CHARACTERISTICS OF LEAST BELL'S VIREO NEST SITES ALONG THE SANTA YNEZ RIVER[1]

Thomas E. Olson and M. Violet Gray [2]

*Abstract: Due primarily to alteration of riparian vegetation and nest parasitism by brown-headed cowbirds (*Molothrus ater*), the least Bell's vireo (*Vireo bellii pusillus*) has undergone a tremendous decline in range and numbers since the 1920's. In 1987, we sampled vegetation at 32 nest sites to characterize nesting habitat of least Bell's vireos in the Santa Ynez River drainage. Most next (59.4%) were located in willows (*Salix spp.*) or mugwort (*Artemisia douglasiana*) at heights of less than 1 m. Vireos selected sites with relatively dense vegetative cover in the vicinity of the nests. Herbaceous species and dead plant material comprised much of the nesting cover.*

The least Bell's vireo nests in California and northwestern Baja California, and winters in southern Baja California. It is one of four recognized subspecies of Bell's vireo (*Vireo bellii*)(American Ornithologists' Union 1983). Nests are usually constructed in dense, willow-dominated riparian vegetation within 3 m of the ground.

Although formerly a common to abundant breeding species in the Central Valley and other low-elevation riparian zones in California, the least Bell's vireo has undergone a dramatic decline in abundance and distribution. Despite a substantial decrease in numbers that began as early as the 1920s, this species was still widely distributed within California in the 1940s, extending northward to Red Bluff, Tehama County (Grinnell and Miller 1944). Since that time, the number and breeding range of least Bell's vireos have steadily decreased, with all northern California populations believed to be extirpated by 1970 (Goldwasser and others 1980). The decline has been attributed primarily to: (1) alteration and destruction of riparian vegetation that comprises suitable breeding habitat; and (2) nest parasitism by brown-headed cowbirds. Because of this decline, the least Bell's vireo is a state-and federal-listed endangered species.

The population in California in 1985 was estimated at approximately 300 pairs, based primarily on surveys conducted during the previous 12 years by Gaines (1974, 1977), Goldwasser (1978, 1981), Goldwasser and others (1980), and Gray and Greaves (1984). Nearly 20 percent of that total occurred along the Santa Ynez River in Santa Barbara County.

Continued residential and industrial development in southern and central California has increased the demand for water projects that could result in further alteration of least Bell's vireo nesting habitat. Information about this endangered species must be developed to resolve current and future conflicts between the demands of an increasing human population and habitat requirements of the least Bell's vireo. Such information will be necessary to mitigate adverse effects to vireos. The objective of this study was to characterize nest sites of least Bell's vireos and to describe trends in use of nesting habitat within the Santa Ynez River drainage.

Study Area and Methods

We sampled vegetation at 32 least Bell's vireo nest sites in 1987 along the Santa Ynez River in Santa Barbara County (fig. 1). The study area was located approximately 10 km north of Santa Barbara and included the eastern end of Gibraltar Reservoir, a 3-km portion of the Santa Ynez River upstream from the reservoir, and Mono Creek from its confluence with the Santa Ynez River to the Mono Debris Basin.

Approximately 240 ha of suitable vireo breeding habitat occurred in the study area. Riparian vegetation types included cottonwood forest, willow woodland, riparian scrub, and dry wash. Dominant overstory species were Fremont cottonwood (*Populus fremontii*), arroyo willow (*Salix lasiolepis*), and red willow (*S. laevigata*). Common species in a diverse understory included mugwort (*Artemisia douglasiana*), mule fat (*Baccharis salicifolia*), and willow (*Salix* spp.) shrubs. Adjacent vegetation types were primarily chaparral, with smaller areas of oak woodland. Unlike most areas where least Bell's vireos nest in California, this study area was completely publicly owned and administered (United States Forest Service and the City of Santa Barbara). As such, little disturbance occurred in the study area and surrounding buffer areas.

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[2] Terrestrial Biologist, Dames & Moore, Goleta, California; Independent Consultant, Santa Barbara, California.

Figure 1– The study area was located along Gibraltar Reservoir, the Santa Ynez River, and Mono Creek in Santa Barbara County, California.

Vegetation was sampled at 18 successful and 14 unsuccessful least Bell's vireo nest sites using methodology modified from James (1971). Similar methodology has been used in other studies of least Bell's vireos. Successful nests were defined as those from which at least one young vireo fledged. At each nest site, a 0.04-ha circle was established, centered on the nest. In addition, two 20-m by 2-m transects were established across the circle. These transects were oriented parallel and perpendicular to the main stream channel and were divided into 10 cells, each 2 m by 2 m. All vegetation sampling was done after nesting activity had ceased.

