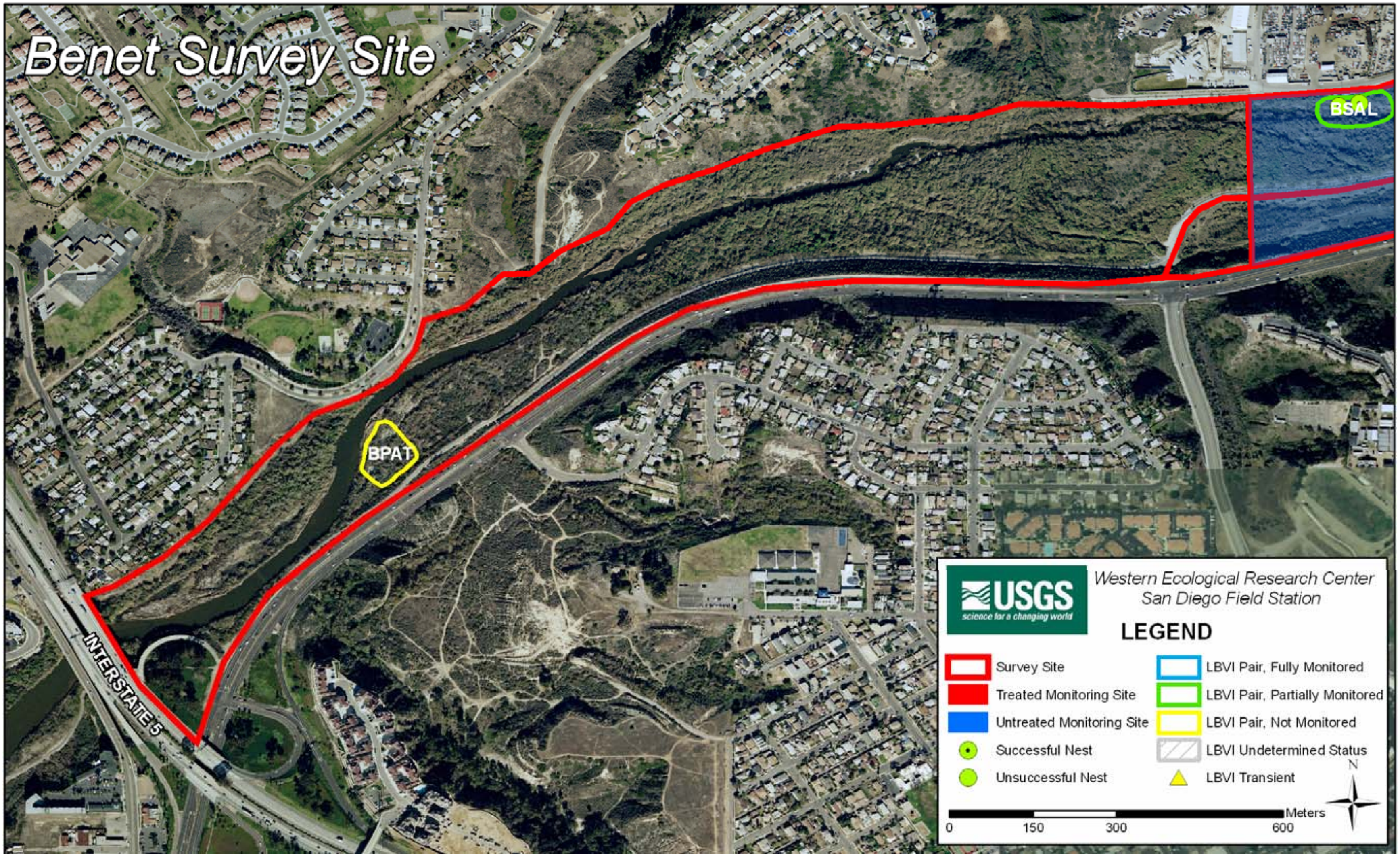

Figure 5. (a) Locations of least Bell's vireo territories (LBVI) and nests in the Benet, Lower Pond, and Tuley Canyon survey sites at the San Luis Rey River Flood Control Project area, California, in 2007.

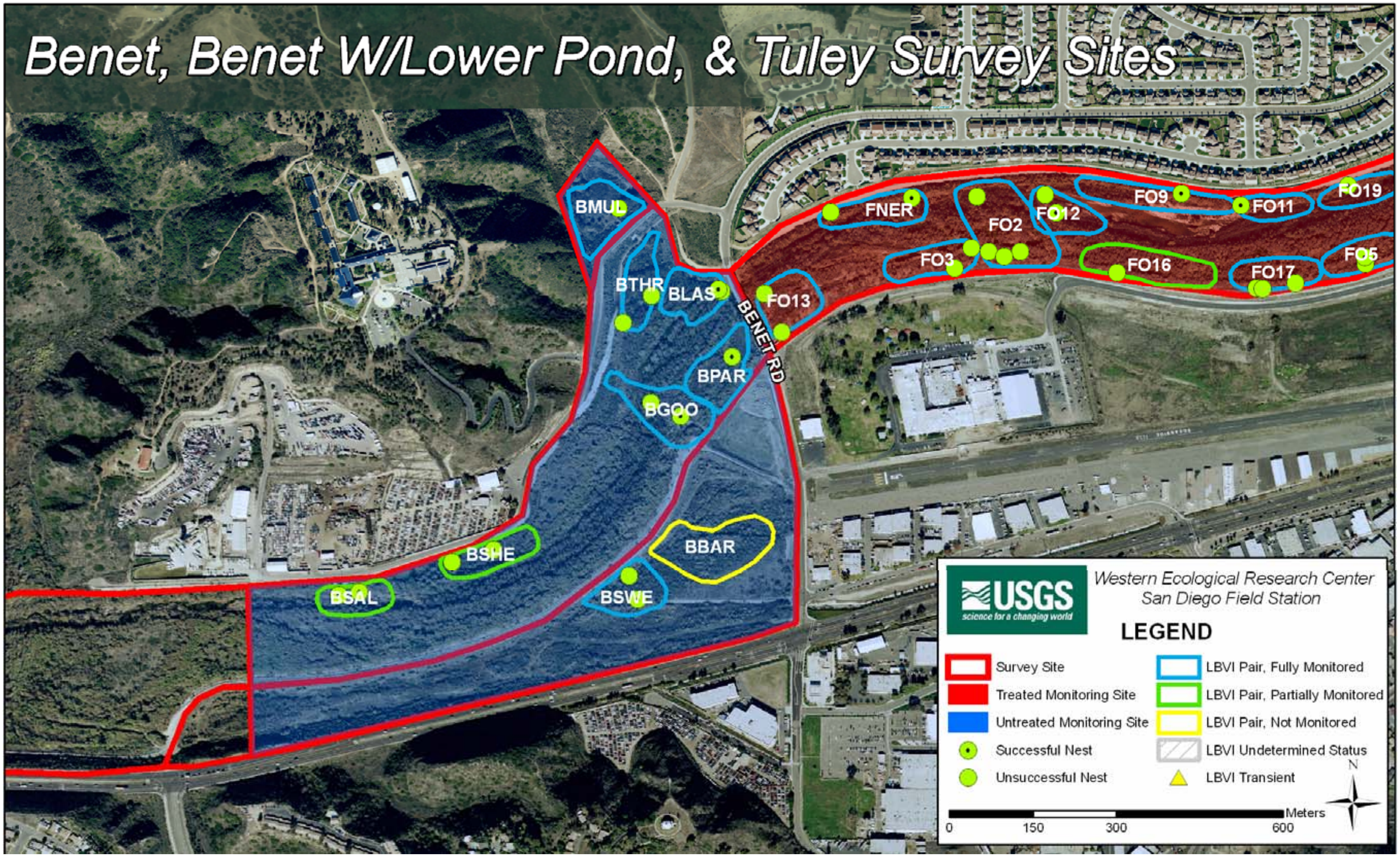

Figure 5. (b) Locations of least Bell's vireo (LBVI) territories and nests in the Benet survey site at the San Luis Rey River Flood Control Project area, California, in 2007.

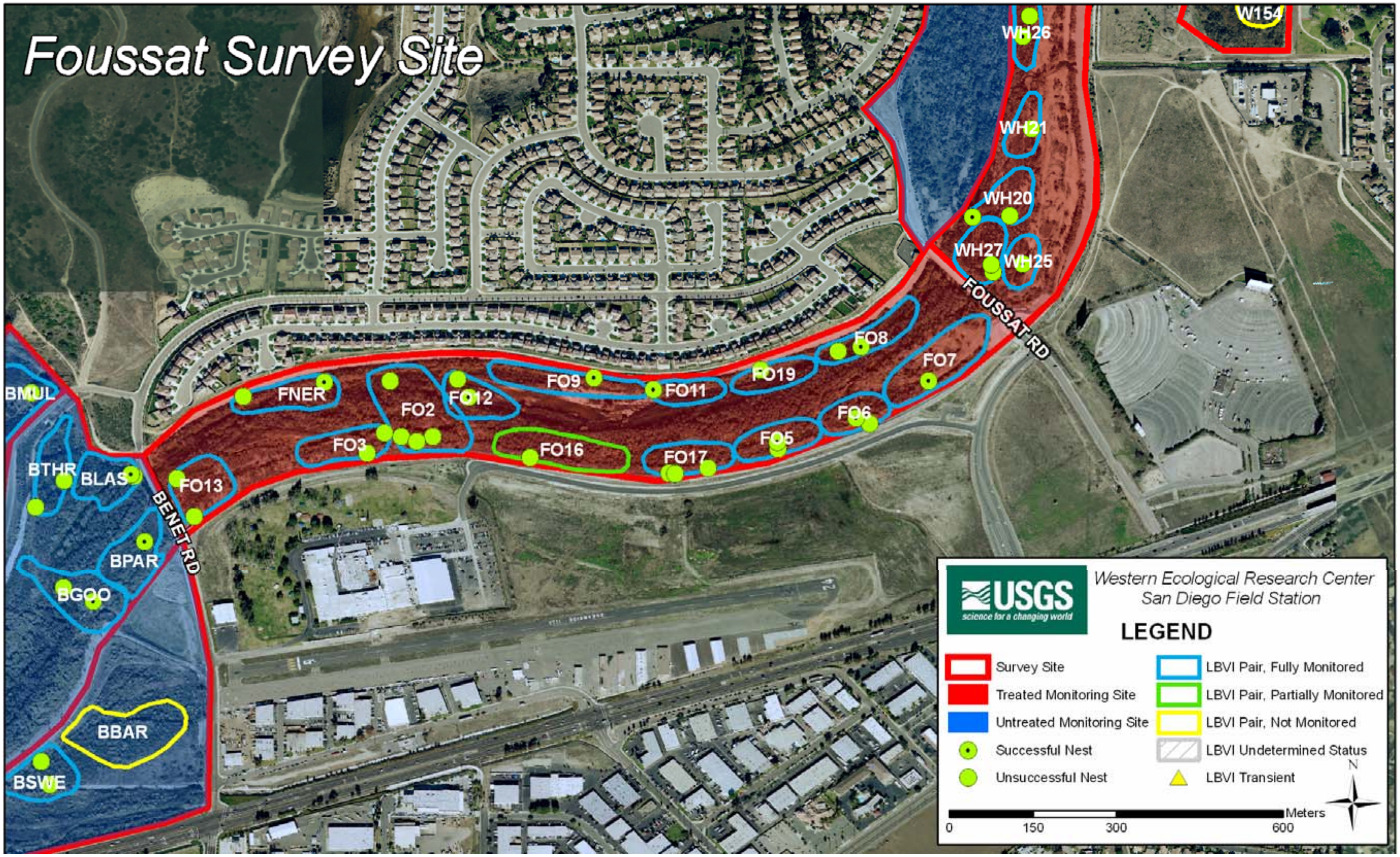

Figure 6. Locations of least Bell's vireo (LBVI) territories and nests in the Foussat survey site at the San Luis Rey River Flood Control Project area, California, in 2007.

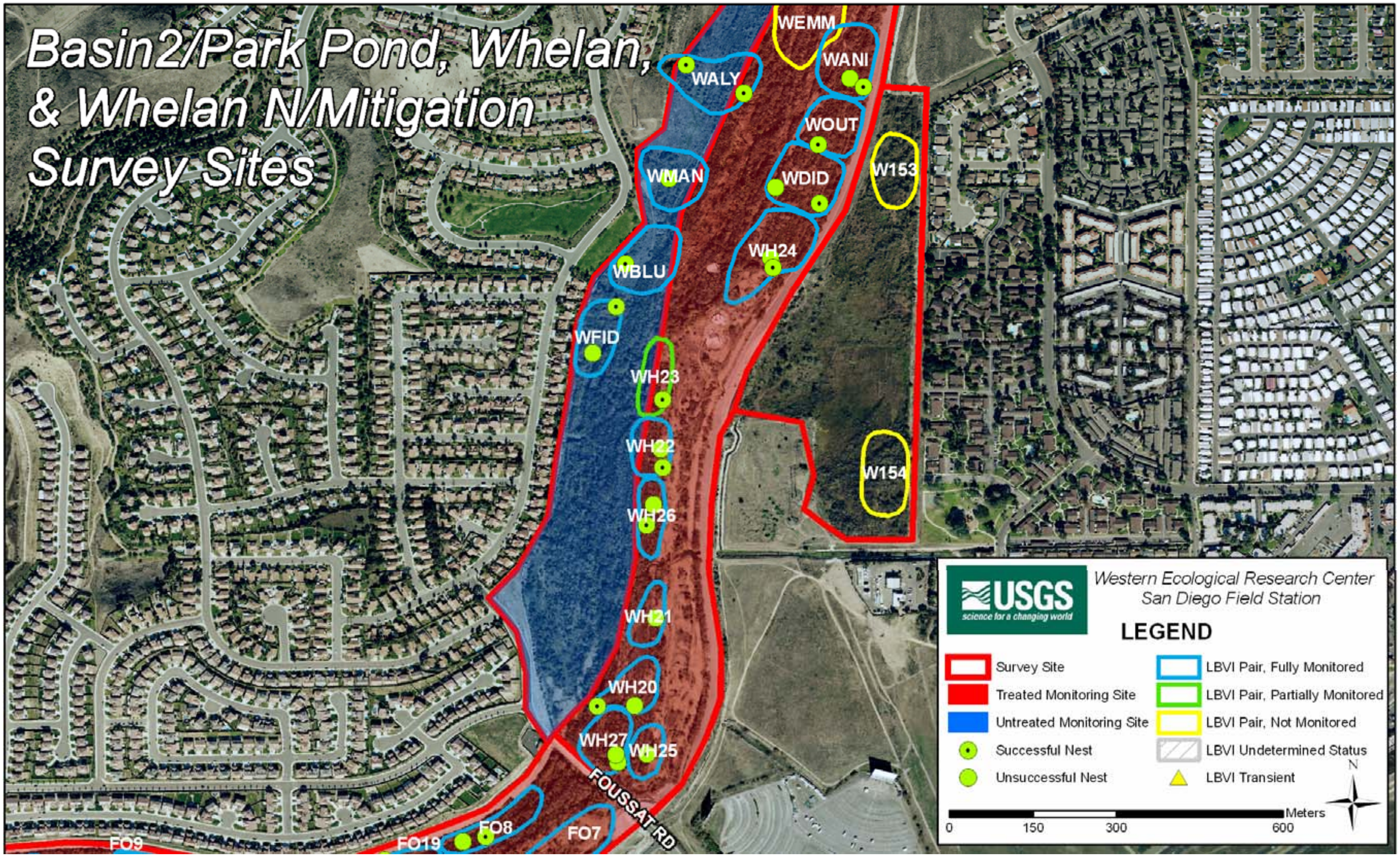

Figure 7. (a) Locations of least Bell's vireo (LBVI) territories and nests in the Douglas, Park Pond, Whelan and Whelan Mitigation survey sites at the San Luis Rey River Flood Control Project area, California, in 2007.

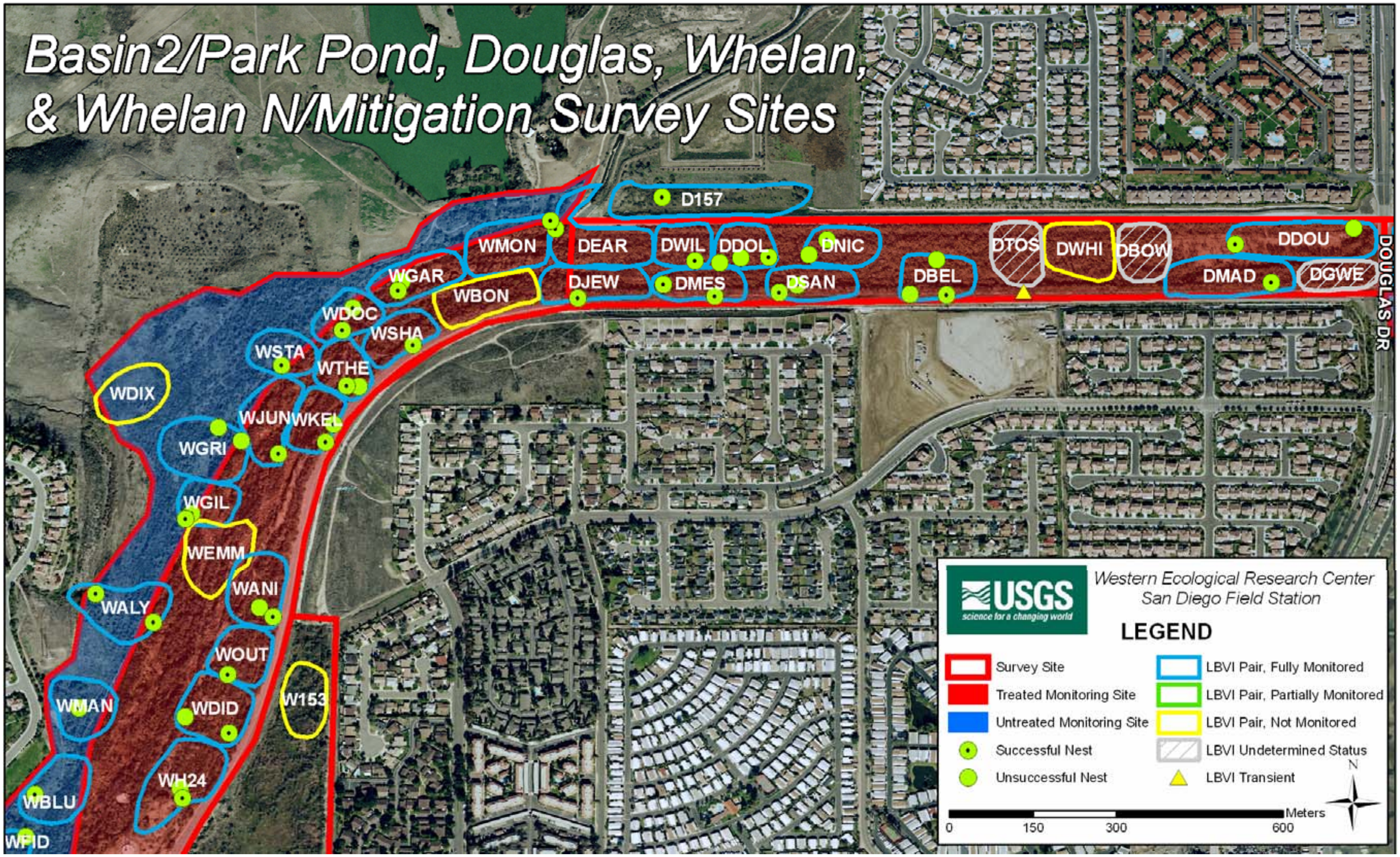

Figure 7. (b) Locations of least Bell's vireo (LBVI) territories and nests in the Douglas, Park Pond, Whelan and Whelan Mitigation survey sites at the San Luis Rey River Flood Control Project area, California, in 2007.

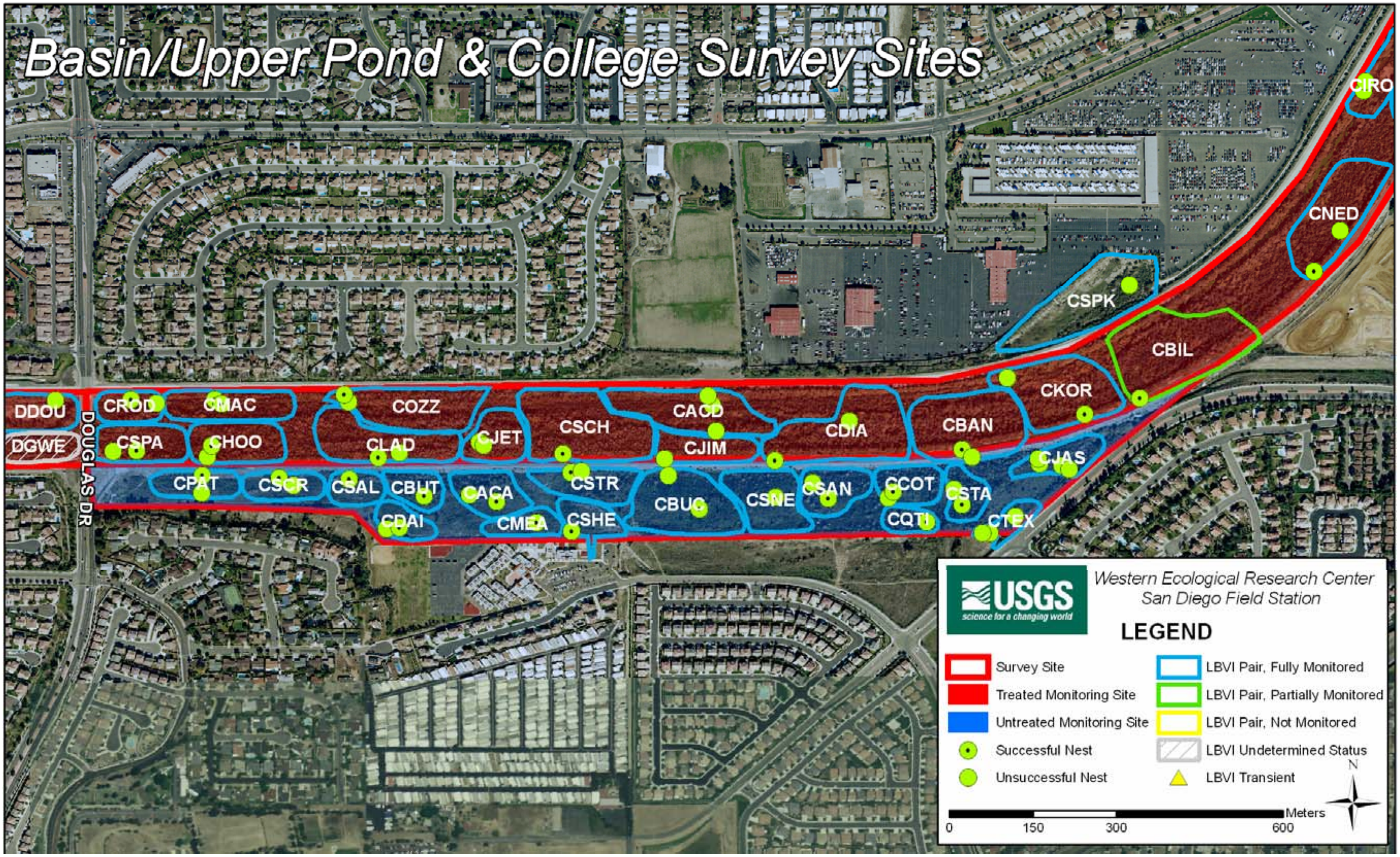

Figure 8. (a) Locations of least Bell's vireo (LBVI) territories and nests in the College and Upper Pond survey sites at the San Luis Rey River Flood Control Project area, California, in 2007.

