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State of California
THE RESOURCES AGENCY
Department of Fish and Game

HABITAT REQUIREMENTS OF THE LEAST BELL'S VIREO

by

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ABSTRACT

From April through July, 1980, the nesting habitat of the Least Bell's Vireo (Vireo bellii pusillus) was analyzed at two sites in northern San Diego County to determine critical nesting requirements of the subspecies. Vegetation at these sites were compared to vegetation at a third site located in similar habitat which did not support any vireos. Vegetational characteristics of nesting areas such as age and species composition varied greatly, but dense understory vegetation was found consistently on both sites where vireos were present. Shrub stem counts averaged 5500 stems/ha at the nest sites. Higher foliage densities below 3 m were recorded on the sites occupied by vireos compared to the unoccupied site. Examination of more than 100 nesting records and observation of foraging behavior suggest that the critical area for feeding is limited to vegetation below 6 m and that nesting takes place below 3 m, frequently at heights of less than 2 m. Nesting substrates were not limited to any particular shrub species. The presence of a dense understory below 3 m appears to be the most important aspect of nesting habitat for Least Bell's Vireos.

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RECOMMENDATIONS

Based on the results of this study, I recommend the following:

1. Protect Least Bell's Vireo habitat from land-use practices, such as clearing and grazing, which damage or destroy riparian vegetation. Discourage intensive recreational uses such as motorcycle riding in riparian areas.

2. Manage occupied and potential Bell's Vireo habitat under federal, state or local governmental jurisdiction for the maintenance of a dense understory, to maintain or develop suitable nesting habitat for Least Bell's Vireos.

3. Encourage reestablishment of riparian vegetation on lands under the jurisdiction of federal, state and local governments to develop additional potential habitat for Least Bell's Vireos.

4. Contact private landowners and encourage protection of potential nesting habitat.

5. Conduct further studies of the foraging behavior of Least Bell's Vireos to clarify the relationship between habitat and foraging requirements.

INTRODUCTION

The Least Bell's Vireo nests almost exclusively in lowland riparian woodlands within its range in southern California. Although the vireo's use of the dense thickets formed by willows and other understory vegetation has been mentioned by many authors (Tyler 1913, Grinnell and Storer 1924, Grinnell and Miller 1944, Goldwasser 1978), no quantitative habitat descriptions exist, nor have specific habitat requirements been thoroughly investigated. The purpose of this study was to investigate and describe the preferred habitat of the Least Bell's Vireo. This information is critical for the identification, protection and management of occupied and potential nesting habitat of this species.

METHODS

Riparian vegetation was analyzed on three sites along the San Luis Rey and Santa Margarita rivers in northern San Diego County (Figures 1-4). Two of the sites support breeding populations of Least Bell's Vireos. The third site is located in similar habitat along the San Luis Rey River, and does not support any vireos.

Density, basal area, dominance, shrub densities, canopy cover and ground cover were measured using the method described by James and Shugart (1970). Six 0.25 ha circles were established around randomly chosen points on each site. In addition to the random plots, 0.25 ha circles were centered at the nests or preferred singing perches of each vireo nesting in the study area using the method described by James (1971). Trees within each circle were counted and classified according to DBH and species.

One km transects were established in the riparian woodland at Fallbrook and Pala Mesa, where several breeding pairs of vireos were present. A transect of 875 m was established at the Bonsall study area, where the habitat is less extensive. Relative foliage density was measured at 16 stations, in vegetation at heights of 0.2 m, 1.5 m, 3.0 m and successive 1.5 m intervals. Measurements were taken on each side of the transect at points located 6 m into the vegetation. The species and distance to the nearest plant whose foliage covered half of the area of a clipboard was recorded. Each distance was divided by 0.69 and the mean value for each level was computed, giving a measure of relative foliage density for that level of vegetation. These measurements are analagous to those used in the calculation of foliage height diversity (McArthur 1961).

Understory composition at various heights was also determined from these measurements.

Nest heights and substrate vegetation were determined from egg collection records from the Western Foundation of Vertebrate Zoology, the San Bernardino County Museum, and from personal observations in 1977, 1978 and 1980.

Foraging behavior was observed at both study sites where vireos were present, using a variation of Sturman's method (1968). I recorded the foraging method, foraging height, tree or shrub height, plant species and foraging substrate.