Data collection was completed in three parts: At the nest, within the 0.04-ha circle, and along the 20-m by 2-m transects. The species and height of the nest substrate plants were recorded, as well as the height of the nest above the ground.

Within the 0.04-ha circle, the species, height, and diameter at breast height (DBH) of all trees (DBH $\geq$ 7.5 cm) were noted. The physical and vegetative characteristics of the habitat were diagramatically sketched and qualitatively described.

Along the two transects, we determined stem density by counting the number of stems of forbs, shrubs, and young trees (DBH < 7.5 cm) within each cell. Vertical foliage density was measured along the transects by placing a 4-m sampling rod at the edge of each cell farthest from the nest. Plant species (leaves or stems) impinging upon the sampling rod were recorded as "foliage hits" in five height intervals: 0-0.2 m, 0.2-1.0 m, 1.0-2.0 m, 2.0-4.0 m, and >4.0 m. Hits in the latter interval were visually estimated. Foliage density in each height interval at a given nest site was represented by the total number of hits at 20 stops (sampling points).

Results

In 1987, least Bell's vireo nests in the study area were generally located in vegetation characterized by riparian species. Nineteen (59 percent) nest sites, however, occurred on flood plain terraces 2-5 m above the level of the main river channel. Those nests were located 10-200 m laterally from the nearest edge of the channel and were situated in vegetation cover that also included upland species, such as summer mustard (*Brassica geniculata*), coast live oak (*Quercus agrifolia*), star thistle (*Centaurea solstitialis*), and annual grasses. In constrast, only 10 (31 percent) nests were located within 3 m of the main river channel.

Eleven different plant species were used as nest substrate (table 1). Nineteen of 32 nests (59.4 percent) occurred in 4 species: arroyo willow, red willow, narrowleaf willow (*Salix exigua*), and mugwort. The remaining 13 (40.6 percent) nests were located in 7 different species. The species of substrate plant used did not influence nesting success ($x^2, P > 0.50$).

Most nests were situated at relatively low heights. Mean nest height was 70.6 $\pm$ 3.5 cm (table 2). There was no difference between mean nest height of successful (66.3 cm) and unsuccessful (72.8 cm) nests ($t, 0.20 < P < 0.40$). Although nearly half of all nests were located in willow species which are capable of developing into large canopy trees, mean total height of all nest substrate plants was only 2.8 $\pm$ 0.4m. Vireos used a variety of growth forms as nest substrate, including shrubs, upright trees, and trees previously downed in floods that continued to grow horizontally. Mean height of substrate plants did not differ between successful (2.6 m) and unsuccessful (2.9 m) nests ($t, P > 0.50$). Nest height expressed as percent of total height of the nest substrate plant varied considerably. The mean was 32.5 $\pm$ 3.0 percent, with a range of 4-78 percent. Mean values for successful (32.4 percent) and unsuccessful (32.6 percent) nests were similar ($t, P > 0.50$).

Table 1 – Plant species used by least Bell's vireos as nest substrate, Santa Ynez River, 1987.

Species	Number of nests: Successful	Number of nests: Unsuccessful	All nests	Percent of total
Arroyo willow *Salix lasiolepis*	4	2	6	18.9
Red willow *S. laevigata*	3	2	5	15.6
Narrowleaf willow *S. exigua*	3	1	4	12.5
Mugwort *Artemisia douglasiana*	1	3	4	12.5
Mule fat *Baccharis salicifolia*	2	1	3	9.4
Fremont cottonwood *Populus fremontii*	0	3	3	9.4
California blackberry *Rubus ursinus*	2	0	2	6.2
Summer mustard *Brassica geniculata*	1	0	1	3.1
Star thistle *Centaurea solstitialis*	1	0	1	3.1
Coast live oak *Quercus agrifolia*	0	1	1	3.1
California wild rose *Rosa californica*	0	1	1	3.1
California blackberry *Rubus ursinus*-mugwort *Artemisia douglasiana*	1	0	1	3.1
Total	18	14	32	100.0

Table 2 – Height of nests and substrate plants, Santa Ynez River, 1987.