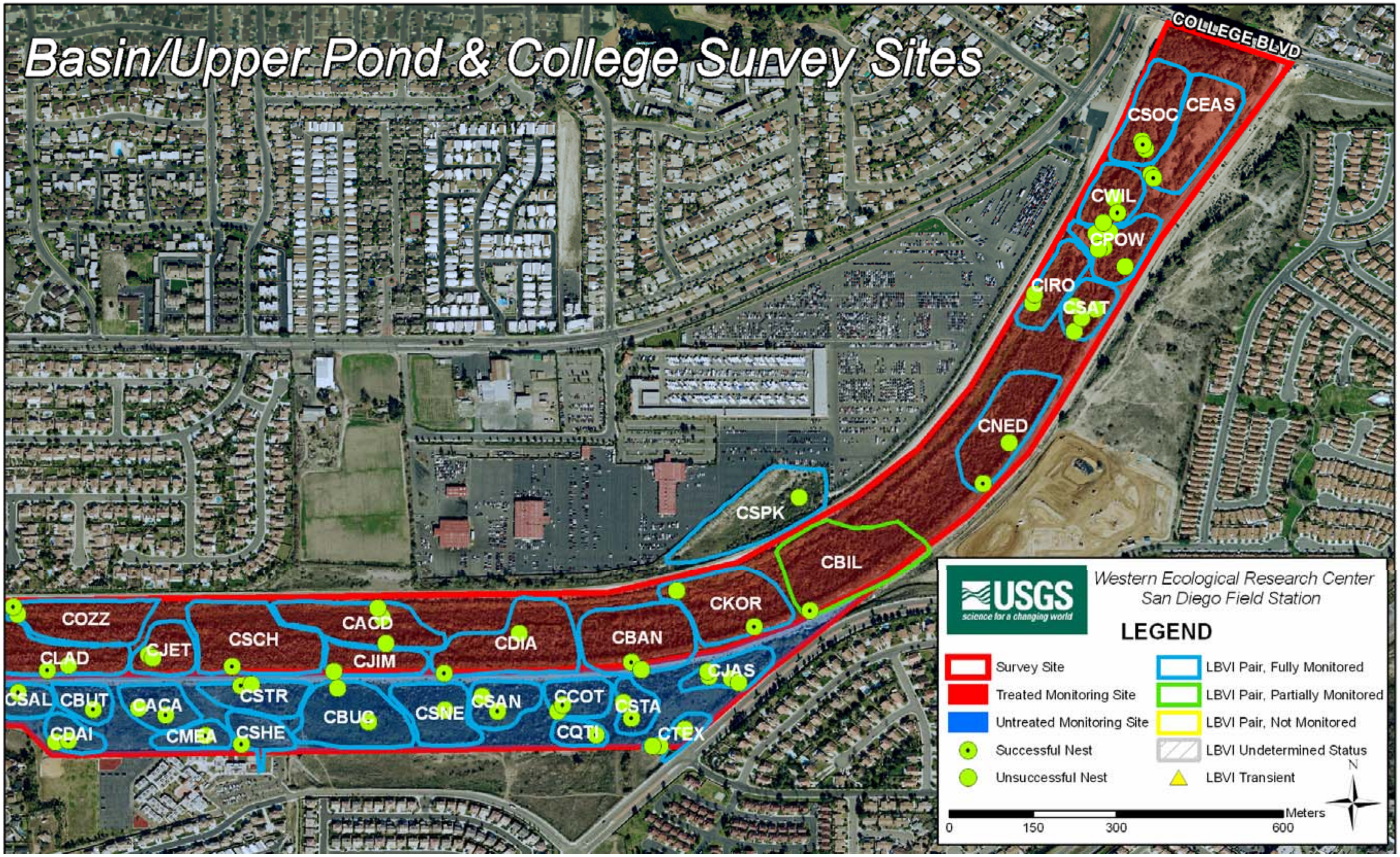

Figure 8. (b) Locations of least Bell's vireo (LBVI) territories and nests in the College and Upper Pond survey sites at the San Luis Rey River Flood Control Project area, California, in 2007.

Habitat Characteristics

Vireos used three different habitat types at the San Luis Rey River Flood Control Project area (Table 5). The majority of vireo territories occurred in habitat characterized as Mixed Willow Riparian, with 70% of the males in the study area found in this habitat. An additional 10% of birds occupied willow habitat co-dominated by cottonwoods. The second most commonly used habitat type, occupied by 20% of the population, was Riparian Scrub dominated by *B. salicifolia* and/or *S. exigua*.

The majority of vireo territories (63%) were placed in habitat where 50 to 95% of the vegetation cover was native species and the remaining 37% of the territories were placed in habitat vegetated almost entirely by native species (>95%). *A. donax* was the most commonly identified exotic species within territories followed by *B. nigra*, poison hemlock (*Conium maculatum*), and *T. ramosissima*.

Table 5. Habitat types used by least Bell's vireos at the San Luis Rey River Flood Control Project area, California, in 2007.

	Number of Territories			
Habitat Type	**>95% Native**	**50-95% Native**	**Total**	**Percent of Total**
Mixed Willow	29	46	75	70%
Riparian Scrub	9	13	22	20%
Willow/Cottonwood	2	9	11	10%
Total	40	68	108	100%

Nest Monitoring

Nesting activity was monitored in 97 territories within the San Luis Rey River Flood Control Project monitoring sites (Table 6, Figures 5-8, Appendix 1). Of these, 92 territories were "fully" monitored, meaning that all nests within the territory were found and monitored during the breeding season. Pairs within the remaining five territories were documented as nesting; however, only a subset of nests by a pair was found and monitored (“partially monitored” territories). A total of 180 nests were monitored during the breeding season, 173 (96%) of which came from fully monitored territories. Four nests were not completed and subsequently excluded from nest success and productivity calculations.

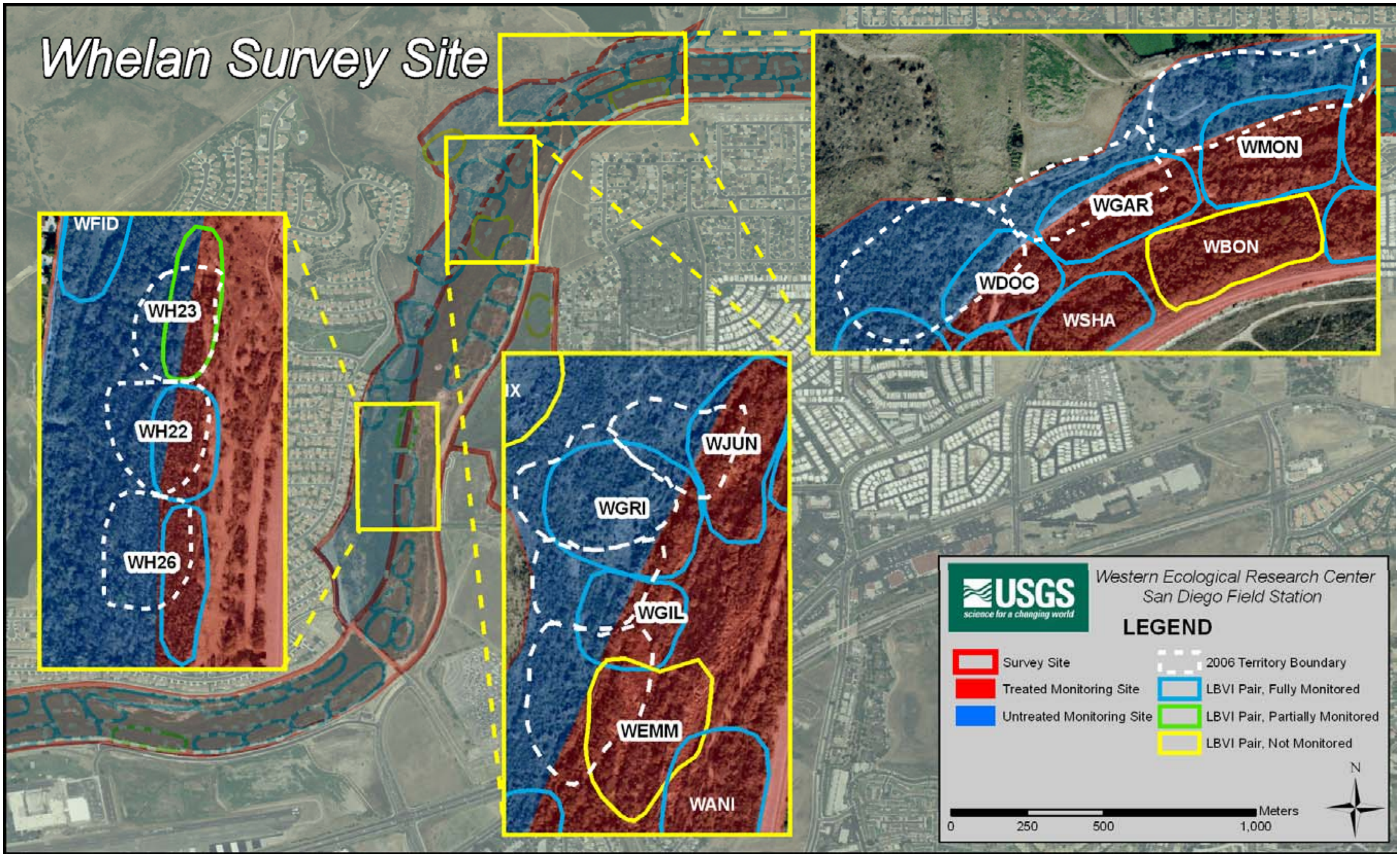

Figure 10. (a) Least Bell's vireo (LBVI) shifts in territory use from 2006 to 2007 from Whelan Mitigation to Whelan at the San Luis Rey River Flood Control Project area, California.

Table 6. Number of least Bell's vireo territories and nests monitored at the San Luis Rey River Flood Control Project area, California, in 2007.

	Site Type		
	Treated	**Untreated**[a]	**Total**
Fully monitored:			
Territories	61	31	92
Nests	119	50	169
Incomplete/false nests[b]	2	2	4
Total number of nests	121	52	173
Completed nests/pair (std)	2.0 ± 0.81	1.6 ± 0.72	1.8 ± 0.79
Partially monitored:			
Territories	3	2	5
Nests	3	4	7
Incomplete/false nests	0	0	0
Total number of nests	3	4	7
Total # of nests monitored	124	56	180

[a] Numbers were combined for untreated sites: Benet West, Upper Pond, and Whelan Mitigation.

[b] Incomplete nests were partially built, but not completed; false nests were partially built by a single male, but not completed.

Nest Success

Overall, 52% (92/176) of completed nests were successful at the San Luis Rey River Flood Control Project monitoring sites (Table 7). Forty-nine % (60/122) of nests in the Channel fledged young, while 59% (32/54) of nests in the Untreated sites (Table 8). Since sample sizes were low, we combined numbers for the Untreated sites.

Table 7. Fate of least Bell's vireo nests in fully and partially monitored territories at the San Luis Rey River Flood Control Project area, California, in 2007. Proportion of total nests shown in parentheses.

	Number of Nests		
Nest Fate	**Treated**	**Untreated**[a]	**Total**
Successful	60	32	92 (52%)
Failed			
Predation	50	19	69 (39%)
Parasitism[b]	2	0	2 (1%)
Other/Unknown	10	3	13 (7%)
Total Completed Nests	122	54	176 (100%)

[a] Numbers were combined for the three untreated sites: Benet West, Upper Pond, and Whelan Mitigation.

[b] One brown-headed cowbird egg was removed from each nest.

Causes of nest failure were similar between Treated and Untreated sites. Predation was believed to be the primary source of nest failure for all sites, although only two predation events were witnessed (Table 7). Predation accounted for 81% (50/62) and 86% (19/22) of nest failures at Treated and Untreated sites, respectively. While most predators were believed to be bird, mammal, or snake, predation by Argentine ants (*Linepithema humile*) was observed for two nests during the nestling stage. Overall, 41% (50/122) of Treated nests and 35% (19/54) of Untreated nests were lost to predation.

Nests failed for reasons that were known and unknown in this study. One nest, placed in *B. salicifolia*, failed when the supporting branch, which was too weak to support the nest, tipped sideways, preventing the pair from incubating the eggs. The cause of failure of 11 nests was unknown. Seven nests were abandoned prior to or during egg laying; because we did not observe eggs in these nests, they could have been either abandoned before egg laying or depredated in the egg stage. Four nests were abandoned during the egg stage.

One instance of post-fledging predation was directly observed. A biologist observed a California kingsnake (*Lampropeltis getula*) actively hunt and consume two of three fledglings.

Table 8. Fate of least Bell's vireo nests in fully and partially monitored territories at the San Luis Rey River Flood Control Project area, by monitoring site, in 2007. Proportion of total nests shown in parentheses.

	Treated		Untreated					
	Channel		Upper Pond		Benet West		Whelan Mitigation	
Nest Fate	**Nests**	**Terr.**[a]	**Nests**	**Terr.**	**Nests**	**Terr.**	**Nests**	**Terr.**
Successful	60 (49%)	52	15 (52%)	15	9 (64%)	7	8 (73%)	7
Failed	62 (51%)	12	14 (48%)	2	5 (36%)	1	3 (27%)	1
Total	122 (100%)	64	29 (100%)	17	14 (100%)	8	11 (100%)	8

[a] Territories indicated as successful fledged at least one young and may have had failed nest attempts.

We tested whether vegetation treatment or monitoring site had an effect on nest fate (successful vs. failed). Nest fate was independent of treatment ($\chi^2_{0.05,1}$ = 0.140, P = 0.237). Nests were equally likely to be successful or fail whether they were located in the treated site or untreated sites. Nest fate was also independent of monitoring site ($\chi^2_{0.05,3}$ = 3.00, P = 0.391). Therefore nest fate was not significantly different between the Channel, Benet West, Upper Pond, and Whelan Mitigation.

<u>Parasitism</u>

Brown-headed cowbirds parasitized six active nests (3%; 6/176), from which we removed one cowbird egg each, and one inactive nest which was discovered after it had already failed (Table 9). Two nests were directly lost to parasitism; each pair abandoned their nest after a cowbird egg was removed and subsequently re-nested. One nest was parasitized and later depredated, and three nests were parasitized, but were eventually successful, producing a total of seven fledglings (Appendix 1). In addition, one probable cowbird nest predation event was documented; the nest was found with three intact eggs in the nest and one punctured egg on the ground below the nest. None of the eggs were consumed, indicating that predation was an unlikely cause of failure. Parasitism occurred primarily in the river channel, and was distributed throughout; three nests were located between College Boulevard and Douglas Drive, two nests were located near Foussat Road and one nest was located near Benet Road. Just one parasitized nest, located in the Upper Pond, was located outside of the river channel.

Table 9. Fate of parasitized least Bell's vireo active nests in fully and partially monitored territories at the San Luis Rey River Flood Control Project area, California, in 2007. One brown-headed cowbird egg was removed from each nest.

	Number of Nests		
Nest Fate	**Treated**	**Untreated**[a]	**Total**
Parasitized	2	0	2
Parasitized and depredated	1	0	1
Parasitized and successful	2	1	3
Total	5	1	6

[a] Numbers were combined for the three untreated sites: Benet West, Upper Pond, and Whelan Mitigation.

Nesting Attempts

Within fully monitored territories, Treated pairs averaged significantly more nesting attempts (2.0 nests/pair) than Untreated pairs (1.6 nests/pair) ($t_{0.05,\,90} = 1.97$, $P = 0.050$) over the course of the 2007 breeding season. Fully monitored pairs at Treated and Untreated sites were equally likely to re-nest after their initial attempt; 77% and 62% of pairs attempted a second nest in the Treated and Untreated sites respectively ($\chi^2_{0.05,1} = 0.348$, $P = 0.555$). Nest fate influenced the likelihood that pairs would re-nest. Pairs whose nests failed during their first nest attempt were more likely to re-nest than were pairs that were successful. Ninety-one percent of Treated pairs and 100% of Untreated pairs re-nested after their initial nest attempt failed, compared to only 54% of Treated and 19% of Untreated pairs re-nesting after a successful first attempt. Nine pairs from the Treated site and two pairs from the Untreated sites initiated three nesting attempts; of these, only three pairs at the Treated site were successful. We observed four pairs that built four nests and one pair that built five nests during the breeding season; although each pair had at least one nest that reached the nestling stage, none of the pairs were able to successfully fledge young. In addition, we documented eight Treated pairs and three Untreated pairs that successfully raised and fledged two broods.

Reproductive Success and Productivity

Reproductive success did not differ between Treated and Untreated pairs (Table 10). Likewise, measures of productivity did not vary at the egg, nestling, or fledgling stage as average clutch size, average brood size, and average number of young were not statistically different between Treated and Untreated sites.

Pairs at Treated sites exhibited a lower hatching rate of eggs (71% vs. 78%) and a lower proportion of nests in which at least one egg hatched (74% vs. 86%) than did pairs in Untreated sites. Differences in hatching rates were largely related to the lower survival rate of Treated nests from the egg stage to the nestling stage compared to Untreated nests; 42% (26/62) of

Table 10. Reproductive success and productivity of nesting least Bell's vireos at Treated and Untreated sites at the San Luis Rey River Flood Control Project area, California, in 2007. Numbers given for all pairs, both fully and partially monitored, unless otherwise noted. Standard deviations presented with means.

	Number		
Parameter	**Treated**	**Untreated**[a]	**Overall**
Nests with eggs	108	51	159
Eggs laid	319	159	478
Average clutch size[b]	3.2 ± 0.59	3.3 ± 0.49	3.2 ± 0.55
Nests with hatchlings	80	44	124
Hatchlings	227	124	351
Average brood size[c]	3.0 ± 0.77	2.9 ± 0.69	3.0 ± 0.74
Hatching success:			
Eggs[d]	71%	78%	73%
Nests[e]	74%	86%	78%
Nests with fledglings	60	32	92
Fledglings	163	94	257
Fledging success:			
Hatchlings[f]	72%	76%	73%
Nests[g]	75%	73%	74%
Fledglings per nest	1.5	1.8	1.6
Average number of young fledged per pair[h]	2.6 ± 1.76	2.8 ± 1.54	2.7 ± 1.69
Pairs fledging ≥ one young[i]	50 (82%)	27 (87%)	77 (84%)
Pairs fledging two broods	8	3	11

[a] Numbers were combined for untreated sites: Benet West, Upper Pond, and Whelan Mitigation.

[b] Based on 82 Treated and 44 Untreated non-parasitized nests with a full clutch (Two-sample *t*-test: $t_{0.05, 124} = -0.294$, $P = 0.770$).

[c] Based on 66 Treated and 41 Untreated non-parasitized nests known to have a full brood (Two-sample *t*-test: $t_{0.05, 105} = 0.393$, $P = 0.695$).

[d] Percent of all eggs that hatched.

[e] Percent of all nests with eggs in which at least one egg hatched.

[f] Percent of all nestlings that fledged.

[g] Percent of all nests with nestlings in which at least one young fledged.

[h] Based on 61 Treated and 31 Untreated pairs who were fully monitored (Two-sample *t*-test: $t_{0.05, 90} = 0.045$, $P = 0.686$).

[i] Based on pairs whose territories were fully monitored.

unsuccessful Treated nests failed during the egg stage compared to 23% (5/22) of unsuccessful Untreated nests. However, differences in hatching rate did not influence the average brood size because Treated pairs had a higher percentage of nests with four-nestling broods compared to Untreated pairs; 24% (16/66) of Treated nests had nests with 4-nestling broods compared to 15% (6/41) of Untreated nests.

Fledging success parameters were similar between treatments. Overall, 74% of nests with nestlings produced at least one young while 73% of hatchlings survived to the fledgling stage. Pair success was high; 84% (77/92) of pairs in fully monitored territories were successful and produced at least one vireo fledgling by the end of the season.

We tested for differences in year and treatment type for average clutch size, average brood size, and average number of fledglings. Average clutch size and average brood size were significantly lower in 2007 than in 2006 while average number of fledglings per pair was significantly higher in 2007 than in 2006 (Table 11). Treatment was not a significant factor in explaining differences in average clutch size, brood size, or number of fledglings. However, there was a significant treatment-by-year effect for average number of fledglings produced per pair. In 2006, the average number of fledglings was significantly lower for Untreated pairs compared to Treated pairs (Figure 11). This trend was not repeated in 2007, when the average number of fledglings did not significantly differ between Treated and Untreated pairs.