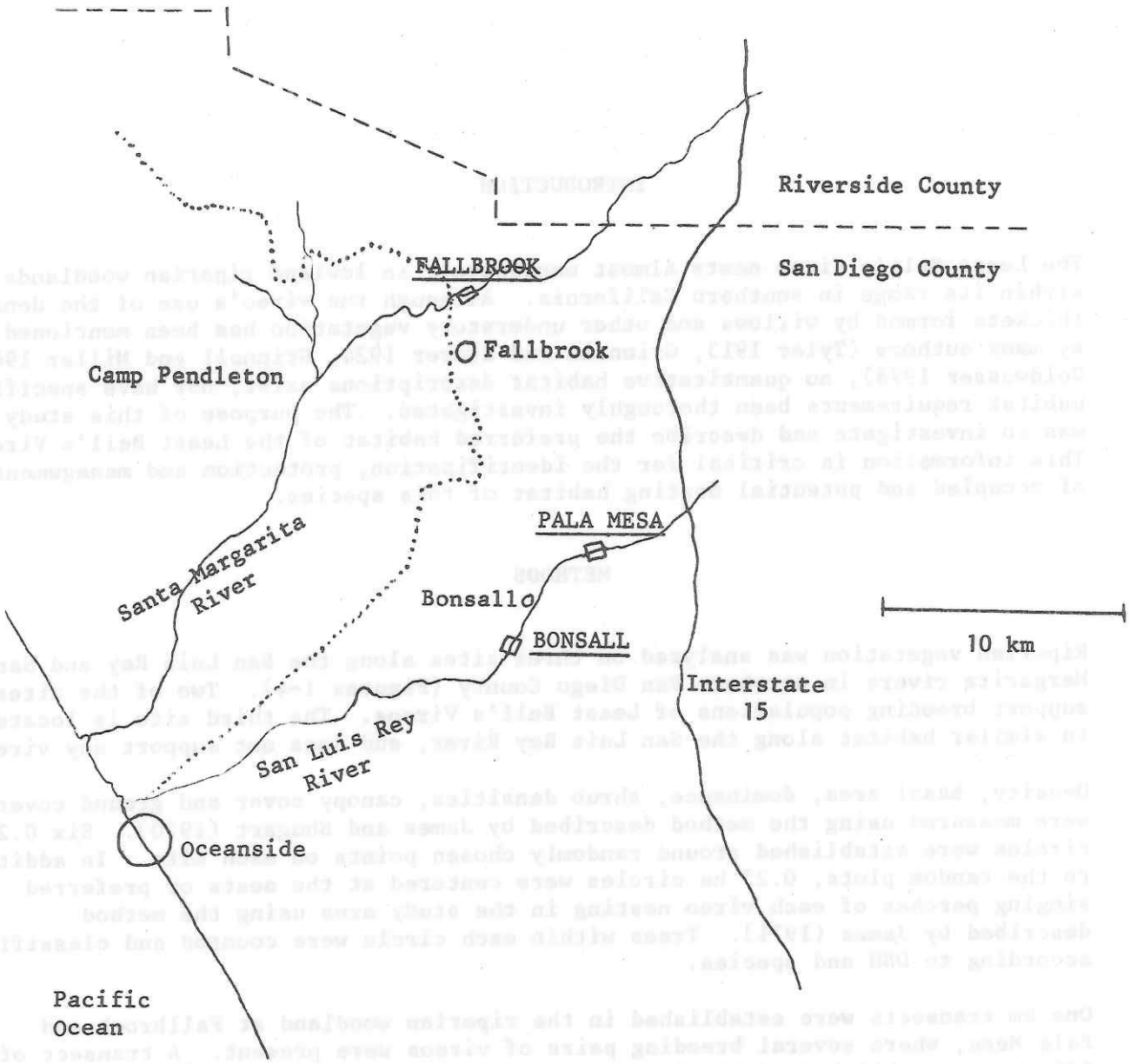

Figure 1. Study site locations for habitat requirement study of the Least Bell's Vireo, April-July 1980.

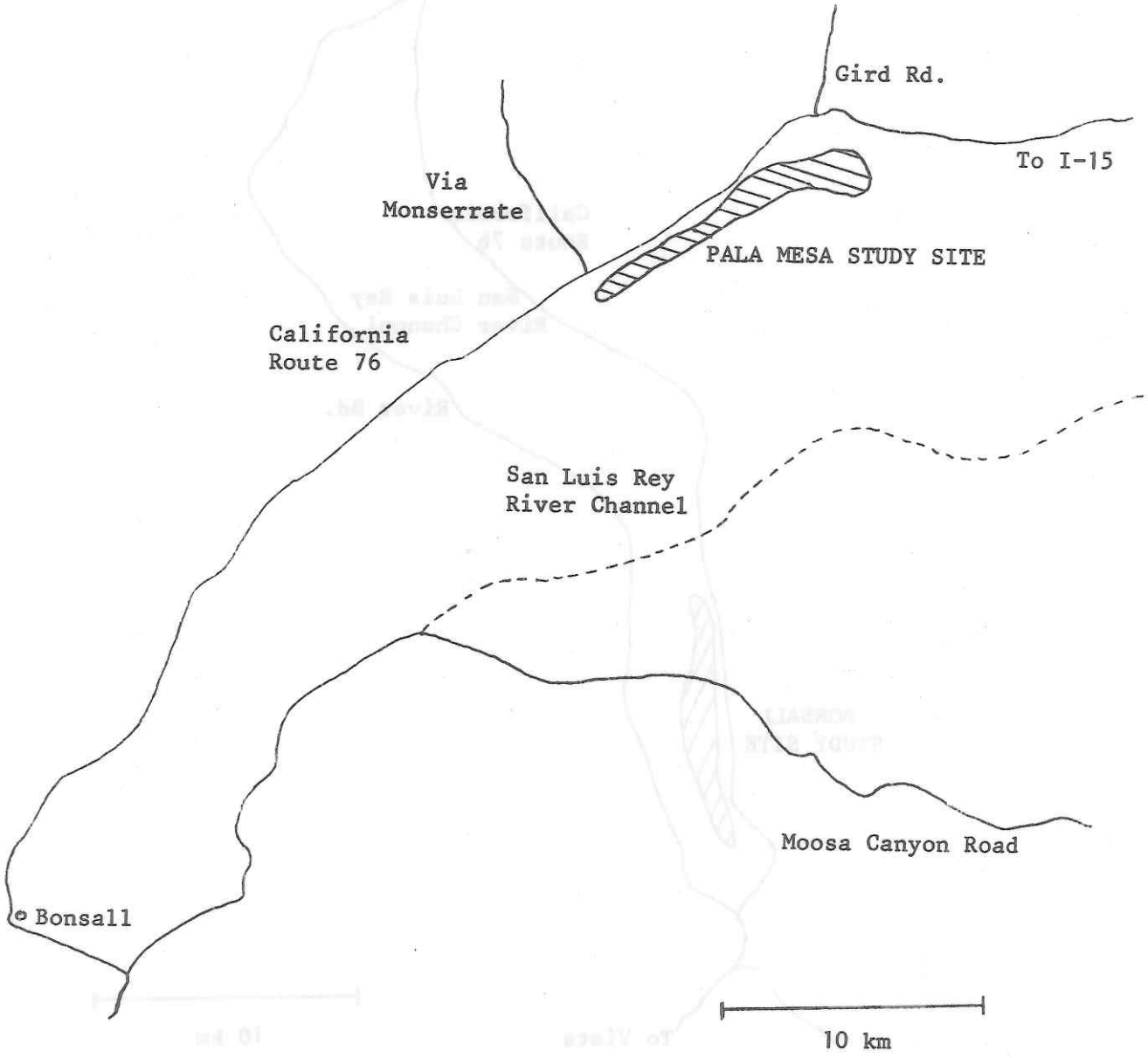

Figure 2. Location of the Pala Mesa Least Bell's Vireo study site, April-July 1980.