Nest Characteristic	Mean Successful (n=18)	Mean Unsuccessful (n=14)	Mean All nests (n=32)	Range for all nests
Height of nest above ground (cm)	66.3	72.8	70.6	37-118
Total height of substrate plant (m)	2.6	2.9	2.8	0.8-12.2
Nest height as pct of substrate plant height	32.4	32.6	32.5	4-78

Although the density of foliage within different height intervals at the nest sites was relatively constant, greatest density at successful and unsuccessful nests occurred from 0.2 to 1.0 m (fig. 2) Below 1.0 m, mugwort and summer mustard contributed most to foliage density. Above 1.0 m, foliage density was comprised mostly of mule fat, Fremont cottonwood, and willows. Similar to foliage density, plant species richness was somewhat greater in the 0.2-1.0 m interval than in other intervals. Overall number of species encountered within various height intervals at all nest sites included 20 at 0-0.2 m, 22 at 0.2-1.0 m, 18 at 1.0-2.0 m, 14 at 2.0-4.0 m, and 7 over 4.0 m.

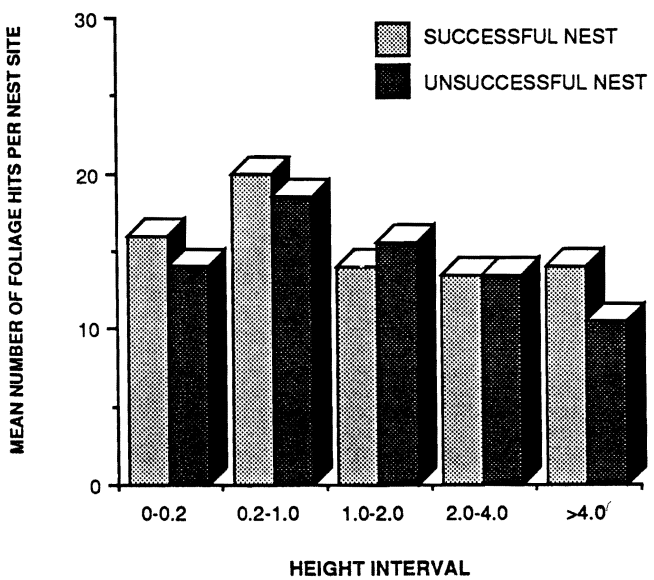

Figure 2– Vertical foliage density at successful and unsuccessful nest sites as expressed by the mean of foliage hits per nest site, Santa Ynez River, 1987.

Density and species richness of foliage at various height intervals were similar between successful and unsuccessful nests. However, mean species richness in the 0.2-1.0 m interval was greater at successful nest sites (5.2) than at unsuccessful nest sites (4.1) ($t, 0.02 < P < 0.05$), perhaps indicating better nesting cover at the former sites. An apparent difference noted in the >4.0 m interval (13.5 foliage hits per successful site, compared to 10.5 foliage hits per unsuccessful site) was not significant ($t, 0.20 < P < 0.30$).

The mean stem density of herbs, shrubs, and saplings (< 7.5 cm diameter) at breast height for the 32 nest sites was $45,668 \pm 619$ per ha. The range of stem densities was considerable: 6,875-190,000 stems per ha. Mean stem densities at successful ($42,305 \pm 4317$ stems per ha) and unsuccessful ($49,991 \pm 13,239$ stems per ha) nests were not different ($t, P > 0.50$). Of 23 plant species recorded at breast height, 6 accounted for 79 (successful nests) to 89 (unsuccessful nests) percent of all stems: mugwort, narrowleaf willow, mule fat, arroyo willow, white sweetclover (*Melilotus albus*), and summer mustard (fig. 3). Thirty-four percent of the stems recorded at all nest sites were dead, primarily mugwort, with lesser amounts of mule fat, summer mustard, willows, and star thistle. The proportion of stems that were dead did not differ between successful (33 percent) and unsuccessful (36 percent) nests ($t, P > 0.50$).

The density of trees (DBH > 7.5 cm) at nest sites averaged 376.5 ± 53.2 per ha, of which 309 (82 percent) were live. Densities of trees at successful (393.1/ha) and unsuccessful (355.4/ha) nest sites were not different (table 3; $t, P > 0.50$). Size of trees varied, with an average height of 8.3 m (range = 1.8-18.3 m) and a mean DBH of 15.5 cm (range = 8.0-50.0 cm). Although trees at successful and unsuccessful nest sites were similar in mean height, mean DBH differed. Trees at successful nest sites were significantly greater in mean DBH than at unsuccessful nest sites ($t, P < 0.01$). Dominant trees at all nest sites were red willow, arroyo willow, and Fremont cottonwood. Cottonwoods and sycamores were the tallest canopy species, and coast live oaks had the greatest mean DBH. Most nests were located under extensive overhead tree density; at 19 of 32 nest sites, more than 10 trees were present within the 0.04-ha sampling circle.