Table 11. Least Bell's vireo average clutch size, average brood size, and average number of fledglings per pair and results of two-way ANOVA at the San Luis Rey River Flood Control Project area, California, in 2006-2007. Standard error presented in parentheses.

Productivity	**2006**	**N**[a]	**2007**	**N**	**Variable**[b]	**F-ratio**	***P***[c]
Average Clutch Size	3.6 (0.06)	76	3.2 (0.06)	86	Year	17.26	**0.000**
					Treatment	0.07	0.787
					Year x Treatment	0.06	0.815
Average Brood Size	3.5 (0.10)	46	3.0 (0.08)	83	Year	19.43	**0.000**
					Treatment	0.15	0.695
					Year x Treatment	0.09	0.769
Average Number of Fledglings per Pair	2.3 (0.14)	85	2.8 (0.15)	77	Year	7.14	**0.008**
					Treatment	1.87	0.173
					Year x Treatment	5.30	**0.023**

[a] Sample size
[b] Model: Response variables: Average Clutch Size, Average Brood Size, or Average Number of Fledglings per Pair = Year (2006, 2007) + Treatment (Treated, Untreated) + Year x Treatment.
[c] *P* = P-value

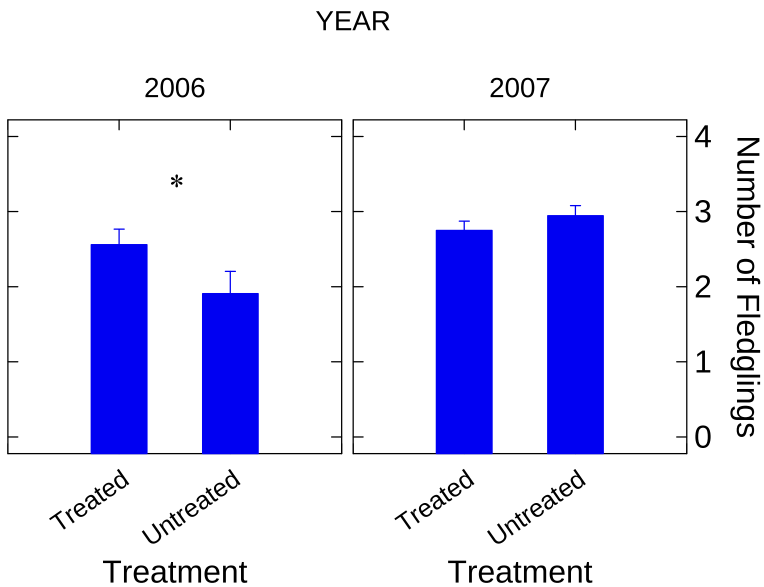

Figure 11. Average number of fledglings per pair by Year and Treatment at the San Luis Rey River Flood Control Project area, California, in 2006-2007. Asterisk denotes significant difference between treatments. Standard error bars are shown.

Nest Survival

Analysis of DSR showed year to be the best single predictor of vireo nest survival (Table 12). Although treatment appeared in the best supported model, analysis of odds ratios showed that the confidence interval for this variable included 1, which indicates that treatment did not by itself affect vireo nest survival (Table 13). However, an interaction between year and treatment was found to be significant, echoing results presented above relating these variables to annual production of fledglings. Vireo nest survival was higher in Treated sites than in Untreated sites in 2006, but DSR did not differ between treatments in 2007. Overall, nests were twice as likely to be successful in 2007 as in 2006.

Table 12. Logistic regression models for the effects of treatment and year on nest survival of least Bell's vireos at the San Luis Rey River Flood Control Project area, California, in 2006 and 2007. 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 loge likelihood (L) and the number of parameters (K) in the model.

Model	**Deviance**	**# Parameters**	**AIC_C**	**ΔAIC_C**	**AIC_C Weight**
Year + Treatment + Year x Treatment	922.11	4	930.12	0.00	0.39
Year	927.23	2	931.23	1.11	0.23
Constant	929.29	1	931.29	1.17	0.22
Year + Treatment	927.19	3	933.20	3.08	0.08
Treatment	929.23	2	933.23	3.12	0.08

Table 13. Parameter estimates (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 the San Luis Rey River Flood Control Project area, California, in 2006 and 2007.

Effect	**β**	**SE**	**Odds Ratio**	**95% CI**
Year	0.77	0.3	2.16	1.20-3.90
Treatment	0.4	0.24	1.49	0.93-2.39
Year x Treatment	-0.83	0.37	0.44	0.21-0.91

Nest Characteristics

Successful and failed nests within Treated and Untreated sites did not differ statistically in height of the host plant, distance the nest was placed from the edge of the host, distance of nest to nearest clump or distance of nest to edge of riparian (Table 14). Nest height of successful nests averaged significantly lower than nests that failed in the Treated site, but not the Untreated sites. There was a significant difference between Treated and Untreated sites for nest height and height of the host plant; Treated nests were higher than Untreated nests, but were placed in host plants that were shorter than the host plants in the Untreated sites (Table 14).

Table 14. Least Bell's vireo nest characteristics and results of two-sample t-tests comparing successful and failed nests at the San Luis Rey River Flood Control Project area, California, in 2007. Standard deviation presented in parentheses.

Nest Characteristic	Successful	N[a]	Unsuccessful	N	df[b]	*t*[c]	*P*[d]
Treated Site							
Average nest height (m)	1.0 (0.3)	54	1.2 (0.5)	53	105	2.71	**0.008**
Average host height (m)	3.8 (2.6)	54	4.3 (2.7)	53	105	1.01	0.316
Average distance to edge of host (m)	0.9 (1.0)	53	1.2 (1.5)	52	103	1.10	0.274
Average distance to edge of clump (m)[e]	7.7 (12.3)	54	4.8 (4.5)	52	104	-1.60	0.113
Average distance to edge of riparian (m)	34.2 (37.9)	54	28.5 (25.6)	53	103	-0.92	0.361
Untreated Site[f]							
Average nest height (m)	0.9 (0.30)	31	1.0 (0.4)	24	53	0.40	0.691
Average host height (m)	4.9 (4.4)	31	5.7 (4.8)	24	53	0.65	0.521
Average distance to edge of host (m)	1.0 (1.2)	31	0.9 (1.4)	24	53	-0.25	0.802
Average distance to edge of clump (m)	9.9 (14.5)	31	6.6 (7.7)	24	53	-1.02	0.314
Average distance to edge of riparian (m)	31.3 (25.5)	31	23.5 (22.8)	24	53	-1.18	0.245
Overall	**Treated**	**N**	**Untreated**	**N**	**df**	***t***	***P***
Average nest height (m)	1.1 (0.5)	107	1.0 (0.3)	55	160	2.07	**0.040**
Average host height (m)	4.1 (2.6)	107	5.3 (4.6)	55	160	-2.16	**0.032**
Average distance to edge of host (m)	1.0 (1.0)	105	1.0 (1.3)	55	158	0.21	0.832
Average distance to edge of clump (m)	6.3 (9.4)	106	8.5 (12.1)	55	159	-1.26	0.211
Average distance to edge of riparian (m)	31.3 (32.3)	105	27.9 (24.5)	55	158	0.70	0.487

[a] Sample size
[b] df = degrees of freedom (sample size – 2)
[c] *t* = two-sample unequal variance t-test test statistic
[d] *P* = P-value
[e] Clump boundaries were defined where leaves and/or branches of neighboring plants no longer overlapped.
[f] Numbers were combined for untreated sites: Benet West, Upper Pond, and Whelan Mitigation.

Vireos at Treated and Untreated sites were comparable in their selection of host species, with 80-90 percent of nests placed in *S. lasiolepis*, *B. salicifolia*, *S. exigua,* and *S. gooddingii* (Table 15). Whereas vireos in both treatments selected *S. lasiolepis* and *S. exigua* in similar proportions, birds at Treated sites placed proportionately fewer nests in *B. salicifolia* and proportionately more nests in *S. gooddingii* than did birds at Untreated sites. Differences in host species were likely a reflection of the relative availability of those species at each site. An additional six plant species were used as nest support by vireos. Vireos used two non-native plants for host species; two nests were placed in *A. donax* at the Treated site (one of which was successful) and two nests were placed in *T. ramosissima*, one in the Treated and one in the Untreated sites, both of which were successful.

Table 15. Host plant species used by least Bell's vireos at Treated and Untreated sits at the San Luis Rey River Flood Control Project area, California, in 2007.

Host Species	Treated			Untreated[a]		
	Successful	Unsuccessful	Total[b]	Successful	Unsuccessful	Total[a]
Salix lasiolepis	24	29	53 (0.45)	13	10	23 (0.42)
Baccharis salicifolia	16	7	23 (0.19)	11	7	18 (0.33)
Salix exigua	5	8	13 (0.11)	4	3	7 (0.13)
Salix gooddingii	4	5	9 (0.08)	1	1	2 (0.04)
Populus fremontii	1	2	3 (0.03)	0	2	2 (0.04)
Toxicodendron diversilobum	2	0	2 (0.02)	0	1	1 (0.02)
Arundo donax	1	1	2 (0.02)	0	0	0
T. ramosissima	1	0	1 (0.01)	1	0	1 (0.02)
Vitis californica	0	1	1 (0.01)	0	0	0
Rubus ursinus	0	0	0	1	0	1 (0.02)

[a] Numbers were combined for the Untreated sites: Benet West, Upper Pond, and Whelan Mitigation.
[b] Numbers in parentheses are proportions of total nests.

Banded Birds

A total of 54 least Bell's vireos banded prior to the 2007 breeding season returned to the San Luis Rey River Project area to establish territories in 2007 (Appendix 2). Of these, 41 were returning adult vireos and 13 were returning first year vireos that were banded as nestlings in 2007. One additional returning adult male vireo was resighted once early in the breeding season but did not establish a territory within the project area. With the exception of one bird banded as a nestling at Pilgrim Creek in 2002, all birds were banded in the San Luis Rey River Project Area. Adult birds of known age ranged from one to eight years old.

We banded 254 least Bell's vireos during the 2007 season. These included seven adult vireos that were target netted and banded with a unique color combination and 236 hatch-year birds that were banded with a single dark blue numbered federal band. We also captured and added color bands to 10 vireos that were banded as nestlings in 2006 and one vireo that was banded as a nestling at Pilgrim Creek in 2002. We were unable to recapture four banded vireos, although the presence of a dark blue band indicated that that they had been banded as nestlings on the San Luis Rey River.

Survivorship, Fidelity, and Movement

The recapture and resighting of banded birds allowed us to estimate survivorship, or the proportion of individuals known to survive from one year to the next. Adult survivorship was high: of 61 uniquely color banded adult vireos present during the 2006 breeding season, 69% (42/61) returned to the San Luis Rey River Project area in 2007 (Appendix 3). The only adult female to be banded in 2006 returned in 2007.

Territory site fidelity was strong among adult vireos that were uniquely banded in 2006 and were resighted in 2007; 80% (33/41) of adults returned to breed in the same territory as the previous year (Appendix 3). In addition, the remaining eight vireos returned to a territory adjacent to the territory they occupied in 2006. The banded male vireo transient detected just once during the season was observed 100 meters from the territory he held in 2006. Average distance dispersed by returning adult vireos was 0.1 ± 0.06 km (std).

Thirteen of the 220 hatch-year vireos banded in 2006 that survived to fledge were resighted at the San Luis Rey River Project area in 2007, yielding an estimated first year survivorship of 6% (Appendix 3). Inclusion of three females captured outside of the Project area and confirmed to natal territories within the Project area (see below; Appendix 4) increases the estimate of annual survivorship to 7%. Seven of the 13 first year birds detected in the Project area were male. We recaptured six males and four females and banded them with a unique color combination in 2007. Dispersal distance within the project area of first year vireos ranged from 0.07 – 4.4 km and averaged 1.6 ± 1.1 km (std). Males dispersed twice as far on average as did females (2.0 ± 1.3 km vs. 1.0 ± 0.3).

Banding allowed us to examine adult and juvenile dispersal within and between Treated and Untreated sites. Ten first year birds were recaptured and their natal territories identified (Appendix 3). Of these, seven were fledged from Treated sites and three from Untreated sites. Although sample sizes were small, no clear dispersal pattern emerged within or between treatment types or sex of the returning birds. Five birds remained within the Treated site, one remained within the Untreated sites, three dispersed from a Treated location to an Untreated site, and one dispersed from an Untreated site to a Treated location (Appendix 3). Nine adult birds moved to new territories between 2006 and 2007; four stayed within the treated sites, four moved to another territory within Upper Pond, and one with a partial band combination moved from an undetermined 2006 territory. By comparing the banding status of adults in 2006 and 2007 territories, we were able to determine that seven of the dispersing adults displaced the 2006 adult from that territory. Three territories occupied by dispersing males in 2007 contained banded adults in 2006 that were not detected during the 2007 breeding season, suggesting that the birds may have died prior to the 2007 breeding season.

Banding and surveying of least Bell's vireos at other study sites allowed us to examine dispersal movements between the San Luis Rey River Project area and Camp Pendleton and the upper San Luis Rey River study area. At Camp Pendleton, two female first-year birds were recaptured and banded with a unique color combination in 2007 (Appendix 4). Both females were banded as nestlings in 2006 and dispersed 12.0 and 13.9 km from the San Luis Rey River Project area to Camp Pendleton. In addition, two male and two female vireos were resighted at Camp Pendleton with a metal dark blue federal band on the left leg indicating they were originally banded either at the San Luis Rey River Project area or at the upper San Luis Rey River study area. Although the exact natal territory was unknown, we calculated the nearest distance that a vireo could have dispersed from either study site at the San Luis Rey River to their 2007 territory (Appendix 4). We recaptured one female first-year vireo at the upper San Luis Rey River study area 21.6 km distant from her natal territory in the Benet West site. In addition, we resighted 11 male and 2 female vireos with metal dark blue federal bands, indicating they were been banded either at the San Luis Rey River Project area or at the upper the San Luis Rey River.

Southwestern Willow Flycatcher

Population Size and Distribution

One southwestern willow flycatcher pair was found within the Whelan Lake area and monitored throughout the breeding season (Figure 12). We also detected ten transient willow flycatchers of unknown sub-species within the San Luis Rey River Flood Control Project area in 2007 between 15 May and 4 June. Five transients were observed in the river channel; three between Douglas Road and Foussat Road and two between Foussat Road and Benet Road. We detected two transients in the Upper Pond, and three transients in Whelan Mitigation, outside of the river channel.

Habitat Characteristics

Flycatchers used Mixed Willow Riparian and Riparian Scrub habitat types at the San Luis Rey River Flood Control Project area (Table 16). All flycatcher locations were in habitat where 50 to 95% of the vegetation cover was native species. Dominant native species included *S. lasiolepis, S. gooddingii, S. exigua,* and *P. fremontii*. *A. donax, B. nigra*, *C. maculatum* and *F. vulgare* were the most commonly identified exotic species within territories. Flycatchers were detected between 0 and 75 m away from surface water, and the resident flycatcher territory encompassed part of the San Luis Rey River that remained wet for the duration of the 2007 breeding season.

Table 16. Habitat characteristics of southwestern willow flycatcher locations at the San Luis Rey River Flood Control Project area, California in 2007.

Bird ID	Date First Detected	Status[a]	Habitat Type	% Cover Exotics[b]	Dominant Exotics[c]	Distance to Surface Water (m)
WL2	15 May	P	Mixed Willow	1	CON	0
WL4	15 May	T	Mixed Willow	1	ARU	10
WL4A	15 May	T	Mixed Willow	1	ARU	10
07WIFL3	22 May	T	Mixed Willow	2	ARU	20
07WIFL4	22 May	T	Riparian Scrub	2	FOE	50
07WIFL4A	22 May	T	Riparian Scrub	2	FOE	50
07WIFL2	17 May	T	Riparian Scrub	1	BRA	75
07WIFL2A	17 May	T	Riparian Scrub	1	BRA	75
07WIFL1	22 May	T	Mixed Willow	2	ARU	20
WIFL 1	4 Jun	T	Mixed Willow	1	ARU	5
07WIFL5	24 May	T	Mixed Willow	2	ARU	75

[a] T = transient, P = breeding pair.

[b] 1 = <5%, 2 = 5-50%, 3 = 51-95%, 4 = >95%.

[c] ARU = *Arundo donax*, BRA = *Brassica nigra*, CON = *Conium maculatum*, FOE = *Foeniculum vulgare*.

Nest Monitoring

Only one of four 2006 flycatcher territories was occupied in 2007. The flycatcher pair (WL2) nested in the area between Whelan Lake and the San Luis Rey River (Figure 12). We located one nest for this pair which was abandoned because the eggs never hatched. The nest was initially found on 26 June with three eggs. Hatch date was estimated at 7 July. However, the nest remained active; the female was observed incubating until at least 13 July, the second to last visit, well past when the eggs should have hatched. On 17 July, during the eighth nest visit, the nest was discovered with one punctured egg and two intact eggs, which may have resulted from a possible cowbird predation attempt. The nest failed between 13 July and 17 July. The pair did not attempt another nest and was not detected again for the duration of the breeding season. The nest was placed 1.5 m high in *S. lasiolepis*.

Banded Birds

We detected just one banded adult flycatcher during the 2007 season. The WL2 female returned to breed in the same territory as 2006. She was originally banded in 2005 as an adult when she was one of three polygamous females; therefore she is at least three years old. We were unable to confirm whether the WL2 male was banded.

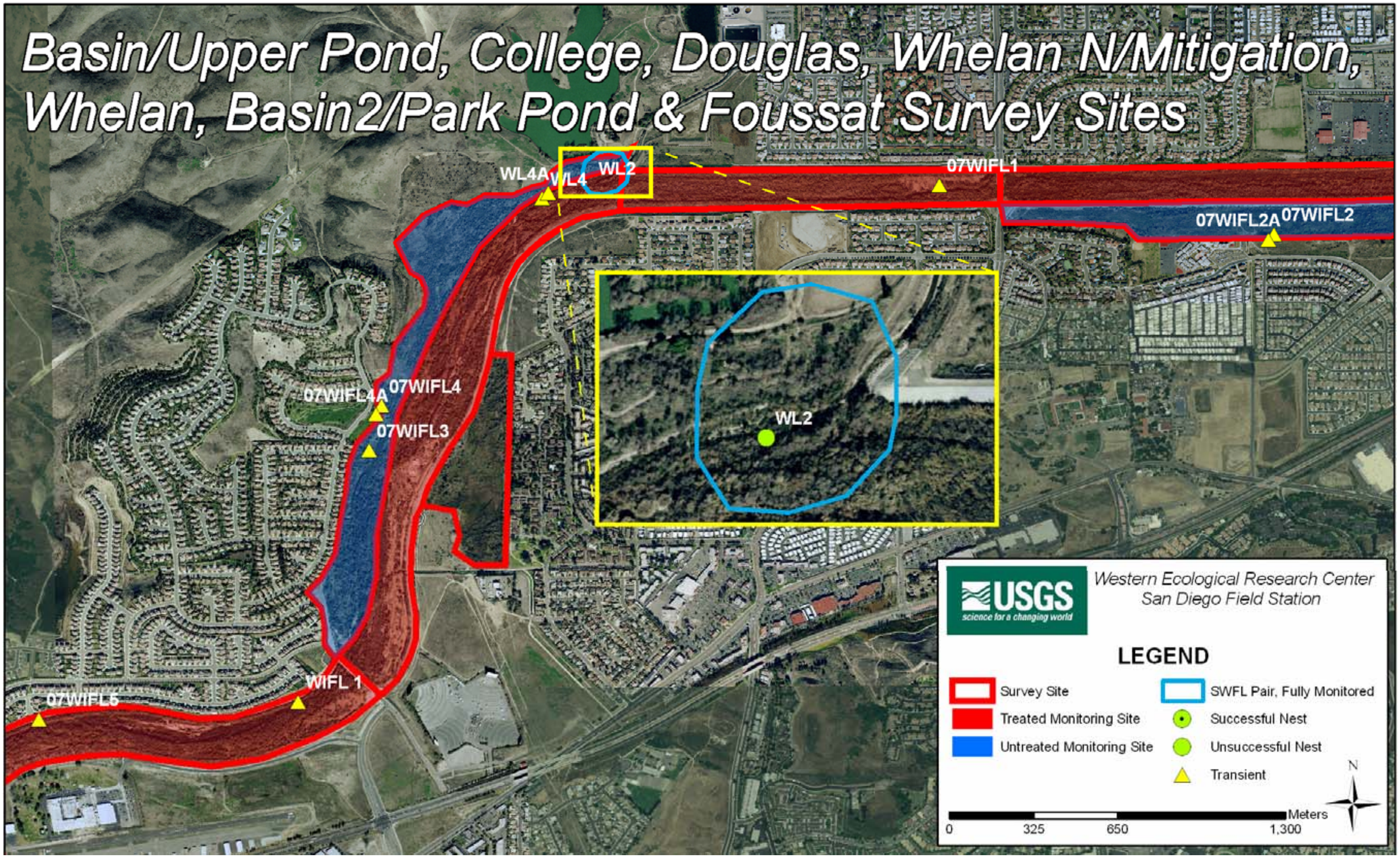

Figure 12. Locations of southwestern willow flycatchers (SWFL) territories and nests at the San Luis Rey River Flood Control Project area, California, in 2007.

Baseline Vegetation Study

A total of 46 transects (526 points) were established and sampled at the San Luis Rey River Flood Control Project area in 2006 (Table 17, Figures 13–15). One transect was dropped in 2007 because of the lack of treated points on this transect and a new one was added (Table 17, Figures 13-14). Seventy-two percent (378/526) of points were located in the Channel site while the remaining 28% (148/526) were located at Upper Pond and Whelan Mitigation. The number of points per transect varied between 4 and 18.

One hundred and twelve of the 526 points, all within the Channel site, were located in areas cleared of vegetation (64%, 72 points), *A. donax* (21%, 23 points) or both (15%, 17 points). Points in cleared areas made up 30% (112/378) of the points in the Channel and 21% (112/526) of all points sampled in these sites. All Channel transects spanned areas cleared of vegetation and/or *A. donax* (represented by up to seven points per transect). GPS coordinates for the start and end point of each transect are provided in Appendix 5.