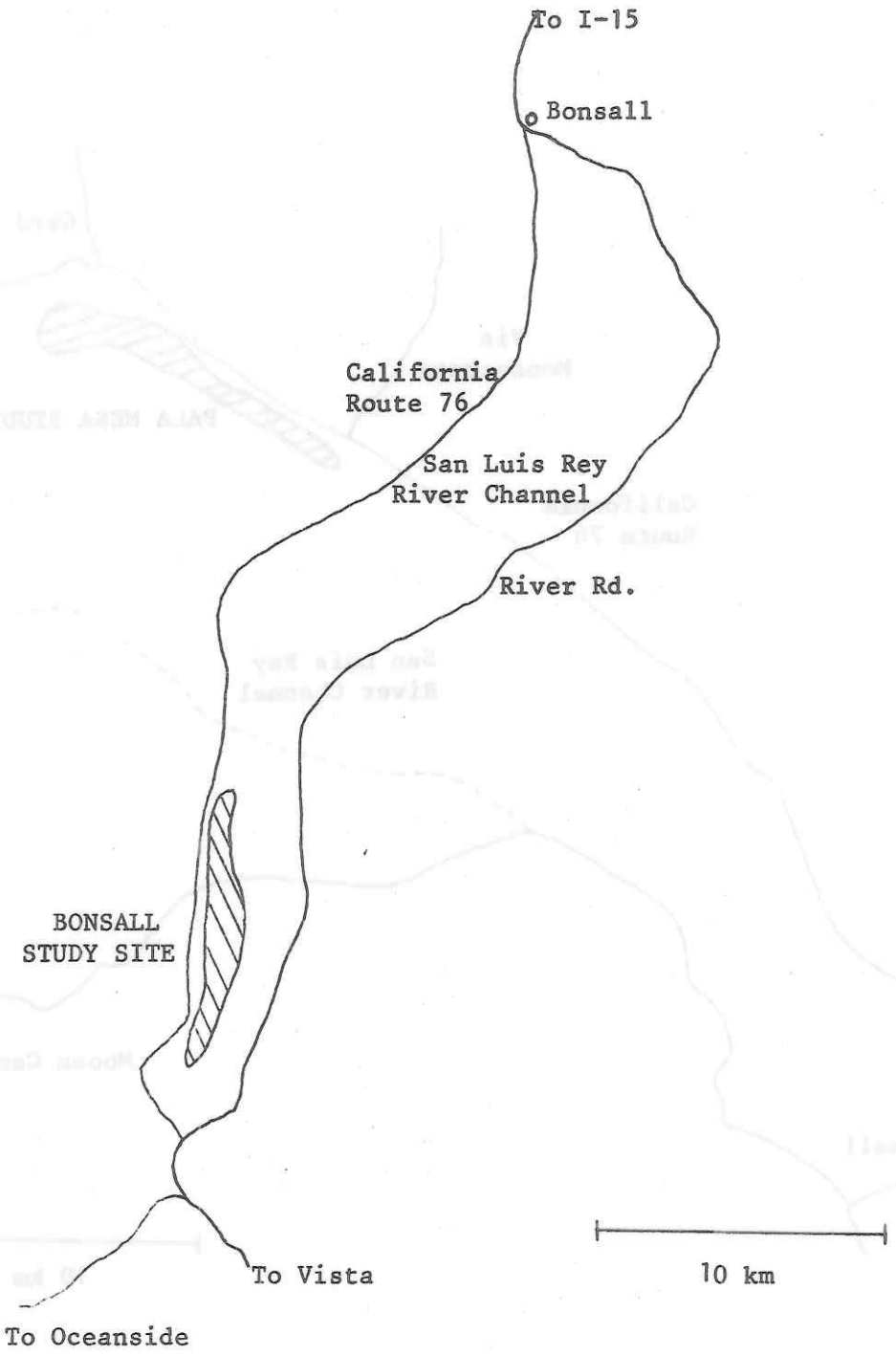

Figure 3. Location of the Bonsall Least Bell's Vireo study site, April-July 1980.