Discussion

Vegetative cover at least Bell's vireo nest sites in 1987 was comprised not only of riparian plants, but also of several upland species. Despite the use of varied sites, most nests were constructed near open water in washes and the main stream channel. Proximity to open water may be an important factor in food (insect) availability.

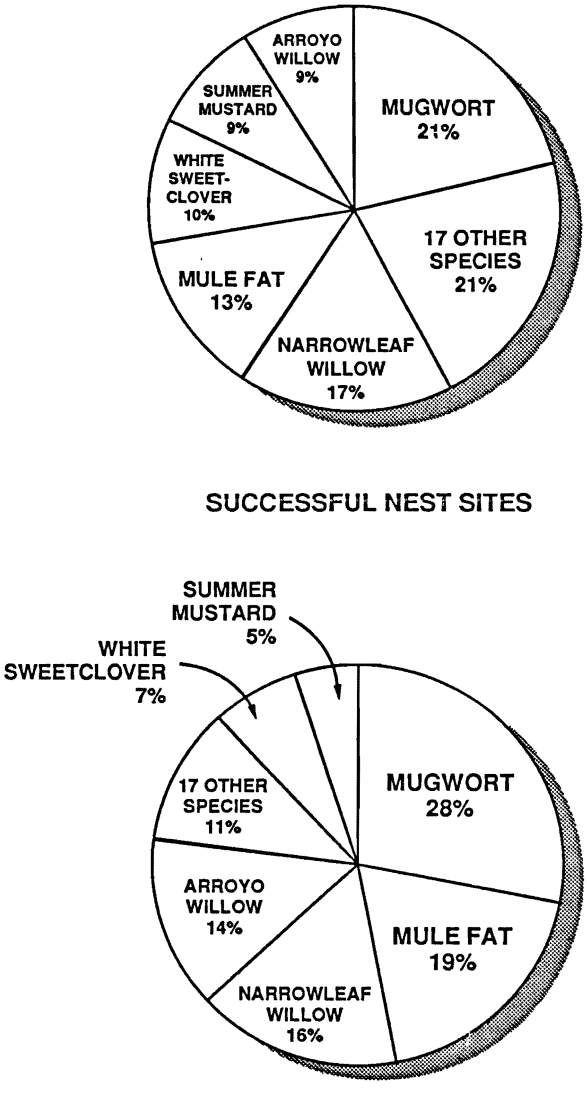

Figure 3– Stems encountered at breast height along 20-m by 2-m transects at successful and unsuccessful nest sites by species, Santa Ynez River, 1987.

We found that the use of plant species as nest substrate was not proportionate to their availability. Vireos selected 3 species of willows (arroyo, red, narrowleaf) as nest substrate over more dominant plants, particularly mugwort and summer mustard. Within the 0.2-1.0 m height interval (in which 30 of 32 nests were constructed), mugwort and summer mustard accounted for 54.4 percent of all foliage hits at nest sites, compared to percentages of 21.2 for the 3 species of willows and 24.4 for all other species. However, nearly half (47.0 percent) of all vireo nests were situated in willows. Nests constructed in mugwort and summer mustard accounted for only 18.7 percent of all 1987 nests. The remaining nests (34.3 percent) were in 6 other plant species. Using a statistical technique suggested by Neu and others (1974), we determined that the disproportionate use of plant species as nest substrate was significant ($x^2, P < 0.01$) and that vireos preferred willows while avoiding mugwort and summer mustard (Bonferroni Z statistic, 90 percent family confidence coefficient). The selection of willows as nest substrate suggests a preference for rigid structural support for construction of nests.

Vireos in the study area appeared to construct nests and were more successful in a height interval that provided a high degree of vegetative cover. Thirty of 32 nests (94 percent) were located at heights between 0.2 and 1.0 m where foliage density and plant species richness were greatest. Height of nests, size of substrate plants and foliage density within the 0.2-1.0 m interval did not affect nesting success. We did, however, observe higher plant species richness in that interval at successful nest sites (average number of species = 5.2) than at unsuccessful nest sites (4.1) ($t, 0.02 < P < 0.05$).

Mean height of nests in this study area during 1981 (the only other year in which comparable data were collected) (Gray and Greaves 1984) was 64 cm, similar to our findings. In contrast, mean nest heights elsewhere have been substantially higher, including 1.0 m at several northern San Diego County sites (Goldwasser 1981); 1.0 m at Camp Pendleton, also in San Diego County (Salata 1983); and 1.2-1.3 m at Prado Basin, Orange County (Zembal 1985, Collins and others 1986).