Table 17. Number of vegetation transects and points at the San Luis Rey River Flood Control Project area, California, in 2007.

Site	Transects	Untreated Points	Treated Points[a]	Total Points
Channel	31	266	112	378
Upper Pond	13	113	0	113
Whelan Mitigation	2	35	0	35
Total	46	414	112	526

[a] Treated points were located in areas with vegetation clearing and/or *A. donax* removal.

Vegetation Structure

Foliage cover below 1 m was higher at the treated Channel points than at the untreated Channel points and the other sites, likely a result of herbaceous re-growth following vegetation treatments in 2006 (Figure 16). Foliage cover was greatest for treated and untreated Channel points at 1-2 m. However, at heights above 2 m, vegetation at untreated Channel points was taller and more dense than that at treated points and sites outside of the flood control channel. In general, foliage cover was more similar among treated Channel points, and Upper Pond and Whelan Mitigation because of their lower average canopy height (treated points: 4.4 ± 2.9 m; Upper Pond: 4.1 ± 2.5 m; Whelan Mitigation: 4.2 ± 1.7 m). In contrast, average canopy height at untreated Channel points measured approximately 4 m higher (8.2 ± 3.2). Consequently, 80% of the total cover measured was below 3 m for treated Channel points, and Upper Pond and Whelan Mitigation, whereas 80% of the total cover measured for untreated Channel points was below 6 m (Figure 17).

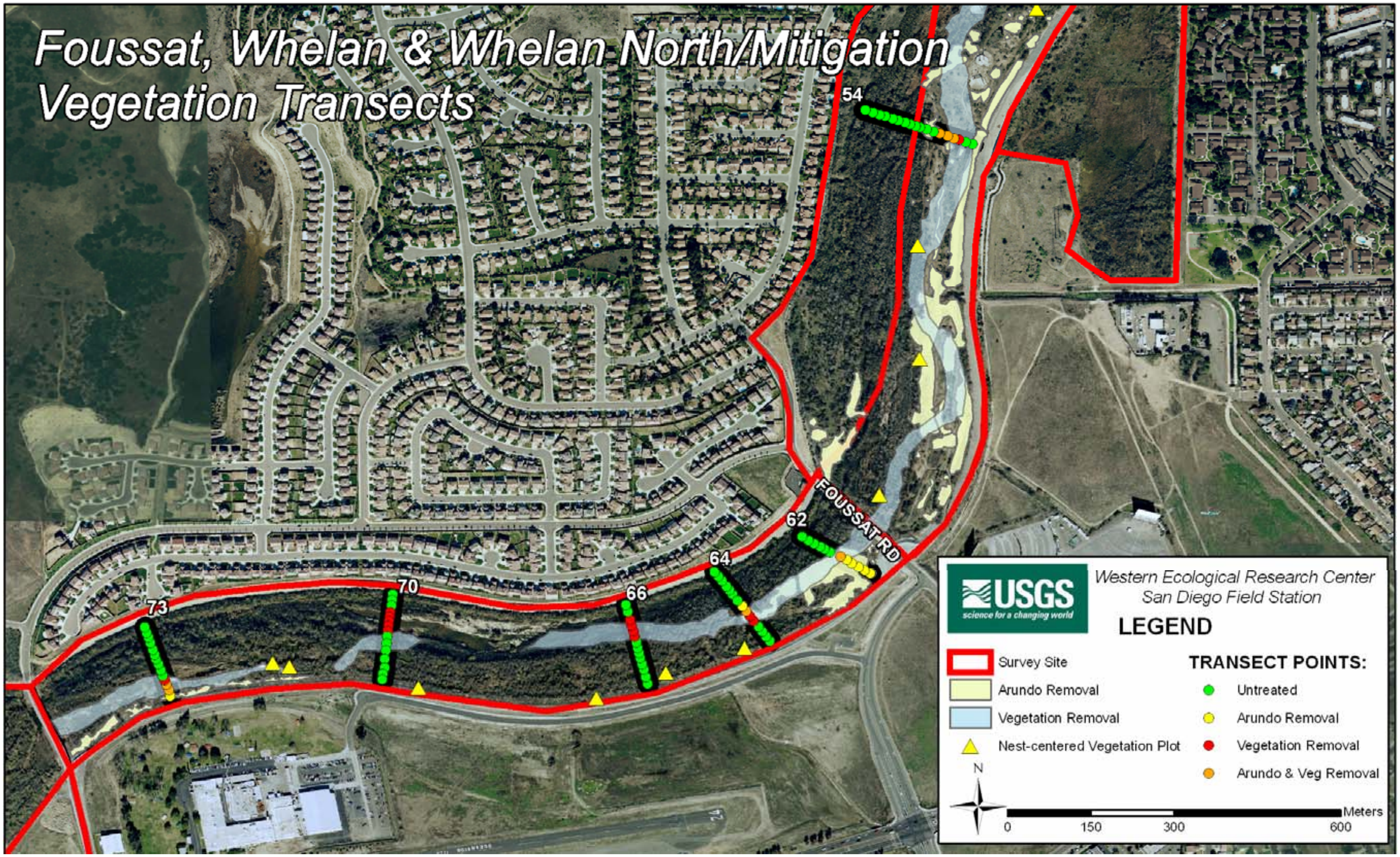

Figure 13. Locations of vegetation transects and nest-centered vegetation plots in the Foussat and Whelan survey sites at the San Luis Rey River Flood Control Project area, California, in 2007.

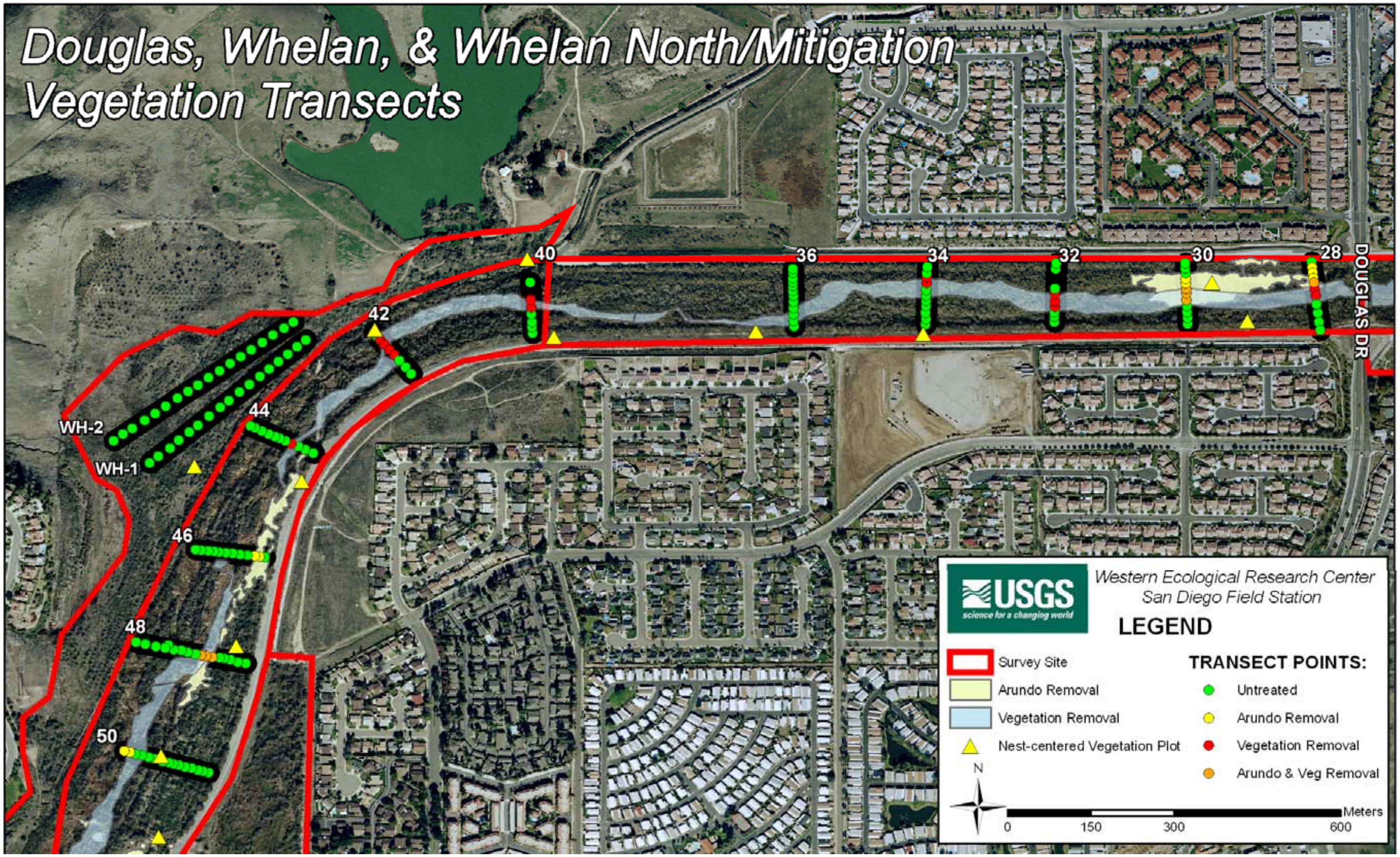

Figure 14. Locations of vegetation transects and nest-centered plots in the Douglas, Whelan, and Whelan Mitigation survey sites at the San Luis Rey River Flood Control Project area, California, in 2007.

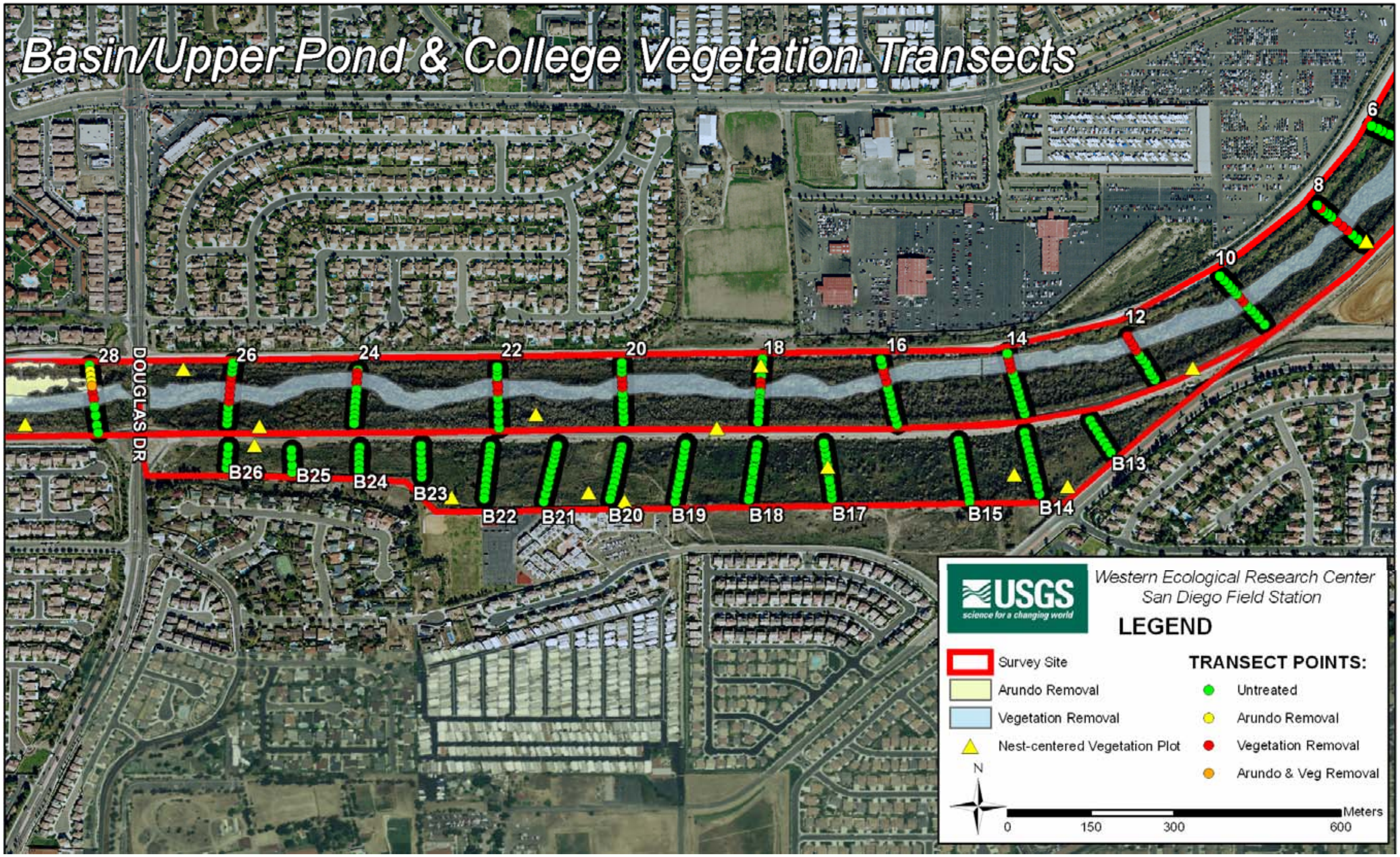

Figure 15. (a) Locations of vegetation transects and nest-centered plots in the College and Upper Pond survey sites at the San Luis Rey River Flood Control Project area, California, in 2007.

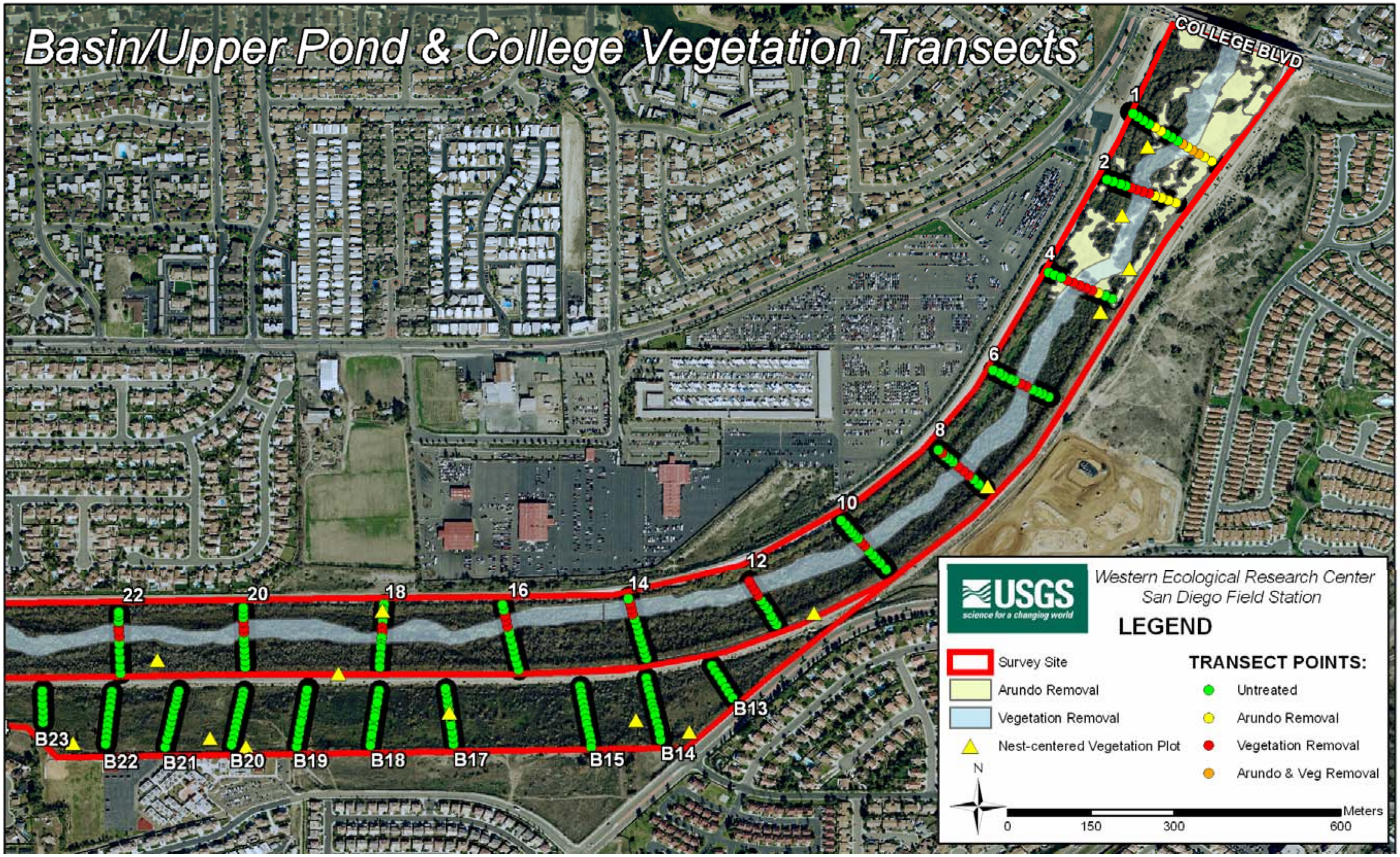

Figure 15. (b) Locations of vegetation transects and nest-centered vegetation plots in the College and Upper Pond survey sites at the San Luis Rey River Flood Control Project area, California, in 2006.

Vegetation Composition

Cover of tree species was highest at untreated Channel points and lowest at the Upper Pond (Figure 18). Dominant tree species in the Channel included *S. lasiolepis* and *S. gooddingii*, with a higher percent cover of *S. lasiolepis* at all height classes. Together these species represented 55% and 26% of the total foliage cover over all heights for untreated and treated points, respectively. *P. fremontia* was also documented in the Channel, although it only contributed <3% of the total cover for treated and untreated points. *S. lasiolepis* was the dominant tree species at Upper Pond and Whelan Mitigation, representing 21% and 28% of the total foliage cover. Other species at the Upper Pond and Whelan Mitigation sites included *S. gooddingii* and *P. fremontia*, both of which contributed <5% at each site.

Cover of shrub species was highest outside of the flood control channel at Upper Pond and Whelan Mitigation (Figure 19). There shrub cover represented a higher proportion of the total foliage cover than any other plant type; 41% of Upper Pond and 39% of Whelan Mitigation was shrub cover. *S. exigua* and *B. salicifolia* were co-dominants at Upper Pond while *B. salicifolia* was the dominant shrub species at Whelan Mitigation. In the Channel, shrub cover was dominated by *B. salicifolia* and comprised 9% and 6% of the total foliage cover of the untreated and treated points, respectively.

Within the Channel at the treated points, 24% of the total foliage cover was classified as herbaceous (Figure 20). Twenty-three percent of foliage cover at the Upper Pond was herbaceous while 10% of Whelan Mitigation was herbaceous. Vegetation at the untreated Channel points had the lowest percent herbaceous cover; only 4% of the total cover was classified as herbaceous.

Freshwater marsh, which included such species as cattail (*Typha* spp.) and rush (*Juncus* spp.) was recorded only in the Channel and represented 14% of the total foliage cover at untreated and treated points (Figure 20).

Cover of dead woody species was highest at Whelan Mitigation, where 9% of the total foliage cover was comprised of dead woody species (Figure 20). Five percent of the total cover at the untreated Channel points was dead cover. Dead woody cover was 6% of the total cover at the Upper Pond and <1% of the total cover at treated Channel points.

Oenothera hookeri occurred in the Channel and at the Upper Pond (Figure 20). Cover was highest at the treated Channel points comprising 2% of the total cover.

A. donax and *T. ramosissima* were the dominant exotic perennial species across sites (Figure 21). *A. donax* was most prevalent at treated points, making up approximately 22% of the total cover, an amount over three times that of untreated Channel points (6%). *A. donax* represented <1% of the total cover at Whelan Mitigation and in the Upper Pond. *T. ramosissima* was found in the Channel and the Upper Pond; foliage cover was highest at the untreated points (3%) and lowest at the treated points (1%) and in the Upper Pond (<1%).

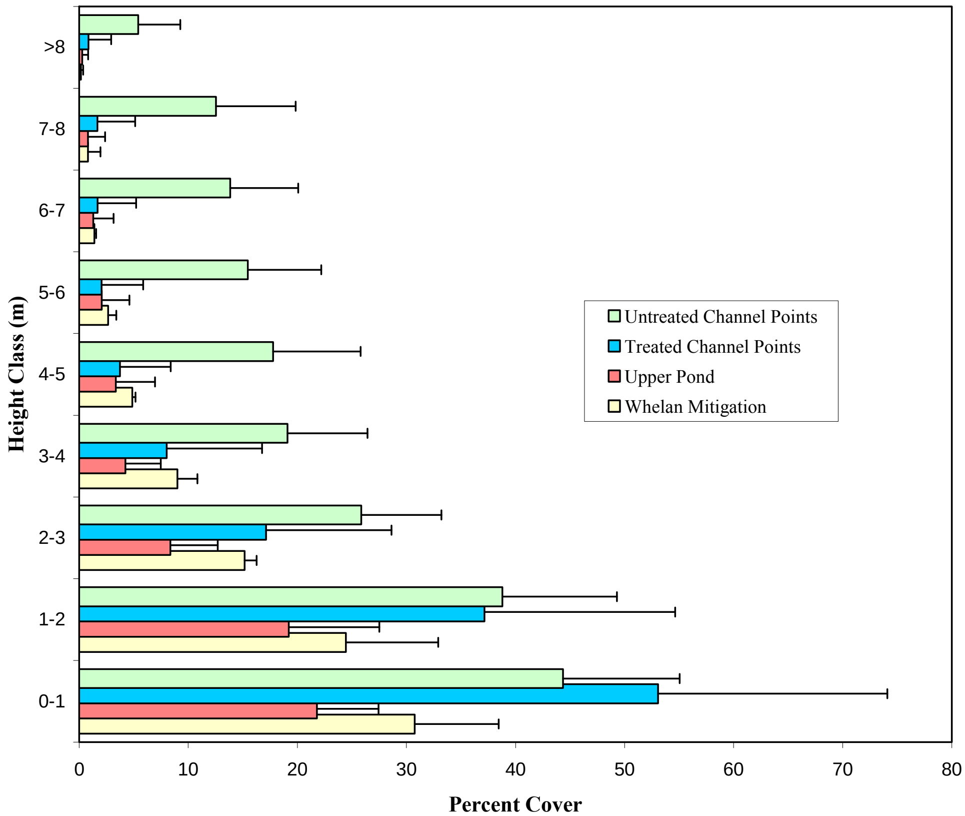

Figure 16. Average percent foliage cover by height class (m) at the San Luis Rey River Flood Control Project area, California, in 2007. Bars are standard deviations.

