Assistance with the 5-Year Review of the Valley elderberry longhorn beetle *(Desmocerus californicus dimorphus)*

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For: U.S. Fish and Wildlife Service
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Assistance with the 5-YEAR REVIEW

Species reviewed: valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*)

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ASSISTANCE WITH THE 5-YEAR REVIEW
valley elderberry longhorn beetle
Desmocerus californicus dimorphus

1. GENERAL INFORMATION

1.1. Methodology used to complete the assistance report

- Assistance Team. This report was the effort of a three-person team, with expertise in the valley elderberry longhorn beetle, Central Valley ecology and landscape change, and regulatory practices.
- Concurrent review. As drafts of the assistance report were completed they were reviewed by FWS and returned for revision.
- Documents used. Both peer-reviewed and non-peer reviewed publications were used, with weight accorded to the information being determined by its corresponding support by other accumulated data. Unpublished data was generally avoided but where essential it is documented in the administrative record (for example, personal communications).
- Other pertinent information. Statistical analyses conducted for this report used procedures available in Microsoft Excel and G-Power.

1.2 USFWS contacts

Sacramento Fish and Wildlife Service Office
Craig W. Aubrey
Recovery Branch Chief
U.S. Fish and Wildlife Service - SFWO
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Sacramento, California 95825-1846
Phone: (916) 414-6742
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1.3 Background- FR Notice citation announcing initiation of the review:

Federal Register: July 7, 2005, Vol. 70, No. 129, Pp 39327-39329

1.4 Listing history

FR notice: Vol. 45, No. 155, Pp 29373-29375
Date listed: Friday, August 8, 1980
Entity listed (*species, subspecies, DPS*): *Desmocerus californicus dimorphus*
Classification (*threatened or endangered*): threatened

1.5 Associated rulemakings- Critical habitat

FR notice: Vol. 45, No. 155, Pp 52803-52807
Date listed: Friday, August 8, 1980
Locations: California, Sacramento County
(1) Sacramento Zone. An area in the city of Sacramento enclosed on the north by Route 160 freeway, on the west and southwest by the Western Pacific railroad

tracks, and on the east by Commerce Circle and its extension southward to the railroad tracks.

(2) American River Parkway Zone. An area of the American River Parkway on the south bank of the American River, bounded on the north by latitude 30°37'30"N, on the west and southwest by Elmanto Drive from its junction with Ambassador Drive to its extension to latitude 38°37'30", and on the south and east by Ambassador Drive and its extension north to latitude 38°37'30". Goethe Park, and that portion of the American River Parkway northeast of Goethe Park, west of the Jedediah Smith Memorial Bicycle Trail, and north to a line extended eastward from Palm Drive.

1.6 Review History (*in chronological order, the most recent agency status review(s), 5-year review(s), other relevant reviews/documents*:

1984 Recovery Plan

Compensation/Conservation Guidelines (all versions)

Barr 1991

Jason Douglas memo, SFWO, July 10, 2000 (Douglas 2000)

1.7 Recovery Plan or Outline

Name of plan: Recovery Plan, Valley Elderberry Longhorn Beetle

Date issued: 8 June 1984

Dates of previous revisions: N/A

2. ASSISTANCE REPORT

2.1 Updated Biological Information

2.1.1. Taxonomy and Distribution.

As mentioned in the recovery plan (USFWS 1984; and references therein each), three species of *Desmocerus* can be found in North America (Linsley and Chemsak 1972)- *D. palliatus* occurs in the northeastern half of the U.S. and eastern Canada (NHESP 1992); *D. auripennis* with subspecies spanning the western U.S. and British Columbia (Monné and Hovore 2005); and D. *californicus* found throughout California's Central Valley and coastal range (Halstead and Oldham 2000, Bezark 2005). All species use species of elderberry (*Sambucus* spp.) as host plants (Linsley and Chemsak 1972, USFWS 1984). Two subspecies of *D. californicus* have been described- *D. c. californicus* Horn (California elderberry longhorn beetle, "CELB"), which lives coastally from Los Angeles to Mendocino County (USFWS 1984); and *D.c. dimorphus* Fisher (Valley elderberry longhorn beetle, "VELB"), which is endemic to the Central Valley. *D. californicus* was more recently recorded from as far south as San Diego (Halstead and Oldham 2000).

While CELB male and female adults resemble each other with a dark metallic green to black elytra and a bright red border, VELB males and females differ. The VELB females appear similar to the CELB while the males have elytra that are predominantly red with 4 oblong, dark metallic spots. Intergrades of the two color patterns exist (USFWS 1984, Halstead and Oldham 1990). Halstead and Oldham (2000) state that the VELB may simply be a color morph of the CELB so that subspecies status in unwarranted. At least several beetle experts do not agree with this assessment (Hovore 2000, Chemsak 2006, Rogers 2006) and believe them to be separate subspecies with the presence of intergrades in areas of overlap (USFWS 1984). Such hybrid zones are a common phenomenon in areas where two similar species or subspecies meet (Barton and Hewitt 1985). Counter to their own conclusion, the work of Halstead and Oldham (1990) appears to support the existence of two, fairly distinct types of ELB. They found that males from outside the proposed historic range have 85-95% black coloration on their elytra (total n=166). Of the males found in the Sacramento Valley, 80% of males have elytra that are 66% or less black coloration and 20% are 67-95% black (total n=56; no breakdown given for the 85-95% black color range). The values of elytra color for ELB appear, therefore, to be bimodal and not that of a gradient. Halstead and Oldham (1990) found no significant differences in body size between CELB and VELB, although power analysis performed for this report on data taken from their Table 2 revealed that only extremely large effects could have been detected using the sample sizes available*. CELB tended to have larger body length, elytra length and elytra width than VELB while eltyra length to width ratios were similar between VELB and CELB. Finally, antennal hair color was dark in all but one *D.c. californicus* individuals and pale in 82% of VELB males and 67% of VELB females (Halstead and Oldham 1990) again demonstrating bimodal distributions of this trait. Small numbers of specimens limit our ability to distinguish statistically sound differences between these two types. Furthermore, the causal or correlative relationships between these traits and reproduction and isolation are uncertain. It is therefore uncertain whether these are appropriate traits to use to distinguish potential subspecies.

The distribution of exit holes across counties within the hypothesized range of the VELB has not changed since Barr’s 1991 report (CNDDB 2006). The distribution of VELB based on sightings or collections of typically colored adult males is, however, smaller than that of exit holes (Figure 1) ranging from Tehama Co. to the north (40.16146 N latitude; CNDDB Occurrence record 133) and the west (122.17833 W Longitude; Occurrence record 171), Fresno Co. to the east and south (36.72101 N Latitude, 119.46247 W longitude; Occurrence record 165) (CNDDB 2006). However, one VELB-colored male adult was observed in the coast range although this is not published or registered with CNDDB (Rogers 2006).

The ranges of the CELB and VELB may abut oroverlap along the eastern edge of the coast range and in southern San Joaquin Valley, with both typically VELB- and CELB-colored males observed in the following counties: Colusa, Yolo, San Joaquin, Mariposa, Merced, and Fresno (Halstead and Oldham 1990, Barr 1991, Halstead and Oldham 2000, CNDDB 2006, Talley 2006, Weintraub 2006, Wright 2006) (Figure 1). While the VELB has been reported to occur in Kern and Tulare Counties, no typically colored male specimens have been observed or collected from Tulare Co. (Kaweah Oaks Preserve 2003, occurrence records 66, 154 in CNDDB 2006, Haines 2006) and no adult specimens exist for K*ern Co. despite previous claims (see Section 2.1.3).

Atypically colored (predominantly dark) males were additionally observed toward the center and eastern end of the VELB’s range. Atypical males were collected from Sacramento Co. by Eya in 1975 (Rogers 2006) and from Davis, CA by B.E. White in the 1934 (Rogers 2006, Talley 2006). One dark male each during 2003 and 2004 were observed in a mitigation bank in Placer Co along the eastern edge of the VELB’s range (CNDDB 2006, Ehrhardt 2006). Although elderberry transplants that might harbor ELB larvae are brought to the mitigation bank from within the bank’s delimited service area, it is possible that one or more were from the intergrade

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* Due to the variability of these data and the low sample sizes, effect sizes (d) for the variables examined were 1.37-1.58. By comparison, the conventional value for data that could reveal a large effect is about 0.80, a medium effect is 0.50, and a small effect is 0.20 (Buchner et al. 2001).

zone and contained CELB or intergrades. It is also possible that atypical individuals arrived on their own since the presence of atypicals has been observed in counties, such as Yolo and Sacramento, that lie between Placer Co. and the coast range, and before the existence of mitigation sites or banks (1934 and 1975). These are currently the only two adult male specimens from Placer Co.

Figure 1. Distribution of elderberry longhorn beetles (*Desmocerus californicus dimorphus* and *D. c. californicus*) based on museum specimens and recorded sightings of male adults within California's Central Valley, the presumed historic range of the *D. c. dimorphus.* V= adult male had typical VELB coloration (predominantly red), C= adult male had atypical coloration (predominantly black). Exit holes were reported in all Central Valley counties, from Shasta to Kern Co. and *D. c. californicus* adults are reported from most coastal and southern California counties (not shown).

The difference in local, seasonal climate between the Central Valley and the coastal range encourages asynchronization of the phenology of VELB and CELB (e.g., different emergence times) and their host plants (e.g., different flowering times) throughout most of the two ranges. This supports the idea that populations of each variety are mostly isolated in space and time but that there are likely areas of overlap. The extent to which the two interbreed is still uncertain. Since the adults are too rare in space and time to observe and compare directly, genetic analyses would be useful for determining amounts of isolation or mixing between the VELB and CELB. In what seems to be the core geographic area, from Tehama to Fresno Co., there appear to be many fewer atypically colored specimens compared to the number of typical specimens. Large numbers of atypical specimens occurring over large geographic areas might be expected if a gradient in coloration did exist. While data pertaining to this are sparse, the bulk of evidence currently points to two distinct types as might be expected for subspecies. To reassess this with complete accuracy would require genetic information. Regardless of the outcome of the 5-year review, we recommend a systematic geographic morphological and genetic study to respond to questions about the subspecific differentiation of *D. californicus*. Without such a study it is likely that the distributional boundaries of the subspecies will remain a subject of conflict.

2.1.2. Biology and Ecology

2.1.2.1. Life History

Adult VELB live for a few days to a few weeks between mid-March and mid-May (Davis and Comstock 1924, Linsley and Chemsak 1972, USFWS 1984) with most records from late-April to mid-May (Arnold 1984b, USFWS 1984, Halstead and Oldham 1990, Talley 2003a). Adults feed on elderberry leaves (Eya 1976, Arnold 1984b, Barr 1991, Talley 2003a) and possibly flowers although this has only been observed for *D. palliatus* (Linsley and Chemsak 1972, Arnold 1984b, USFWS 1984). Adults mate within the canopy and females deposit eggs on the surface of leaves or in crevices of bark or stem/petiole junctions (Linsley and Chemsak 1972, USFWS 1984, Halstead and Oldham 1990, Barr 1991, Talley 2003a). Females appear to be not particular about where they deposit eggs as long as they were in close proximity of elderberry (within cm's) (Talley 2003a). Oviposition was observed to occur on a green suckering shoot, on a dried up leaf (Halstead and Oldham 1990), on the sides of glass or screen cages, and on a piece of paper towel (Arnold 1984a, Talley 2003a). Records of number of eggs per female in captivity vary from several to 180 (Burke 1921, Arnold 1984a, Barr 1991, Talley 2003a). The causes of differences in egg production are unknown but may include the life span and/or health of the female, whether in captivity or not, and site specificity or chance. Halstead and Oldham (1990) observed two caged females from the Kings River producing 140 eggs combined and another from Merced River producing 16 eggs. Barr (1991) observed one female that laid 80 or more eggs of which about half hatched, and another female that laid 110 eggs. Talley (2003) observed 136 larvae, with an additional 44 eggs that never hatched, all from one female. Hatching success may therefore be roughly between 50-67% of eggs laid. Survival rates of the larvae are still unknown.

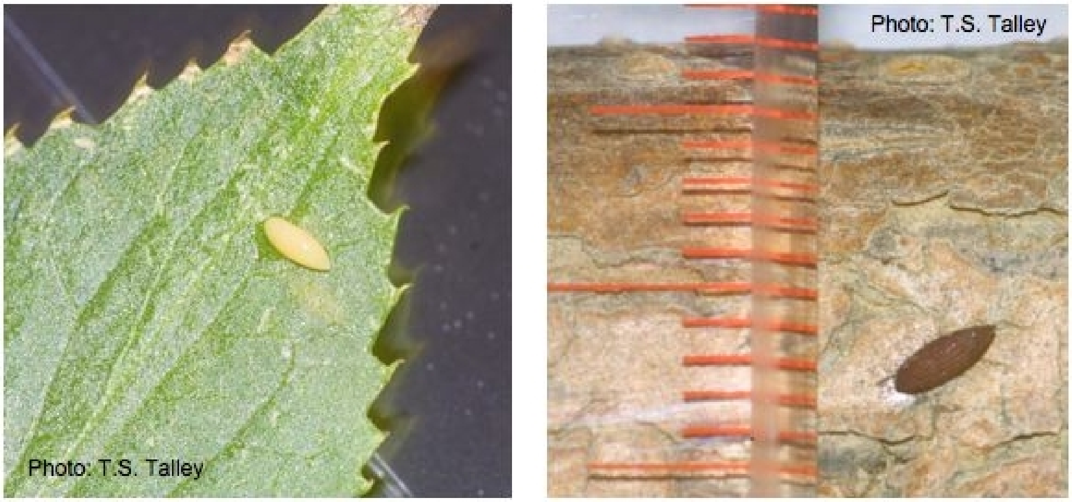

Figure 2. Eggs of the Valley elderberry longhorn beetle. Eggs are bright yellow shortly after oviposition and turn dark red to brown after exposure. Both are ca. 3 mm long.

Eggs are oblong, about 1x3 mm in size. They are initially white (Burke 1921, Halstead and Oldham 1990, Barr 1991) to bright yellow (Talley 2003a) (Figure 2) and then darken to tan and then a reddish brown (Burke 1921, Arnold 1984b, Barr 1991, Talley 2003a) (Figure 2). Eggs hatch within a few days (Linsley and Chemsak 1972, USFWS 1984, Talley 2003a) and bright yellow, soft bodied larvae emerge (Figure 3).

Figure 3. Larvae of the Valley elderberry longhorn beetle. Larva to the left is 1-2 days old, to the right 4-5 days old. Both are 3-4 mm long.

The first instar larvae, which may be exposed on the surface of a shrub from a few minutes to several hours or a day (Halstead and Oldham 1990), bore to the center of elderberry stems where they create a characteristic feeding gallery in the pith at the center of the stem (Davis and Comstock 1924, Lang et al. 1989, Barr 1991). The larvae develop for 1 or 2 years feeding on pith (Burke 1921, Linsley and Chemsak 1972, Eya 1976, USFWS 1984, Halstead and Oldham 1990) and leaving behind frass (droppings and wood shavings) (Barr 1991). Only one larva inhabits each feeding gallery but the presence of multiple larvae per stem can occur if the stem is large enough to accommodate multiple galleries. The late (fifth) instar larvae chew through the inner bark (Halstead and Oldham 1990), all or most of the way to the surface (Figure 4), then return inside plugging the holes with wood shavings (Figure 4). The larvae move back down the feeding gallery to an enlarged pupal chamber (Halstead and Oldham 1990) packed with frass (Barr 1991). Here, the larvae metamorphose into pupae between December and April (Burke 1921, Davis and Comstock 1924).

The length of pupation is thought to be about one month with the emergent adult remaining in the chamber for up to several weeks (Burke 1921). Adults complete the hole in the outer bark (Figure 4) and emerge during the flowering season of elderberry, between mid-March and mid-June (Davis and Comstock 1924, Linsley and Chemsak 1972, USFWS 1984). The holes are circular to oval and range in size from 4-10 mm diameter (Figure 4) (Arnold 1984b, Lang et al. 1989, Halstead and Oldham 1990, Barr 1991). The VELB is the organism most likely to create these characteristic holes in live elderberry stems in the Central Valley (Lang et al. 1989, Barr 1991). Holes eventually heal, but distinct scars remain for several to many years, depending upon shrub growth rates.

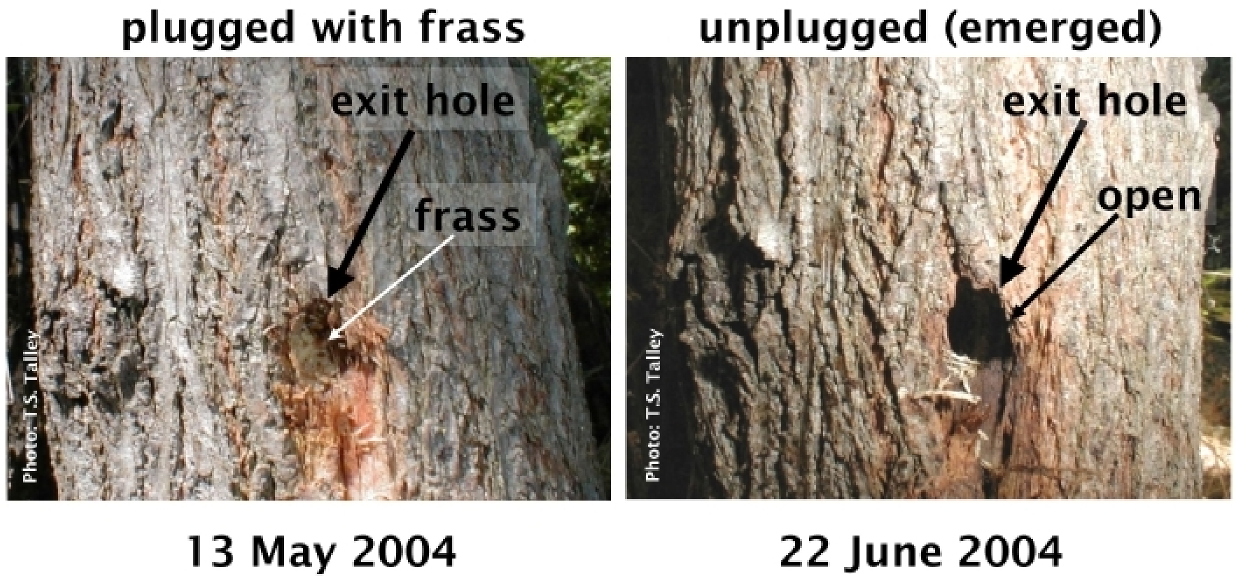

Figure 4. Exit holes of the Valley elderberry longhorn beetle. The last stage larva bores the exit hole then returns to the center of the stem to pupate, plugging the hole with frass (left). Once pupation is complete, the adult pushes out the plug to emerge from the stem center (right).