The variation in mean nest height among southern California populations of least Bell's vireos may support our finding of a preference for dense cover in the vicinity of the nest. Vegetation structure at some other study areas in California is different, possibly lacking a dense understory below 1.0 m (J. Greaves, pers. comm., 1988; Gray, pers. obs.). Overmire (1963) found that the midwestern subspecies of Bell's vireo (*Vireo bellii bellii*) nested in Oklahoma at greater heights in grazed areas where understory vegetation had been reduced. Mean number of stems per ha at breast height at Camp Pendleton (134,541) was nearly three times as great as that recorded in this study area (45,668), perhaps reflecting denser, more complex vegetation at a higher interval within the understory at the former study area. Other investigators have reported much lower mean stem densities, including 5500 stems per ha in San Diego County (Goldwasser 1981) and 9914 stems per ha at Prado Basin (Zembal 1986).

Table 3 – Density and size of trees at least Bell's vireo nest sites, Santa Ynez River, 1987[1].

Species	Successful nests (n=18)			Unsuccessful nests (n=14)		
	Number per ha	Mean height (m)	Mean DBH[2] (cm)	Number per ha	Mean height (m)	Mean DBH[2] (cm)
Western sycamore	2.8	9.9	14.0			
Fremont cottonwood	123.6	10.2	19.0	128.6	10.2	16.7
Coast live oak	16.7	8.0	35.9	14.3	6.2	21.0
Narrowleaf willow	1.4	4.6	9.0			
Red willow	220.8	7.4	15.4	150.0	7.1	13.2
Arroyo willow	22.2	7.0	10.6	150.0	6.4	10.5
Other	5.6	9.1	24.0			
Total	393.1	8.4	17.2	355.4	8.1	14.3

[1]Based on occurrence of trees (DBH $\geq$ 7.5 cm) within a 0.04-ha circle, centered on the nest site.
[2]DBH = diameter at breast height.

Interestingly, overhead cover at most nest sites, especially in the 1.0-2.0 m interval, was not comprised entirely of live, woody plant material. Counts of stems/ha at breast height indicated that herbaceous species, particularly mugwort and white sweetclover, accounted for a substantial proportion of overhead cover (fig. 3). In addition, approximately 34 percent of all stems (herbaceous and woody) recorded at breast height were dead, as were 21 percent of the foliage hits in the 0.2-1.0 m height interval.

Overstory tree density which provides overhead cover also appears to be an important component of nesting cover. Nearly all nest sites were under some degree of overhead cover from trees of different size classes, especially red willow and Fremont cottonwood. Of 32 nest sites, 19 (59 percent) were under a dense canopy where $\geq$10 trees occurred within the 0.04-ha circle. Two other findings also suggest a need for overhead cover. First, within the nest substrate plant, nests were usually located in the bottom half (nest height averaged 32 percent of total height of plant). In addition, trees at successful nest sites were significantly greater in DBH than those at unsuccessful nest sites; trees in older age classes may provide more cover. A combination of cover in the vicinity of the nest and overhead cover may be important for protection from terrestrial and avian predators. Although foliage densities in the 0.2-1.0 m (vicinity of nest) height interval were similar for successful and unsuccessful nest sites, plant species richness differed. Successful nest sites contained a higher species richness between 0.2 and 1.0 m, perhaps indicating a higher degree of cryptic cover.

Conclusions

We conclude that several components of the Santa Ynez River riparian zone appear to be important for least Bell's vireo nesting habitat. These components include:

1. Minimally disturbed vegetation types adjacent to the riparian zone. Many nests were located at edges between riparian and upland vegetation types. These adjacent areas are often sites of foraging by adult and fledgling least Bell's vireos (Gray and Greaves 1984) and can act as a buffer zone between vireo breeding habitat and disturbed areas.
2. Complex vegetation, including high plant species richness and stem density below 2.0 m for actual and cryptic cover at the nest site. A substantial proportion of the vegetation in this height interval may be comprised of herbaceous species or dead material of woody and herbaceous species.
3. Shrubby willows in the understory to provide rigid structural support for nests.
4. A relatively high overstory tree density comprised mostly of Fremont cottonwoods and willows which provides a dense overstory canopy. A relatively higher proportion of the trees should be from older age classes.

Our results generally agree with those of other studies of least Bell's vireos. Goldwasser (1981) and Salata (1983) believed that structure and composition of vegetation below 3 and 4 m, respectively, were critical. Salata (1983) also reported the importance of a mix of tree size classes, with a mean height of 8 m. Gray and Greaves (1984) recommended protection of ground cover and low shrub layers. Additional research is needed to

identify specific habitat requirements necessary for mitigation and revegetation plans.

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