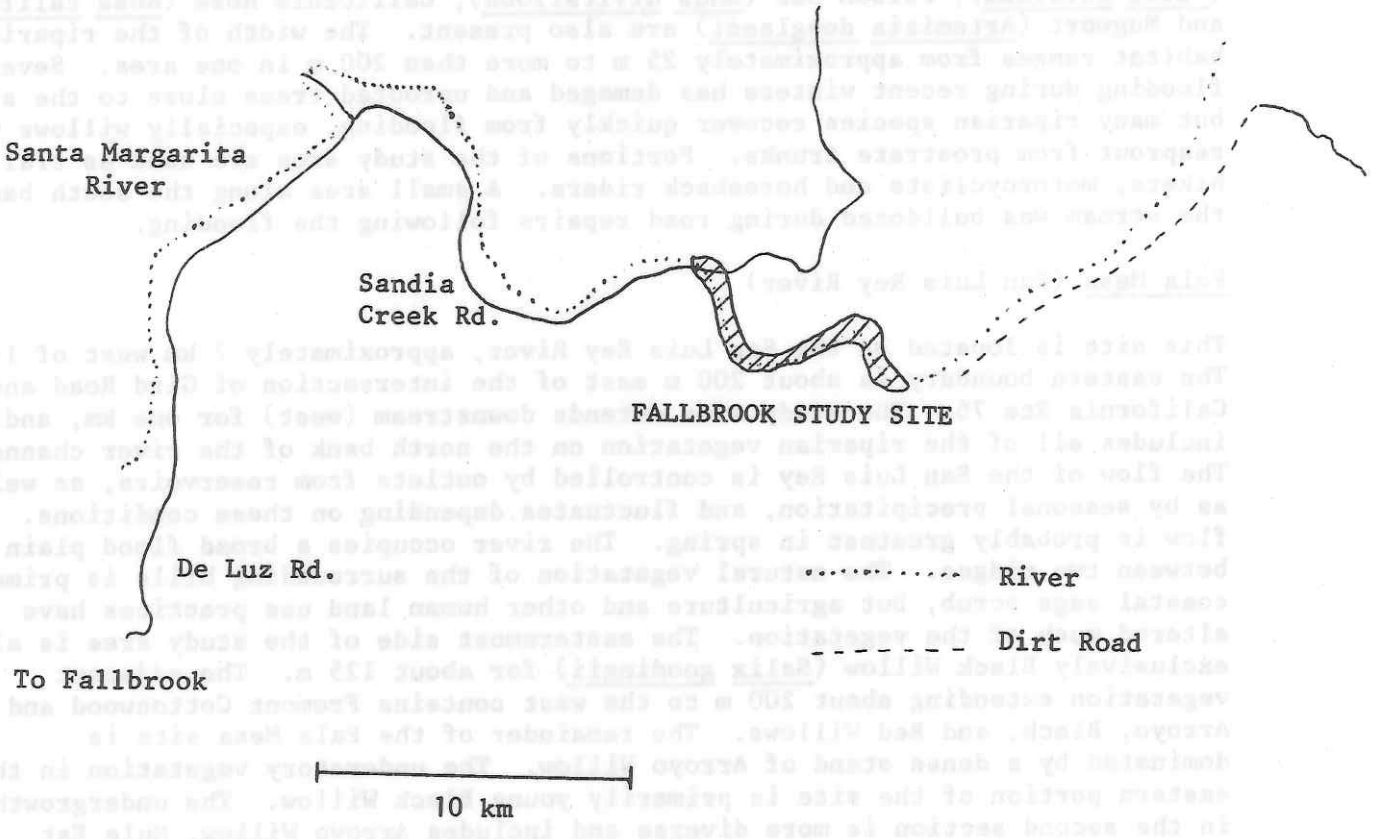

Figure 4. Location of the Fallbrook Least Bell's Vireo study site, April-July 1980.

STUDY AREAS

Fallbrook (Santa Margarita River)

This site is located on the Santa Margarita River approximately 5 km north of the town of Fallbrook, at the intersection of Sandia Creek Road and the river. It encompasses riparian habitat that extends 125 m downstream (west) and 875 m upstream (east) of the ford. The Santa Margarita River flows intermittently and is usually dry in late summer. The stream is restricted to a narrow valley between two ridges. The surrounding habitat is composed of coastal sage scrub and oak woodland. The riparian woodland is dominated by Black Cottonwood (Populus trichocarpa), Fremont Cottonwood (Populus fremontii), California Sycamore (Platanus racemosa), Red Willow (Salix laviegata) and Arroyo Willow (S. lasiolepis). The understory is composed mainly of willows, including Arroyo and Sandbar (S. hindsiana) willows. Mulefat (Baccharis glutinosa), wild grape (Vitis girdiana), Poison Oak (Rhus divirsiloba), California Rose (Rosa californica) and Mugwort (Artemisia douglassi) are also present. The width of the riparian habitat ranges from approximately 25 m to more than 200 m in one area. Severe flooding during recent winters has damaged and uprooted trees close to the stream, but many riparian species recover quickly from flooding, especially willows which resprout from prostrate trunks. Portions of the study area are used as trails by hikers, motorcyclists and horseback riders. A small area along the south bank of the stream was bulldozed during road repairs following the flooding.

Pala Mesa (San Luis Rey River)

This site is located on the San Luis Rey River, approximately 7 km west of I-15. The eastern boundary is about 200 m east of the intersection of Gird Road and California Rte 76. The study area extends downstream (west) for one km, and includes all of the riparian vegetation on the north bank of the river channel. The flow of the San Luis Rey is controlled by outlets from reservoirs, as well as by seasonal precipitation, and fluctuates depending on these conditions. The flow is probably greatest in spring. The river occupies a broad flood plain between two ridges. The natural vegetation of the surrounding hills is primarily coastal sage scrub, but agriculture and other human land use practices have altered much of the vegetation. The easternmost side of the study area is almost exclusively Black Willow (Salix goodingii) for about 125 m. The adjacent vegetation extending about 200 m to the west contains Fremont Cottonwood and Arroyo, Black, and Red Willows. The remainder of the Pala Mesa site is dominated by a dense stand of Arroyo Willow. The understory vegetation in the eastern portion of the site is primarily young Black Willow. The undergrowth in the second section is more diverse and includes Arroyo Willow, Mule Fat California Blackberry (Rubus ursinus), and Sandbar Willow grows along the sunnier outlying edges. The width of the riparian vegetation at the Pala Mesa site ranges from 20 m to more than 60 m. Most of this site was under cultivation until approximately 15 years ago (H. Wier pers. comm.). Only the second section contains trees larger than 15 cm in diameter. A small area of willows was bulldozed during early 1980 for unknown purposes.