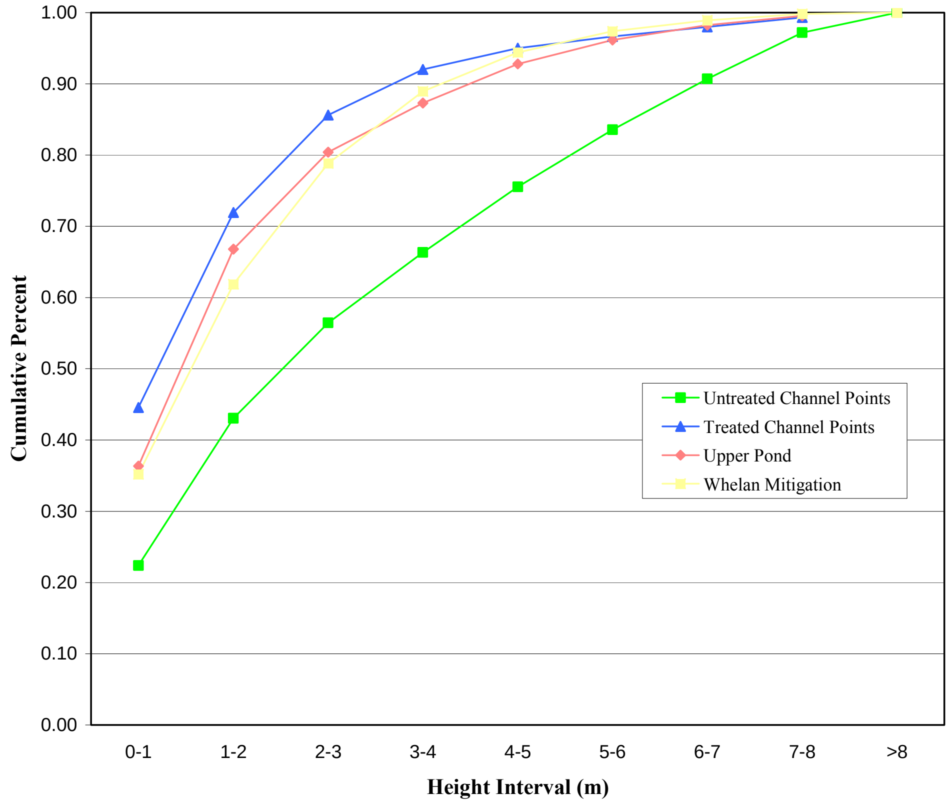

Figure 17. Cumulative percent foliage cover by height interval (m) at the San Luis Rey River Flood Control Project, California, in 2007.

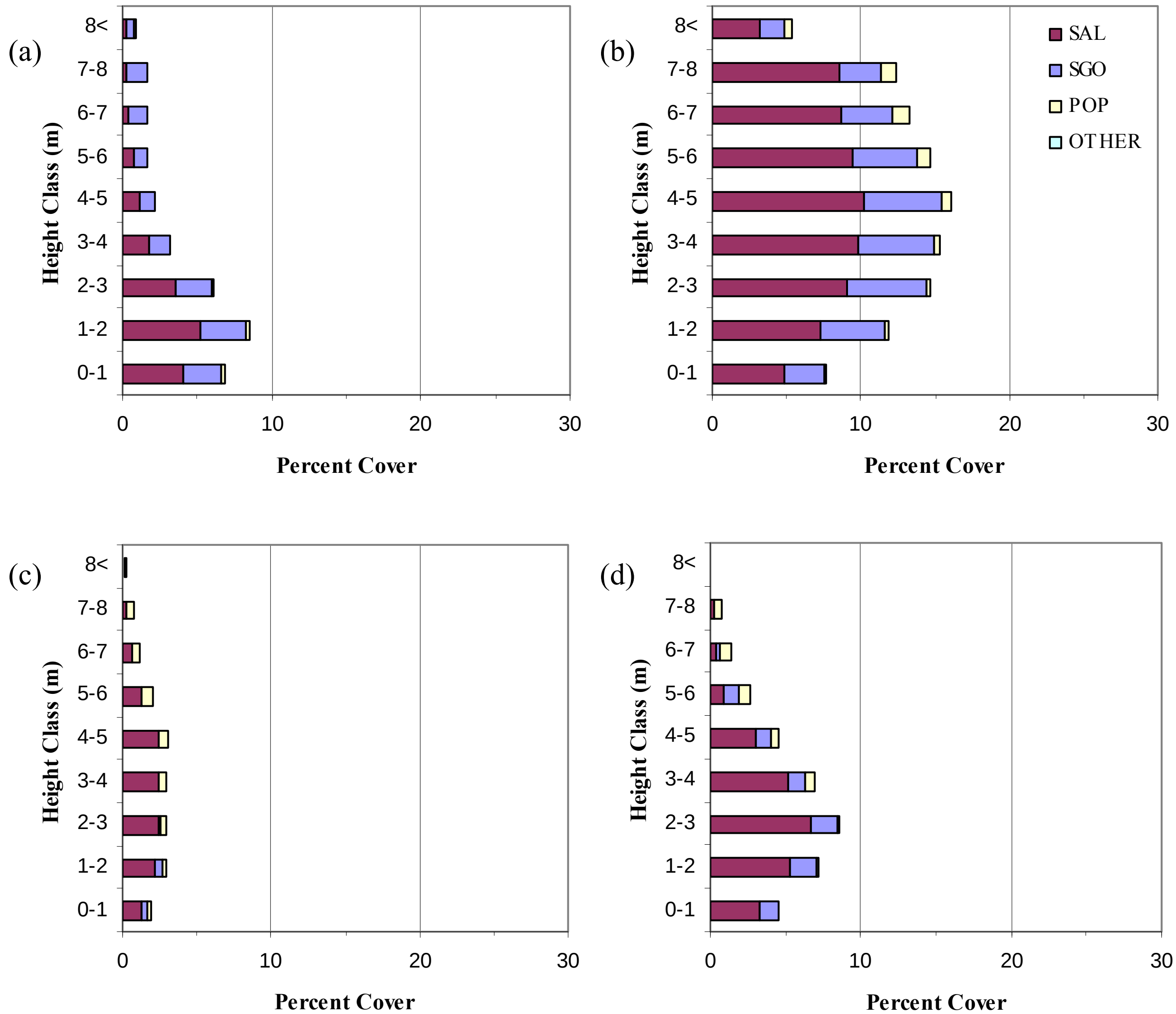

Figure 18. Average percent cover of tree species: *S. lasiolepis* (SAL), *S. gooddingii* (SGO), *P. fremontia* (POP), and the remaining tree species (OTHER) by height class (m) for: (a) Channel treated points (b) Channel untreated points (c) Upper Pond and (d) Whelan Mitigation at the San Luis Rey River Flood Control Project area, California, in 2007.

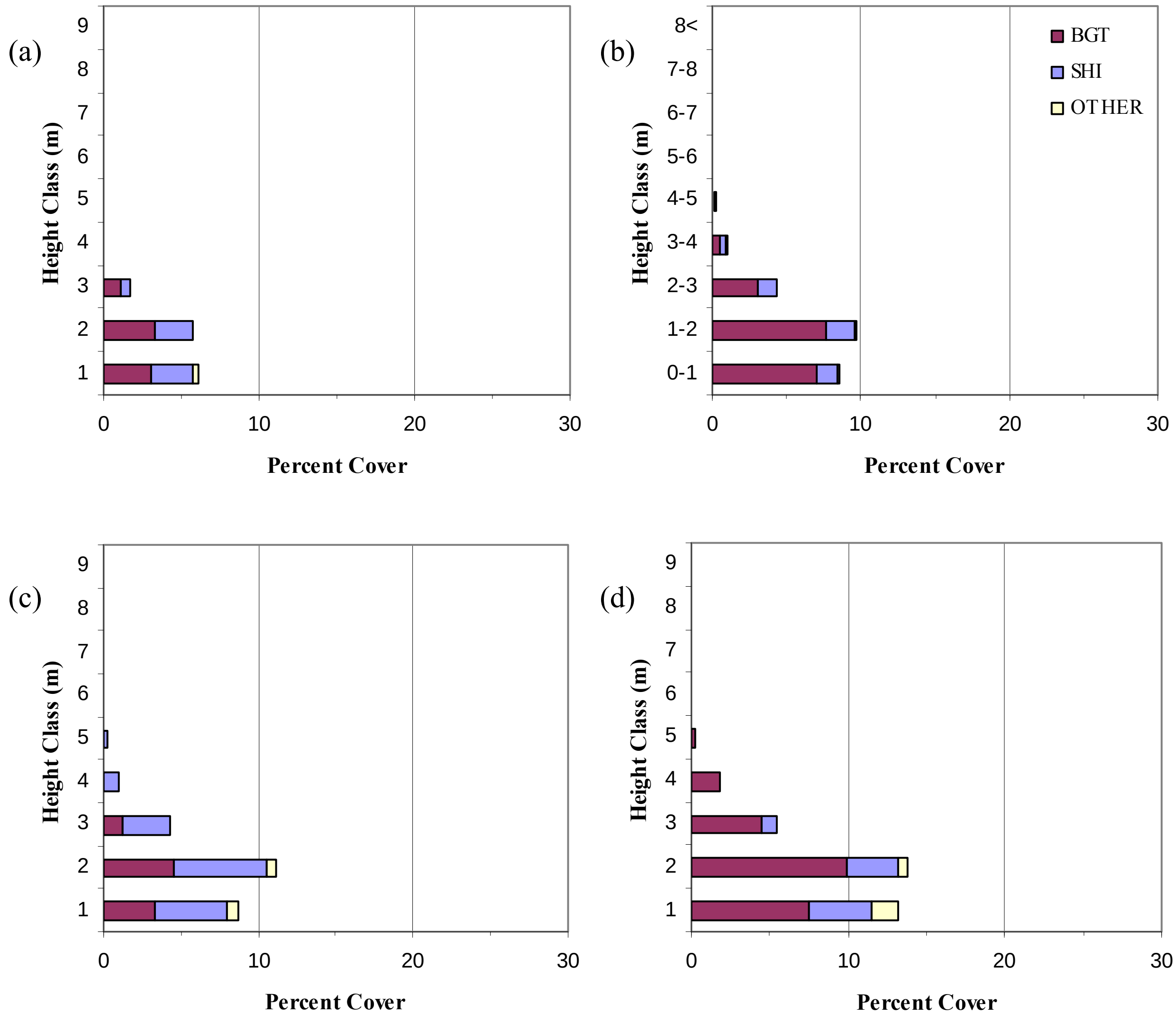

Figure 19. Average percent cover of shrub species: *B. salicifolia* (BGT), *S. exigua* (SHI), and remaining shrub species (OTHER) by height class (m) for (a) Channel treated points (b) Channel untreated points (c) Upper Pond and (d) Whelan Mitigation at the San Luis Rey River Flood Control Project area, California, in 2007.

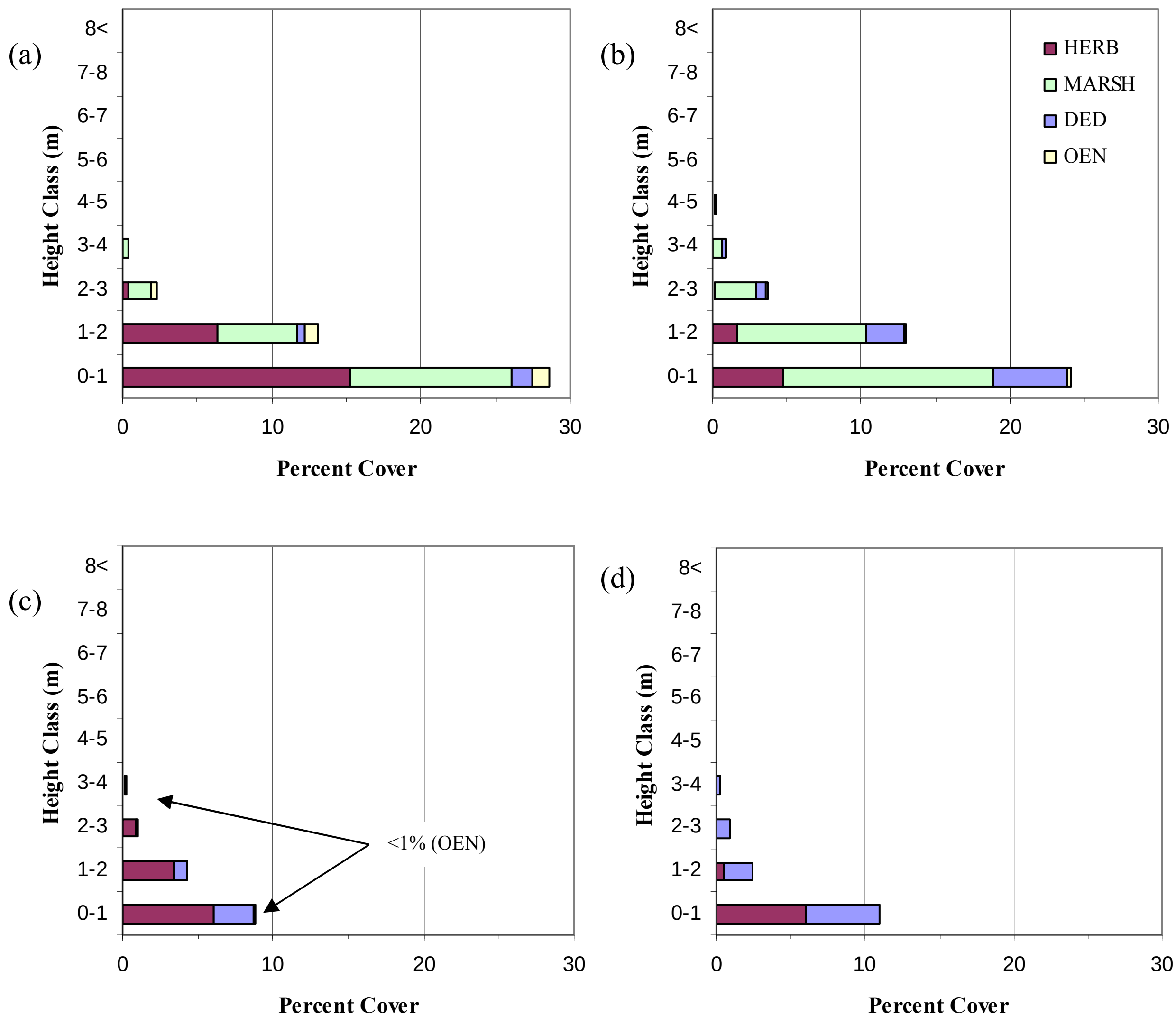

Figure 20. Average percent cover of herbaceous species (HERB), marsh species (MARSH), dead woody cover (DED), and *Oenothera hookeri* (OEN) by height class (m) for (a) Channel treated points (b) Channel untreated points (c) Upper Pond and (d) Whelan Mitigation at the San Luis Rey River Flood Control Project area, California, in 2007.

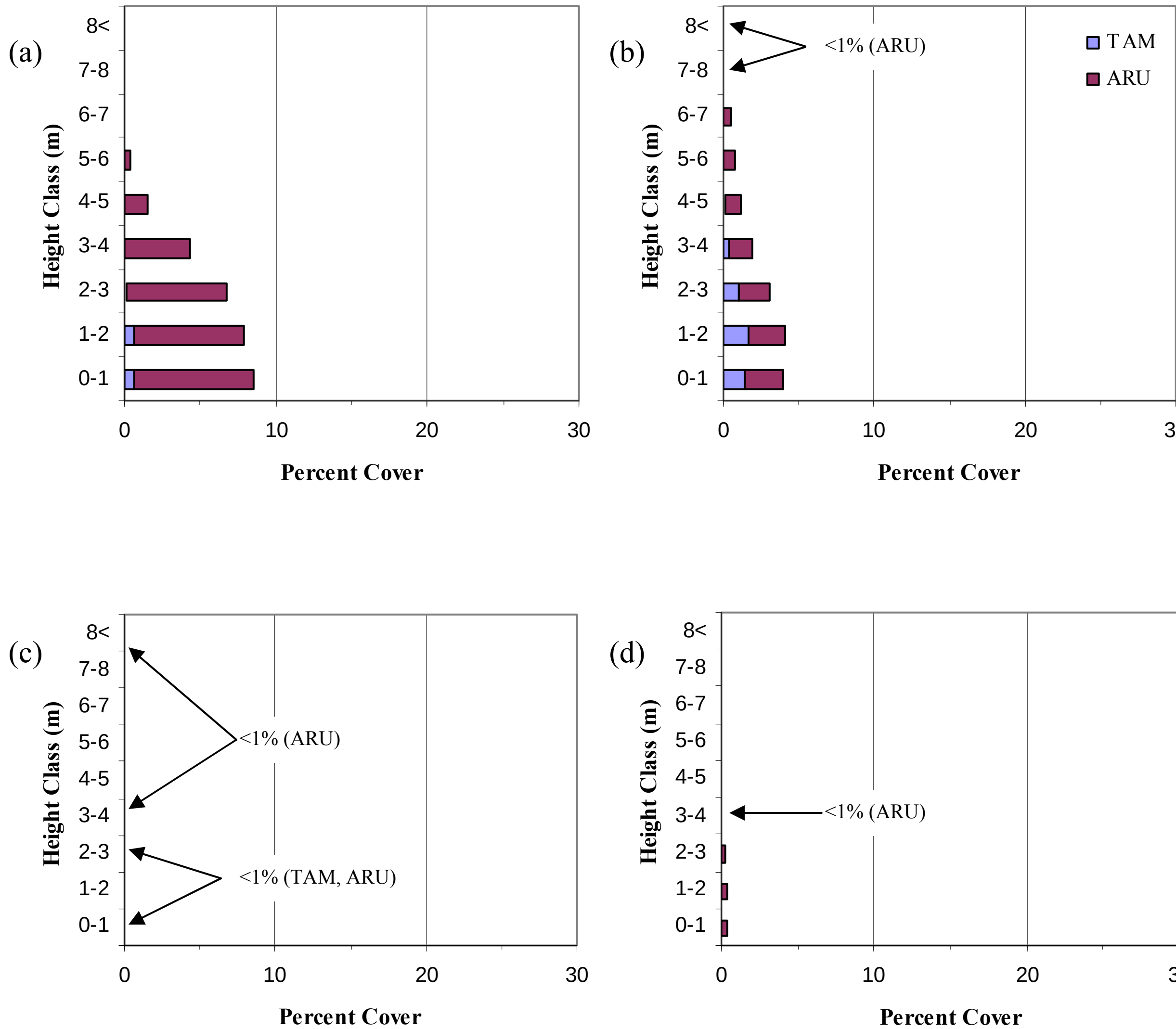

Figure 21. Average percent cover of *A. donax* and *T. ramosissima* by height class (m) for (a) Channel treated points (b) Channel untreated points (c) Upper Pond and (d) Whelan Mitigation at the San Luis Rey River Flood Control Project area, California, in 2007.

Vegetation Changes from 2006 to 2007

Year-to-year differences in vegetation cover were most pronounced in the sites outside of the Channel (Figures 22-23). Whereas foliage cover did not change significantly from 2006 to 2007 in the Channel, significant decreases in foliage cover at the Upper Pond and Whelan Mitigation sites were observed at 0-3 m. The largest vegetation changes occurred in the Upper Pond where foliage cover significantly decreased by about half between 2006 and 2007 at all height intervals below 6 m. Foliage cover significantly decreased by roughly one third at Whelan Mitigation at the two lowest height intervals.

Differences in overall vegetation cover from 2006 to 2007 were attributed to a decrease in herbaceous cover. Not unexpectedly, total cover of tree, shrub, and dead woody species remained the same across sites, attributable in large part to the lack of vegetation clearing prior to the 2007 breeding season. However, herbaceous species cover declined throughout the project area, particularly in the sites outside of the Channel. From 2006 to 2007, total herbaceous cover across all height intervals declined by half at Whelan Mitigation (21% vs. 10%) and one third at the Upper Pond (33% vs. 23%). One species in particular, *O. hookeri*, at Upper Pond, decreased from 12% in 2006 to <1% in 2007.

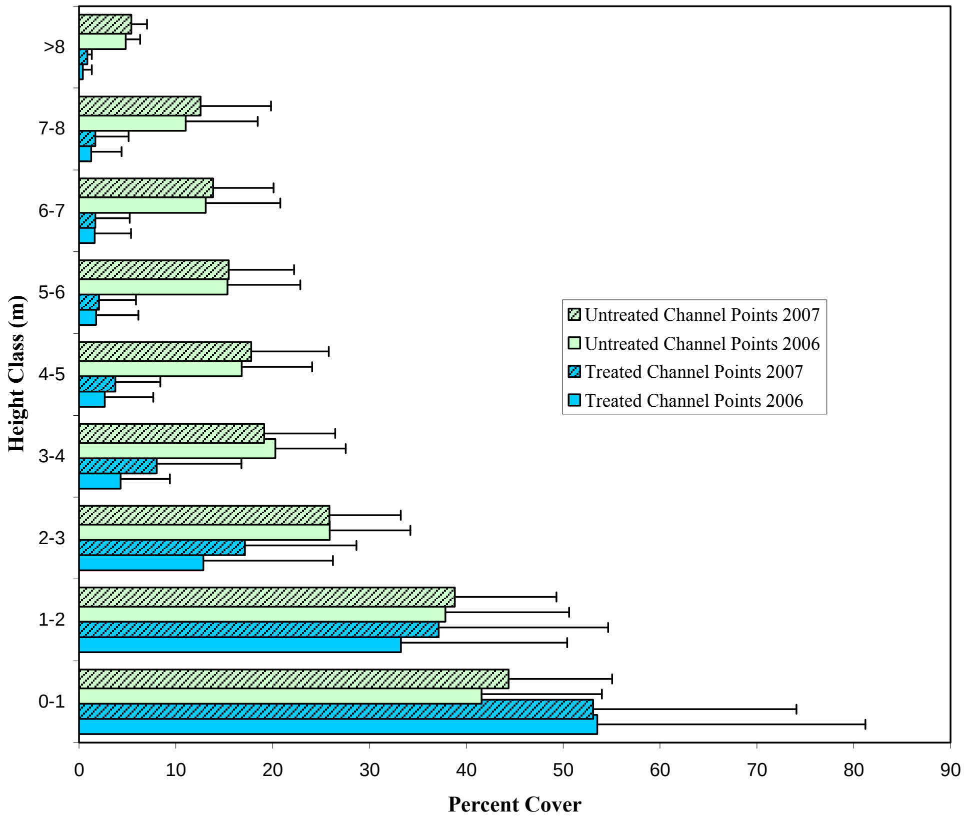

Figure 22. Average percent foliage cover by height class (m) for untreated and treated Channel points at the San Luis Rey River Control Project area from 2006 to 2007. Bars are standard deviations.