Exit holes may be created by other organisms, but the combination of the use of live stems, burrowing in the pith, and the creation of holes of this particular morphology (size, shape, sharp edges) makes VELB holes fairly distinctive. The larvae of horntails or wood wasps (Siricidae) burrow beneath the surface of trees, mostly conifers, and feed on wood (Nagano 1989). It is possible that two widespread species of woodboring moths, *Parathene robinae* (Sessidae) and *Prionoxystus robiniae* (Cossidae), could utilize elderberry and possibly make similar sized holes, although at least one would leave behind a pupal skin that would remain in the hole for up to several weeks and neither utilize pith (Nagano 1989). The hardwood boring bostricid beetle, *Polycaon stouti*, has not been observed using elderberry, though it does feed on a variety of tree species and the emergence holes are similar in size to the VELB but pith is not used (Nagano 1989). No species of flat headed wood boring beetles (Buprestidae) are known that would make emergence holes similar to the VELB (Nagano 1989).

Rogers (2003) mentions the possibility that another cerambycid, *Triodoclytus lanifer* (LeConte), creates exit holes similar to (although often smaller than) the VELB. *T. lanifer* occurs in southern Oregon and California and has multiple hosts, including *Sambucus* spp., *Rhamnus californicus*, and *Pickeringia montana* (Linsley 1964). It was observed emerging from a dead stem of *P. montana* (chaparral pea) and was collected from the surface of a dying trunk of *Ceanothus thyrsiflorus* (Leech 1959). Chemsak (2006) stated that *T. lanifer* likely uses dead or dying hosts, and other members of the same tribe (Clytini) tend to use weakened or stressed hosts, and, to a lesser extent, healthy hosts (Hanks 1999). *T. lanifer* bores through woody or subcortical tissue and not pith (e.g., Hanks 1999).

Current survey methods stress the importance of only recording holes from live stems (Talley 2004a) because VELB use live hosts only. Exit holes of live- and dead-host users may be present in the same stem or branch, however, due to the ability of individual elderberry stems to contain both live and dead (or nearly dead) tissues. VELB, however, creates a feeding chamber in pith so the insertion of a flexible wire should go in toward the stem center and then vertically up or down (Talley 2004a). Once abandoned by the VELB, other species inhabit the holes and may fill them with frass and debris (e.g., ants) making it difficult to detect the feeding chamber (although a sharp wire may often be worked through the debris). Because the beetles are rare in space and time, whereas exit holes typically survive for at least several years, exit holes are needed to estimate population size (Barr 1991).

2.1.2.2. Population Biology.

Genetics. No genetic analyses have been performed on the VELB to date but they would be useful to determine amounts of genetic mixing among populations or subspecies, to infer movement distances and to establish benchmarks for genetic diversity.

Population structure.

Spatial structure. As seen from maps of VELB sightings or exit holes in Barr (1991) or from CNDDB (see also figures in Thornton 2006), the VELB is strikingly concentrated in major riparian areas. To some extent these maps may show artifacts of where surveys were conducted or reported, since VELB certainly occurs away from major drainages. Other data, however, discussed further below, confirm that the beetle occurs most frequently and is most abundant in significant riparian zones.

In the northern half of its geographic range (along the Sacramento River and 13 tributaries), the VELB occurs in drainages that function as distinct, relatively isolated metapopulations (Collinge et al. 2001). Each regional population, or metapopulation, occurs within a drainage (<40 km scales) and is comprised of subdivided local populations that are clustered over 10-20 and 30-40 km scales and associated with patches of elderberry and particular drainages (Collinge et al. 2001).

The structure of beetle populations within smaller scales (<10 km) were consistent with a metapopulation structure (Talley 2005). In 4 rivers tested (American River, Cache Creek, Cosumnes River, Putah Creek), the beetle's population structure consisted of a network of local aggregations that composed a larger patch (Figure 5), although patch sizes and arrangements were variable (Talley 2005). On Cache Creek (Cache Creek Conservancy land) the local aggregations were individual occupied shrubs and these occupied shrubs displayed no particular pattern across the landscape (Talley 2005). Local aggregations covering 25-50 m scales (therefore multiple shrubs) occurred at distances of 200-300 m apart along the American River (Figure 5) and 600-800 m apart along Putah Creek. Local aggregations are themselves loosely concentrated in large clusters; the extent of each cluster of aggregations was c. 800 m along the American River and up to several km along Putah Creek. Local aggregations along the Cosumnes River (Sacramento County. Parks land in Sloughhouse, CA) were larger (200-300 m) and were separated by 400-600 m distances, with 600 m the extent of the cluster in the area sampled (Talley 2005). The similar structure but varying within- and between-aggregation distances illustrates that VELB population sizes (or areal extent) may be river-specific.

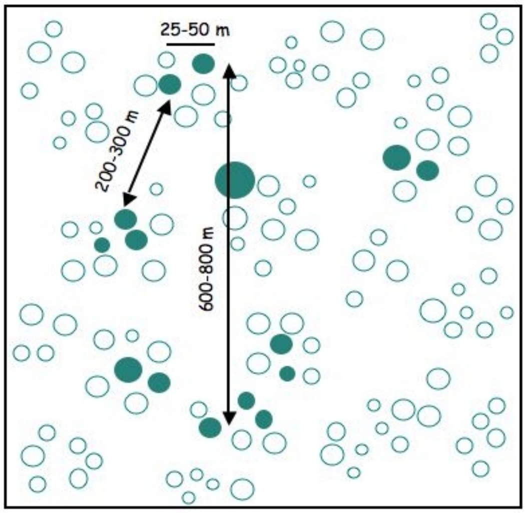

Figure 5. Schematic diagram of the spatial population structure of the valley elderberry longhorn beetle. Open circles represent unoccupied elderberry shrubs, closed circles are occupied by the VELB. Aggregation sizes and distances used are those of the American River Parkway. Local aggregations span 25-50 m, distances between local aggregations are 200-300 m, and the extent of the cluster of aggregations is 600-800 m.

Within the American River Basin, local beetle movements were, on average, farther within the riparian corridor than in the adjacent non-riparian scrub (average±1 standard deviation nearest neighbor distances between recent exit holes: riparian 43±44 m; non-riparian 25±16 m) illustrating that VELB population extents may also be habitat specific (Talley et al. In press).

Occupancy and abundance patterns.

Adult sightings. Sightings of adult VELB are rare. In the 3 month field sampling period (April-June) of 1991, Barr (1991) observed two males and two females in the southern half of the Central Valley. In the same period in 1997, Collinge et al. observed one male and one female and, during 2002, Talley observed one male and one female together and mating (Talley 2003a). Intensive collection efforts compared with observations during field surveys yield more sightings but the number of sightings depend upon collector ability, methods and timing so results cannot be used to evaluate abundance or occurrence patterns (Halstead and Oldham 1990).

Occupancy of drainages. Half of the 14 major river drainages surveyed by Barr (1991) and again by Collinge et al. (2001) remained unoccupied in both studies (1991 and 1997), two drainages experienced extirpation of the VELB in the sites sampled, and no previously unoccupied drainage experienced colonization. Collinge et al. (2001) concluded that because of dispersal limitations, unoccupied drainages were likely to remain unoccupied and those that experienced extinction were not likely to be recolonized. One of the implications of their results for conservation was that there is little chance that VELB populations would naturally recover following drastic declines or migrate to isolated but suitable habitat (Collinge et al. 2001).

Recent surveys forfor the VELB were completed in the American River, Putah Creek, Cache Creek and the Cosumnes River drainages (Talley 2005). VELB exit holes were recorded throughout all 37 km of the American River Parkway and in each of three extensive reaches along lower Putah Creek that could be legally accessed. While VELB exit holes were also observed in the smaller reaches of the Cosumnes River (Sacramento County. Parks land, Sloughhouse, CA) and Cache Creek (Cache Creek Nature Preserve) that were examined (Talley 2005), VELB occupancy throughout the rest of these drainages is somewhat uncertain and thought to be minimal. Surveys within the Cosumnes River Preserve (The Nature Conservancy land) from a few years ago revealed little to no evidence of the VELB (Marty 2006) and much of the remaining land is privately owned and heavily cultivated. Surveys of 9 sites (3-5 shrubs per site) along the length of lower Cache Creek in 2002 revealed only 1 site with an exit hole (one shrub with an old exit hole along County Road 51) (Talley unpublished data 2002). Cache Creek and the areas of the Cosumnes River outside of existing preserves are typical of many formerly extensive riparian areas in the Central Valley: they are largely privately owned and intensively farmed, often with extremely narrow (<25 m), fragmented riparian zones, or none. The Natomas Basin provides another example: in what once probably contained substantial bands of suitable habitat for elderberry and VELB, there now remains only a very limited number of elderberry shrubs in over 50,000 acres of intensively farmed, developed, and otherwise modified lands. Thus the VELB population structure described here is that found in the better remaining areas of habitat, and is scattered among wide areas of poor habitat or none.

Occupancy of sites by the VELB. In 1991, Barr (1991) found recent exit holes in 20% of the 79 sites she sampled along the major rivers and streams of the Sacramento Valley. Collinge et al. (2001) found the same occupancy rates when they resampled most of Barr's sites (65 sites). Occupancy rates of 64% were found in the mid-1980's along the Sacramento River (183 miles from Sacramento to south of Red Bluff) (Lang et al. 1989). Occupancy along this stretch varied from 28% of sites between Sacramento and Colusa to 94% of sites between Chico and Red Bluff (Lang et al. 1989). They attributed this difference in occupancy to the flood control measures in the southern reach, which caused a reduction of the riparian corridor and, therefore elderberry, to a narrow, fragmented strips of vegetation along the river (Lang et al. 1989).

Occupancy of elderberry groups was measured by both Barr (1991) and Collinge et al. (2001) (Barr: 117 elderberry "groups"; Collinge et al.: 111 groups, each containing 4-22 shrubs), with roughly 25% of elderberry groups occupied in both 1991 and 1997 (Barr 1991, Collinge et al. 2001). By comparison, VELB occupancy ranged from 2.9% in a non-riparian scrub area to 7-11.2% of shrubs in riparian reaches of Putah Creek and the American River (Talley 2005, Talley et al. In press) (see Sections 2.1.2.3.7 and 2.1.2.3.8). The seemingly lower occupancy rates in Talley et al. (In press) compared with both the Barr (1991) and Collinge et al. (2001) studies may be due to the different locations and years surveyed, and the methods. The determination of occupancy of a group of shrubs could account for higher estimates in their studies, since not all shrubs in a group would likely be occupied.

Local VELB density. VELB population densities appear to average quite low, even as estimated by exit hole counts, in keeping the rarity of observations of adults. Beetle density averaged about 2 new exit holes per "site" (average of 12.6 shrubs, only a fraction of which typically is occupied) in occupied sites in the Barr and Collinge et al. studies (i.e., 1 – 2 holes per *occupied* shrub) and 1.6-2.9 holes per *occupied* shrub in Talley et al. (In press). The slightly higher densities in Talley et al. (In press) compared with the Barr (1991) and Collinge et al. (2001) studies may, again, be due to the different locations, years and methods used. Talley et al.

(In press) and Talley (2005) examined all shrubs in large, continuous regions and included holes that were new and 1-yr old, whereas Barr and Collinge et al. reported new holes and examined a subset of shrubs, which may have underestimated densities.

When standardized per unit area of *occupied* shrub, average recent hole densities were 5.3 holes per m^2 of occupied shrub in the non-riparian and 2.0-2.5 holes per m^2 of occupied shrub in the riparian (Talley et al. In press) illustrating that (1) VELB are probably more limited by suitable habitat in the non-riparian so tend to stay closer and re-use the same shrubs, and (2) abundance does not necessarily increase with increased canopy area of shrubs (Talley et al. In press).

Comparison with CELB. The few data available indicate that CELB exit holes at one coast range site (Hasting Natural History Reserve, Monterey Co., CA) were three times as numerous per 0.25 ha plot as VELB exit holes along the American River and Putah Creek (Collinge et al. 2001).

Rarity and extinction

Species that are rare have at least one of the following characteristics:- limited geographic range, high habitat specificity, or small local populations (Rabinowitz 1981). The VELB is especially rare, having all three of these characteristics. Although it is naturally rare with respect to these characteristics and has low mobility, the loss and fragmentation (isolation) of its habitat increases its susceptibility to extinction through demographic and local environmental stochasticity- in other words, increased risk of local extinctions due to chance events (Talley 2005). For example, the extirpation of the beetle at two drainages between 1991-1997 was not influenced by the number of occupied (or unoccupied) sites in the 20 km surrounding a site where an extinction occurred, illustrating density-independent extinction (i.e., external forces) and low chances of re-colonization of extirpated patches (Collinge et al. 2001).

Population trends.

Long-term datasets on VELB occupancy are limited to those collected by Collinge et al. (2001) who, in 1997, re-surveyed sites visited by Barr (1991). Both found about 25% occupancy of elderberry groups and 20% occupancy of sites. However, decreases in the number of sites with elderberry (down 7 of 72 re-visited sites: about a 10 % decline) and in density of elderberry between surveys (Figure 6), resulted in lower total numbers of occupied sites and shrub groups (Collinge et al. 2001). Considering elderberry loss, and VELB extirpations (exit holes no longer found) and colonizations (exit holes found in 1997 where there were none in 1991) at sites that still had elderberry, Collinge et al. (2001) counted extirpations at 9 sites of 72 re-visited (12.5 % over 6 years, or about 2.5 % of sites per year), and colonizations at 4 sites of 43 previously unoccupied sites revisited (9% over 6 years or about 1.5% of sites per year). Colonizations only were identified within major drainage systems.*

Lang et al. (1989) found much lower occupancy rates along the southern half of the Sacramento River than in the northern half and attributed the lower rates to the loss and narrowing of riparian corridors associated with agricultural development. This pattern may also reflect changes that have occurred through time- loss of over 90% of riparian habitat (Katibah et al. 1984, GIC 2003) and subsequent fragmentation in the VELB's range may have resulted in not

* "Colonizations" in this study could have been due to failure to detect existing exit holes in the first (1991) survey; similarly, 2 of the "extirpations" may constitute failure to find existing exit holes in the second survey (the other 7 may be inferred from complete loss of habitat). More repeated surveys are needed.

only loss of populations occurring in destroyed areas but also degradation and declines in occupancy rates within remnants of habitat.

Long-term data sets are sorely needed. A long term data set would be one that allows enough time to see how beetle populations change with natural inter-annual environmental variations (e.g., before, during and after drought years), how long it takes unoccupied shrubs to become colonized, and how long beetles persist in the same localized area. Elderberry shrubs on average are not particularly long-lived. Five-year datasets from a couple of areas along the American River (Klasson et al. 2005) reveal that shrubs or clumps may stay occupied for at least 3-5 yr periods but this needs to be tested for longer and in more areas. To capture this variability in population and environmental conditions, data sets of 10 yrs or, ideally, longer would be useful for understanding natural variations and processes in beetle populations.

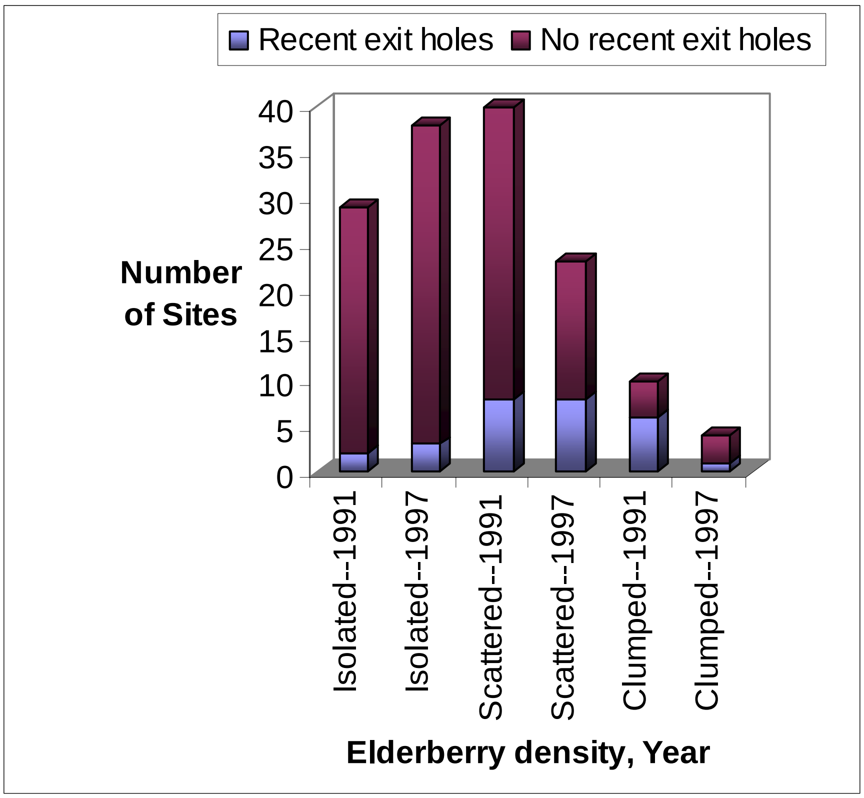

Figure 6. Adapted from Collinge et al. 2001, showing that in that study, numbers of sites supporting only isolated elderberries increased, while scattered and clumped elderberry categories (higher density categories) declined from 1991 to 1997.