Bonsall (San Luis Rey River)

This site is located from 0.5 to 1.4 km east of the Rte. 76 bridge across the San Luis Rey River. All of the riparian vegetation within this region on the north bank of the river channel is included in the study area. The flood plain

is wider here than at Pala Mesa, and the hills are somewhat gentler. Otherwise, features of the topography and surrounding vegetation are similar. The canopy species are predominantly large willows, such as Black, Red and Arroyo willows, and Fremont Cottonwood. The important understory plants are Poison Oak, California Rose, Hoary Nettles (Urtica holosericea), Mugwort and shrubby willows. The width of the riparian vegetation varies from a minimum of 20 m to more than 75 m. The distribution of understory vegetation is less consistent than on the other two sites, perhaps partly as a result of recent flooding.

RESULTS

Species Composition

Species composition differed considerably among the three sites, depending on their respective ages and land use histories. Table 1 presents the relative frequency of trees comprising the canopy layer on all three sites, and in the plots centered in vireo territories. Arroyo Willow, which was also an important component of the understory, was present on all plots except one. Red Willow also appeared frequently. Black Cottonwood was restricted to the Santa Margarita River. Sycamore was more abundant in this location than at Bonsall and Pala Mesa, where it was observed but not recorded on any of the sampled plots. Black Willow was not observed in the Fallbrook area.

Understory

Understory vegetation was dominated by willows on all three sites (Table 2). Several other species contributed to the composition of the understory below 3 m, including wild grape, Poison Oak and California Rose at Bonsall and Fallbrook. Mulefat was found at Pala Mesa and Bonsall. Annuals such as Mugwort and goldenrod (Solidago sp.) were dense and tall enough to be considered as understory vegetation.

The proportions of shrub species on each site were derived from the species recorded while measuring foliage density. One of the 0.25 ha circles in a vireo's territory contained a high proportion of California Blackberry (approximately 90%), which was not recorded elsewhere.

A nonspecific count of shrub stems/ha was taken at each 0.25 ha circle (Table 3). Circles centered in vireo territories had significantly higher shrub counts than the mean shrub count of all of the circles sampled (binomial expansion, $p<0.05$). Conversely, the circles sampled at Bonsall had significantly fewer shrub stems/ha.

Density

Results of the measurements of density and relative density are presented by size class and species in Tables 4 and 5. Total density on the Bonsall plot was significantly greater than the mean density of all of the plots (binomial expansion, $p<0.05$). The density of trees in size classes "A" (7.5-15 cm) and "B" (15-22.5 cm) was also significantly higher than on other plots. Arroyo Willow occurred in greater densities than any other species on all plots except those at Fallbrook. Red Willow was the second most abundant species at Pala Mesa and on the circles in vireo territories. The reverse situation was true at Fallbrook, where Red Willow occurred in greater densities than Arroyo Willow. At Bonsall, Black Willow

TABLE 1. Percent frequency of occurrence of canopy tree species.

Species	Pala Mesa	Bonsall	Fallbrook	Nest-sites
Arroyo Willow	100	100	83	88
Red Willow	83	33	100	75
Black Willow	17	100	-	25
Fremont Cottonwood	50	50	-	13
Black Cottonwood	-	-	33	-
California Sycamore	-	-	17	25

TABLE 2. Relative frequency of understory vegetation (%).

Height	Plant Species							
	Arroyo Willow	Red Willow	Black Willow	Sandbar Willow	Wild Grape	Fremont Cottonwood	Poison Oak	Other
0.6 m								
Pala Mesa	72	3	-	3	-	-	-	23 1/
Bonsall	54	-	4	-	-	-	18	24 2/
Fallbrook	48	13	-	3	36	-	-	-
1.0 m								
Pala Mesa	88	6	3	-	-	-	-	3 (Mule Fat)
Bonsall	82	-	7	-	-	4	4	3 (Phragmites)
Fallbrook	41	28	-	3	28	-	-	-
3.0 m								
Pala Mesa	91	3	3	3	3	-	-	-
Bonsall	86	-	14	-	-	-	-	-
Fallbrook	33	38	-	3	26	-	-	-
4.6 m								
Pala Mesa	91	3	3	-	-	6	-	-
Bonsall	65	7	14	-	-	7	-	7 (Mule Fat)
Fallbrook	33	36	-	-	27	-	-	3 (Black Cottonwood)
6.1 m								
Pala Mesa	69	7	10	-	-	14	-	-
Bonsall	57	11	14	-	-	14	-	4 (Sycamore)
Fallbrook	28	52	-	-	6	-	-	9 3/

1/ Scirpus 6%, annuals 6%, Mugwort 6%, Juncus 3%

2/ California Rose 11%, Mule Fat 12%, Mugwort 2%

3/ Black Cottonwood 6%, Sycamore 3%

TABLE 3. Shrub stem counts.

Site	No. of Shrub Stems/ha
Pala Mesa	3673
Bonsall	1693
Fallbrook	2740
Nest-sites	5550

TABLE 4. Density and relative density of canopy trees by species in trees/ha (and percent of total)

Species	Pala Mesa	Bonsall	Fallbrook	Nest-sites
Arroyo Willow	56.0 (61.7)	96.0 (66.4)	16.7 (25.8)	46.0 (70.4)
Red Willow	24.7 (27.3)	8.0 (5.5)	32.7 (50.5)	11.3 (17.3)
Black Willow	0.7 (0.8)	27.3 (18.9)	- -	5.4 (8.3)
Fremont Cottonwood	9.3 (10.2)	13.3 (9.2)	- -	1.3 (2.0)
Black Cottonwood	- -	- -	12.7 (19.6)	- -
California Sycamore	- -	- -	2.7 (4.3)	1.3 (2.0)
Total Density	90.7	144.6	64.7	65.3

TABLE 5. Density and relative density by size class in trees/ha (and percent of total)

Size Class (DBH)	Pala Mesa	Bonsall	Fallbrook	Nest-sites
"A" (7.5-15.0 cm)	87.4 (96.3)	112.0 (77.5)	34.7 (53.6)	55.3 (84.7)
"B" (15.0-22.5 cm)	3.3 (3.6)	28.7 (19.8)	21.3 (32.9)	7.3 (11.1)
"C" (22.5-37.5 cm)	- -	2.6 (1.8)	8.0 (12.4)	2.7 (4.1)
"D" (37.5-57.5 cm)	- -	1.3 (0.9)	0.7 (1.1)	- -

was second in abundance to Arroyo Willow. Trees belonging to the smallest size class were the most abundant on all of the plots sampled.