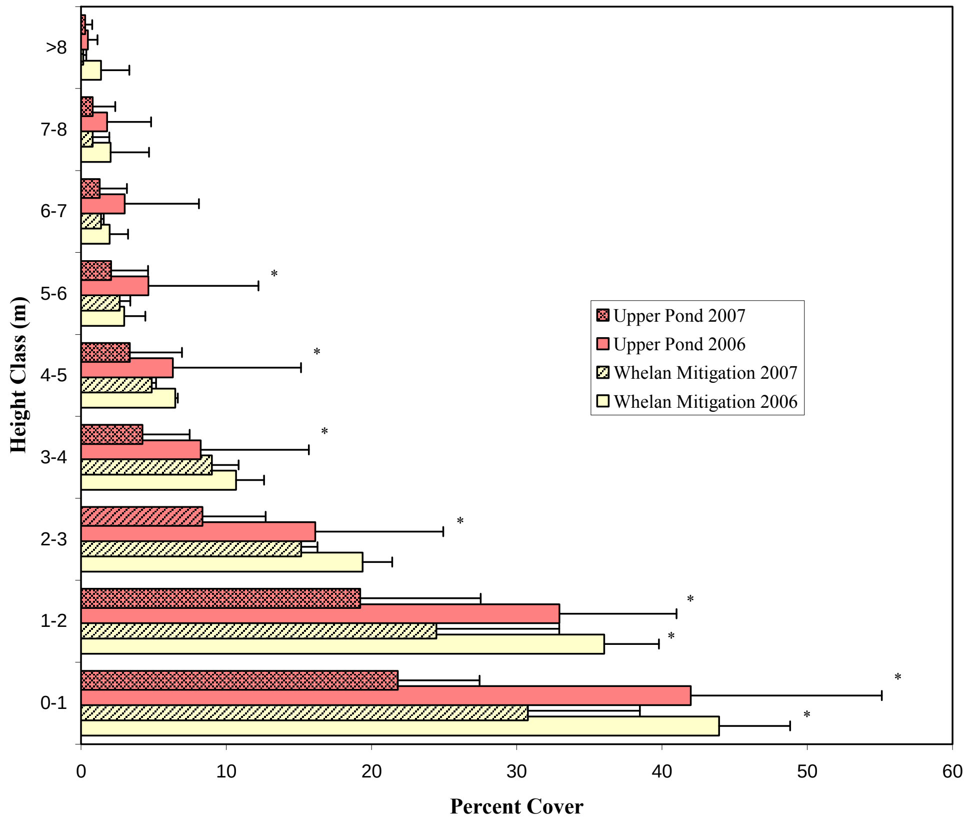

Figure 23. Average percent foliage cover by height class (m) for the Upper Pond and Whelan Mitigation sites at the San Luis Rey River Control Project area from 2006 to 2007. Bars are standard deviations. Asterisks denote significant differences between years by height class and site ($P \leq 0.10$).

Vireo Habitat Use

Forty-four vireo nests and 44 random plots (352 sampling points in total) were sampled following the 2007 breeding season. We measured 33 paired plots in the Channel, 9 paired plots in the Upper Pond, and 2 paired plots at Whelan Mitigation (Figures 24–25). Comparisons were made between the Treated and combined Untreated sites; therefore nests and random plots in the Channel were separated from those in the Upper Pond and Whelan Mitigation sites. Although most vireo nests in the Channel were located in areas without treatment, some sampling points from nest and random plots fell within the boundaries of vegetation removal areas. In addition, two nests and one random plot fell completely within treated areas of the channel. Treated points represented 7% (12/176) of the total points for nest plots and 3% (5/176) of the total points for random plots. Small sample sizes prevented us from examining the effects of treatment at the scale of the nest/random plot; thus we pooled treated and untreated points for nest plots and random plots in the Channel.

Least Bell's vireo nest plots had greater average percent cover than did random plots at all height classes in untreated sites and below 6 m in the Channel (Figures 24-25). At untreated sites, foliage cover differed significantly between nest and random plots at canopy heights below

4 m. In the Channel, where differences in foliage cover were less pronounced, nests had significantly greater foliage cover than did random plots at 0-1 m, while at 6-7 m and >8 m, foliage cover was significantly greater at random plots than at nest plots.   Thus, vireos appeared to have selected nest sites non-randomly within the territory, favoring locations with dense foliage cover at lower canopy heights.

Average canopy height was lower at nest plots (6.6 ± 3.3 m) in the Channel compared to random plots (7.3 ± 3.5 m) (two-sample t test: $t_{0.05,262} = -1.160$, $P = 0.106$). Nest plots (4.6 ± 2.5 m) were not significantly different from random plots (4.2 ± 2.5) in the Untreated sites (two-sample t test: $t_{0.05,86} = 0.711$, $P = 0.479$). However, when we compared canopy height at the nest center with the three points located 10 m from the nest center, the nest point (5.8 ± 2.6 m) averaged 1.5 m higher than the remaining points (4.2 ± 2.3 m) in the Untreated sites. Thus, vireos in the Untreated sites selected for higher canopy at the scale of the nest but not at the scale of the territory.

We compared vegetation structure at nest plots and random plots in the territories to that measured along vegetation transects in the Channel and Untreated sites (Figures 24-25), using transect data as our estimate of the structure of habitat available at these sites. Vireos placed nests non-randomly with regard to vegetation available in their territories, and placed territories non-randomly with regard to vegetation available at each site. At the territory scale, vireos at the Upper Pond and Whelan sites selected nest sites with greater cover than that at random points for heights up to 4 m. Above 4 m, nests and random points did not differ in cover; however, vireos selected territories with more cover at these heights than was available at the sites overall. Thus, vireos selectively used habitat at both the site and territory scales that resulted in the placement of nests in the densest habitat available to them. At the Channel, where overall vegetation cover was roughly double that at the Upper Pond and Whelan sites at all heights (Figure 16), vireos were less selective when placing nests. Within territories, vegetation cover differed between nest sites and random points only at the lowest canopy height. However, vireos in the Channel were selective in their territory placement with regard to the habitat available to them, preferring areas with higher cover in the mid-canopy range (2-6 m) (Figure 24). The result of this non-random habitat use, although achieved differently in the Channel and Untreated sites, was that vegetation structure at nest sites was remarkably similar across all pairs.

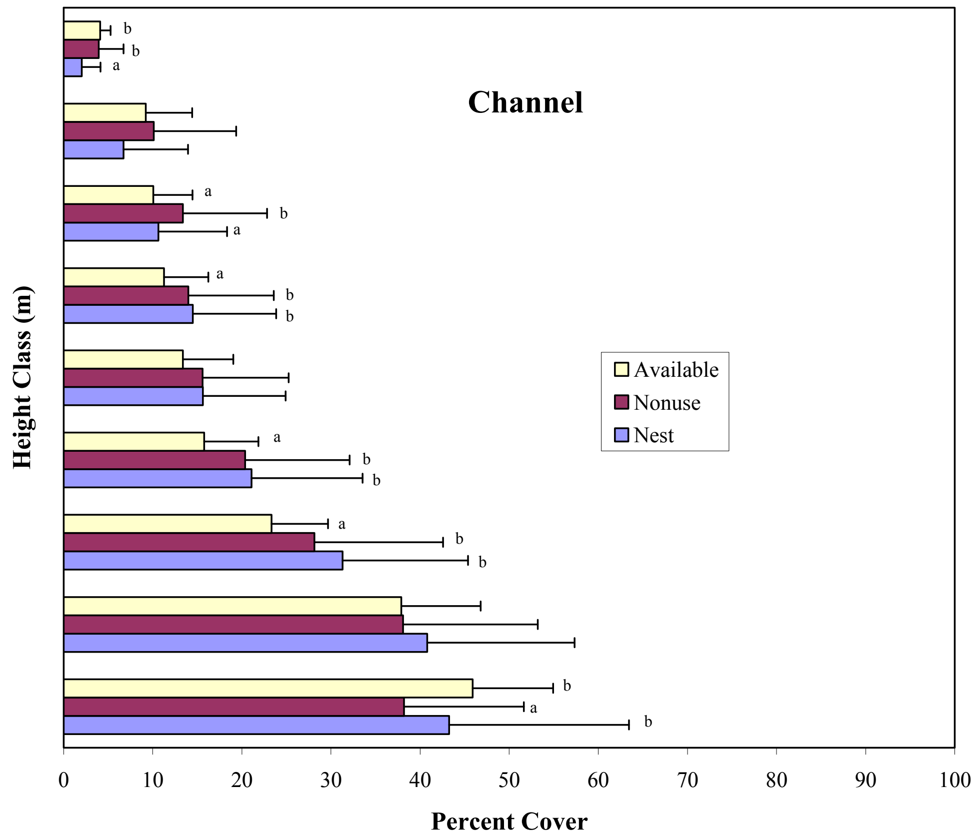

Figure 24. Average percent foliage cover for nest plots (N=33), random plots (N=33), and vegetation transects (N=31) (shown as “available”) by height class in the Channel site at the San Luis Rey River Flood Control Project area, California, in 2007. Bars are standard deviations. Bars with different letters differed significantly from one another ($P \leq 0.10$).

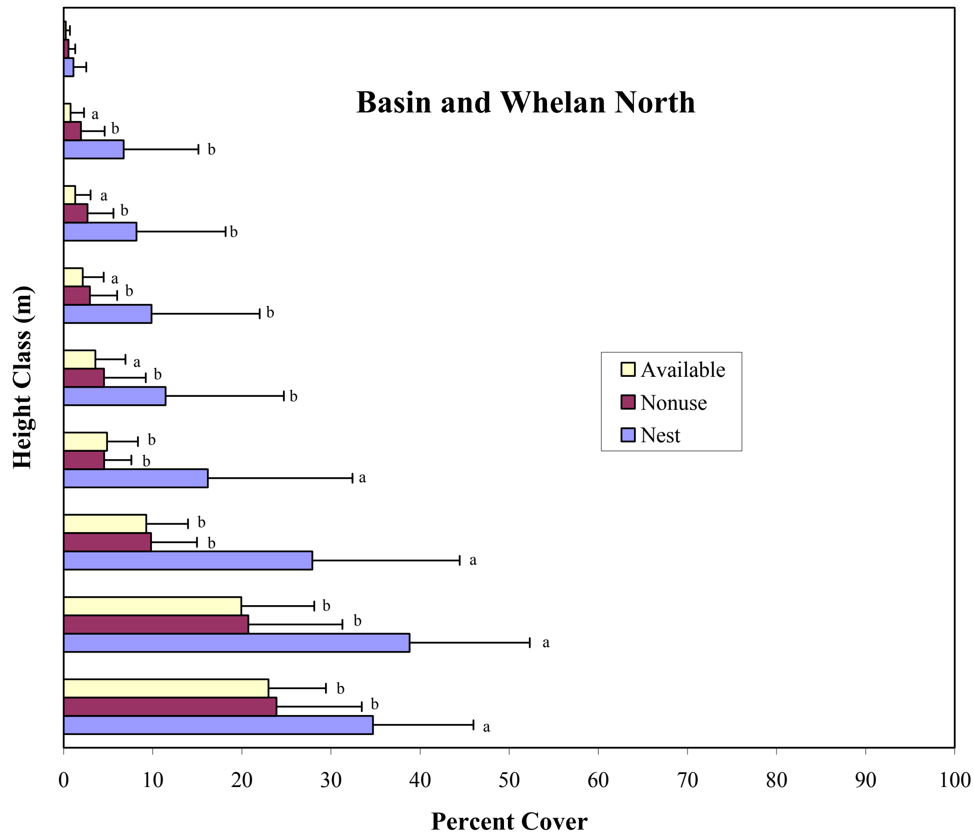

Figure 25. Average percent foliage cover for nest plots (N=11), random plots (N=11), and vegetation transects (N=15) (shown as "available") by height class in the Upper Pond and Whelan Mitigation sites at the San Luis Rey River Flood Control Project area, California, in 2007. Bars are standard deviations. Bars with different letters differed significantly from one another ($P \leq 0.10$).

Nest Survival and Habitat Characteristics

We investigated the effect of habitat structure at vireo nest sites on nest survival by constructing a series of models relating the vegetation cover variables to nest outcome (successful or failed) (Table 18). None of the cover variables, either individually or in combination, nor canopy height, yielded models that improved the constant only model. Thus, we found no support for an influence of vegetation structure on nest survival in this system.

Table 18. Logistic regression models for the effects of habitat structure on nest survival of least Bell's vireos at the San Luis Rey River Flood Control Project area, California, in 2006 and 2007. 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 loge likelihood (L) and the number of parameters (K) in the model.

Model	Deviance	# Parameters	AIC_C	ΔAIC_C	AIC_C Weight
Constant	181.85	1	183.85	0.00	0.139
Percent Cover 7-8 m	180.00	2	184.01	0.16	0.129
Percent Cover 5-6 m	180.06	2	184.06	0.22	0.125
Average Percent Cover[a]	180.60	2	184.61	0.76	0.095
Percent Cover 0-1 m	180.90	2	184.90	1.05	0.082
Percent Cover 6-7 m	181.18	2	185.19	1.34	0.071
Percent Cover 4-5 m	181.19	2	185.20	1.35	0.071
Canopy Height	181.29	2	185.29	1.45	0.068
Percent Cover 5-6 m + 7-8 m	179.40	3	185.42	1.57	0.064
Percent Cover 2-3 m	181.82	2	185.82	1.97	0.052
Percent Cover 3-4 m	181.83	2	185.84	1.99	0.052
Percent Cover 1-2 m	181.85	2	185.85	2.00	0.051
Percent Cover 1-2 m + 2-3 m + 3-4 m + 4-5 m + 5-6 m + 6-7 m + 7-8 m	174.21	9	192.33	8.48	0.002

[a]Percent cover in 1-m height intervals averaged over all heights

DISCUSSION

Least Bell's Vireo

The Least Bell's vireo population at the San Luis Rey River Flood Control Project area declined by 9% (11 territories) from 2006, the largest drop observed in five years (although data are not available for 2004). Following the largest annual increase in 2003 (RECON 2006), when a 30% increase in territories was observed (82 to 117 territories), territory numbers appeared to stabilize, increasing by only two territories from 2003 to 2006. Since surveys began in 1984, the least Bell's vireo population at the project area has steadily risen from a low of six territories in 1989 (Kus 1989) to the 2006 high of 119 territories, likely a result of an increase in the availability of suitable riparian habitat and high productivity of nesting pairs (Kus and Whitfield 2005). Declines in population size have been observed over the past 23 years, although changes were minor, ranging from two to six territories. Given that the site may have reached a carrying capacity in 2006 as evidenced by the low quantity of unoccupied habitat and the tight packing of territories in many sections of the channel, the loss of 11 territories may be within the range of natural variation of size for this population. Furthermore, it is not unusual for bird populations to fluctuate in response to changes in abiotic and biotic factors such as weather, food supply, and predation rates (Holmes *et al.* 1986, Holmes and Sherry 2001). What is most striking about the population decline is that it was confined to untreated sites. Indeed, vireo abundance actually increased slightly where vegetation removal had occurred and decreased outside of the treated areas. Overall, there was a net increase of five territories in the Treated sites of the channel and a net loss of 16 territories in the Untreated sites, suggesting that factors other than vegetation removal may have contributed to the 2007 vireo population decline. Continued surveys are necessary to assess the short- and long-term effects of vegetation removal on this vireo population.

The approximate two-week lag in territory establishment that was observed in 2006 was not repeated in 2007 for the lower San Luis Rey project area vireos or other nearby vireo populations including the Camp Pendleton population (Rourke and Kus 2008) and vireos on the upper San Luis Rey River (Kus unpublish.). Arrival patterns appear to have returned to what they were in 2005 for the Pendleton and upper San Luis Rey River populations. However, the rate of territory establishment at Camp Pendleton was markedly slower than that at the San Luis Rey project area; while 70% of territories were established by 15 April at the San Luis Rey project area, it wasn't until after 29 April, more than two weeks later, that 70% of all vireos had established territories on Camp Pendleton (Rourke and Kus 2008). One possible explanation for the difference in territory establishment of these populations is that the lower San Luis Rey population is more intensely monitored than the Pendleton population, resulting in more accurate arrival dates for the lower San Luis Rey population compared to the Pendleton population. Both the project and Camp Pendleton vireo populations experienced a decline in territory numbers, although the Camp Pendleton population decline was much lower, just 2% (loss of 11 territories) from 2006 to 2007. Remarkably, the vireo population on the upper San Luis Rey River increased by 11%, a gain of 16 territories.

From 2006 to 2007, territory numbers in the untreated sites declined by 25% (16/64), a significant drop possibly resulting from a combination of factors including drier conditions, poor habitat quality, and human disturbance. The largest loss of territories occurred in the Benet survey area, which also has the lowest habitat quality which may be attributable to the high proportion of non-native species such as *A. donax* and *Cortaderia* spp. (pampas grass) and the heavy human activity throughout this area. We detected 10 territories, down from 17 in 2006 and 20 in 2005. Notably, the four territories that were abandoned after failed nest attempts in 2006 were not occupied in 2007, indicating potentially poor habitat quality in those areas. In addition, multiple small fires were ignited in the habitat during the winter by an arsonist. While most of the fires occurred in habitat unoccupied by vireos, four territories were located within 50-200 m of a burned area and several additional territories were located within 50-200 m of habitat that had been disturbed by bull dozers when several fire breaks were constructed. Clear shifts in territory distribution were apparent at Whelan Mitigation, which declined overall by five territories in 2007. We observed a significant reduction in herbaceous undergrowth compared to 2006, which may have contributed to the lowered vireo abundance and altered distribution at the site. We were able to document the changes in territory use because all of the males were banded as adults in the same territories in 2006. Five territories that were located primarily in the upland Whelan Mitigation site shifted into the channel so that the majority of the territory was located in the river channel. In addition, these vireo pairs placed their nests in the channel; in contrast, 2006 nests were located 20-100 m away from the levee edge. Three territories were unoccupied and three territories were in areas that have never been occupied at the site. Because the birds in the three new territories were unbanded, we were unable to tell whether territory changes occurred. However, two of the three newly occupied territories were in thick stands of *B. salicifolia* which had a more robust structure than the 2006 territories, which were characterized by a more open habitat structure with high herbaceous cover and scattered stands of *S. lasiolepis* and *S. goodingii.* Compared to 2006, the vegetation in these areas appeared more water stressed; willows and cottonwoods were observed dropping leaves in July and the herbaceous undergrowth was almost completely dried out by the beginning of April whereas in 2006, the herbaceous undergrowth remained green for most of the breeding season. Finally, Upper Pond lost three territories overall, down from the 2006 high of 20 territories. We observed changes in territory distribution and size in the Upper Pond which may be a response to the drier conditions as well as increased illegal use of off-road vehicles at this site. We observed four territories that either shifted in response to habitat destruction or increased in size. Despite these changes, Upper Pond still retained the highest density of vireo territories by area.

Although we did not document a decrease in vireo abundance in the treated areas, other life history attributes could be affected by vegetation removal such as habitat use, reproductive success, predation rates, and nestling and adult survival rates. We observed patterns of habitat use that may be a response to the 2005-2006 *A. donax* removal and vegetation mowing within the channel. Just as in 2006, vireo territories within treated sites appeared to encompass larger areas than vireo territories within untreated sites, although we did not measure territory size quantitatively. We also observed fewer territories in areas where *A. donax* had been removed, specifically in the Douglas and Whelan survey sites. For example, two territories with returning banded males adjacent to the Douglas Bridge shifted away from the large areas where *A. donax* had been cleared. However, not all treatment effects were observed to be negative. Whereas many 2006 territories were positioned closer to the levees, away from the channel clearing areas, in 2007 we documented several pairs using cleared areas of the channel and one pair even nested in the treated area of the river channel. Part of this shift may have been a result of the drier conditions in the upland habitat. Significant regrowth of herbaceous vegetation and willow resprouting during the 2006 season provided 1-2 m high vegetation which was frequently used by vireos for foraging.

Hatching rate, fledging rate, and reproductive measures such as average clutch size, average brood size, and average number of young fledged per pair did not differ significantly between Treated and Untreated sites. One notable difference was in nesting attempts; Treated pairs averaged significantly more nesting attempts (2.0 nests/pair) than Untreated pairs (1.6 nests/pair) over the course of the 2007 breeding season. It is unknown why Treated pairs nested more frequently than Untreated pairs. Pair success was high; 84% of pairs in fully monitored territories were successful and produced at least one vireo fledgling by the end of the season.