Behavior. Mechanisms for population structure include not only environmental influences but also aspects of the species life history and individual behavior (Thrush 1991, Sih et al. 2004; and references therein each). VELB adults have fairly limited movement distances. The likelihood of site colonization by the VELB between 1991 (Barr 1991) and 1997 increased with greater numbers of occupied sites in the 20 km surrounding the initially empty site, illustrating that VELB are limited dispersers in the northern portion of their range (Collinge et al. 2001). Finer-scale studies (covering ≤20 km distances) revealed that the local VELB aggregations and, especially, the several-hundred meter distances between them were only weakly correlated with environmental factors (Talley 2005). Talley (2005) suggested that clustering of the beetle over within- and between-aggregation scales may be due to aggregation behaviors that are relatively decoupled from the environment and that cause variability in occupancy patterns, such as the somewhat-chance detection of volatile host plant chemicals (≤100-m scales) and mate pheromones (cm scales) (e.g., Leal et al. 1995, Hanks 1999). In other words, the VELB may not respond strongly to habitat quality differences on small scales due to other behaviors. It is, therefore, important to maintain large areas of high habitat quality so as to avoid the creation of population sinks (low quality areas that increase mortality).

Furthermore, female VELB adults tend to be less active than males, which are more apt to take flight and move between branches, shrubs, or clusters of shrubs (Arnold 1984b, Talley 2003a). These sex-specific activity patterns were also observed in *Desmocerus palliatus* in Connecticut during July 2003 (Talley 2003a). The short movement distances of the females is evidenced by the observation that the VELB tends to re-occupy its host shrubs- 73% of shrubs with recent holes also had old holes in the American River basin (Talley et al. in press), and 81% of occupied sites in 1997 had also been occupied in 1991 (based on presence of old and new holes) (Barr 1991, Collinge et al. 2001). In summary, behavior, including limited dispersal, can affect VELB distributions and decouple relationships with environmental variables (i.e., habitat quality) signifying that the maintenance of high quality, contiguous habitat is needed and that unoccupied areas may not indicate low quality (Talley 2005).

2.1.2.3. Habitat Requirements

Elderberry taxonomy and distribution. The VELB feeds on from one to four species of elderberry and has been documented as using both blue and red elderberry in the Central Valley (USFWS 1984, Barr 1991). As was true at the time of listing, the taxonomy of *Sambucus* is confused. *Sambucus* is a genus within which there is much hybridization and backcrossing (Crane 1989b). There are two general types of elderberry: blue and red (Jepson and Hickman 1993) and VELB has been recorded as feeding on both (USFWS 1984, Barr 1991). The blue elderberry taxa are thought to be more drought tolerant than the red and include *S. glauca, S. caerulea* and *S. mexicana*. *S. mexicana* and *S. caerulea* are, however, often treated as synonyms because they cannot yet be distinguished (Jepson and Hickman 1993). The red elderberry in America is thought to be *S. racemosa* spp. *pubens* and consist of several varieties, although others argue the varieties should be separate species (Crane 1989b). *S. racemosa* var. *microbotrys,* was recorded from the Central Valley (Barr 1991). Jepson and Hickman (1993) state that *S. racemosa* (no variety specified) occurs in moist places <3300 m elevation, while *S. racemosa* var. *microbotrys* occurs in moist and/or montane places between 1800-3300 m in the Sierra Nevada and the Coast Range (Crane 1989b, Jepson and Hickman 1993) making it likely that Barr (1991) observed *S. racemosa*. As with other red elderberries, *S. racemosa* is generally a circumboreal species (Crane 1989b) that occurs more frequently in higher elevations and moist, cool regions than blue elderberry (Jepson and Hickman 1993). While blue elderberry is more common within the Central Valley, there is overlap of the distributions. The taxonomic uncertainties within *Sambucus* need to be sorted out before assessments of the VELB's host shrub preferences can be made.

Requirements of elderberry. Inundation regime, measured as relative elevation above the river, was the primary control of elderberry distributions across floodplains in the lower alluvial reaches of the American River, Cache Creek, Cosumnes River and Putah Creek (Talley 2005). Shrub frequency was highest at intermediate relative elevations, with flooding (i.e., anoxia and/or scour) affecting low elevations and water availability restricting upper elevational limits (Talley 2005). The relative elevation value at which elderberry frequency was highest increased with increased river width (from 0.5 to 5.5 m RE on rivers from 20 to130 m width) illustrating an interaction with the geomorphology of the river. At mid and upper elevations, elderberry frequency increased with low competition (little or no canopy) and finer soil texture, which has higher water-holding capacity (Talley 2005).

Blue elderberry grows best on loam, silty loam or sandy loam soils (Crane 1989a, Vaghti et al. Submitted), in depths of 20 cm or more, neutral pH and organic matter content of 5.6-8% (Crane 1989a). *S. racemosa* is similarly found on rich, moist loamy soils (loam, silt loam or sandy loam) with a pH of 5.0-8.0 and a depth of 20 cm or more (Crane 1989b). Seedling growth and mortality of *S. mexicana* have been shown to respond positively to nitrogen availability and negatively to saturated soil conditions (Chirman 1994).

Relationships between elderberry density, lateral size (age/size) or stress (proportion of dead stems per shrub) and environmental variables (soil texture, relative elevation, local canopy cover and topography) differed among rivers indicating different processes acting within each drainage (Talley 2005). Much of the variance in elderberry abundance, lateral size and stress was unexplained, especially within local aggregations, and attributed to stochasticity in seed dispersal patterns and seedling mortality (Talley 2005). Since replication was high and an initial long list of explanatory variables was tested, it was concluded that unexplained variance was in part due to stochasticity (Talley 2005). Implications for mitigation and restoration include river-specific assessments of elderberry requirements and reference sites, preserving large sites with a range of habitat values, adaptive restoration (trying different planting strategies), and incorporating areas where elderberry can survive extreme flow and climatic events.

Elderberry shrub variability.

Distinguishing shrubs and stems. Elderberry grows vegetatively from rhizomes, resulting in shrubs that often have multiple main stems. Because stems originate from underground, it is difficult to discern where one shrub ends and the next begins. The number of main stems per shrub can range from one to hundreds. Recent studies have calculated the number of main stems per unit area to quantify the amount of habitat available for the VELB (Talley 2005, Talley et al. In press). The identification of main stems can be tricky because of branching close to ground level (above and below), and is subject to the morphology of the plant and the impressions of the person recording data. The use of 'shrub' as a unit is useful, however, for field surveys where time is limited, and is ecologically meaningful. Standardized methods for the determination of shrubs and main stems are needed so that comparisons can be made across time, sites and/or agencies. Unofficial standardized methods have been written, distributed to local agencies and companies, and are available on-line (Talley 2004b). These or similar methods would be useful if included in Conservation Guidelines or restoration information so that measurements are taken consistently.

Shrub age. While the diameter of tree trunks is often used as a proxy for tree age, the maximum basal diameter of elderberry shrubs varies widely and is likely affected by shrub age and environmental conditions. No known studies have thoroughly examined the correlation between shrub age and diameter or the longevity of elderberry. Mitigation and restoration sites are potentially useful to examine elderberry growth rates since the time of planting is known, and growth measurements and environmental conditions are monitored. In a sampling of 6 restoration sites along the Sacramento River, positive correlations between maximum basal diameter and site or shrub age were found although diameters varied a lot within sites (Figure 7) (Holyoak and Talley 2001).

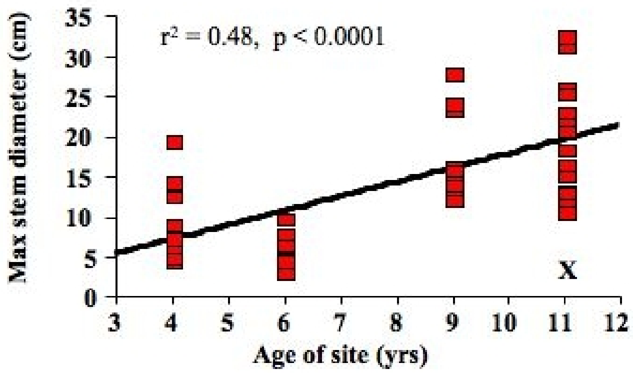

Figure 7. Relationship between restoration site age (therefore shrub age) and maximum stem diameter of elderberry shrubs. Data were collected from restoration sites along the Sacramento River, July 2001. X= VELB exit holes present in sites. Two 4-yr and 11-yr sites, and one 6-yr and 9-yr sites were used.

Available habitat per shrub. Better estimates of the amount of habitat (all available stems and branches) provided by each shrub for the VELB are also needed. Often, the loss of ≥ 2.5 cm diameter branches from a shrub is considered equal value to a plant with the same sized maximum stem diameter. A whole shrub may provide much more habitat area than a branch of equal diameter. In a small sampling of sites (n=7) along Putah Creek and the American River, a positive relationship (R^2=0.67, $P<0.05$) was found between the maximum diameter of an elderberry shrub and the number of branches 2.5 cm or more in diameter on the whole shrub (Holyoak and Talley 2001).

Distributions within host shrubs. VELB exit holes are found on stems or branches of 2.5 cm (1 inch) diameter or more (Barr 1991, Collinge et al. 2001) and infrequently in smaller stems (1.3-2 cm) (Halstead and Oldham 1990, Talley 2005). Across the northern portion of the VELB's range, exit holes were most frequently encountered in branches 5-10 cm diameter (Barr 1991, Collinge et al. 2001). Correspondingly, VELB holes occurred most frequently in stem or branch diameter classes of 2-7 cm (47%) and 7-12 cm (36%) in the American River basin (Talley et al. In press). Stems and branches 12-20 cm and >20 cm in diameter hosted proportionally fewer holes (13% and 4% respectively), which may be due to less availability than smaller branches (Talley et al. In press) or to the drying and loss of pith, which is common in older stems (Haack and Slansky 1987).

Exit holes of the VELB usually are found relatively close to the ground. The height of holes from the ground averaged 58-61 cm and ranged between 0-189 cm in 1991 and 1997 across the northern range (Collinge et al. 2001). Similarly, the height of holes from the ground in the American River basin occurred at height classes of 0-1 m for 79% of holes, 1-2 m for 19% of holes, and 2-3 m for 2% of holes (Talley et al. In press). Heights exceeding 3 m were observed in only a few instances (0.3% of holes) (Talley et al. In press). Other species of *Desmocerus* bore in the pith of roots/root crown, so low exit holes may reflect a similar tendency in VELB (Linsley and Chemsak 1972). Furthermore, the response of VELB larvae to disturbance appears to be curling up and dropping to the ground (Talley 2003a). If disturbed larvae subsequently bored in near the base of the shrub, then exit holes would occur in the same vicinity.

Distribution patterns of holes in shrubs were generally similar across the three riparian habitat types (lower alluvial, narrow corridor, upper terrace), but differed from the non-riparian scrub where no holes were detected in any of the nine ≥20-cm stems (Talley et al. In press).

VELB relationship with elderberry

Beetle occupancy increased with higher elderberry shrub density, from isolated (one to a few bushes with no others for at least 200 m), scattered (several bushes spaced 30-50 m apart) to clumped (many bushes, often in large groves) (Barr 1991, Collinge et al. 2001).

Several shrub characteristics were associated with a higher probability of beetle presence in the American River basin (Talley et al. In press). This study system contained elderberry densities that Barr and Collinge et al. would have classified as clustered and scattered (few were isolated). Shrub age, area, and perimeter, below thresholds of 1500 m^2 in area and 250 m in perimeter, had a relatively strong positive influence (6-7% of variability) on beetle presence. Above those thresholds, neither increases in shrub area nor perimeter affected occupancy (Talley et al. In press). Older shrubs are more likely to be occupied than younger shrubs because older, larger shrubs have been available for colonization for longer and because shrubs tend to remain occupied once colonized by the beetle (Talley 2005). Older, relatively large shrubs also tended to support the greatest number of branches and diversity of branch sizes, increasing the availability of oviposition and larval feeding sites for the beetle (Talley et al. In press).

Percent nitrogen content of pith and, to a lesser extent, leaves was associated with increased occupancy (Talley 2005). This is consistent with the decreased larval development time and increased survival of most other internal stem borers associated with increased wood nutrient concentrations (Haack and Slansky 1987). Nitrogen content of an elderberry shrub is influenced by many factors, including the soil and plant litter immediately around it, root competition, water, plant condition and health, shading, and presumably the genetic makeup of the shrub itself.

Spatially dependent relationships with the environment. Relationships between the VELB and environment variables, such as elderberry availability (shrub density, shrub area and maximum stem diameter) and other fine and broad scale factors (e.g., shrub quality, associated plants, relative elevation) varied with location (American River, Putah Creek, Cosumnes River, Cache Creek) and scale (Talley 2005, Talley In revision). For example, the occurrence of beetles in local aggregations (25-50 m scales) along the American River became more likely with larger maximum shrub diameters (shrub size and age), increased cover of black locust (but see Section 2.2.5.5), and higher shrub quality (nitrogen content) (Talley 2005, Talley In revision). Controls on the movement between local aggregations (200-300 m distances), however, were the least well explained (83% vs. ~40% unexplained variance) indicating the influence of an unmeasured factor or a larger role of chance acting at these intermediate distances. Compared with the American River, beetle occurrences across all scales on Putah

Creek were more likely with increased shrub density and connectivity of beetle aggregations (Talley 2005, Talley In revision).

The different relationships between the beetle and environment at different scales and the large remaining amount of unexplained variance in beetle occurrence at all scales (Talley 2005, Talley In revision) illustrate that different processes act on the beetle at different spatial scales. The well-replicated, spatially extensive dataset makes it unlikely that a lack of statistical power was responsible for most of the unexplained variance. These results suggest that stochasticity, or chance, played a role in beetle occupancy in all systems (Bonsall and Hastings 2004). Additionally, these processes vary across the VELB's geographic range illustrating that habitat definitions may change with location. While various characteristics of elderberry tended to be the strongest explanations for VELB occurrence in all rivers (e.g., shrub density, shrub area, size/age, nitrogen content), other factors such as relative elevation and connectivity to other VELB aggregations were also important in some areas (Talley 2005, Talley In revision).

Effects of geographic location.

Collinge et al. (2001) concluded that declines in occupancy rates across the VELB's range (from center to edge) were due to dispersal limitation (limited movement ability of beetles) and not to declines in habitat quality. Habitat quality variables, such as shrub density or amount of cultivation, did not change uniformly with distance from range center to edge. This finding was supported in a study of the American River Parkway and Putah Creek. While beetle abundance within occupied shrubs was similar and averaged 2-3 beetle holes per 100m^2 of shrub along each river, beetle occupancy of shrubs was lower along Putah Creek (6.7% of shrubs) than the American River (10.4%) (Talley 2005). The American River did not, however, consistently differ from Putah Creek in the habitat quality traits that were associated with increased likelihood of occupancy within rivers (see "habitat requirements" below) (Talley 2005). This supports the idea that distinct VELB metapopulations occur within rivers or drainages, with little or no exchange,.

Habitat types. Within the American River basin, four habitat types were examined. From down stream to upstream, the three riparian habitats were alluvial plain, riparian corridor, and upper riparian terrace, and a non-riparian scrub habitat was located away from the river (Talley et al. In press). Recent VELB exit holes occurred in 11.2% of elderberry shrubs in the alluvial plain, 10.5% in the riparian corridor, 8.7% in the upper riparian terrace, and 2.9% in the non-riparian scrub (Talley et al. In press). This is consistent with prior expectation that VELB is more likely to occur in riparian habitats and near water sources (Halstead and Oldham 1990, USFWS 1999). In the American River basin, average number of beetle holes per occupied shrub did not differ among habitat types (Talley et al. In press). The density of holes (number of holes per 100 m^2 of elderberry shrub canopy), however, was more than twice as high in the non-riparian scrub than in other habitat types (5 vs. 2-2.5 holes/m^2 of shrub; Talley et al. In press). This was because shrubs in the non-riparian scrub were smaller than in the riparian habitats, so that the same number of holes was squeezed into a smaller shrub area. Furthermore, an overall lack of high-quality habitat may have limited expansion of aggregation across multiple shrubs (Talley et al. In press).

Effects of landscape and land use type. A study conducted in the American River Parkway and along Putah Creek tested the assumption that the type of land use surrounding elderberry shrubs or patches would affect the movement of beetles between patches (connectivity) and, therefore, patch occupancy rates (Talley 2005). Land use type in these areas had no significant effect on beetle occupancy of shrubs (Talley 2005). The American River consisted predominantly (92%) of parkland, while dominant uses along Putah Creek were divided relatively evenly (15-25%) among parkland, private property, public access, reserves and agriculture. Most of the agriculture along Putah Creek is organic, reducing the chance of influences of herbicides and pesticides (see Section 2.2.4.2). The broad vegetation community did not influence beetle occupancy along Putah Creek, but had weak effects on occupancy along the American River (Talley 2005). Occupancy by the beetle tended to be more common in woodlands dominated by exotic trees (64% of observances of woodlands due to black locust; but see Section 2.2.5.5.) and black walnut, and in mixed riparian forests (Talley 2005). Occupancy was less common in annual grasslands (primarily dominated by exotic annuals) and live oak woodlands (Talley 2005). The physical architecture of the landscape affected occupancy along both rivers with fewer occupied shrubs than expected by chance in open and sparsely wooded areas, and more occupied shrubs than expected found in wooded areas (Talley 2005). Of the occupied shrubs found in wooded areas, about half were under a canopy cover of 25-50% while a quarter each were under canopies with 50-75% and 75-100% cover; frequencies that somewhat reflect the frequency of each level of canopy cover. Although significant, vegetation community and architecture explained 5% or less of the variation in beetle occupancy of shrubs (Talley 2005).