Basal Area

The results of the measurements of basal area and calculations of relative dominance are shown in Tables 6 and 7. Total basal area at the Bonsall study site was significantly greater than on the other plots (binomial expansion $p < 0.05$). Basal areas of the trees in the "A" and "B" size classes were also significantly greater at Bonsall (binomial expansion $p < 0.05$). Arroyo Willow accounted for more than half of the total basal area on all of the plots except Fallbrook, where Red Willow was more important. Large trees such as Fremont Cottonwood, Black Cottonwood and California Sycamore contributed proportionately more to basal area than they did to density. "A" class trees predominated on all plots except at Fallbrook, where trees of size class "C" contributed the greatest amount of basal area.

Canopy Cover

The canopy cover measured at Bonsall was significantly greater than the mean canopy cover of all circles sampled (binomial expansion $p < 0.05$). Many, but not all, of the circles centered in vireo's territories had relatively little canopy cover.

Ground Cover

Percent ground cover in the circles centered in vireo's territories was significantly higher than the mean of all of the sampled plots (binomial expansion $p < 0.05$).

Foliage Density

Table 8 presents the results of foliage density measurements on each transect. At the 1.5 m layer, and in the combined 0.6-3.0 layer, there were significantly higher foliage volumes on the Fallbrook and Pala Mesa study sites (t test, $p < 0.05$) These are the levels of vegetation most frequently used for nesting.

Nest Site Choice

Examination of 108 records of Bell's Vireo nests revealed a mean height of 1.0 m (Figures 5 and 6). Nests were built as low as 0.2 m and as high as 3.6 m, however the majority of nests were built below 1.6 m. Nests were most frequently constructed in willows, but other important shrub species used include California Rose, *Rubus* spp., California Sycamore, Poison Oak, and Mexican Elderberry (*Sambucus mexicanus*).

Foraging Behavior

Twelve successful foraging attempts were observed during the study (Table 9). Foraging heights ranged from about 2 to 6.5 m. The vireos usually glean or snatch-glean prey from leaves and small twigs. The most common tree species used during foraging were Arroyo and Red willows.

TABLE 6. Basal area and relative dominance by species in m^2 and percent of total.

Species	Pala Mesa	Bonsall	Fallbrook	Nest-sites
Arroyo Willow	0.534 (32.7)	1.190 (50.8)	0.180 (11.0)	0.558 (59.0)
Red Willow	0.254 (15.5)	0.223 (9.5)	0.924 (56.8)	0.205 (21.7)
Black Willow	0.065 (4.0)	0.730 (31.2)	- -	0.058 (6.1)
Fremont Cottonwood	0.781 (47.8)	0.199 (9.5)	- -	0.012 (1.3)
Black Cottonwood	- -	- -	0.261 (16.1)	- -
California Sycamore	- -	- -	0.261 (16.1)	0.112 (11.9)
Total Basal Area	1.634	2.342	1.626	0.945

TABLE 7. Basal area and relative dominance by size class in m^2 and percent of total.

Size Class	Pala Mesa	Bonsall	Fallbrook	Nest-sites
"A" (7.5-15.0)	1.541 (94.3)	0.992 (42.3)	0.323 (19.9)	0.541 (57.2)
"B" (15.0-22.5)	0.093 (5.7)	0.780 (33.3)	0.595 (36.6)	0.205 (21.7)
"C" (22.5-37.5)	- -	0.346 (14.8)	0.596 (36.7)	0.199 (21.1)
"D" (37.5-57.5)	- -	0.199 (9.6)	0.112 (6.9)	
Total Basal Area	1.634	2.342	1.626	0.945

TABLE 8. Relative foliage density in m^2 per m^3.

Height	Pala Mesa	Bonsall	Fallbrook
0.61 m	0.776	1.048	1.309
1.5 m	0.913	0.546	1.093
3.0 m	1.487	0.824	0.747
4.6 m	1.615	0.799	0.469
6.1 m	1.010	0.850	0.655
0.61-1.5 m	1.080	0.828	0.614
0.61-3.0 m	2.637	2.675	2.007
0.61-4.6 m	4.791	3.618	3.217

TABLE 9. Foraging observations.