Predation was the primary cause of nest failure in Treated and Untreated sites, accounting for 35-41% percent of all nest losses. Unlike in 2006, when predation rates were higher in the Upper Pond and Whelan Mitigation sites, predation was highest within the river channel in 2007. Predation rates varied within the Channel: 60-62% of nests were lost to predation in the Foussat and College sites while 33-35% of nests were lost to predation in the Douglas and Whelan sites. Thus, there appears to be a spatial and temporal component to predation within the river channel, suggesting that potential site-specific differences such as vegetation composition and structure, or predator community and abundance in these areas may contribute to varying predation rates.

Average clutch size and average brood size were significantly lower in 2007 compared to 2006 (3.2 vs. 3.6 eggs per nest; 3.0 vs. 3.5 nestlings per nest). Clutch size reduction is a common evolutionary strategy employed by many bird species to reserve energy during stressful environmental conditions (Newton 1998, Rotenberry and Wiens 1991). Vireos may have been responding to the extremely dry conditions during the 2007 breeding season. Despite lowered clutch and brood sizes, pairs in 2007 had a higher percentage of eggs that hatched, a higher percentage of nestlings that fledged and fledged more young per nest than 2006 pairs (2.7 vs. 2.4 fledglings per nest). Treatment did not influence these measures; thus clutch size, brood size, and the number of fledglings per nest were similar for treated and untreated pairs in both years. The most dramatic difference between 2006 and 2007 was among Untreated sites, where the average number of fledglings per nest significantly increased from 1.9 to. 2.8.

Overall, this population averaged 2.7 fledglings per pair, indicating productivity for this population should be sufficient to at least maintain a stable population. Productivity was also high in 2006, with vireos fledgling over 2.4 young per pair (Ferree and Kus 2007). Thus, the cause of the 2007 population decline does not appear to be related to productivity.

Our analysis of daily nest survival using MARK supported our findings that reproductive performance of vireos was not negatively influenced by Treatment. The best-fitting model describing nest survival revealed an effect of Treatment in just one of the two study years, and showed the effect to be positive, i.e. nest survival was higher in Treated than in Untreated sites. Taken together, our results suggest that in the short term, vireos nesting in the San Luis Rey Flood Control Project area were not adversely affected by vegetation removal operations. Only through continued monitoring will we determine if vireo reproductive success and productivity in Treated and Untreated sites remain similar as more vegetation is removed in the coming years.

Reproductive success and productivity were similar for this population and the nearby Camp Pendleton population monitored by USGS in 2007 (Rourke and Kus 2008). At Camp Pendleton, 89% of pairs successfully fledged young compared to 84% of the San Luis Rey project pairs. The mean number of fledglings per nest was 1.4 for Camp Pendleton and 1.6 for San Luis Rey project area vireos. The mean number of fledglings per pair was 2.7 at both sites.

The banding of least Bell's vireos with unique color combinations that was started in 2006 allowed us to estimate adult and juvenile return rates as well as to examine adult and juvenile dispersal between Treated and Untreated sites. Adult return rates were high; 69% of adults that were uniquely color banded in 2006 returned to breed in the project area. Furthermore, territory fidelity was strong among adult vireos, with 80% of adults returning to breed in the same territory as the previous year and the remaining 20% returning to an adjacent territory of the territory they occupied in 2006. It will be interesting to document whether return rates and site fidelity changes in the coming years as more vegetation is removed. Not unexpectedly, juvenile return rates were significantly lower than adult return rates. Only 6% of hatch-year birds banded in 2006 were detected this year, comparable to the 10% return rate observed at Camp Pendleton in 2007 (Rourke and Kus 2008). Several possibilities might account for this low return rate. First, the decline in population that we observed in 2007 for adult vireos may have also been reflected in juvenile survivorship, especially if mortality during migration or on the wintering grounds was higher than in previous years. Alternatively, because the San Luis Rey River vireo population is large and habitat availability is low, first-year birds may have dispersed to other areas. Notably, six of the 13 first-year birds that were banded in 2006 occupied a territory that had not been occupied in 2006 suggesting habitat availability is limited in this population. We recaptured two first-year females at Camp Pendleton. In addition we resighted four first-year birds (two males, two females) at Camp Pendleton that were banded either at the San Luis Rey River Project area or at the upper San Luis Rey study area. Thus the San Luis Rey River Project area is functioning as a source population for other populations.

Southwestern Willow Flycatcher

The 2007 population of southwestern willow flycatchers consisted of just one pair, the lowest number observed since the area was colonized and monitoring began in 2000 (Kus and Rourke 2005). In addition, the single nest attempt by the pair was unsuccessful. It is unknown why so few birds returned to breed in the study area. One potential explanation could be the changes in habitat we observed as a result of drier conditions. As mentioned earlier, upland areas of the San Luis Rey River Project area, including Whelan Lake where the flycatchers were located, were considerably drier, resulting in significantly less herbaceous growth than in 2006. Of the three historic territories located closest to Whelan Lake and dominated by *C. maculatum* and stinging nettle (*Urtica dioica*), two were unoccupied, and the other shifted away from the upland area into the river channel, indicating a likely preference for wetter habitat. Where in 2006, both herbaceous species were 2-3 m high, in 2007, most plants were 1-2 m and by early May had already begun to dry out. Therefore, by the time flycatchers arrived, the understory habitat around Whelan Lake had already begun to dry out. Flycatchers may have arrived in this area and subsequently moved to another location where habitat conditions for nesting and foraging were more favorable. To punctuate the dry conditions at Whelan Lake, we observed two pairs of ash-throated flycatcher (*Myiarchus cinerascens*), a xeric-loving species that was not present in 2006, breeding in these areas. It is unknown why the remaining 2006 territory (WL3) located in the San Luis Rey River was unoccupied, as habitat changes were less pronounced in the river channel than in the upland habitat.

A concomitant decline in southwestern willow flycatchers was observed at Camp Pendleton (Rourke *et al*. 2008), indicating there could have been a region-wide decline in flycatcher populations during 2007. Although it is possible that flycatchers could have moved to other locations in their range, more information on the status of the 2007 region-wide population of flycatchers is needed. In 2007, vegetation clearing does not appear to have played a role in the decline of the flycatcher in the San Luis Rey River Project area population. More likely explanations include the drought or other life history factors such as juvenile or adult mortality experienced during migration or on the wintering grounds. More information is warranted for this challenging species.

Baseline Vegetation and Vireo Habitat Use

We did not detect large changes in vegetation structure or composition from 2006 to 2007 largely because vegetation removal did not occur during the prior non-breeding season. The significant changes that we documented appear to be a result of the lack of rainfall during the 2007 winter and spring. Total foliage cover significantly decreased outside of the channel, where the greatest changes in foliage cover occurred below 3 m. Whelan Mitigation had the largest decline in foliage cover and was also the driest site followed by the Upper Pond which had intermittent water but remained mostly dry throughout the season. Differences in overall vegetation cover from 2006 to 2007 were attributed to a decrease in herbaceous cover, indicating that the low rainfall was a key factor explaining the observed loss in foliage cover.

As in 2006, habitat use by vireos in 2007 was non-random, particularly with regard to nest site selection. Vireos favored as nest sites locations within territories with higher foliage density and canopy height than that in the territory as a whole. In contrast to 2006, when vireos did not select for territories at the site level, in 2007, vireos appeared to favor territories with dense canopy compared to what was available throughout the site. Given the more lush appearance of vegetation throughout the project area in 2006 when rainfall was higher, territory selection may not have been as critical to vireos compared to 2007 when habitat structure was more variable. In 2007, vireos were less selective at the Channel where there was more suitable habitat compared to the non-Channel sites where the habitat structure and composition was more variable.

Despite evidence of non-random habitat use, we found no evidence that habitat structure at nest sites was a significant predictor of nest survival. It may be that vireos are using habitat selectively at the scales of both the territory and the nest such that nest sites do not vary much in surrounding cover. Alternatively, it is likely that the risk of predation, the major cause of nest failure at our site, is not influenced by vegetation cover because of the diversity of ground and aerial predators using a variety of search techniques that are typical of southern California riparian habitat (Kus *et al*. in press). Continued study of nest survival and the influence of habitat structure, particularly as habitat variability becomes more extreme with future vegetation mowing, should provide more insight into this relationship and how it can be managed to best achieve the multiple objectives of the Project.

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APPENDIX 1

Status and nesting activities of least Bell's vireos at the San Luis Rey River Flood Control Project area, California, in 2007.

Treatment[a]	Territory	Nest	Monitoring[b]	Nest Fate[c]	# Fledged	Comments
Treated	CACD	1	full	UNK		Cause of failure unknown.
Treated	CACD	2	full	PRE		
Treated	CACD	3	full	PRE		
Treated	CBAN	1	full	SUC	3	
Treated	CBAN	2	full	PRE		
Treated	CBIL	1	partial	SUC	2	
Treated	CBOB	1	full	SUC	4	
Treated	CBOB	2	full	PRE		
Treated	CDIA	1	full	UNK		Cause of failure unknown.
Treated	CDIA	2	full	SUC	3	
Treated	CEAS	1	full	PRE		
Treated	CEAS	2	full	SUC	3	
Treated	CHOO	1	full	PRE		
Treated	CHOO	2	full	SUC	1	
Treated	CIRO	1	full	PAR		Nest abandoned after brown-headed cowbird egg was removed.
Treated	CIRO	2	full	PRE		
Treated	CJET	1	full	SUC	4	
Treated	CJET	2	full	PRE		One 6-7 day-old nestling found dead below nest.
Treated	CJIM	1	full	SUC	2	Partially depredated.
Treated	CJIM	2	full	FAL		Male observed building a nest, but nest was never completed.
Treated	CKOR	1	full	SUC	3	
Treated	CKOR	2	full	PRE		
Treated	CLAD	1	full	PRE		One 5 day-old nestling found dead below nest.
Treated	CLAD	2	full	SUC	3	
Treated	CMAC	1	full	SUC	3	
Treated	CMAC	2	full	SUC	3	
Treated	COZZ	1	full	PRE		
Treated	COZZ	2	full	SUC	2	Partially depredated.
Treated	CPOW	1	full	UNK		Cause of failure unknown.
Treated	CPOW	2	full	PRE		
Treated	CPOW	3	full	PRE		
Treated	CPOW	4	full	UNK		Cause of failure unknown.
Treated	CPOW	5	full	PRE		
Treated	CROD	1	full	PRE		One brown-headed cowbird egg observed after nest failed.
Treated	CROD	2	full	SUC	3	
Treated	CSAT	1	full	PRE		
Treated	CSAT	2	full	PRE		
Treated	CSAT	3	full	PRE		One brown-headed cowbird egg removed.
Treated	CSAT	4	full	PRE		
Treated	CSCH	1	full	SUC	4	

Status and nesting activities of least Bell's vireos at the San Luis Rey River Flood Control Project area, California, in 2007.						
Treatment[a]	Territory	Nest	Monitoring[b]	Nest Fate[c]	# Fledged	Comments
Treated	CSOC	1	full	PRE		
Treated	CSOC	2	full	PRE		
Treated	CSOC	3	full	SUC	2	One brown-headed cowbird egg removed.
Treated	CSPA	1	full	PRE		
Treated	CSPA	2	full	SUC	3	
Treated	CSPK	1	full	PRE		
Treated	CWIL	1	full	PRE		
Treated	CWIL	2	full	PRE		
Treated	CWIL	3	full	SUC	1	
Treated	DBEL	1	full	OTH		Possible brown-headed cowbird predation; one punctured, broken egg below nest, three intact eggs in nest.
Treated	DBEL	2	full	PRE		
Treated	DBEL	3	full	SUC	4	
Treated	DDOL	1	full	SUC	3	
Treated	DDOL	2	full	PRE		
Treated	DDOL	3	full	PRE		
Treated	DDOU	1	full	PRE		
Treated	DDOU	2	full	SUC	3	
Treated	DJEW	1	full	SUC	3	
Treated	DJEW	2	full	SUC	2	
Treated	DMAD	1	full	SUC	1	
Treated	DMES	1	full	SUC	2	
Treated	DMES	2	full	SUC	3	
Treated	DNIC	1	full	UNK		Cause of failure unknown.
Treated	DNIC	2	full	SUC	3	
Treated	DSAN	1	full	SUC	3	
Treated	DSAN	2	full	SUC	3	
Treated	FNER	1	full	PRE		
Treated	FNER	2	full	SUC	2	
Treated	FO 11	1	full	SUC	3	
Treated	FO 12	1	full	PRE		
Treated	FO 12	2	full	SUC	3	
Treated	FO 13	1	full	UNK		Cause of failure unknown.
Treated	FO 13	2	full	UNK		Cause of failure unknown.
Treated	FO 16	1	partial	UNK		Cause of failure unknown.
Treated	FO 17	1	full	PRE		
Treated	FO 17	2	full	PAR		Nest abandoned after brown-headed cowbird egg was removed.
Treated	FO 17	3	full	PRE		Ant predation
Treated	FO 19	1	full	SUC	3	One brown-headed cowbird egg removed.
Treated	FO 2	1	full	PRE		
Treated	FO 2	2	full	PRE		
Treated	FO 2	3	full	PRE		
Treated	FO 2	4	full	PRE		
Treated	FO 3	1	full	FAL		Male observed building a nest, but nest was never completed.
Treated	FO 3	2	full	PRE		

Status and nesting activities of least Bell's vireos at the San Luis Rey River Flood Control Project area, California, in 2007.

Treatment[a]	Territory	Nest	Monitoring[b]	Nest Fate[c]	# Fledged	Comments
Treated	FO 5	1	full	SUC	4	
Treated	FO 5	2	full	SUC	2	
Treated	FO 6	1	full	PRE		
Treated	FO 6	2	full	SUC	3	
Treated	FO 7	1	full	SUC	4	
Treated	FO 8	1	full	PRE		
Treated	FO 8	2	full	SUC	2	
Treated	FO 9	1	full	SUC	3	Observed two fledgling depredated by kingsnake.
Treated	SWIL	1	full	SUC	2	
Treated	WANI	1	full	PRE		
Treated	WANI	2	full	SUC	2	
Treated	WDID	1	full	PRE		
Treated	WDID	2	full	SUC	2	
Treated	WDOC	1	full	SUC	3	
Treated	WDOC	2	full	SUC	2	
Treated	WGAR	1	full	UNK		Cause of failure unknown.
Treated	WGAR	2	full	SUC	4	
Treated	WGIL	1	full	SUC	3	
Treated	WGIL	2	full	SUC	3	
Treated	WH 20	1	full	PRE		
Treated	WH 20	2	full	SUC	3	
Treated	WH 21	1	full	PRE		
Treated	WH 22	1	full	PRE		
Treated	WH 22	2	full	SUC	2	
Treated	WH 23	1	partial	SUC	1	
Treated	WH 24	1	full	PRE		
Treated	WH 24	2	full	SUC	3	
Treated	WH 25	1	full	SUC	1	Partially depredated
Treated	WH 26	1	full	PRE		
Treated	WH 26	2	full	SUC	4	
Treated	WH 27	1	full	PRE		
Treated	WH 27	2	full	PRE		
Treated	WJUN	1	full	SUC	3	
Treated	WKEL	1	full	SUC	3	One dead nestling in nest.
Treated	WKEL	2	full	SUC	3	
Treated	WMON	1	full	SUC	4	
Treated	WOUT	1	full	SUC	1	
Treated	WSHA	1	full	SUC	4	
Treated	WTHE	1	full	PRE		
Treated	WTHE	2	full	SUC	2	
Untreated	BGOO	1	full	PRE		
Untreated	BGOO	2	full	SUC	3	
Untreated	BLAS	1	full	SUC	3	
Untreated	BLAS	2	full	SUC	4	
Untreated	BMUL	1	full	SUC	3	
Untreated	BPAR	1	full	SUC	3	
Untreated	BSAL	1	partial	SUC	2	
Untreated	BSAL	2	partial	SUC	3	
Untreated	BSHE	1	partial	PRE		

Status and nesting activities of least Bell's vireos at the San Luis Rey River Flood Control Project area, California, in 2007.

Treatment[a]	Territory	Nest	Monitoring[b]	Nest Fate[c]	# Fledged	Comments
Untreated	BSHE	2	partial	SUC	3	
Untreated	BSWE	1	full	UNK		Cause of failure unknown.
Untreated	BSWE	2	full	SUC	2	
Untreated	BTHR	1	full	PRE		Two nestlings missing on 5/16/2007, third nestling missing on 5/18/2007.
Untreated	BTHR	2	full	PRE		
Untreated	CACA	1	full	PRE		
Untreated	CACA	2	full	SUC	3	
Untreated	CBUC	1	full	INC		Nest building was initiated, but the nest was never completed
Untreated	CBUC	2	full	SUC	4	
Untreated	CBUT	1	full	SUC	2	Nest tipped sideways, nestlings on ground, two died, two warmed up and placed back in repaired nest.
Untreated	CCOT	1	full	PRE		
Untreated	CCOT	2	full	SUC	1	
Untreated	CDAI	1	full	PRE		
Untreated	CDAI	2	full	SUC	3	
Untreated	CJAS	1	full	PRE		One flattened 7-8 day-old nestling in bottom of intact nest.
Untreated	CJAS	2	full	PRE		
Untreated	CJAS	3	full	PRE		
Untreated	CJAS	4	full	PRE		Partially depredated.
Untreated	CPAT	1	full	PRE		Nest was partially depredated prior to banding on 6/5/2007.
Untreated	CPAT	2	full	SUC	3	
Untreated	CQTI	1	full	SUC	3	
Untreated	CSAG	1	full	SUC	3	
Untreated	CSAN	1	full	INC		Nest building was initiated, but the nest was never completed
Untreated	CSAN	2	full	SUC	4	
Untreated	CSCR	1	full	PRE		
Untreated	CSCR	2	full	SUC	2	Nest repaired.
Untreated	CSHE	1	full	SUC	3	Nest composed of artificial material, white stuffing.
Untreated	CSNE	1	full	SUC	2	One brown-headed cowbird egg removed.
Untreated	CSTA	1	full	OTH		Nest abandoned, tipped sideways because of weak nest support.
Untreated	CSTA	2	full	SUC	3	
Untreated	CSTR	1	full	SUC	3	
Untreated	CSTR	2	full	PRE		One dead nestling below intact nest.
Untreated	CTEX	1	full	PRE		
Untreated	CTEX	2	full	PRE		
Untreated	CTEX	3	full	PRE		
Untreated	CWAT	1	full	SUC	3	
Untreated	WALY	1	full	SUC	3	
Untreated	WALY	2	full	SUC	3	
Untreated	WBLU	1	full	SUC	4	
Untreated	WEAR	1	full	SUC	3	

Status and nesting activities of least Bell's vireos at the San Luis Rey River Flood Control Project area, California, in 2007.

Treatment[a]	Territory	Nest	Monitoring[b]	Nest Fate[c]	# Fledged	Comments
Untreated	WFID	1	full	UNK		Cause of failure unknown.
Untreated	WFID	2	full	SUC	3	
Untreated	WGRI	1	full	PRE		
Untreated	WGRI	2	full	PRE		
Untreated	WMAN	1	full	SUC	4	
Untreated	WSLR	1	full	SUC	3	
Untreated	WSTA	1	full	SUC	3	

[a] Treated = territories located in the Channel monitoring site; Untreated = territories located in Benet West, Upper Pond, or Whelan Mitigation monitoring sites.

[b] Monitoring: full = fully monitored territory; partial = partially monitored territory; not = not monitored.

[c] Nest Fate: FAL= nest built by unpaired male; INC = nest never completed; SUC = fledged at least one least Bell's vireo young; PRE = nest failure caused by predation event; PAR = failure/abandonment caused by brown-headed cowbird parasitism event; OTH = reason for nest failure known, such as substrate failure; UNK = reason for nest failure/abandonment unknown.

APPENDIX 2

Banded adult least Bell's vireos at the San Luis Rey River Flood Control Project area, California, in 2007.				
Treatment[a]	**Band Combination (Left Leg : Right Leg)[b]**	**Sex[c]**	**Age[d]**	**Comments**
Treated	: Unknown color Mdb	M	AHY	Banded as an adult prior to 2007. Combination doesn't match any in database.
Treated	BKLP pupu : Mdb	M	AHY	Banded as an adult in 2007 (CJET territory).
Treated	LPBK pupu : Mdb	M	≥ 2 yrs	Banded as an adult in 2006 (CMAC territory).
Treated	Mbk : pupu	M	4 yrs	Banded as a nestling in 2003 on Pilgrim Creek. Color bands added in 2007 (CBAN territory), likely same male as in 2006.
Treated	Mdb :	F	1 yr	Banded as a nestling in 2006.
Treated	Mdb : DBDP pupu	F	1 yr	Banded as a nestling in 2006 (CPOW territory). Color bands added in 2007 (CSPK territory).
Treated	Mdb:	F	1 yr	Banded as a nestling in 2006.
Treated	Mdb:	M	1 yr	Banded as a nestling in 2006.
Treated	Mdb: WHDB pupu	M	1 yr	Banded as a nestling in 2006 (CSOC territory). Color bands added in 2007 (CROD territory).
Treated	pupu : DPDP Mdb	M	≥ 2 yrs	Banded as an adult in 2006 (CEAS territory).
Treated	WHDB Mdb :	M	AHY	Banded as an adult in 2007 (CLAD territory).
Treated	YEPU Mdb: pupu	M	1 yr	Banded as a nestling in 2006 (CSHE territory). Color bands added in 2007 (CSPK territory).
Treated	YEPU pupu : Mdb	M	≥ 2 yrs	Banded as an adult in 2006 (CWIL territory).
Treated	YEYE Mdb : pupu	M	≥ 2 yrs	Banded as an adult in 2006 (CSAT territory).
Treated	: DBDP Mdb	M	AHY	Banded as an adult in 2007 (DMAD territory).
Treated	BKBK Mdb : pupu	M	≥ 2 yrs	Banded as an adult in 2006 (DDOU territory).
Treated	Mdb : BWST pupu	M	≥ 2 yrs	Banded as an adult in 2006 (DWHI territory).
Treated	Mdb : YEPU pupu	M	≥ 2 yrs	Banded as an adult in 2006 (DBEL territory).
Treated	PUPU Mdb : pupu	M	≥ 2 yrs	Banded as an adult in 2006 (DSAN territory).
Treated	DBWH Mdb : pupu	M	1 yr	Banded as a nestling in 2006 (WOUT territory). Color bands added in 2007 (FO19 territory).
Treated	DPDP pupu : Mdb	M	≥ 2 yrs	Banded as an adult in 2006 (FO2 territory).
Treated	Mdb : DPWH pupu	M	≥ 2 yrs	Banded as an adult in 2006 (FO6 territory).
Treated	pupu : WHWH Mdb	M	≥ 2 yrs	Banded as an adult in 2006 (FO5 territory).
Treated	WHWH Mdb : Msi	M	≥ 2 yrs	Banded as an adult in 2006 (FO8 territory).
Treated	: BYST Mdb	M	≥ 2 yrs	Banded as an adult in 2006 (WDOC territory).
Treated	BWST : pupu Mdb	F	AHY	Banded as an adult in 2007 (WGAR territory).
Treated	BYST Msi : dbdb	M	≥ 2 yrs	Banded as an adult in 2006 (WH23 territory).
Treated	dbdb : WHWH Msi	M	≥ 2 yrs	Banded as an adult in 2006 (WH20 territory).
Treated	DBWH pupu : Mdb	M	≥ 2 yrs	Banded as an adult in 2006 (WDID territory).
Treated	DPDB Mdb: pupu	F	1 yr	Banded as a nestling in 2006 (WGIL territory). Color bands added in 2007 (WH25 territory).
Treated	DPDP Mdb : pupu	M	≥ 2 yrs	Banded as an adult in 2006 (WTHE territory).
Treated	DPDP Msi : dbdb	M	≥ 2 yrs	Banded as an adult in 2006 (WH24 territory).
Treated	LPBK dbdb : Msi	M	≥ 2 yrs	Banded as an adult in 2006 (WH21 territory).
Treated	Mdb : WHDP pupu	M	AHY	Banded as an adult in 2007 (WGAR territory).
Treated	Mdb : YEYE pupu	M	≥ 2 yrs	Banded as an adult in 2006 (WKEL territory).
Treated	pupu : LPLP Mdb	F	≥ 2 yrs	Banded as an adult in 2006 (WSTA territory).
Treated	pupu : YEYE Mdb	M	≥ 2 yrs	Banded as an adult in 2006 (WGIL territory).
Treated	PUPU dbdb : Msi	M	≥ 2 yrs	Banded as an adult in 2006 (WH22 territory).
Treated	PUPU pupu : Mdb	M	≥ 2 yrs	Banded as an adult in 2006 (WANI territory).