Defining habitat for the VELB. Currently, the basic metric of habitat loss and compensation for the VELB (and therefore our primary metric of habitat quality) is the abundance of elderberry shrubs (USFWS 1999). The results of recent work reveal that habitat and habitat quality for the beetle can be refined using not only abundance of shrubs but also other shrub characteristics (size, age, nutrient status) and spatial, landscape and local scale factors. The habitat of an organism includes a suite of requirements -- provision of food, shelter, and mating areas -- so it makes sense that habitat have a multivariate definition (Morrison et al. 2003).

Weak relationships between the VELB and environmental variables are often observed and support the idea that VELB populations are stochastic and do not closely track their environment (Fleishman and Murphy 2006, Talley et al. In press). While chance or stochasticity is an important factor in the VELB's population dynamics and structure, it is important to note that these recent extensive studies were conducted in regions that are relatively protected, that usually contain an abundance of elderberry and that seem to have access to water (i.e., the best available habitat). If these studies included more dramatic variations in environmental conditions, such as the range of sites studied by Lang et al. (1989), Barr (1991) or Collinge et al. (2001), stronger relationships with environmental variables might have emerged. Additionally, differences in occupancy rates between areas or habitat types illustrate VELB response to habitat quality (Talley et al. In press). Other work testing spatially explicit relationships between VELB and the environment revealed stronger, spatially dependent relationships that would not have emerged in the non-spatial analyses (Talley 2005).

Habitat quality for the VELB in the American River basin, for example, included characteristics of elderberry shrubs other than density, such as area, maximum stem diameter (also a proxy for age) and pith nitrogen content (Talley 2005, Talley et al. In press). Important non-elderberry variables included relative elevation (depth to groundwater), proximity to openings or edges in the riparian vegetation, and local topography (slope, aspect). The strength and direction of relationships between VELB occupancy and these variables sometimes changed with area examined (e.g., edge proximity was most important in wide reaches of the riparian corridor, proximity to ground water became more important at higher elevations) (Talley 2005, Talley et al. In press). Riparian habitat was higher quality than non-riparian scrub as evidenced by higher occupancy rates (Talley et al. In press). An indication of land area, shrub or stem densities and shrub spacing needed to support beetle populations was obtained by spatial analyses. For example, local aggregations of the VELB covered 25-50 m scales and were separated by 200-300 m distances (Talley 2005). Clusters of these aggregations composed populations that covered 600-800 m distances along the American River (Talley 2005) and these populations may be further clustered over scales of 10-40 km (Collinge et al. 2001).

Again, the American River is all relatively good habitat. The effects of the environment may become stronger and the rate of local extinctions of the VELB increase in areas where elderberry shrubs are more isolated, physical stresses stronger, and effects of land use more hazardous (e.g., use of pesticides).

2.1.3. Habitat status.

2.1.3.1. Trends in spatial distribution.

Loss of habitat.

Host shrub losses. The riparian corridor in the southern reach of the Sacramento River contained few elderberry compared to the northern reach due to loss of shrubs and riparian corridor resulting from the extensive flood control measures in this area (Lang et al. 1989). Furthermore, both the number of sites with elderberry and density of elderberry within sites decreased between studies of the same areas in 1991 and 1997 resulting in lower total numbers of occupied sites and shrub groups (Barr 1991, Collinge et al. 2001). Holyoak and Talley (2001) investigated natural recruitment and mortality rates of elderberry at seven sites along Putah Creek and the American River that had been sampled in 1997 by Collinge et al. (2001). They observed that mortality and recruitment rates were similar within the two areas, illustrating that elderberry shrubs likely replace themselves in these relatively undisturbed areas. More rigorous and extensive studies of elderberry population dynamics are needed in order to determine whether there are declines or increases in particular areas or associated with particular management practices (e.g., flow regulation, vegetation management practices; but see Section 2.2.5.1.2).

Precisely quantifying the loss of elderberry shrubs as a result of the extensive agricultural and urban development over the past 200 years is near impossible. Recent studies have identified plant communities that are associated with elderberry (Vaghti et al. Submitted)- estimating loss of these communities can give some idea of the losses of elderberry and potential VELB habitat (see below).

Riparian and grassland losses. The VELB was listed in large part due the loss of its riparian habitat (USFWS 1980). It is estimated that 90% of historic riparian ecosystems have been lost in the Central Valley due to agricultural and urban development (Katibah et al. 1984). Elderberry can thrive in riparian and low-lying non-riparian areas in the Central Valley, but the VELB has much reduced occupancy rates in non-riparian habitats (e.g., Talley et al. In press) supporting the idea that the most important habitat type for the VELB is riparian. Furthermore, much of the natural non-riparian habitat that could support the VELB has also been lost (e.g., elderberry savannah) (GIC 2003, Fleishman and Murphy 2006). Loss of ecosystems in the Central Valley was studied by the California State University Chico Research Foundation for the Habitat Restoration Program (GIC 2003). They classified land cover in the Central Valley into nine types, three of which may be associated with elderberry: riparian, grassland, and other floodplain. The category "other floodplain" was combined with "grassland" in recent surveys so will be combined in the discussion here. A switch in data sources between 1960 and 1990 partially accounts for increases in grassland reported (GIC 2003). Human judgment of the classification of "grassland" may also cause variability (GIC 2003). Additionally, community composition of "grassland" is unclear and part of the increase may be due to exotic annual grass invasions.

Elderberry is expected to be most common in some types of grasslands (i.e., elderberry savannah) and in riparian woodlands, which contain cottonwood, sycamore, valley oak, box elder, coyote brush, rose and, recently, black walnut and box elder (Sawyer and Keeler-Wolf 1995, Vaghti et al. Submitted). An estimated 65% of these potential VELB habitats have been lost throughout the Central Valley since 1900 (from 9.53 to 3.33 million acres). This includes declines of 87% of riparian habitat, likely the most densely populated habitat for VELB (0.13 million acres remaining) and 61% of grasslands (3.2 million acres remaining). Losses between 1960 and 1990 include a 48% loss of riparian habitat and 15% loss of grassland. There are no data available for 1980 when the VELB was listed to examine whether listing was correlated with any change in loss rates of riparian habitats. From 1980 to 1990 and 1990 to the present, rates of agricultural conversion slowed relative to 1960 to 1980, but rates of urban, suburban, and associated development have increased. A simple linear prorating of the habitat losses to the period from 1980 (VELB listing) to 1990 suggests a 16% loss of riparian and 5% loss of grassland during the ten year period. In the absence of period-specific information, this is our best first-order estimate of the amount of habitat loss during the period.

The increased loss in riparian habitat in the southern Sacramento Valley observed by Lang et al. (1989) was confirmed by this study (GIC 2003). The loss of grassland, however, was higher in the upper than lower Central Valley. GIC (2003) examined three sections of the Central Valley- the north, from Shasta Co. to Solano and Sacramento Cos., the middle, from San Joaquin Co. to Merced Co., and the south, from Fresno Co. to Kern Co. Loss of riparian habitat between 1900 and 1990 was about 96% in the southern (16,000 ac remaining), 84% in the mid (21,000 ac remaining) and 80% in the northern (96,000 acres remaining) Central Valley. Between 1960 and 1990, loss rates had slowed somewhat but were still high with 59% loss in the south, 65% loss in the middle, and 35% loss in the northern Central Valley. The VELB's habitat type and critical habitat was designated as riparian systems in and around Sacramento County. No data are available to test whether this accounted for part of the decline in loss rates in the northern region.

Increases in habitat through restoration and mitigation efforts are valuable, but despite many significant efforts, the area of restored habitat still remains very small in comparison to historic losses. The total acreage for one of the largest restoration programs in the Central Valley, a collaborative effort including U.S. FWS, The Nature Conservancy and River Partners located along the Sacramento River, is 3,034 acres (River Partners 2002), 0.3% of the roughly 870,000 acres of riparian habitat lost in the Central Valley. Loss of VELB habitat continues to the present, now generally accompanied by compensation measures. The extent to which created or restored sites can or actually do compensate for lost remnant natural habitat, in area and in function, is uncertain (Holyoak et al. in press).

Historic understanding of VELB geographic range. While the VELB historically occurred along the margins of the Sacramento and San Joaquin Rivers in California's Central Valley, the beetle was thought to occur in fewer than 10 localities in Merced, Sacramento and Yolo Counties at the time of listing (USFWS 1980). Since then, the VELB presence has been reported across a broader range of counties within the Central Valley- from Tehama Co. in the north to Fresno Co. in the south (Barr 1991 and references therein, Halstead and Oldham 2000, This report section 2.1.1).

Specimens had been reported from as far south as Kern Co. The only two specimens quoted for Kern Co., one male and one female reportedly collected by H.K. Morrison ca. 1880, were listed as being at the National Museum of Natural History (NMNH) by Halstead in an unavailable letter to USFWS (cited in Barr 1991, pg. 4) and in Halstead and Oldham (2000). We have not been able to verify the existence of these specimens. NMNH houses only the lectotype female and the allotype male of *D.c. dimorphus* collected from Sacramento in 1921 by B.G. Thompson (Halstead and Oldham 1990, Lingafelter 2006, Smithsonian Institution 2006). The specimens in question appear to be those of the Kern primrose sphinx moth, collected by Morrison ca. 1880 in Kern Co. (Shields 1990). Two letters written to the Service in response to the November 2005 call for information on the VELB used this erroneous Kern Co. specimen report as evidence that the beetle's range was improperly defined at the time of listing (Fleishman and Murphy 2006, Thornton 2006). However, it appears the distribution at the time of listing was based on the best available knowledge at the time.

The degree of certainty about the range extent of the VELB and the occupied counties within this range is limited by the rarity of sightings of male adults – see section 2.1.1. Taxonomy and Distribution (above).

Few changes in critical habitat. At listing (USFWS 1980), two critical habitat areas were defined, as follows:

(1) Sacramento Zone. An area in the city of Sacramento enclosed on the north by Route 160 freeway, on the west and southwest by the Western Pacific railroad tracks, and on the east by Commerce Circle and its extension southward to the railroad tracks.

(2) American River Parkway Zone. An area of the American River Parkway on the south bank of the American River, bounded (A.) on the north by latitude 38°37'30"N, on the west and southwest by Elmanto Drive from its junction with Ambassador Drive to its extension to latitude 38°37'30", and on the south and east by Ambassador Drive and its extension north to latitude 38°37'30". (B.) Goethe Park, and that portion of the American River Parkway northeast of Goethe Park, west of the Jedediah Smith Memorial Bicycle Trail, and north to a line extended eastward from Palm Drive.

The Sacramento Zone is shown in Figure 8A; the American River Parkway Zone in Figure 8B.

The Sacramento Zone is privately owned. When designated as Critical Habitat it was predominantly riparian woodland. Today it remains undeveloped with similar vegetation communities and continues to be degraded by homeless encampments, which has been a long-standing problem (Arnold 2006). The effects of the encampments include increased trash and debris (e.g., abandoned tents and personal belongings), increased frequency of fires due to out of control campfires and loss of elderberry from burning or removal for firewood (Arnold 2006). The owner of the property, Robert Slobe, has frequent clean up efforts, but the area is soon reoccupied by the homeless. The police do not respond to criminal trespass because it happens so regularly, so this section of Critical Habitat remains somewhat degraded with the threat of continued and more serious degradation (e.g., from wild fires, although elderberry often recover from fires: see section 2.2.5.4). The American River Parkway Zone remains relatively protected as part of the American River Parkway, so is largely unchanged as far as land use and major vegetation types.

A. Sacramento Zone (outlined in blue)

B. American River Parkway Zone (outlined in red dashes)

B. American River Parkway Zone continued east from Goethe Park

B. American River Parkway Zone-area to the east of the above area

Figure 8. Critical Habitat for the VELB as drawn from the map in USFWS 1980: (A) Sacramento Zone and (B) American River Parkway Zone.

2.1.3.2. Habitat or ecosystem condition.

Isolation and Quality. The condition of habitat varies with location and habitat type. Increases in isolation and distance from open water source often result in reduced quality. Isolation is greatest in areas fragmented and constrained by development or agriculture. This is evidenced by the decreased VELB occupancy associated with increased land use in the southern compared with northern Sacramento River (Lang et al. 1989). Isolation of habitat was also a factor limiting occupancy in the study by Collinge et al. (2001). Besides actual habitat loss and fragmentation due to development, the effects of developed areas on remnant natural habitats are largely unknown (see Sections 2.2.3.1, 2.2.5.1, 2.2.5.2). Areas with some sort of protection, such as the American River Parkway, and portions of Putah Creek (e.g., Solano Co. Lake Park), Cache Creek (Cache Creek Conservancy) and the Cosumnes (Sacramento County Parks land) that are designated as public access natural areas or reserves, appear to support populations of VELB (Section 2.5.2.1).

Invasive species effects on habitat. The effects of invasive species on the VELB and elderberry are largely unknown but detrimental effects on native flora and fauna -- especially in riparian ecosystems -- have been well documented. The continued invasion of exotic species offers probably the largest threat of degradation to protected habitat for the VELB and elderberry. The effects of the invasive, predatory Argentine ant are under study, but preliminary results suggest that when densities are high, VELB mortality may be high (Section 2.2.3.1, Huxel 2000, Klasson et al. 2005). A re-survey of Huxel's sites in 2001 revealed that the

Argentine ant spread to three more of the 30 sites examined by Huxel along the American River and Putah Creek in 1998 (Holyoak and Talley 2001).

A suite of invasive plants currently threaten California's riparian ecosystems and may affect the VELB through a variety of mechanisms, including competition with elderberry and changes in flow or fire regimes (See Section 2.3.2.). The short-term effects of one invader, *Robinia pseudoacacia*, on elderberry and VELB have already been observed (Talley 2005). The long-term effects and mechanisms are unclear, but, based on related research, *Robinia* may lead to a decline in elderberry in invaded areas (See Section 2.2.5). Significant and prolonged efforts to identify and control the worst invaders will be needed to minimize effects to riparian habitat and VELB.

2.1.4. Summary and conclusions

Much information on the ecology of the VELB has become available since the last comprehensive status review (Barr 1991), but many uncertainties still exist. The subspecies distinction of *D. c. dimorphus* and *D. c. californicus* seems valid but genetic studies are needed to calm doubts and clarify subspecies boundaries. The precise range of the VELB is also unknown. Available evidence from a limited number of adult males reveals a range from Tehama Co. in the north to Fresno Co. in the south, a smaller range than has been inferred from the presence of exit holes. More information about both the taxonomy and distribution of the VELB is, therefore, still needed.

New observations of the life-history and behavior of the VELB have been made, but many observations are anecdotal with a lack of quantitative data. Egg production per female appears to be highly variable and hatching success is 50-68% based on two observations. The survival rates of the larvae and subsequent pupae are unknown. Adults may rely on the volatile chemicals of elderberry for long distance attraction and likely use short-distance pheromones (cm's) for mate detection. Females are generally less active than males. More quantitative information on the demography, life history and behavior is needed.

The VELB is a patchily distributed species and is a great deal rarer and more patchy than its elderberry host shrubs. VELB metapopulations are regional concentrations of populations that occur within individual drainages and are comprised of local populations. The local populations are in turn comprised of local aggregations associated with one to many shrubs. The size (spatial extent) of aggregations, populations and distances between them vary with drainages.

On average, 64% of sites examined along the Sacramento River in the mid-1980's contained VELB. About 20% of sites examined across the VELB's range in 1991 and again in 1997 were occupied, but these occupancy rates vary with location and land use. Occupancy of shrubs or groups of shrubs was 25% in 1991 and again in 1997 in coarsely sampled sites throughout the Central Valley, and 7-11% of riparian shrubs and 2.9% of non-riparian shrubs sampled in continuous stretches within the American River basin and Putah Creek in 2002-2004. Local abundances are very low with about 2 new exit holes per site found throughout the range in 1991 and 1997. Standardization of sampling methods would help with comparisons across locations and sites.

Determination of trends in population sizes is inhibited by a lack of data and by the fundamental rarity of the beetle. One data set consisted of 2 sampling dates that were 6 yrs apart (1991, 1997). Occupancy rates were similar but declines in sites with elderberry and density of elderberry led to the net decline in the number of holes found. Decline in occupancy observed in the mid 1980's between the highly cultivated south end of the Sacramento River and the less developed north end (Lang et al. 1989) illustrates the declines associated with habitat loss and fragmentation that may occur through time. More long-term datasets are sorely needed to determine whether the VELB is recovering, holding its own, or still in decline. However, a CSU Chico study showing a 48% loss of riparian habitat from 1960 to 1990 suggests that habitat for the beetle is still decreasing (GIC 2003).

Habitat for the VELB consists of not only elderberry abundance but also other characteristics of the elderberry shrubs as well as local and regional characteristics of the landscape. Habitat quality varies among sites and with spatial scale, with different factors affecting VELB occupancy of aggregations than affecting occupancy rates of the local populations or distances between aggregations. The dispersal limitation of the VELB along with its low densities makes it highly vulnerable to chance events that could lead to local extirpation. Declines in habitat quality and greater separation of adequately sized habitat fragments of good quality increase this vulnerability and decrease the likelihood of recolonization from other occupied areas.

While much new information exists about the VELB many important pieces of information needed to make predictions about long term trends and persistence of VELB and its habitat are still missing.