Date	Location	Height (m)	Tree Species	Tree Height (m)	Method	Substrate
20 May	Fallbrook	2	Arroyo Willow	2.7	Snatch-glean	Leaf
20 May	Fallbrook	6.7	Arroyo Willow	10.1	Snatch-glean	Leaf
20 May	Fallbrook	5.5	Arroyo Willow	10.1	Snatch-glean	Leaf top
22 May	Pala Mesa	3.0	Arroyo Willow	5.5	Glean	Dead leaf
22 May	Pala Mesa	4.9	Fremont Cottonwood	10.7	Glean	Leaf top
31 May	Pala Mesa	2.7	Red Willow	4.9	Snatch glean	Leaf bottom
6 June	Pala Mesa	2.7	Arroyo Willow	3.7	Glean	Leaf top
17 June	Fallbrook	2.7	Red Willow	4.9	Snatch-glean	Leaf bottom
23 June	Fallbrook	2.0	Live Oak	7.6	Glean	Leaf top
23 June	Fallbrook	4.9	Black Cottonwood	12.2	Hover-glean	Leaf bottom
23 July	Fallbrook	6.1	Red Willow	9.1	Snatch-glean	Branch
27 July	Fallbrook	9.1	Red Willow	10.7	Snatch-glean	Leaf

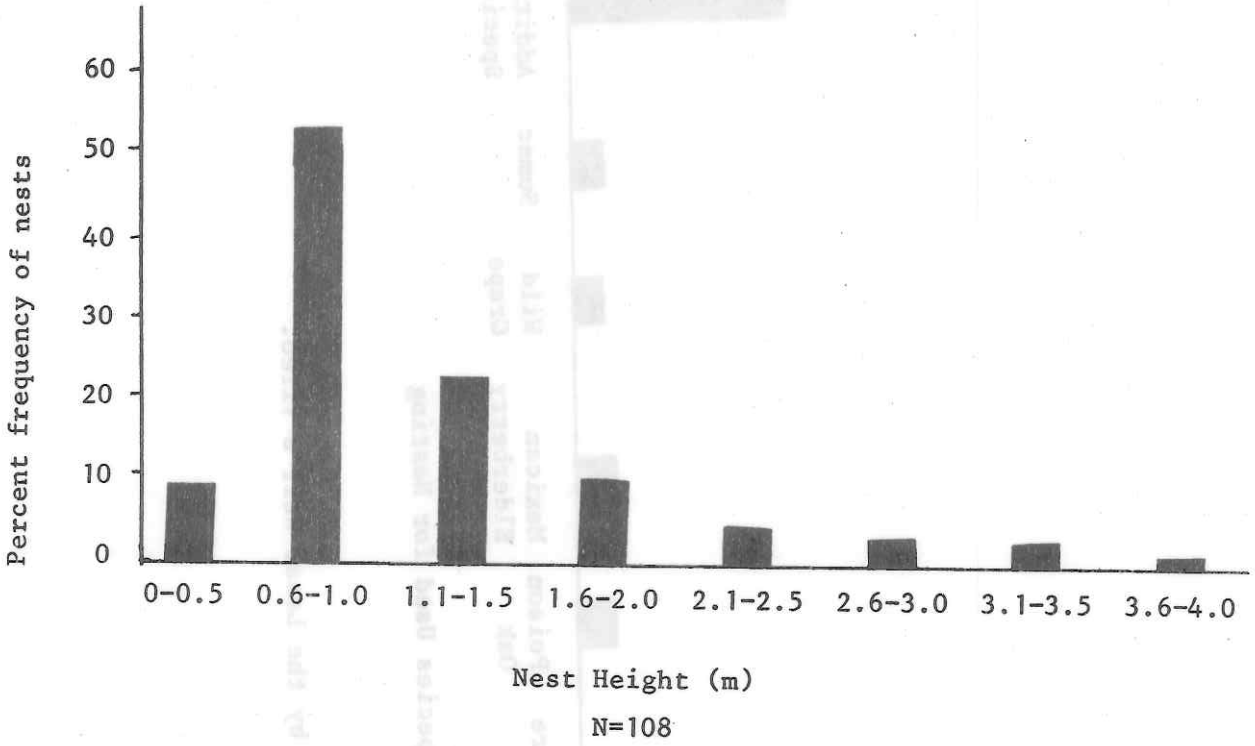

Figure 5. Nest heights of Least Bell's Vireos. Data are from personal observations made in 1977, 1978 and 1980 and from museum collections.