Banded adult least Bell's vireos at the San Luis Rey River Flood Control Project area, California, in 2007.

Treatment[a]	Band Combination (Left Leg : Right Leg)[b]	Sex[c]	Age[d]	Comments
Treated	WHDB pupu : Mdb	F	AHY	Banded as an adult in 2007 (WDOC territory).
Treated	WHDP Mdb : pupu	F	1 yr	Banded as a nestling in 2006 (WTHE territory). Color bands added in 2007 (WH21 territory).
Untreated	: BWST Mdb	M	≥ 2 yrs	Banded as an adult in 2006 (CACA territory).
Untreated	: WHDB Mdb	M	AHY	Banded as an adult in 2007 (CSAG territory).
Untreated	BYST Mdb :	M	≥ 2 yrs	Banded as an adult in 2006 (CSCR territory).
Untreated	BYST Mdb : pupu	M	8 yrs	Banded as nestling in 1999 (Benet territory). Color bands added in 2006 (CSTA territory).
Untreated	DBWH : Mdb	M	≥ 2 yrs	Banded as an adult in 2006 (CSTR territory).
Untreated	LPLP Mdb : pupu	M	1 yr	Banded as a nestling in 2006 (BPAR territory). Color bands added in 2007 (CSHE territory).
Untreated	WHDB Mdb : pupu	M	1 yr	Banded as a nestling in 2006 (CWIL territory). Color bands added in 2007 (CDAI territory).
Untreated	Mdb : DBWH	M	≥ 2 yrs	Banded as an adult in 2006 (CSNE territory).
Untreated	Mdb : PUPU pupu	M	≥ 2 yrs	Banded as an adult in 2006 (CSAP territory).
Untreated	Mdb : WHPU pupu	M	1 yr	Banded as a nestling in 2006 (CHOO territory). Color bands added in 2007 (CQTI territory).
Untreated	pupu : DPDB Mdb	M	≥ 2 yrs	Banded as an adult in 2006 (CCOT territory).
Untreated	pupu : DPWH Mdb	M	≥ 2 yrs	Banded as an adult in 2006 (CSHE territory).
Untreated	pupu : YEPU Mdb	M	≥ 2 yrs	Banded as an adult in 2006 (CDAI territory).
Untreated	WHPU Mdb : pupu	F	1 yr	Banded as a nestling in 2006 (CDIA territory). Color bands added in 2007 (CSAG territory).
Untreated	YEPU Mdb :	M	≥ 2 yrs	Banded as an adult in 2006 (CBUC territory).
Untreated	LPLP Mdb :	M	≥ 2 yrs	Banded as an adult in 2006 (BPAR territory).
Untreated	: DBWH Mdb	M	≥ 2 yrs	Banded as an adult in 2006 (WGRI territory).
Untreated	BWST Mdb : pupu	M	≥ 2 yrs	Banded as an adult in 2006 (WMAN territory).
Untreated	Mdb : DPDB	M	≥ 2 yrs	Banded as an adult in 2006 (WEAR territory).
Untreated	Mdb : DPDB pupu	M	≥ 2 yrs	Banded as an adult in 2006 (WALY territory).
Untreated	Mdb : LPLP pupu	M	≥ 2 yrs	Banded as an adult in 2006 (WFID territory).

[a] Treated = territories located in the Channel monitoring site; Untreated = territories located in Benet West, Upper Pond, or Whelan Mitigation monitoring sites.

[b] Band colors: **Mbk** = black numbered federal band; **Mdb** = dark blue numbered federal band; **Msi** = silver numbered federal band; **BKBK** = plastic black; **BKLP** = plastic black-light pink split; **BKYE** = plastic black-yellow split; **BWST** = plastic blue-white striped; **BYST** = plastic black-yellow striped; **dbdb** = metal dark blue; **DBDP** = plastic dark blue-dark pink split; **DBWH** = plastic dark blue-white split; **DPDB** = plastic dark pink-dark blue split; **DPDP** = plastic dark pink; **DPWH** = plastic dark pink-white split; **LPBK** = plastic light pink-black split; **LPLP** = plastic light pink; **PUPU** = plastic purple; **pupu** = metal purple; **PUWH** = plastic purple-white 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: M = Male, F = Female.

[d] Age: AHY = after hatch-year.

APPENDIX 3

Dispersal movement of least Bell's vireos between 2006 and 2007 at the San Luis Rey River Flood Control Project area, California.

2006 Treatment Type/ Adult/Natal Territory ID[a]	2007 Treatment Type/ Territory ID[a]	Dispersal Distance (km)	Band Combination[b]	Age in 2006[c]	Sex[d]
Unknown	TRT / CJIM	Unknown	Mdb :	HY	M
TRT / CSOC	TRT / CROD	2.4	Mdb: WHDB pupu	HY	M
UNT / CSHE	URT / CSPK	0.9	YEPU Mdb: pupu	HY	M
TRT / WOUT	TRT / FO 19	1.4	DBWH Mdb : pupu	HY	M
TRT / CWIL	UNT / CDAI	1.8	WHDB Mdb : pupu	HY	M
Unknown	TRT / CIRO	Unknown	Mdb :	HY	F
TRT / CPOW	UNT / CSPK	0.7	Mdb : DBDP pupu	HY	F
Unknown	TRT / CROD	Unknown	Mdb :	HY	F
UNT / WGIL	TRT / WH 25	1.4	DPDB Mdb: pupu	HY	F
TRT / WTHE	TRT / WH 21	1.0	WHDP Mdb : pupu	HY	F
Unknown	TRT / CHOO	Unknown	: UNKNOWN Mdb	AHY	M
TRT/ CMAC	TRT / CMAC	0.0	LPBK pupu : Mdb	AHY	M
TRT / CEAS	TRT / CEAS	0.0	pupu : DPDP Mdb	AHY	M
TRT / CWIL	TRT / CPOW	0.1	YEPU pupu : Mdb	AHY	M
TRT / CSAT	TRT / CSAT	0.0	YEYE Mdb : pupu	AHY	M
TRT / DDOU	TRT / DDOU	0.0	BKBK Mdb : pupu	AHY	M
TRT / DWHI	TRT / DBRU[e]	0.1	Mdb : BWST pupu	AHY	M
TRT / DBEL	TRT / DBEL	0.0	Mdb : YEPU pupu	AHY	M
TRT / DSAN	TRT / DSAN	0.0	PUPU Mdb : pupu	AHY	M
TRT / FO 2	TRT / FO 2	0.0	DPDP pupu : Mdb	AHY	M
TRT / FO 6	TRT / FO 6	0.0	Mdb : DPWH pupu	AHY	M
TRT / FO 5	TRT / FO 5	0.0	pupu : WHWH Mdb	AHY	M
TRT / FO 8	TRT / FO 8	0.0	WHWH Mdb : Msi	AHY	M
UNT / WDOC	TRT / WDOC	0.0	: BYST Mdb	AHY	M
TRT / WH 23	TRT / WH 23	0.0	BYST Msi : dbdb	AHY	M
TRT / WH 20	TRT / WH 20	0.0	dbdb : WHWH Msi	AHY	M
TRT / WH 24	TRT / WDID	0.0	DBWH pupu : Mdb	AHY	M
TRT / WH 21	TRT / WTHE	0.0	DPDP Mdb : pupu	AHY	M
TRT / WH 22	TRT / WH 24	0.0	DPDP Msi : dbdb	AHY	M
TRT / WH 21	TRT / WH 26	0.2	LPBK dbdb : Msi	AHY	M
TRT / WKEL	TRT / WKEL	0.0	Mdb : YEYE pupu	AHY	M
UNT / WGIL	TRT / WGIL	0.0	pupu : YEYE Mdb	AHY	M
TRT / WH 22	TRT / WH 22	0.0	PUPU dbdb : Msi	AHY	M
TRT / WANI	TRT / WANI	0.0	PUPU pupu : Mdb	AHY	M
TRT / WSTA	TRT / WTHE	0.1	pupu : LPLP Mdb	AHY	F
TRT / CBAN	TRT / CBAN	0.0	Mbk : pupu	3 yrs	M
UNT / BPAR	UNT / CSHE	4.4	LPLP Mdb : pupu	HY	M
TRT / CHOO	UNT / CQTI	0.9	Mdb : WHPU pupu	HY	M
TRT / CDIA	UNT / CSAG	0.7	WHPU Mdb : pupu	HY	F

Dispersal movement of least Bell's vireos between 2006 and 2007 at the San Luis Rey River Flood Control Project area, California.					
2006 Treatment Type/ Adult/Natal Territory ID[a]	**2007 Treatment Type/ Territory ID[a]**	**Dispersal Distance (km)**	**Band Combination[b]**	**Age in 2006[c]**	**Sex[d]**
UNT / CACA	UNT / CACA	0.0	: BWST Mdb	AHY	M
UNT / CSCR	UNT / CBUT	0.1	BYST Mdb :	AHY	M
UNT / CSTR	UNT / CSTR	0.0	DBWH : Mdb	AHY	M
UNT / CSNE	UNT / CSNE	0.0	Mdb : DBWH	AHY	M
UNT / CSAP	UNT / CTEX	0.1	Mdb : PUPU pupu	AHY	M
UNT / CCOT	UNT / CCOT	0.0	pupu : DPDB Mdb	AHY	M
UNT / CSHE	UNT / CWAT	0.1	pupu : DPWH Mdb	AHY	M
UNT / CDAI	UNT / CSCR	0.1	pupu : YEPU Mdb	AHY	M
UNT / CBUC	UNT / CBUC	0.0	YEPU Mdb :	AHY	M
UNT / BPAR	UNT / BPAR	0.0	LPLP Mdb :	AHY	M
UNT / WGRI	UNT / WGRI	0.0	: DBWH Mdb	AHY	M
UNT / WMAN	UNT / WMAN	0.0	BWST Mdb : pupu	AHY	M
UNT / WEAR	UNT / WEAR	0.0	Mdb : DPDB	AHY	M
UNT / WALY	UNT / WALY	0.0	Mdb : DPDB pupu	AHY	M
UNT / WFID	UNT / WFID	0.0	Mdb : LPLP pupu	AHY	M
UNT / CSTA	UNT / CSTA	0.0	BYST Mdb : pupu	7 yrs	M

[a] Treated = territories located in the Channel monitoring site; Untreated = territories located in Benet West, Upper Pond, or Whelan Mitigation monitoring sites.

[b] Band colors: **Mbk** = black numbered federal band; **Mdb** = dark blue numbered federal band; **Msi** = silver numbered federal band; **BKBK** = plastic black; **BKYE** = plastic black-yellow split; **BWST** = plastic blue-white striped; **BYST** = plastic black-yellow striped; **dbdb** = metal dark blue; **DBDP** = plastic dark blue-dark pink split; **DBWH** = plastic dark blue-white split; **DPDB** = plastic dark pink-dark blue split; **DPDP** = plastic dark pink; **DPWH** = plastic dark pink-white split; **LPBK** = plastic light pink-black split; **LPLP** = plastic light pink; **PUPU** = plastic purple; **pupu** = metal purple; **PUWH** = plastic purple-white 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] Age: HY = hatch-year, AHY = after hatch-year.

[d] Sex: M = Male, F = Female.

[e] Male observed once on 3 April. Not detected again during the 2007 season.

APPENDIX 4

Dispersal movement of least Bell's vireos between 2006 and 2007 from the San Luis Rey River to Camp Pendleton and to the Upper San Luis Rey River, California.

2006 Drainage / Treatment Type/ Natal Territory ID[a]	2007 Drainage/Territory ID	Dispersal Distance (km)	Band Combination[b]	Age in 2006[c]	Sex[d]
San Luis Rey River / UNT / BLAS	San Luis Rey River/HLFDOZ	21.6	Mdb : BKLP pupu	HY	F
San Luis Rey River / TRT / FO12	Santa Margarita River / ARS	13.9	Mdb : WHPU pupu	HY	F
San Luis Rey River / TRT / WOUT	Santa Margarita River / QIN	12.6	WHPU Mdb :	HY	F
San Luis Rey River / Unknown	Santa Margarita River / HE34	8.2[e]	Mdb :	Unknown	F
San Luis Rey River / Unknown	Windmill Canyon / WC05	3.8[e]	Mdb :	Unknown	F
San Luis Rey River / Unknown	Santa Margarita River / AE16	7.0[e]	Mdb :	Unknown	M
San Luis Rey River / Unknown	Santa Margarita River / HE31	9.3[e]	Mdb :	Unknown	M

[a] Treated (TRT) = territories located in the Channel monitoring site; Untreated (UNT) = territories located in Benet West, Upper Pond, or Whelan Mitigation monitoring sites.
[b] Band colors: **Mdb** = dark blue numbered federal band; **pupu** = metal purple; **BKLP** = plastic black-light pink split; **WHPU** = plastic white-purple split.
[c] Age: HY = hatch-year.
[d] Sex: F = Female, M = Male.
[e] Distance measured from 2007 territory to the closest location on the San Luis Rey River where banding has been conducted (i.e., approximately 400m northeast of College Road) (USGS, unpublished data).

APPENDIX 5

GPS coordinates (Decimal Degrees; WGS84) for the start and end points (Quad) of each vegetation transect sampled at the San Luis Rey River Flood Control Project area in 2006-2007. Quad indicates the distance in meters along a transect.

Site	Transect ID	Quad	X-West	Y-North	Transect Bearing
College	1	5	-117.29912	33.24834	Bearing=304 degrees
College	1	145	-117.30033	33.24907	
College	2	5	-117.29964	33.24763	Bearing=310 degrees
College	2	115	-117.30074	33.24805	
College	4	5	-117.30067	33.24607	Bearing=300 degrees
College	4	105	-117.3017	33.24649	
College	6	5	-117.30167	33.24445	Bearing=300 degrees
College	6	105	-117.3026	33.2449	
College	8	5	-117.30274	33.24299	Bearing=314 degrees
College	8	105	-117.30349	33.24361	
College	10	5	-117.30434	33.24167	Bearing=330 degrees
College	10	125	-117.30506	33.24246	
College	12	5	-117.30612	33.24078	Bearing=330 degrees
College	12	95	-117.30656	33.24148	
College	14	5	-117.30823	33.24023	Bearing=352 degrees
College	14	115	-117.30851	33.24	
College	16	5	-117.3103	33.24005	Bearing=358 degrees
College	16	115	-117.31056	33.2411	
College	18	5	-117.31255	33.23992	Bearing=358 degrees
College	18	115	-117.31248	33.24111	
College	20	5	-117.31473	33.24009	Bearing=2 degrees
College	20	115	-117.31476	33.24105	
College	22	5	-117.31675	33.23999	Bearing=2 degrees
College	22	105	-117.31678	33.24098	
College	24	5	-117.3191	33.24006	Bearing=2 degrees
College	24	105	-117.31904	33.24093	
College	26	5	-117.32116	33.24006	Bearing=2 degrees
College	26	115	-117.32106	33.24105	
Douglas	28	5	-117.32325	33.23991	Bearing=0 degrees
Douglas	28	105	-117.32339	33.24101	
Douglas	30	5	-117.32537	33.24037	Bearing=0 degrees
Douglas	30	115	-117.32544	33.24099	
Douglas	32	5	-117.32756	33.24004	Bearing=0 degrees
Douglas	32	15	-117.3275	33.24013	
Douglas	32	25	-117.3276	33.24018	
Douglas	32	35	-117.32754	33.24025	
Douglas	34	5	-117.32965	33.24	Bearing=0 degrees
Douglas	34	105	-117.32968	33.24073	
Douglas	36	5	-117.33178	33.23997	Bearing=0 degrees
Douglas	36	115	-117.3318	33.2409	

GPS coordinates (Decimal Degrees; WGS84) for the start and end points (Quad) of each vegetation transect sampled at the San Luis Rey River Flood Control Project area in 2006-2007. Quad indicates the distance in meters along a transect.					
Douglas	38	5	-117.3339	33.23991	Dropped transect in 2007 because of lack of treated points.
Douglas	38	105	-117.33395	33.24077	
Whelan	40	5	-117.33602	33.23986	Bearing=0 degrees
Whelan	40	95	-117.33606	33.24068	
Whelan	42	5	-117.33802	33.23924	Bearing=332 degrees
Whelan	42	105	-117.33866	33.23998	
Whelan	42	115	-117.33872	33.24006	
Whelan	44	5	-11.33963	33.23798	Bearing=296 degrees
Whelan	44	105	-117.34059	33.23835	
Whelan	46	5	-117.34036	33.23622	Bearing=278 degrees
Whelan	46	115	-117.34148	33.23634	
Whelan	48	5	-117.34067	33.2345	Bearing=284 degrees
Whelan	48	165	-117.34229	33.23481	
Whelan	50	5	-117.34127	33.23273	Bearing=286 degrees
Whelan	50	145	-117.34264	33.23309	
Whelan	54	5	-117.34311	33.2295	Bearing=286 degrees
Whelan	54	175	-117.3448	33.23004	
Foussat	62	5	-117.34478	33.22253	Bearing=304 degrees
Foussat	62	125	-117.34586	33.22306	
Foussat	64	5	-117.34641	33.22144	Bearing=326 degrees
Foussat	64	145	-117.3473	33.22255	
Foussat	66	5	-117.34839	33.22074	Bearing=346 degrees
Foussat	66	135	-117.34877	33.2222	
Foussat	70	5	-117.35272	33.22096	Bearing=6 degrees
Foussat	70	145	-117.35252	33.22219	
Foussat	73	5	-117.35612	33.22054	Added this transect in 2007.
Foussat	73	135	-117.35654	33.22166	
Basin	B13	5	-117.30713	33.24002	Bearing=172 degrees
Basin	B13	65	-117.30683	33.23959	
Basin	B14	5	-117.30823	33.23991	Bearing=172 degrees
Basin	B14	115	-117.30807	33.23901	
Basin	B15	5	-117.3093	33.23978	Bearing=172 degrees
Basin	B15	105	-117.30912	33.23888	
Basin	B15	115	-117.30912	33.2388	
Basin	B17	5	-117.31148	33.23974	Bearing=172 degrees
Basin	B17	105	-117.31135	33.23885	
Basin	B18	5	-117.31256	33.23971	Bearing=182 degrees
Basin	B18	105	-117.3127	33.23883	
Basin	B19	5	-117.31372	33.23972	Bearing=182 degrees
Basin	B19	105	-117.31391	33.23874	
Basin	B20	5	-117.31475	33.2397	Bearing=182 degrees
Basin	B20	105	-117.31495	33.23881	

GPS coordinates (Decimal Degrees; WGS84) for the start and end points (Quad) of each vegetation transect sampled at the San Luis Rey River Flood Control Project area in 2006-2007. Quad indicates the distance in meters along a transect.

Basin	B21	5	-117.3158	33.23972	Bearing=182 degrees
Basin	B21	105	-117.31602	33.2388	
Basin	B22	5	-117.31689	33.23969	Bearing=182 degrees
Basin	B22	95	-117.31699	33.23885	
Basin	B23	5	-117.31802	33.23968	Bearing=182 degrees
Basin	B23	55	-117.318	33.2392	
Basin	B24	5	-117.31901	33.23964	Bearing=182 degrees
Basin	B24	45	-117.31902	33.2393	
Basin	B25	5	-117.32011	33.23963	Bearing=182 degrees
Basin	B25	35	-117.3201	33.23927	
Basin	B26	5	-117.3211	33.23955	Bearing=182 degrees
Basin	B26	35	-117.32118	33.23925	
Whelan North	WH-1	5	-117.33969	33.23975	Bearing=345 degrees
Whelan North	WH-1	325	-117.34222	33.237744	
Whelan North	WH-2	5	-117.33989	33.24004	Bearing=345 degrees
Whelan North	WH-2	345	-117.34281	33.23811	