2.2. Identification of threats.

2.2.1. Present or threatened destruction, modification or curtailment of its habitat or range

2.2.1.1. Assess rates of loss of remnant natural habitat.

Loss of historic riparian and grassland ecosystems remains high- roughly 90% despite numerous restoration and conservation efforts in the Central Valley (see Section 2.1.3.1). Even relatively recent loss rates appear high: e.g., 48% loss of Central Valley riparian habitat from 1960 to 1990 (GIC 2003). Restoration efforts are vital but have not replaced even a fraction of lost historic riparian ecosystems (Sections 2.1.3; 2.3.1). The infrequency and coarseness of GIS studies make it difficult to assess localized and incremental fine-scale losses in habitat that continue. Continued loss of remnant natural areas can best be tracked using Biological Opinions (BiOps) and subsequent mitigation plans and reports. While mitigation appears on its face to more than replace the number of shrubs lost to development, the quality, size and persistence of these shrubs are uncertain, as is the sustainable use of mitigation areas by the VELB. The quality and the net gain or loss of land area is also unknown (Sections 2.1.3; 2.3.1). Assessments of habitat loss from BiOps and mitigation reports are difficult because the metrics of "habitat" vary between numbers of shrubs, numbers of stems, acreage of land, and the time that has passed during which VELB had an opportunity to colonize sites. There is a need for standardized methods and validated measures of loss and compensation.

2.2.1.2. Rates of habitat replacement via mitigation.

There are three general phases of habitat replacement- (1) the amount of mitigation (numbers of shrubs or stems) proposed or required for compensation in biological opinions; (2) compliance (that actually put on the ground), and (3) elderberry survival and/or use by beetles.

Amount of mitigation proposed or required. Of roughly 500 biological opinions in the USFWS database, 110 reported both (a) stems or shrubs *impacted* (authorized take, whether affected directly or indirectly), AND (b) proposed or required mitigation. By pooling data from all 110 biological opinions, we get the following estimates about proposed mitigation.

Shrubs. For impacts to about 2100 elderberry shrubs, opinions anticipated approximately 1600 transplantings (i.e., transplant rate was about 76%). Some unknown number of these shrubs were only indirectly impacted and were left in place. Because of this and routine SFWO practice, we presume a substantially higher percentage of shrubs that would have been directly impacted (those in the direct path of development) were transplanted.

Stems. For impacts to about 13,500 elderberry stems greater than 1" diameter, the biological opinions anticipated approximately 47,300 new elderberry shoots would be planted (and generally maintained as per the Guidelines). This ratio is 3.5 to 1 (compensation to impact).

Compliance.

Reporting. Monitoring and reporting of mitigation actions for VELB impacts is incomplete and uneven in quality. Publicly available mitigation reports were used by Holyoak et al. (in press) to assess the success of VELB mitigation, including compliance. Only 56–67% of reports were found for mitigation sites of up to 4 years old, and 20–30% for 5–7 year reports. There is no reason why reports from older sites should be disproportionately lost since the filing procedures are the same for all reports received by FWS, and this is therefore likely to represent a decline over the time span of a mitigation project in the proportion of reports being submitted to FWS (Holyoak et al. in press). Whether this is due to a lack of report completion or lack of site monitoring is unknown.

Of the reports that were filed, the following information was synthesized:

Elderberry survival and colonization by VELB.

Shrub survival**.** Survival of both seedlings and transplants was highly variable and declined with time since planting. Holyoak et al. (In press) estimated that 72–75% of seedlings or transplants survived planting in the first year of monitoring in sites throughout the Central Valley. By 7 years after planting, however, only 57–64% of transplants and 71% of seedlings survived. Based on the planting of shrubs at ratios of two or more shrubs planted for each one destroyed and the mean shrub survival rates, it is likely that there is a net gain in the number of elderberry shrubs from mitigation (Holyoak et al. In press). Loss or gain of actual land area is however unknown. Furthermore, only 8% of reports contained usable data on growth in stem diameter, a limiting factor for VELB occupancy (Barr 1991, Collinge et al. 2001, Talley et al. In press). Measures of elderberry height and condition were variably reported and calculable for only 8-49% of plantings. Even essential variables like the number of elderberry planted (given for 95% of plantings) or the percent surviving (given for 87% of plantings) were not always recorded (Holyoak et al. in press).

VELB colonization. Holyoak et al. (in press) found that VELB had been present in 47% of areas destroyed by development, and were subsequently found at 43% of mitigation sites. Mitigation therefore caused a small loss in number of populations, although there are no strong trends toward decline or recovery. Whether VELB colonized sites was, recorded in only 81% of reports. We expect colonization of VELB was adequately reported for sites that filed reports; i.e. no mention of VELB in a report probably means no beetles or exit holes were found. This would lower the colonization rate calculated above. Age and size of the elderberry plantings may be a factor, and so some mitigation sites with only early reports on file may not have reported VELB but gained it later.

A considerable but unquantified proportion of elderberry plantings for VELB mitigation were not in riparian areas, and thus not in what is likely to be the best habitat for VELB. In part this may be related to the California State Reclamation Board's opposition to elderberry plantings in jurisdictional floodways. Relatively little of the mitigation bank acreage for VELB approved by the Service –where a substantial proportion of the agreed-upon compensation for elderberry impacts has been channeled – is in major riparian areas. The lack of focus of elderberry compensation measures in riparian areas is an issue that remains to be addressed in VELB conservation.

Cumulative implemented surviving mitigation used by VELB appears to be similar to or somewhat less than authorized impacts (i.e. neutral or negative net effect.) Consideration of additional important factors – such as fragmentation effects (metapopulation connectivity), uncertainty of beetle use of mitigation shrubs and establishment of sustainable populations, uncertainty of elderberry condition, actual habitat area gained or lost, and limited riparian mitigation areas -- may tilt the balance toward negative net effect despite habitat replacement policies.

2.2.1.3. Section 7. Consultations under section 7 of the ESA, yielding a biological opinion, constitute an important catalog of impacts to VELB. Essentially all legal impacts to the species must obtain a biological opinion on the activity—either through a federal agency, or as a FWS internal consultation on issuance of a permit for an HCP. Biological opinions often also describe or prescribe project measures taken to offset these impacts. Here we review available data on section 7 consultations on VELB, including internal section 7 consultations on HCP permits.

Data sources. SFWO maintains an electronic database or log of consultations under section 7 of the ESA. This log is reasonably complete from 1994 to the present. Starting with some consultations begun in 1996, SFWO began to log measures of impact or "take" authorized in formal consultations. In addition, Thornton and ECORP (Ballard 2006) compiled a list of 184 VELB consultations from 1983 to 2005, and recorded data on the impacts estimated in the biological opinions. Many of the consultations listed by Thornton/ECORP are also listed in the SFWO electronic log. Neither data source is 100 percent complete with respect to coverage of biological opinions or recording information about impacts.

We checked these two data sources against one another for reliability. In 40 of 42 cases (95 percent) where both sources recorded values for the same biological opinion, the data on numbers of stems impacted were identical. The two cases of disagreement were not dramatic. For numbers of whole shrubs impacted, values were identical in 34 of 40 cases (85 percent). In two cases the disagreement was greater than or equal to a factor of 3. While the data sources are not flawless they appear adequate to outline broad cumulative trends.

The SFWO has begun an electronic VELB take-tracking spreadsheet, with significant contributions by Ellen Berryman, Roberta Gerson, Christopher Jones, and Susan Jones. The spreadsheet currently lists 141 formal consultations, mostly from 1994 through part of 2002, and records comprehensive information on 40 of these.

We compiled master files that combine the three sources, eliminating duplicative entries. The degree of duplication in these sources suggests that, when merged, they list the great majority of biological opinions written on VELB.

Overview of consultations. The combined dataset lists over 500 consultations including VELB, from 1983 to the first quarter of 2006.* At least one consultation on VELB critical habitat was completed during this period (1-1-02-F-81, "American River Watershed, California Long Term Study," USACE/SAFCA/State Reclamation Board), however, records on critical habitat consultations may be incomplete.

All consultations in the SFWO electronic log had non-jeopardy conclusions or made an amendment to a previous consultation.

However, at least two jeopardy and/or draft jeopardy biological opinions on VELB have been prepared. One and perhaps two jeopardy biological opinions on the effects of the Sacramento River Bank Protection Program (SRBPP) were issued by the Sacramento office in the early or mid-1980's (see files 1-1-84-F-34 and -34R, 1-1-87-F-5; these consultations pre-date the SFWO electronic log). A more recent biological opinion on the SRBPP was non-jeopardy for VELB.

Another consultation which resulted in a draft jeopardy statement regarding the VELB was a national consultation with EPA on registration of 15 pesticides, 1998-1999 (originally begun circa 1991 or earlier; 1998 saw a second attempt to complete it).* A January 6, 1999 memorandum from Acting Field Supervisor Michael Thabault, SFWO, to the Regional Section 7 Coordinator determined that registered uses of acephate, bendiocarb, chlorpyrifos, fenthion, naled, permethrin, and S-fenvalerate (also called esfenvalerate) would jeopardize VELB, and that all these except chlorpyrifos and S-fenvalerate were likely to adversely modify designated critical habitat of the VELB (file 1-1-99-I-464).** A few of the chemicals consulted on since have been cancelled or restricted by EPA and/or are no longer used in California, including bendiocarb, fenthion, and parathion. Many of the rest are still used in very large quantities, in proximity to recorded VELB locations (CDPR 2006; see Threats Section 2.2). According to Mike Horton of the Service's Endangered Species Division at the Headquarters office (Horton 2006), this national pesticide consultation was never finalized, but was supplanted by the publication of counterpart regulations allowing EPA to self-evaluate the need for consultation on pesticide registrations.

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* Not all of these 526 consultations were formal consultations for VELB. Consultations on more than one species sometimes concluded with a not-likely-to-adversely-affect determination for certain species included within the biological opinion for other, adversely affected species. Separate "not likely" determinations were not recorded for most of the log's duration, however, a separate field for determinations for each species was added to the log in 2004. Of 263 consultations with a specific finding for VELB recorded or inferred, 22 determined not likely to adversely affect or no effect on VELB (8.4 percent), and 241 were formal consultations (including amendments and programmatic appendage letters; 91.6 percent), suggesting that most of the 263 unspecified consultations were formal consultations on VELB.

* This consultation does not appear in the SFWO log of formals because the SFWO contribution was prepared in draft and sent to the Regional and Washington Offices for finalizing

** The chemicals aldicarb, azinphos-methyl, carbofuran, endosulfan, parathion, and phorate were judged to adversely affect the species but not cause jeopardy or adversely modify critical habitat. No mention is made of the herbicide trifluralin in the VELB text.

Trend over time. As shown in Figure 9, the number of VELB consultations increased dramatically from the 1990's to a peak in 2001, and has since declined.[***]

Figure 3 of the May 22, 2006 ECORP report (Ballard 2006) shows a similar trend over time, from fewer than 5 consultations per year before 1992, rising to about 20 in 1997 and dipping in 1998. From 1999 onward the ECORP data appear to be incomplete relative to the SFWO log.

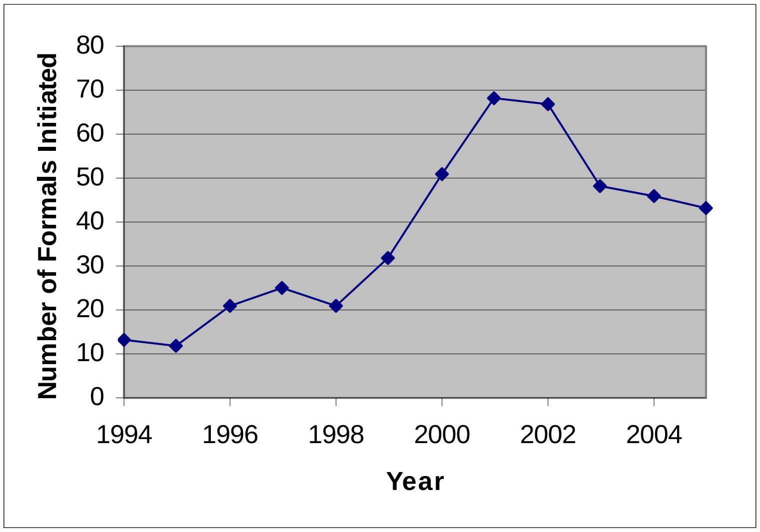

Figure 9. Number of formal consultations including VELB initiated in each year from 1994 to 2005.

Amount of take. Of 291 formal consultations with stem or shrub numbers recorded in the combined data set, 222 recorded the number of stems impacted and 169 recorded the number of shrubs impacted, with many recording both. About 13 were amendments of existing consultations that made no revision to estimated impacts. Number of elderberry stems (greater than or equal to 1 inch in diameter, i.e., stems suitable as hosts for VELB larvae) or number of elderberry bushes impacted provided the most consistent recorded measures of impact.

The values recorded included habitat (shrubs, stems, acres) both directly and indirectly impacted, representing the amount of take authorized, although "impacted" elderberries were not always destroyed. Acres directly and indirectly impacted also were recorded in the SFWO section 7 log and are evaluated below.

Stems impacted - Since 1989, 223 consultations recorded a cumulative impact of about 21,600 stems that were large enough to support VELB. The median number impacted per project was 29 stems but, due to a few projects with very large impacts, the average number of stems impacted per project was much larger: 97.1. A breakdown of projects by numbers of stems impacted is as follows:

[***] Some of the apparent decline during 2005 – and perhaps to a small extent, 2004 – may be attributable to consultations initiated during those years not yet being completed and logged out. The data show only completed consultations.

Number of stems impacted, diam. 1”+	Number of projects
1 to 3	23
4 to 9	30
10 to 30	61
31 to 100	62
101 to 300	32
301 to 1000	12
1001 to 3000	3

The three individual projects with impacts over 1,000 stems were:

Sacramento Flood Control Project System Evaluation, Phase II, Marysville/Yuba City Area (file 1-1-93-F-8)	1538 stems
Detention Dam at Auburn (file 1-1-96-F-28)	2336 stems
Downtown Sacramento Amtrak and Folsom Corridor Light Rail Extensions, Double Tracking Project (file 1-1-00-F-9)	1248 stems

Not all of these projects have been carried out (e.g., Auburn Dam); and the actual impacts of the Marysville/Yuba City Area flood project proved to be somewhat less than estimated (USFWS 2005).

Extrapolation of these 223 cases to all VELB consultations is risky, because of the high degree of variability and strong dependence of the cumulative impact on infrequent high-impact projects. With awareness of this caveat, the estimated stems impacted by 500 projects in the combined databases would be on the order of 50,000 and 97.1 stems per project. Omitting Auburn Dam drops the average impact per consultation to 87.2 stems, and the estimate of cumulative impacts is on the order of 40,000 stems, illustrating the data’s sensitivity to high-impact projects.

Shrubs impacted—Patterns similar to those for numbers of stems also are seen for numbers of shrubs. Impacts to about 4,560 elderberry shrubs were reported in 171 projects, cumulative. The median number impacted per project was 7 shrubs but, due to a few projects with very large impacts, the average number of shrubs impacted was larger: 26.5. About 20 percent of consultations (34 of 171) addressed projects impacting a single elderberry shrub (with stem numbers allegedly ranging from 1 to 147). A distribution of projects by numbers of shrubs impacted is given below:

Number of elderberry shrubs impacted	Number of projects
1 to 3	60
4 to 9	35
10 to 30	44
31 to 100	18
101 to 300	13
301 to 1000	1

The aborted Auburn Dam again was high in the list, with an estimated impact of 210 shrubs (third largest). The single largest project impact was the Pacific Gas Transmission Company, Canada to Panoche pipeline (September 20, 1991), at 473 shrubs.

Extrapolation of these data to all consultations is risky, because of the degree of variability and sensitivity to rare high-impact projects. With awareness of this caveat, the estimated number of shrubs impacted by a cumulative 500 projects in the combined databases is roughly 12,000 to 15,000. Omitting Auburn Dam lowers the average number of shrubs impacted per project slightly to 25.4, and the estimate of cumulative impacts remains similar.

Acres impacted—The majority of project impacts authorized were considered permanent (90 percent, vs. 10 percent temporary; n = 31) and direct (average 25.5 acres, n = 83; vs. 2.2 acres indirect, n = 81). The sample sizes for these estimates were relatively small (permanence of impact) or inconsistently valued (unclear how direct and indirect acreages were determined in each case) and should be considered very approximate. An estimate of total acreage impacted by 500 consultations is on the order of 10,000 to 20,000 acres.

While this is the best estimate using available data, it cannot be considered very reliable because of variability and inconsistency in the data. In most cases the area recorded was not the total area of potential elderberry habitat impacted, but some smaller measure of area actually 'occupied' by the existing shrubs. On the other hand, some of the largest "impact" areas recorded were actually of projects whose major purpose was restoration of riparian habitat, including VELB habitat. For example, an estimate of "take" of 1500 acres was appropriate for the Hamilton City Flood Control and Ecosystem Restoration project (file 1-1-04-F-145, June 30, 2004) because authorization to temporarily take all shrubs in 1500 acres might be needed for flood fighting. However, the project includes a setback levee and restoration work, including planting more than 2,700 elderberries, and should reduce flood risk. In the event of a flood fight damaging elderberry habitat, the Army Corps of Engineers has committed to restore the site afterward.

Not all of these projects authorized under ESA section 7 to take VELB have been implemented, and some may never be implemented. There does not appear to be comprehensive follow-up on how much of the take authorized does occur. Such an effort could be quite laborious after the fact.

A substantial number of consultations on VELB (perhaps half or more) are handled by appending them to one of a number of programmatic biological opinions on the species. The programmatic opinions typically contain language in their project descriptions setting forth maximum cumulative impacts under the programmatic (e.g., a cap of 2000 stems), and that the SFWO will re-evaluate the level of impacts or take at regular intervals (e.g., every 6 months). However, other than the nascent baseline/take-tracking efforts referred to above, we have not encountered evidence that cumulative VELB impacts under the several programmatics are actively tracked or periodically reviewed.

Unauthorized impacts. Unauthorized impacts to VELB and to elderberry shrubs that may be inhabited by VELB also occur, and are relatively unmonitored and their cumulative effects unquantified. SFWO files contain several examples of these, some quite large. To our knowledge, none was ever pursued to the point of ESA penalties or prosecution.

2.2.2. Overutilization for commercial, recreational, scientific, or educational

purposes

Nagano (1989) states that longhorn beetles are popular among insect collectors, getting as much as $200 each. No commercial or private trade of the VELB is known at this point, but demand would be likely if specimens were legally attainable given the rarity of the beetle (Nagano 1989).