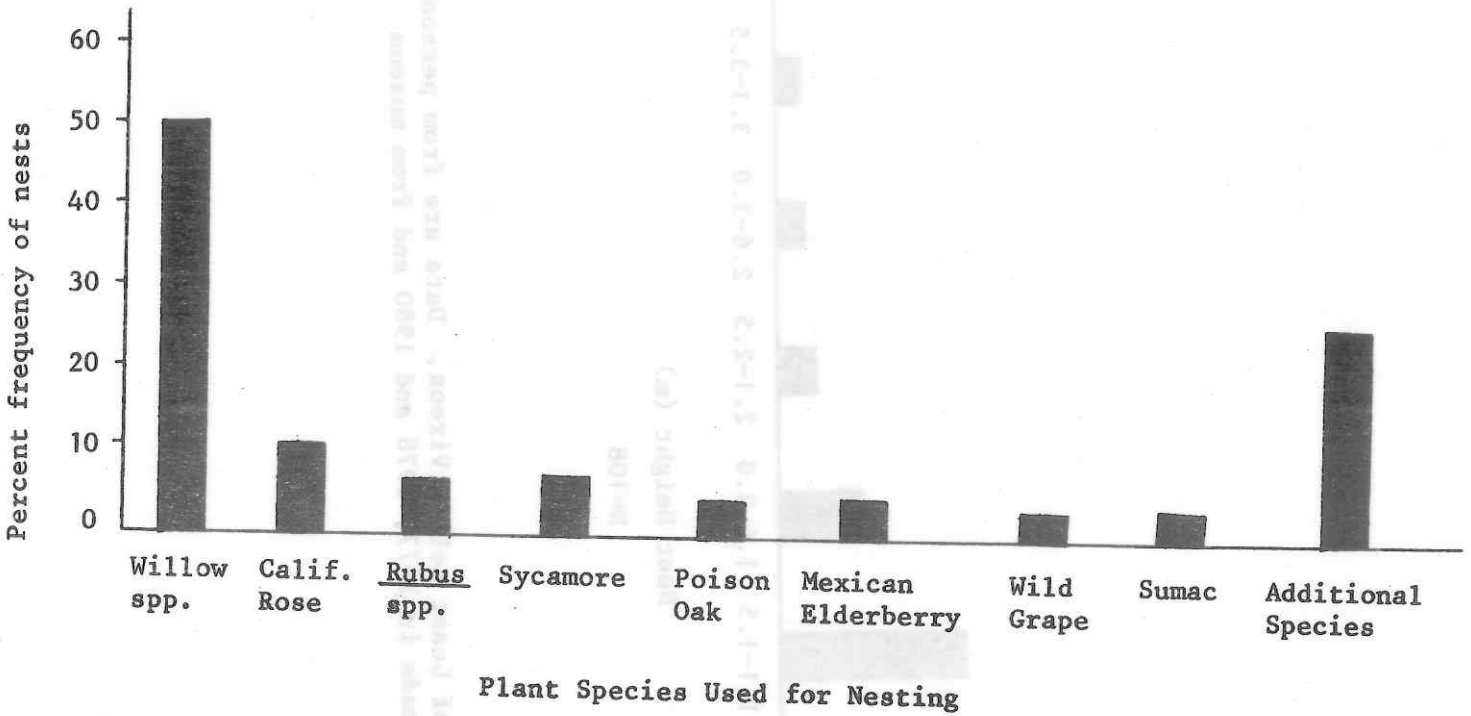

Figure 6. Nest support vegetation used by the Least Bell's Vireo.

DISCUSSION

Least Bell's Vireos nest between 0.2 and 3.6 m above the ground, most frequently at heights below 1.5 m. Foraging activity is concentrated in the understory below 6 m. Males also forage from singing perches, occasionally as high as 10 m, but the majority of nesting and foraging activities take place within the first 6 m of vegetation. The structure, composition and foliage density of this zone determine the most important characteristics of Bell's Vireo habitat.

The two study sites occupied by Least Bell's Vireos were strikingly different in species composition and in structural vegetation components that depend on age, particularly canopy height and basal area. There appears to be no relationship between these vegetation aspects and the suitability of the habitat for Bell's Vireos.

Higher shrub counts were obtained at Fallbrook and Pala Mesa than at Bonsall. The average number of shrub stems at nest sites was higher than the randomly sampled points. Both of the sites which supported vireos have significantly higher foliage densities at a height of 1.5 m, and within a layer between 0.6 and 3.0 m. These correspond to the most important levels of the vegetation for nesting. This suggests that the critical structural component for the vireos is the presence of a dense shrub layer at a level of 0.6 to 3.0 m.

The dominant understory species on all sites were Arroyo Willow and young Red Willow. The proportions of each species appear to be related to the relative age of the vegetation. Arroyo Willow is especially abundant in young stands.

Ground cover has no apparent effect on the value of habitat for nesting vireos, but may reflect the higher overall density of vegetation at low levels. Similarly, canopy cover is relatively unimportant in determining desirable nesting areas. However, shrubby understory plants may flourish in the absence of a dense canopy, thus providing more suitable nesting sites.

Willows are chosen most frequently as nest sites, although nearly all other common riparian shrub species are used. The frequency with which a given plant is chosen seems to be consistent with the relative abundance of shrubs growing in riparian woodlands. There is no obvious preference for any of the uncommon shrubs as nest sites and no apparent avoidance of the abundant species such as willows.

The foraging observations collected during this study are too few to be conclusive, however they provide a rough idea of the species and levels of vegetation used during feeding. These observations are biased towards singing males, whose activities are most easily observed. Females of some vireo species are known to forage at lower heights than males (Williamson 1971). Bell's Vireos may also follow this pattern. If so, then foraging by females probably occurs in the same low understory region used for nesting.

It appears that Bell's Vireos are not limited to riparian habitat of a specific age. In mature riparian woodlands, the vireos nest where a healthy understory of young willows and other species are present. In addition, willows bent over or uprooted by flooding often resprout from the prostrate trunks, forming clumps of shrubby young branches typical of good nesting habitat. If allowed to grow without restriction, willows and other riparian species form dense thickets

within a period of 5 to 10 years. This type of habitat is used extensively by vireos nesting along the San Luis Rey River.

Least Bell's Vireo habitat encompasses a wide range of vegetation characteristics such as the age of the stand, species composition and density of trees. The most important features discerned in this study are the presence of a dense understory below 3 m, including shrub stem counts averaging 5500 stems/ha, and the high foliage densities associated with abundant shrubs.

ACKNOWLEDGMENTS

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LITERATURE CITED

Goldwasser, S. 1978. Distribution, reproductive success and impact of nest parasitism by Brown-headed Cowbirds on Least Bell's Vireos. California Dep. Fish and Game, Final Rep. Proj. W-54-R-10, Job IV-1.5.1.

Grinnell, J., and A. H. Miller. 1944. The distribution of the birds of California. Pacific Coast Avifauna 27.

Grinnell, J., and T. I. Storer. 1924. Animal life in the Yosemite. Univ. Calif., Berkeley. 752 p.

James, F. 1971. Ordination of habitat relationships among breeding birds. Wilson Bulletin 47:215-236.

James, F., and H. Shugart. 1970. A quantitative method of habitat description. Audubon Field Notes 24:727-736.

MacArthur, R. H., and J. W. MacArthur. 1961. On bird species diversity. Ecology 42:594-598.

Sturman, W. 1968. The foraging ecology of Parus atricapillus and P. rufescens in the breeding season, with comparisons with other species of Parus. Condor 70:309-322.

Tyler, J. G. 1913. Some birds of the Fresno district, California. Pacific Coast Avifauna 9.

Williamson, P. 1971. Feeding ecology of the Red-eyed Vireo (Vireo olivaceous) and assorted foliage gleaning birds. Ecological Monographs 41:129-152.