2.2.3. Disease or predation

2.2.3.1. Predation by invertebrates: *Linepithema humile* (Argentine ant)

The invasive Argentine ant (*Linepithema humile*) has been identified as a potential threat to the VELB (Huxel 2000, Huxel et al. 2003). This ant is both an aggressive competitor and predator on native fauna that is spreading throughout riparian habitats in California and displacing assemblages of native arthropods (Ward 1987, Human and Gordon 1997, Holway 1998). Between 1998 (Huxel 2000) and 2002, the number of sites infested by the Argentine ant increased by 3 along Putah Creek and the American River (30 sites total were examined) (Holyoak and Talley 2001). The Argentine ant requires moisture so that populations of this aggressive invader can thrive in riparian or irrigated areas (Menke and Holway 2006), particularly in moist piles of wood and leaves. A negative association between the presence of the ant and VELB exit holes was observed along Putah Creek in 1997 (Huxel 2000). This aggressive ant could interfere with adult mating or feeding behavior, or prey on eggs and larvae (e.g., Way et al. 1992, Figure 9). Preliminary results on the potential mechanisms behind the relationship observed by Huxel (2000), as well as the spatial extent of such relationships and the conditions under which negative relationships may arise are reported in Klasson et al. (2005).

Klasson et al. (2005) reported that analyses using ant trap data and mapping data (elderberry and exit hole locations) revealed positive associations between the Argentine ant and the VELB across shrub-wide (~10 m) and site-wide (100 m) distances, but no relationships when averaged over 25 m and 50 m scales. Co-occurrence of the species over 100 m scales illustrated that the two species have similar environmental requirements (e.g., microclimate, moisture, canopy cover) (Klasson et al. 2005). Co-occurrence on elderberry shrubs (10 m scales) illustrated that elderberry shrubs have something to offer for both species; VELB rely solely on elderberry for food and habitat, while the ant takes advantage of the diverse insect prey, nectar, and fruits, as well as habitat provided by abandoned holes in elderberry stems (Klasson et al. 2005). Klasson et al. (2005) also reported the results of a larvae-tethering experiment (using tiny mealworm larvae) which revealed that given the opportunity, the ant will increase mortality (i.e. predation) of vulnerable beetle larvae. The presence of intact larvae decreased and partially-eaten larvae increased with increased Argentine ant density (Klasson et al. 2005). Previous observations of Argentine ants quickly attacking a VELB larva in the field support this (Figure 10). Klasson et al. (2005) reported that there appeared to be threshold densities of the Argentine ant, under which the amount of predation does not significantly affect VELB populations, but above which predation rates may substantially decrease VELB population survival. Situations where high densities of Argentine ants were observed included mitigation sites.

Figure 10. The Argentine ant (*Linepithema humile*) attacking the larva of the Valley elderberry longhorn beetle. Taken in May 2003 along Putah Creek.

Klasson et al. (2005) reported that the Argentine ant was present in most mitigation sites they surveyed (14 of 15) both because it is introduced with seedlings from nurseries (see below 2.2.5) and because irrigation encourages proliferation of Argentine ant populations. Mitigation sites with Argentine ants had among the highest relative densities of the ant (density ranks of 4 or 5 out of 5) based on the ant traps. These densities were most likely above the hypothesized threshold density of the ant making mitigation sites potentially inhospitable environments for the VELB because of Argentine ant predation (Klasson et al. 2005). Additionally, mitigation sites are often somewhat isolated from remnant natural populations. This isolation coupled with the threat of the Argentine ant within these sites may have disproportionately higher negative effects on the VELB (Huxel et al. 2003).

Other potential natural enemies (native and exotic)

Predation of VELB larvae by birds has been observed (Nagano 1989, Halstead and Oldham 1990) but the low chance of encounter between birds and such rare, small prey makes it seem as though this is a relatively small source of mortality. Other common, potential natural enemies found along the Parkway were ground squirrels, Western fence lizards, yellow jackets and European earwigs (Klasson et al. 2005). These four species move freely up and down elderberry stems searching for food. While squirrels readily ate the tethered mealworm larvae, Klasson et al. (2005) were skeptical that squirrels would be searching for a prey item as tiny as a VELB larva and the aposematic coloration of the adults (warning coloration suggestive of toxicity) makes VELB larvae unlikely prey for a vertebrate. The Western Fence lizard was an effective predator on the mealworm larvae and adults, and would be efficient at preying upon even smaller insect larvae like the VELB. Lizards were common in natural as well as in mitigation sites. In one restoration site along the Sacramento River, every single elderberry seedling out of ~1500 surveyed had a fence lizard on it (Klasson et al. 2005). Again, Klasson et al. doubted that the lizards would prey on VELB adults although either squirrel or lizard activities could disrupt VELB adult activities of feeding and mating. Yellow jackets (vespid wasps) were observed aggressively attacking live mealworm larvae but were not common in all sites tested (Klasson et al. 2005). Finally, the European earwig is a scavenger and omnivore that was often found feeding on the tethered mealworm larvae. The earwig is common in elderberry and often nests in abandoned holes in the stems. The earwig, like the Argentine ant, requires moisture and is often found associated with irrigation. Earwig presence and densities tended to be highest in mitigation sites likely because of the irrigation, although this needs to be statistically tested (Klasson et al. 2005). The presence of earwigs could contribute to unnaturally high predation rates in mitigation sites. Besides direct effects, the high densities of Argentine ants and earwigs in mitigation sites, could be subsidizing higher abundances of lizards, and further increasing predation pressure on invertebrates in these areas. These ideas need to be tested further but our preliminary recommendations are: (1) to reduce the introductions of Argentine ants and earwigs into mitigation sites; (2) water in such a way as not to encourage their population growth; (3) and populations of lizards are also likely to decline, thereby relieving predation pressure on invertebrates in these sites (Klasson et al. 2005).

2.2.3.2. Parasitoids. Parasitoids are common enemies of other wood boring species (Agular 2005, Deans and Jennings 2006, Jennings and Deans 2006), but unknown for the VELB. The parasitoid adult female deposits eggs within the woodborer's larvae inside of the plant. Given the rarity of the VELB, it seems unlikely that there would be parasitoids that specialize on this beetle, but there are a number of generalist parasitoids of this nature. Furthermore, the use of parasitoid wasps as biocontrol for the eucalyptus longhorn beetle in California (Hanks et al. 2001) may be a potential threat to the VELB if the wasp switches hosts (the USDA believes it will not). Further research on VELB parasitoids is needed.

2.2.4. Inadequacy of existing regulatory mechanisms

2.2.4.1. VELB habitat and riparian protections. With federal listing of the VELB in 1980, many regulatory failings were ameliorated. For example, as an insect, the beetle cannot be listed under the State of California's Endangered Species Act, and so receives no state protections under that law. Elderberry plants were not protected. VELB might have achieved some consideration under CEQA as a rare species; however, CEQA fundamentally regulates disclosure rather than impact. CEQA requires project impacts to be properly analyzed and fully disclosed to the public, but the final choice of alternatives is at the discretion of the acting state or local agency. The agencies are not required to—and frequently do not—choose the least environmentally damaging project. Some reduction and mitigation of VELB impacts under CEQA might have been achieved through exploration of alternatives and mitigation of "significant" impacts. NEPA, the federal analogue of CEQA, is very similar: it is a disclosure law, and does not necessarily limit impact. NEPA did not mandate consideration of impacts to VELB before the species was listed.

Impacts to wetlands *per se* were and continue to be regulated under the Clean Water Act (CWA) but CWA offered little protection to VELB. Despite frequently occurring near water, the VELB's host elderberry often does not grow in jurisdictional wetlands or waters of the U.S. Elderberry are more common in areas with good drainage and only can tolerate temporary root crown inundation. Moreover, in the Central Valley, many areas that once would have been within CWA jurisdiction are now behind levees and unregulated, despite still having reasonable proximity to groundwater and being suitable for elderberries and other riparian vegetation. Finally, even where elderberries grow in undisputed riparian settings, and within the scope of jurisdiction determined by the ordinary high water mark, the CWA expresses no interest in beetles or elderberries beyond disclosure under NEPA or protection of species listed or proposed for listing under the ESA. Before listing, only projects seeking to place a permanent structure within a 100-year floodplain were appreciably limited (in VELB impacts) by the CWA.*

Listing under ESA not only solidified regulatory protections but also raised some barriers to conservation of VELB. Though quantification is lacking, loose talk is common about landowners wiping out elderberries on their land because they fear the hassles or costs of dealing with the FWS. One well-documented backlash that is problematic for the conservation of VELB is opposition to elderberry planting in floodplains by the State Reclamation Board (see section 2.3.1). The Reclamation Board does not want to have to contend with elderberry impacts and mitigation from maintenance or flood fighting activities.

Remaining inadequacies in existing regulatory mechanisms are addressed below.

2.2.4.2. Pesticide regulation. EPA regulates pesticides and their use, for example through the pesticide registration process. FWS, usually (with exceptions) and as a matter of policy, does not consult about routine "on-label" use of pesticides. However, pesticide registrations—a federal agency action which should be subject to consultation under section 7 of the ESA—have almost never been consulted on (see also Section 2.2.1.3.). ESA consultation between EPA and FWS has been completed only for a handful of rodenticides. This leaves hundreds of pesticides in use in California in proximity to VELB without ESA review of impacts, avoidance or minimization (Marovich and Kishaba 1997). See section 2.2.5.2 for a discussion of threats from pesticides to the VELB.

2.2.4.3. Conservation guidelines. There has been mention of the potential ineffectiveness of current (1999) compensation guidelines (Fleishman and Murphy 2006). New information on habitat quality, the effects of management practices, and mitigation recommendations can now be incorporated. Better understanding habitat quality for the VELB can inform evaluation of the value of areas slated for development and the value of areas to be used for compensation. Mitigation goals can be better defined (also see Section 2.2.5). Similarly, spatial information about the beetle can guide estimates of minimum number, area, and elderberry density/spacing needed to sustain populations, as well as the minimum distances to the next nearest population or aggregation. More scientifically-based guidelines will be more effective, efficient and therefore better supported.

2.2.4.4. Potential impacts of a change in VELB listing status

Presumably, existing conditions will continue with only minor or gradual change if, pursuant to the Service's 5-year Review, the listing status of the VELB is retained as threatened. Here we discuss what regulatory inadequacies might be remedied if the species were uplisted or delisted, or what regulatory effectiveness might be lost.

The listing of VELB dramatically increased the degree of attention to this rarely observed beetle. Uplisting to endangered might further enhance awareness of the species and the degree

* One commenter went so far as to claim California's Porter-Cologne Act protects the VELB, which stretches credulity. Without listed status there was little or no reason for application of this or other water quality laws to consider VELB, or other vegetation besides bermudagrass, for that matter.

of consideration, avoidance, minimization of impacts, and mitigation that the species receives. The level of funding available for habitat acquisition and restoration and other projects contributing to VELB recovery also is strongly tied to its listed status (J. Silveira, FWS, pers. comm.). Uplisting would enhance the ability of the beetle to compete for funding and potentially speed recovery.

Delisting the VELB would greatly reduce its ability to draw funding for habitat acquisition and restoration projects, such as those ongoing on major rivers in the Sacramento and San Joaquin Valleys. However, riparian restoration in the Central Valley also is driven by restoration of habitat for species such as migratory birds and salmonids, so it seems likely these projects would continue, albeit at a reduced pace. Elderberry is an important habitat component in these riparian ecosystems and would continue to be planted. In fact, delisting might have the perverse effect of allowing more elderberry planting in certain restoration projects, since the State Reclamation Board might no longer block its planting if ESA concerns were removed.[*] Delisting would reduce the responsiveness of development projects to VELB needs under CEQA and NEPA. Routine destruction of elderberry plants would no longer be regulated.

2.2.5. Other natural or human made factors affecting VELB's continued existence.

2.2.5.1. Management and maintenance practices

Effects of access road dust

In a study involving natural experiments, field surveys and GIS along the American River Parkway, Talley et al. (2006) found that dust deposition varied among sites and was highest within 10 m of trails and roads, but was similar adjacent to dirt and paved surfaces. Elderberry density did not differ with distance from dirt surfaces. Despite similar within-site dust levels, elderberry adjacent to paved surfaces were less stressed than those near dirt ones, possibly because increased runoff from paved surfaces benefited elderberry. Dust deposition across all sites was weakly correlated with elderberry stress symptoms (e.g., water stress, dead stems, smaller leaves), indicating that ambient dust levels (or unmeasured correlates) can influence elderberry. Direct studies of the VELB exit holes showed that distributions were not negatively associated with the proximity to dirt surfaces. The effects of dust on VELB adults, eggs and larvae could not, however, be tested. It was assumed that if such effects existed, patterns in exit holes would have been exhibited. The effects of larger amounts of dust than were found in this study on the VELB while on the surface of shrubs and/or elderberry condition and survival need to be tested. Dust from low traffic dirt and paved access roads and trails, however, did not affect VELB presence directly nor indirectly through changed elderberry condition. The study concluded that the placement of VELB mitigation, restoration and conservation areas could proceed independently of access roads if dust and traffic levels do not exceed those in the study system and that dust control measures are likely to be unnecessary under such conditions.

Effects of pruning.

Klasson et al. (2005) reported two experiments that quantified the effects of each of two types of tree trimming, pruning and topping, on elderberry growth and condition, as well as VELB occupancy and abundance. Experiments were conducted along the American River Parkway, Sacramento County, California, USA between 2002-2004 (pruning) and 2003-2004

[*] However, it should be noted that a few Safe Harbor Agreements and other recent innovative approaches by the SFWO are showing ways to work with the Reclamation Board to allow elderberry plantings.

(topping). For each experiment, sampling occurred before trimming, then after at 1-2 wk, 1 yr, and 2 yr (pruning only). Both experiments are on-going but results are available for only these periods. The pruning experiment mimicked the trimming of shrubs that overhang roads or trails. The topping experiment investigated the form of pruning that occurs beneath power lines, where "topping" removes the top 1 m of a shrub or clump of shrubs. Most branches at this height are ≤2.5 cm diameter.

Effects of shrub trimming on VELB: Neither pruning nor topping affected the colonization or loss of VELB from shrubs, or the length of time that a shrub was either occupied or unoccupied by VELB. Length of occupancy was related to the occupancy status at the start of the experiment, with occupied shrubs remaining occupied and those without holes remaining vacant (Klasson et al. 2005).

Effects of trimming on elderberry:

Nutrients & chemicals. Neither pruning nor topping had any detectable effects on elderberry nutrient content (leaf C:N, pith N) at any of the dates sampled. Similarly, hydrogen cyanide was at negligible levels at the start of both experiments (no test paper color change), and remained so in both experiments at all dates (Klasson et al. 2005).

Survival, growth, condition. There were no short-term changes (2-4 wks) in these shrub variables—survival, growth or condition—in response to pruning or topping. Shrub mortality occurred only in the pruning experiment but did not differ between VELB and no-VELB or between pruned and not-pruned shrubs for either year (2003, 2004). The initial presence of VELB, pruning and topping did not affect changes in the number of main stems per shrub, the maximum basal stem diameter or shrub height for any year. Topping had removed 50-100 cm from the top of the shrubs but the lack of height differences among treatments the following spring suggested that the small cut stems grew quickly. Elderberry condition (percent of stems that were dead on each live shrub) was not affected by pruning or topping (Klasson et al. 2005).

Temporary loss of habitat. The only negative effect observed of trimming elderberry was a temporary loss of habitat in the form of the cut stems. After one year, an average of 2.3 new branches emerged from each pruned shoot and 2.0 new branches from each topped shoot. The new branches, which were thin (≤1 cm diameter) and so not usable by the VELB, emerged from the first node beneath the cut. After 2 years, there was an average of 1.8 new branches for each pruned branch suggesting some mortality of these new shoots. In this second year shoot diameters were 1.5 to 2 cm and had become fairly woody although they still appeared unsuitable for use by the VELB based on their size. Assuming a constant annual stem mortality rate, there would be 1.5 new branches for each one pruned in year 3 and 1.0 new branches by year 4. From the observed growth rates, surviving branches are expected to reach 2.5 cm diameter in the 3rd year. These preliminary experiments illustrate that, on average, each 2-2.5 cm diameter branch that is cut will be replaced in about 3 to 4 years (Klasson et al. 2005).

Direct take. There is a risk in cutting stems of removing a stem that contains a larva. The risk of taking larvae declines, however, with decreased diameter of cut stems (e.g., <2 cm diam are not usable) and with height within the shrub (e.g., most holes occur 3 m or lower in the shrub) (Section 2.1.2.3). Compensation ratios for elderberry could be adjusted accordingly. There is also a risk of harming adults if the trimming activity occurs in the spring while adults are present.

Flow regulation

Water flow regulation on many California rivers augments historically low summer flows and attenuates peak winter/spring floods. Flow regulation reduces sediment and organic deposition, and decreases disturbance events that create openings in the canopy in the floodplain. Theoretically, such disturbance favors blue elderberry recruitment throughout floodplains although this has not been examined. Reductions in the establishment of other pioneer species, such as cottonwood, have been observed in the Central Valley; lower winter and spring floods limit seed dispersal and germination, and elevated summer flows drown seedlings (Strahan 1984, Stillwater Sciences 2001, Stella et al. 2003). The reduction in cottonwood forests in the Central Valley has potential long-term impacts on successional patterns for these floodplains, including increased establishment of box elder and black walnut (Jones 1997, Fremier 2003). Vaghti et al. (submitted) found blue elderberry to be strongly associated with black walnut, but it was unknown whether this was due to similar ecological requirements or direct effects between the species (Vaghti et al. submitted). Elucidation of the relationship between black walnut and blue elderberry is needed.

Altered flows likely affect the distribution of elderberry. Elderberry frequency was higher on older flood plains and at higher relative elevations along the Sacramento River suggesting that recruitment or survival in younger, lower floodplains is reduced (Vaghti et al. submitted). Elderberry size distributions (reflective of recruitment and/or survival patterns) may also be affected. Proportions of small elderberry stems (<5 cm diameter) were lower in four dammed rivers than in the undammed Cosumnes River (Vaghti et al. submitted). There was, however, considerable variation among the dammed rivers; 5% of stems were <5 cm in diameter on the Sacramento River, and 19% were <5 cm diam along Cache Creek and the American River (this was still statistically lower than the 21% proportion along the Cosumnes River) (Vaghti et al. submitted).

Mitigation techniques

Planting in the floodway. There has been recent concern that VELB cannot tolerate flooding so elderberry should not be planted on floodplains. Based on current evidence, this concern appears unwarranted. The VELB has higher occupancy rates in riparian than non-riparian habitats, and associations between the beetle and proximity to rivers were either not observed or there was a weak positive correlation with nearness to the river (Halstead and Oldham 1990, Talley 2005, Talley et al. In press). These findings illustrate that the beetle is not likely harmed by flooding and that higher habitat quality may be associated with rivers. Furthermore, if elderberry, a facultative riparian shrub, can withstand flooding then the beetle should be able to survive (i.e., the shrub does not fill with water). Most floods occur during winter or early spring when the beetle is most likely pupating so that the effects of floods are even less likely to affect the beetle. If the shrub is exposed to prolonged flooding (i.e, anoxia) and becomes severely stressed then the beetle may be affected, although this is speculative. There are likely occasional floods that are high enough for long enough in some areas that shrubs and /or beetles die, but this seems no more likely than other types of environmentally stochastic events that may kill the beetle (e.g., brush fires). Elderberry has adaptations that plants use to help cope with flooding such as lenticels and aerenchyma, illustrating that it is probably at least somewhat flood tolerant. Finally, if an area is flooded too frequently so that elderberry cannot survive then no beetles could occupy the area (Talley 2005).

Spread of harmful exotic species through plant movement. The spread of the Argentine ant is facilitated by moisture (Menke and Holway 2006); this is problematic because restoration nurseries may inadvertently harbor and transport the ant in elderberry seedlings used that are used in VELB mitigation sites (Klasson et al. 2005). Samples of ants taken from a local restoration nursery in 2003 revealed the presence of the Argentine ant in almost all seedling containers sampled (Talley 2003b). Furthermore, another species of exotic ant, *Cardiocondyla mauritanica*, was found only in samples taken from a mitigation site in Discovery Park along the American River and not in surrounding remnant natural areas or anywhere else along the Parkway (Talley 2003b). It is, therefore, likely that these ants, which are not highly invasive like the Argentine ant, were brought in with seedlings. Control procedures, preferably at the source, need to be investigated and employed to limit the spread of the Argentine ant (see Section 2.3.2).

Variability of seedling and transplant survival.

Holyoak et al. (in press) found that survival of both seedlings and transplants in mitigation sites was highly variable and total survival declined with time since planting. Year of planting accounted for 14.5% of variation in initial seedling mortality. First year seedling survival varied from 56% in 1995 to 94% in 1996 (mean = 72%). For transplants, year of planting accounted for 15.6% of variation in annual mortality with annual survival between 41 and 93% depending on the year. Annual precipitation data from Sacramento Mather Field Airport was not related to annual mortality in seedlings (Holyoak et al. in press). First year survival of seedlings and transplants along the Merced River in 1999 was 97% (Morrison et al. 2003), and first year survival of transplants and propagated root cuttings along the American River Parkway in the mid-1980's was ca. 80% and 90%, respectively (Sutter et al. 1989). Over 50% of propagated root cuttings planted along the American River in 1986 survived into the second year (Sutter et al. 1989). The effects of temperature, timing of precipitation and interactions between site characteristics (e.g., relative elevation, soil texture) and climate should be explored (Holyoak et al. in press).

By 7 years after planting only 57–64% of transplants were alive compared to 71% of seedlings (Holyoak et al. In press). Excluding high mortality the first year following planting, the average annual mortality rate for seedlings was 0.4–0.5% per year, compared to 1.5–2.2% dying per year for transplants. Mortality rates of 9% the second year and 5% the third year were observed for transplants and seedlings combined in a mitigation site along the Merced River and, after 3 years, 88% of all plants had survived (no breakdown of transplants vs. seedlings) (Morrison et al. 2003).

Site identity accounted for 25% of the variance in the proportion of seedling survival (sample size was too small to conduct this analysis for transplants) (Holyoak et al. In press). The proportion of shrubs alive following planting mortality at different sites varied from 22 to 100% (mean = 69%). The large amount of variation in plant survival rates among sites indicates that the choice of site can have large effects on our ability to establish elderberry (this appears to be independent of year of planting) (Holyoak et al. In press).

Some of the site-to-site variation in proportion of shrubs surviving observed by Holyoak et al. (In press) was explained by the type of irrigation used. Irrigation type (bubbler, hand, sprinkler, drip, or none specified) accounted for a total of 9.5% of variation in proportion surviving. Proportion of shrubs surviving was highest for bubbler irrigation (92%), followed by hand and drip irrigation (77% and 76% survival), then no specified type of irrigation (51%) and sprinkler (48%) had lowest survival (Holyoak et al. In press).

The effect of ground squirrel and pocket gopher burrow systems on elderberry shrub vigor and stem number was tested in a site along the Merced River. While neither had significant effects on shrub vigor, shrubs had twice as many stems when pocket gopher burrows were ≥4 m away (Morrison et al. 2003). The effects of irrigation in this site may have offset any desiccation effect the burrows were having on the shrub, an effect observed in the field (Talley pers. obs.)

High mortality of associated plant species in the Merced site was attributed to the use of container stock that was too small and therefore not able to withstand the stress of planting (Morrison et al. 2003). While this did not appear to be the case with the elderberry seedlings, use of container stock that is too small is a potential concern. Morrison et al. (2003) concluded that use of larger stock may have initially been more expensive but would have reduced replanting and assisted the establishment of wildlife habitat.

The standardized collection and compilation of these sorts of data would allow the completion of analyses that would help determine the factors affecting mitigation site success throughout the range of the VELB.

2.2.5.2. Environmental contaminants

Pesticide use Commonly used pesticides within the range of the VELB include insecticides, most of which are broad-spectrum and likely toxic to the VELB; herbicides, which may harm or kill its host elderberry plants; and broad-spectrum pesticides toxic to many forms of life. The California Department of Pesticide Regulation (CDPR) in 1997 listed 239 pesticide active ingredients applied in proximity to CNDDB-documented locations of VELB (same square mile; Marovich and Kishaba 1997). No equivalent updated analysis is available, but pesticide use remains common and widespread in the Central Valley. Perhaps more than any other listed species in California, elderberries and VELB locations are deeply interspersed in an agriculture-dominated landscape.

In 2004, 180 million pounds of pesticide active ingredients were reported used in California. Reported pesticide use was 176 million pounds in 2003, 172 million pounds in 2002, 151 million pounds in 2001 (Kern County data incomplete), and 188 million pounds in 2000 (active ingredients; CDPR 2006).

The greatest pesticide use occurs in the San Joaquin Valley. Four counties in this region had the highest use: Fresno, Kern, Tulare, and San Joaquin (CDPR 2006). Fresno and San Joaquin Counties, at least, appear to be within the range of the VELB. The peak timing of application depends on the chemical and many other factors but not infrequently coincides with the most vulnerable period: that of VELB adult activity, egg-laying and initial larval exposure on the outside of elderberry stems. These warm spring weeks are periods of high plant and insect activity that also lead to demand for chemical use.

Pesticide use reported to CDPR is only a fraction of the pesticides sold in California each year. About two-thirds of the active ingredients sold in a given year are not subject to use reporting, including home-use pesticide products. Pesticide active ingredients sold in California have averaged on the order of 600 million pounds per year since about1998 (CDPR 2006).

In 1999 SFWO prepared a draft jeopardy statement regarding the VELB for a national consultation with EPA on registration of 15 pesticides (file 1-1-99-I-464). This consultation was never finalized (see Section 2.2.1.3). Many of these chemicals are still used very widely in California, for example, in 2004 the following acreages of use were reported (CDPR 2006):

Acephate	212,000 acres
Chlorpyrifos	1,323,000 acres

Esfenvalerate	680,000 acres
Naled	110,000 acres
Permethrin	698,000 acres
Trifluralin	920,000 acres

There are many dozens of other insecticides with comparably widespread use (acephate and naled are not even in the top 100). Spray applications of many chemicals are commonplace—both aerial and ground-based.

Given this great amount and scope of pesticide use, along with unreported household and other uses, and the proximity of agriculture to riparian vegetation in the Central Valley, impacts of pesticides on VELB appear highly likely. However, none of the hundreds of pesticides has been consulted on under section 7 of the ESA (see section 2.2.4.2), and there has been no specific evaluation of VELB exposures or response. The magnitude and population-level importance of pesticide effects on VELB remains uncertain, and requires empirical study.

CDPR has noted a moderate trend toward shifting to "lower-risk" pesticides; however it should be noted that this generally means lower risk to humans and other vertebrates, not to insects.

Pollution. We are not aware of documented effects of air pollutants on VELB or elderberry within the range of the VELB (except access road dust, see Section 2.2.5.1). However, available information on ozone suggests more research may be needed.

Ozone is known to be harmful to some plants at levels common in polluted air, and also can alter relative plant species dominance, vulnerability to insects, and plant community composition (Treshow and Stewart 1973, Hakkarienen 1987, Skelly et al. 1987). Ozone levels often are elevated in the Sacramento metropolitan area, the San Joaquin Valley south to Kern County, and other Central Valley locations (USEPA 2006).

Ozone is known to affect another elderberry species that grows in the Northeast and Canada: *Sambucus canadensis* (Porter 2000). VELB host blue elderberry and potential host red elderberry (*S. racemosa*) are used as sensitive species in biomonitoring of ozone effects (Smith et al. 2003). The degree to which ozone may affect elderberries—individually or at a population level in the Central Valley—and any effects on VELB are presently unknown, but may warrant study.

Mercury, a toxin commonly of concern for other species, is not concentrated by vascular plants and is unlikely to be a concern for elderberry or the VELB.

The effects of noise and dust pollution from high traffic freeways and roadside maintenance practices is being investigated now in a collaboration between U.C. Davis (Holyoak and Talley) and CalTrans.

2.2.5.3. Vulnerability to low numbers. The VELB is naturally rare and vulnerable to chance extinctions. Human impacts, notably habitat loss, have reduced the size (number of beetles) and extent (area populated) of VELB populations, increased population isolation and fragmentation. These factors, together with degraded habitat quality, will increase risks of local extinction (see above for fuller discussion, particularly Section 2.1.2.2.). Local extinctions tend to cause wider separations and thus further isolation of remaining populations. Due to dispersal limitations, the VELB will not likely recolonize areas that have undergone extirpation leading to regional population declines (Collinge et al. 2001).

2.2.5.4. Fires—Elderberry condition is affected by fire, which is common at the urban-wildland interface. Brush fires initially have a negative effect on shrub condition and therefore beetle larvae through direct burning and stem die-off. A year after fire, however, surviving elderberry resprout and display rapid stem growth (Crane 1989a). Fires often scarify the hard elderberry seed coat leading to germination of seedlings the following season (Crane 1989a). Frequent or repeated fire, however, may kill remaining shoots, root crowns and seeds, causing elderberry to be eliminated from an area for many years since recruitment by seeds is patchy and generally slow (Crane 1989a). Elderberry shrubs appeared suitable for the beetle two to six years after burning, but were often uninhabited, with the presence of old, burned exit holes suggesting pre-burn occupancy and post-burn vacancy (Talley et al. unpub. ms.). The post-fire lag in occupancy is likely the result of the limited movements of the beetle. Beetle occupancy occurred six to seven years post burn and, in the alluvial plain of the American River Parkway, was similar in the post-burn compared with unburned areas (Talley et al. In press). No quantitative studies of the net effects of fire on the VELB have been undertaken (e.g., examining VELB and elderberry through time after burns or in areas with varying burn frequencies and magnitude).

2.2.5.5. Competition by invasives

Invasive plant species are legion in central California riparian ecosystems. They have potential, without control, to dramatically alter VELB habitats, and may ultimately crowd out its host elderberry plants. Pest plants of major importance in Central Valley riparian systems include black locust (*Robinia pseudoacacia*), giant reed (*Arundo donax*), red sesbania (*Sesbania punicea*), Himalaya blackberry (*Rubus armeniacus*), tree of heaven (*Ailanthus altissima*), Spanish broom (*Spartium junceum*), Russian olive (*Eleagnus angustifolia*), edible fig (*Ficus carica*), and Chinese tallowtree (*Sapium sebiferum*), to name a few (Cal-IPC 2006). Even non-woody invasives such as ripgut brome (*Bromus diandrus*), foxtail barley (*Hordeum murinum*), *Lolium multiflorum*, and starthistle/knapweed (*Centaurea* spp.) may impair elderberry germination or establishment, or elevate fire risk. No rangewide assessment of the overall impact of invasive plants on VELB habitat appears to be available at this time.

See Section 2.3.2 for a discussion of efforts to control invasive species and Sections 2.1.3, 2.2.3 and 2.2.5.1 for discussion of the invasive Argentine ant. The remainder of this section will focus on the threats of *Robinia pseudoacacia* (black locust) to elderberry and VELB.

Black locust is a fast growing, shallow-rooted, long-lived, prolific seed-producing tree that can grow vegetatively from underground shoots, allowing it to quickly form dense stands (Converse 1984, Hunter 2000). Black locust can form monotypic stands, but is not yet dominant over river-wide scales. There are often time lags, however, from the introduction and establishment of a few individuals to population explosion and increased rates of spread (Crooks and Soule 1996). Data from 4 rivers in the southern Sacramento River Valley reveal that locust covers 5% of the areas surveyed along the American River and 0-0.1% along the Cosumnes River, Cache Creek and Putah Creek. (Talley 2005). Black locust was positively associated with beetle occupancy along the American River and Putah Creek (Talley 2005). The mechanisms for this relationship are unclear, but may include the promotion of beetle occupancy through increased nitrogen content of elderberry tissues resulting from uptake of available fixed nitrogen (*Robinia* is a legume that fixes nitrogen), or stress from shading and allelopathic chemicals (Hunter 2000, Talley 2005). Black locust has appeared along the American River relatively recently and positive associations between black locust and beetle occupancy are likely temporary as dense stand development will eventually displace elderberry (Hunter 2000, Von Holle et al. 2005).

2.2.5.6. Animal impacts to elderberry plants. Rodents (squirrels, voles) have been observed to damage young elderberry saplings (Mager pers. comm., Bielfeldt pers. comm.) During vole outbreaks the animals killed planted elderberries at two conservation banks by girdling. Browsing animals such as deer and cattle are known to feed on elderberry shoots and bark (Crane 1989b, a).

2.3. Summary of conservation efforts

Since listing of the species in 1980 there have been many conservation efforts carried out or begun for the VELB. These include both voluntary efforts to conserve VELB and conservation that is done to offset or mitigate adverse impacts to the species or its habitat. Here, we discuss both voluntary efforts and the VELB-beneficial side of mitigation for impacts. We also make brief mention of significant conservation efforts now in advanced planning that may move forward in some form in the near future.

2.3.1. Habitat protection and restoration

There is active interest in acquiring and restoring riparian ecosystems in the Central Valley, and an apparent acceleration in the pace of implementation of riparian restoration projects has been seen in recent years. However, the benefit of these projects for VELB has been markedly limited by the opposition of the State of California Reclamation Board, which oversees the integrity of floodways and flood control systems in the Central Valley. Most riparian restoration projects require an encroachment permit from the Reclamation Board. The Reclamation Board for more than a decade has generally denied planting of elderberry in floodplains within their broad jurisdiction, for fear that the presence of VELB habitat would interfere with flood-fighting or entail costly mitigation afterward (e.g., River Partners 2003, 2004a, b, c).

Habitat protection. Table 2.3.1.1 lists some of the major habitat acquisition and protection efforts in the Central Valley with potential to benefit the VELB.

Table 2.3.1.1. Acquisition or protection of riparian habitat in the Central Valley since 1980.

Project/Program	Floodplain acres (approx.)	Comments
Sacramento Valley:		
Sacramento River NWR	11,000	May acquire up to 18,000 ac
TNC Sacramento	~3000	Many projects turned over to Sac. R. NWR
Big Chico Creek Ecological Preserve, CSU Chico Research Fdn.	4000	

Fenwood Ranch, Shasta Land Trust	2160	2.5 mi river frontage. Conservation easement
Gover Ranch/Bloody Island, BLM	800	Conservation easement
Hamilton City levee setback	1500	planned
[Bobelaine Sanctuary, Audubon]	[400]	[Acquisition pre-dates listing (1975) but was then considered outside VELB range]
Feather River Wildlife Area, CDFG	2500	Units flank Bobelaine Sanctuary. [May pre-date listing]
American River Parkway		Much park area pre-dates listing
Cosumnes River Preserve, TNC and partners	5500	Approx. 40,000 ac non-floodplain
Stone Lakes NWR	4000	May acquire up to 18,200 ac
San Joaquin Valley:		
San Joaquin River NWR	6600	May acquire up to 12,900 ac
Partners for Fish & Wildlife, NRCS		23+ miles river frontage. Conservation easements
San Joaquin River Parkway	~2000	http://www.sjrc.ca.gov/docs/Parkway_map_01-06.pdf
Bobcat Flat, Friends of the Tuolumne	300	
Big Bend, Tuolumne R., NRCS (easement)	250	Conservation easement
Grayson River Ranch, Tuolumne R., NRCS	137	Conservation easement
Mining Reach-7/11 Segment, Tuolumne R., Turlock ID	87	2.2 river miles. Don Pedro 1996 FERC Settlement Agmt.
Merced River Salmon Habitat Restoration Program		Mostly for channel restoration
Fine Gold Creek, CDFG	708	
Kaweah River watershed, Sequoia Riverlands Trust	2200+	in fee and conservation easements
Kern River Preserve, Audubon California	1,000	Benefit to VELB not established
Total:	~45,000	

The Sacramento River National Wildlife Refuge (NWR), and San Joaquin River NWR are very significant habitat protection actions, currently totaling more than 17,000 acres, combined. Restoration of riparian habitats is proceeding rapidly on these refuges and is discussed below.

Another large, well-known area of conserved riparian habitat is the American River Parkway, 4,600 acres in Sacramento County, including designated critical habitat and essential habitat for the VELB. Much of this park was in place at the time of listing of the VELB and was within the species' range as it was understood at that time. The park continues to provide essential habitat to an important population (or populations) of the beetle.

South of the American River, along the Cosumnes River, extensive potential habitat for elderberry shrubs has been protected in the lower watershed by The Nature Conservancy and others. Roughly 5500 acres of floodplain which may be or may become suitable for VELB has been protected, including much of about 12 river miles, within a larger protected area of about 45,000 acres. Not all of the floodplain area is certain to be inhabitable, nor is it presently inhabited by elderberries, but restoration is proceeding, and VELB is known from the watershed.

Another sizeable river parkway is taking shape along the San Joaquin River, with a significant state and local effort along with the San Joaquin NWR. As of 2003 the San Joaquin River Parkway had protected 1749 acres, including all or portions of Spano Ranch, Rank Island, Jensen River Ranch, and Wildwood Park, with partners San Joaquin River Parkway and Conservation Trust, San Joaquin River Conservancy, Trust for Public Land, and others. A map of parcels can be viewed on-line (San Joaquin River Conservancy 2005). The benefits of this parkway to VELB, outside of federal lands, remain to be seen.

Habitat restoration. Table 2.3.1.2 presents a sample of riparian restoration projects, in two categories: those that have planted elderberry, and those that have not. These data cannot be considered exhaustive, but probably cover most of the large projects that have been completed and that actively restored native riparian vegetation. To our knowledge, this table excludes plantings for mitigation; these projects are entirely benefit. Most elderberry plantings are on federal land.

Table 2.3.1.2. Riparian/VELB habitat restoration projects in the Central Valley

Riparian Restoration Projects With Planted Elderberry (EB)

Project/Name	Owner/Manager	Planted by	River	Acres	# EB planted	Comments
Llano Seco	USFWS	River Partners	Sacramento	271	1472	
Ord Bend	USFWS	River Partners	Sacramento	111	1616	
Turtle Bay	McConnell Arb., Turtle Bay Explor'n Pk.	River Partners	Sacramento	100	1323	Has FWS BiOp 1-1-03-F-189, appears pure restor'n
Flynn	USFWS	TNC	Sacramento	247	5605	
Kopta	State Controller's Trust	TNC	Sacramento	105	2086	
Lohman		TNC	Sacramento	20	882	
Ohm	USFWS	TNC	Sacramento	206	7613	
O'Connor Lakes Ecological Reserve	CDFG	River Partners	Feather	228	900	300-400 more elderberry plantings planned
Packer Island	USFWS	TNC	Sacramento	175	7633	
Partners for Fish & Wildlife projects	private		Sacramento	700		Elderberry planted, number not recorded
Phelan Island	USFWS	TNC	Sacramento	117	2730	
Pine Creek	USFWS	TNC	Sacramento	270	6781	
Princeton Ferry	USFWS	TNC	Sacramento	44	2700	
Rio Vista	USFWS	TNC	Sacramento	799	36735	

River Unit	DWR	TNC	Sacramento	27	486	
Ryan	USFWS	TNC	Sacramento	164	6164	
Sam Slough	DWR	TNC	Sacramento	72	7200	
Shaw	DWR	TNC	Sacramento	11	383	
Southam	USFWS	TNC	Sacramento	65	2574	
Sul Norte	USFWS	TNC	Sacramento	46	1271	
Mohler Tract II	USFWS	River Partners	Stanislaus	35	520	AFRP funding
McHenry Ave Recreation Area	ACoE	River Partners	Stanislaus	32	512	
Merced NWR	USFWS	USFWS	San Joaquin	40	160	
San Luis NWR	USFWS	USFWS	San Joaquin	210	840	
San Joaquin River NWR	USFWS	River Partners	San Joaquin	800	32512	
Mining Reach-7/11 Segment	Turlock ID	HART Restoration	Tuolumne	87	160	2.2 river miles. Don Pedro 1996 FERC Settlement Agmt.
Totals:				**4,950**	**130,345**	
Planned:						
Hamilton City Setback	ACoE, TNC, CDFG, USFWS		Sacramento	1,500	About 2700 planned	

Riparian Restoration Projects With No Elderberry Plantings

Project/Name	Owner/Manager	Planted by	River	Acres	# EB planted	Comments
Battle Creek	CDFG	River Partners	Battle Creek	21		
Beehive Bend	CDFG	River Partners	Sacramento	59		
Big Bend	Tuolumne R. Preservn. Trust	River Partners	Tuolumne	250		Planning in 2003
Butler Slough	CSU Chico Res. Fdn.	River Partners	Sacramento	54		
Cottonwood Creek	CDFG	River Partners	Cottonwood Creek	15		
Del Rio	?CDFG	River Partners	Sacramento	259		Acquisition. Adj. to Llano Seco NWR unit. Future SHA?
Drumheller Slough	USFWS	River Partners	Sacramento	135		
Gianella Landing/Beard	CDFG	River Partners	Sacramento	20		
Howard Slough, Butte Basin	CDFG	River Partners	Butte Creek	51		
Jacinto	CDFG	River Partners	Sacramento	37		
Moulton Weir	CDFG	River Partners	Sacramento	46		

Partners for Fish & Wildlife, NRCS projects	Private		San Joaquin		23+ river miles
Pine Creek	CDFG	River Partners	Sacramento	235	
Princeton	CDFG	River Partners	Sacramento	34	
River Ranch	Private	River Partners	Sacramento	3	
Sacramento R., Big Chico Ck., Mud Creek [confluence]	CDPR? [Bidwell-Sac R SP]	TNC	Sacramento	217	acquisition and rest'n planning only at this stage?
Thomas	CDFG	River Partners	Sacramento	19	
Merced River Salmon Enhancement	CDWR/CDFG		Merced	unknown	planning stage for vegetation?
Grayson River Ranch	NRCS (easement)		Tuolumne	137	
Total:				**1592**	
Planned:					
Chico Landing	**CDPR**	**TNC**	**Sacramento**	813	

Projects that did not plant elderberry probably still have some benefit for VELB, since elderberry is likely to colonize many of these project areas (as has been found in particular projects: e.g., River Partners 2003b, River Partners 2004a). While it is difficult to compare the degree of benefit relative to sites initially planted with elderberries, some major factors involved are time until elderberries colonize and time until elderberries achieve densities comparable to natural or planted riparian ecosystems. If restoration projects lacking elderberry plantings are far from existing elderberry shrubs, time to colonization may be long. The extent to which planted vegetation might affect colonization or density of elderberries in restoration sites initially without elderberries is unknown at present.

Overall, the number of elderberry shrubs planted (over 130,000) compares favorably to the impacts estimated to have been authorized under section 7 (40,000-50,000 stems greater than 1 inch in diameter, 12,000 to 15,000 shrubs); this is in addition to elderberry planted as mitigation. Several factors cast a shadow on the favorable face of restoration, however: 1) depending on the age of the restoration, the elderberry plants may be young, small, and prone to considerable year-to-year mortality; 2) restoration sites may not all be suitable places for elderberry where bushes will survive and recruit over the long term; 3) the sites may not be populated by the VELB and VELB may be unlikely to or incapable of dispersing to some sites; and, perhaps most important, 4) even if occupied by the VELB, the likelihood of a VELB population at a restoration site being viable over the long term, and of participating in and contributing to large-scale, landscape level metapopulation dynamics and viability of the species, is highly uncertain.

Doubts about the viability of restoration sites (and mitigation sites) can be eased by certain considerations. In the absence of other threats, very large, completely contiguous areas –

or very nearly contiguous areas (gaps well under a kilometer) – of VELB habitat are likely to be able to support the species for the foreseeable future. Targeting sites adjacent to existing habitat occupied by the VELB for restoration therefore is beginning to be seen as a priority. Facilitating the colonization of the VELB into high quality, unoccupied restorations, by transplanting occupied shrubs, is a strategy that can be pursued and further developed.

A very large scale restoration effort is well underway along the Sacramento River, with the Sacramento NWR and partners, including The Nature Conservancy and RiverPartners. The Sacramento River NWR – part of the Sacramento NWR Complex – was established in 1989, with a focus on conserving the VELB as well as other native riparian species. The refuge is authorized to acquire up to 18,000 acres of riparian lands generally within the 100-year floodplain along the Sacramento River between Red Bluff and Colusa. Currently the refuge is at about 11,000 acres, between Red Bluff and Princeton, California. The refuge, with its partners and various funding sources, has been engaged actively in restoring riparian ecosystems in suitable riparian lands, specifically including restoring elderberry and habitat for VELB as a restoration objective. This project is "pure restoration," i.e., it has not been done as mitigation for any corresponding contemporary impact. Over 100,000 elderberry seedlings or transplants have been planted in the refuge (J. Silveira, USFWS, pers. comm.; Table 2.3.5.1).

In 2003, monitoring of elderberry plants planted in the Sacramento River NWR found 449 VELB exit holes in 299 of 7793 shrubs surveyed (3.8 percent; River Partners 2004d).[*] Exit holes were found at all five refuge units surveyed (Flynn, Ord Bend, Packer, Phelan Island, Rio Vista). A greater percentage of VELB exit holes were found at sites with older elderberry plantings or in proximity to existing riparian vegetation.

Certain restoration programs that may enhance riparian vegetation are not included in Table 2.3.5.2 because of the difficulty of developing comparable data. Cooperative private lands programs sometimes fit this category. One is the Landowner Incentives Program (LIP), a cooperative program of CDFG, FWS, and Ducks Unlimited. Under this program, landowners receive financial assistance for 3 years to irrigate and weed riparian plantings or riparian vegetation in need of management. This assistance is intended to increase the chances that native riparian vegetation will establish successfully. In 2005, LIP wrote contracts for 967 acres in 5 Central Valley counties within the geographic regions of the Tulare Basin, San Joaquin Basin, Sacramento-San Joaquin Delta/Suisun Marsh and Sacramento Valley. This program does not carry long-term protections on the riparian areas. The USDA Natural Resources Conservation Service also partners on substantial riparian area, with contracts of longer term. No data were available on acres or number of elderberry plantings.

2.3.2. Invasive species control

Efforts to control invasive riparian plant species are very numerous and often local to particular habitat areas. For example, the American River Parkway has invasive species removal efforts by Sacramento Weed Warriors (a community stewardship project associated with the California Native Plant Society) and others. Invasive plant control efforts often are limited by funding, labor, coordination with landowners, and the resilience and spread of their target plants. See section 2.2.5.5 for further discussion of invasive species.

The Argentine ant (*Linepithema humile*) is an invasive animal species that potentially

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[*]The FWS national website page that states no VELB have been recorded from any NWR (http://www.fws.gov/endangered/wildlife.html ; search on "Desmocerus"; click on the species name; and click on "USFWS Refuges ") is apparently out of date. SFWO files also suggest the species occurs at Stone Lakes NWR.

poses a threat to the VELB (Sections 2.1.3, 2.2.3.1). We are not aware of coordinated efforts to control Argentine ants in natural areas in the Central Valley. Limiting irrigation and other exogenous water may restrict this invasive ant, since it appears to need moist soil to live and breed (Menke and Holway 2006). The significance of this finding for California riparian areas is not yet clear (see Section 2.2.5).

2.3.3. Safe Harbor Agreements

Safe Harbor Agreements (SHAs) typically allow the future removal of habitat down to the baseline at the time of signing the agreement, at the discretion of the landowner, so the long-term benefits of such agreements are uncertain. Over the near term, however, some habitat and perhaps population benefits to VELB are reasonably likely. To date two SHAs covering VELB have been finalized by the Service: Burrows and Big Bluff Ranches SHA (SFWO file 04-SH-2617), and the Mokelumne River Programmatic SHA.

Located in Tehama County, the Burrows-Big Bluff Ranches agreement covers 2 landowners. One ranch is 4000 acres in size, the other is 3450 acres; most of which is used for grazing and dry land farming. The ranchers agreed to a baseline of 39 shrubs on one ranch and 25 on the other. The properties have not been surveyed for VELB so its presence is unknown, but not likely due to habitat type and that the nearest known VELB is 10 miles away.

The Mokelumne River Programmatic Safe Harbor is for 20 river miles of habitat on the lower Mokelumne River and about 3,500 acres. The Mokelumne SHA has one landowner signed up so far. The enrolled property is about 1800 acres of vineyards with about 300 acres of slough and riparian forest on it – much of which has been voluntarily enhanced over the years. The landowner has an existing baseline of 12 elderberry bushes 1 inch or greater in diameter. The agreement does not require acreages - but he has restored about 9 acres of former vineyard with other riparian vegetation and will now add elderberries to those acres since the SHA is on place. Much or all of this could include VELB habitat.

Not yet completed (as of mid-June 2006) but apparently close to finalization is a third SHA to cover VELB: the River Partners SHA for their Del Rio Wildlands Preserve. This property is about 259 acres in Glenn County, adjoining the Llano Seco Unit of the Sacramento River NWR, and includes 27 acres of existing riparian habitat and 232 acres of current and proposed restoration projects. River Partners is actively engaged in about 30 riparian habitat restoration projects along the Sacramento, Feather, Tuolumne, Stanislaus, and San Joaquin Rivers (River Partners 2003a). One purpose of the Del Rio SHA is to assure the State Reclamation Board that elderberry plantings will not interfere with flood fighting (see section 2.3.1). Another purpose of the SHA is to enhance habitat and populations of VELB. Current baseline is only one elderberry shrub with 9 stems greater that 1 inch. They will be planting 1500 elderberry shrubs on the property under the agreement

2.3.4. HCP activities

ESA Section 10(a)(1)(B) permits are issued for HCPs to allow take of the species, but HCPs include avoidance, minimization, mitigation, and conservation measures intended so that the net effect of each HCP should be to further the survival and recovery of the species. We emphasize mitigative and conservation efforts here; for additional analysis of adverse effects of HCP's see Section 2.2.1.3. While the net effect of HCP's is intended to further the conservation of species, this cannot be a foregone conclusion but rather needs monitoring and empirical checks.

Service records indicate 18 permits under section 10(a)(1)(B) of the ESA have been issued for HCPs covering VELB (Table 2.3.4.1)*. Ten of these were permitted as low-effect HCPs; and three which might have qualified pre-dated the low-effect policy. The total area of these 18 HCPs is approximately 970,000 acres. Take of the VELB or loss of elderberry habitat will be less than this total, since relatively little of the total acreage is suitable habitat, and because permanently protected mitigation acreage within this total area is required. Cumulative impacts to stems and shrubs of elderberry are unknown, particularly since the larger HCPs typically cannot precisely estimate in advance the impacts over the course of their long-duration permits.

Some further information is available about the course of impacts and mitigation under an active HCP with substantial potential to impact the VELB: the San Joaquin Valley HCP, covering much of San Joaquin County. As of the 2005 Annual Report (SJCOG 2005), 7,820 acres of land had been converted for development under the HCP. About 80 percent of this was conversion of agricultural lands. Impacts to remaining habitat of the VELB have been relatively small. There have been some challenges with adequacy of funding and acquisition of conservation lands. Consequently, the fees to support conservation have been raised and a habitat acquisition "Jumpstart" program initiated. In 2005 the HCP operators obtained a conservation easement and restoration agreement on 24 acres intended for VELB habitat along the Mokelumne River. This brought the program within about 1 acre of outstanding VELB mitigation obligations at that time, according to the plan operator (SJCOG 2005). Additional impacts and mitigation needs appear likely to be of comparable magnitude in the next 2 years.

Another large HCP with indeterminate impacts in Table 2.3.4.1 is the Natomas Basin HCP. However, there has been relatively little elderberry growth identified within this HCP boundary. Small numbers of the shrubs were noted on two of the HCP's reserves, and several more northwest of Sacramento International Airport. There is suitable riparian habitat along the basin margins (Natomas Basin Conservancy 2005). In 2003, a few elderberry plants were impacted by development; mitigation took place at a conservation bank (Wildlands).

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* One permit listed through the national FWS web site, Tulare Irrigation District Main Intake Canal Lining Project, issued in February 2000, is recorded by SFWO as having been cancelled February 15, 2002, because the project was not going to be carried out. This project is not included in our table.

Table 2.3.4.1 – HCP's permitted by the Service that include VELB as a covered species (links to ECOS website at http://www.fws.gov/endangered/hcp/index.html ; SFWO HCP database)*

	HCP Description:	Year Permit Issued:	Extent (acres)	Low Effect (Y=yes)	Number of elderberry shrubs to be impacted**	Number of stems > 1 inch diameter to be impacted**	Comments
1	Lennane Properties	1990	48 ac				Exp. 7/95
2	City of Marysville	1991	27 ac		(6)	(186)	Exp. 1/97
3	City of Waterford	1995	5 ac		15 or 16	149 (112-120)	Exp. 6/05
4	Kern Water Bank Authority	1997	19,900 ac				Duration 75 yr
5	LaRue Housing & Bowley Center, UC Davis	1999	16.7 or 150 ac	Y	14	168	Duration 10 yr
6	Teichert Esparto Mining	1999	148 ac		4	(11)	Exp. 12/04
7	Ox Yoke Road, Shasta Co.	2000	19 ac	Y	2	(5)	Duration 10 yr
8	Prairie City Crossing, Regency Realty, Folsom	2000	11 ac	Y	(1)	(4)	Exp. 6/02
9	Union Pacific Railroad Sacramento Rail Yard	2000	240 ac	Y	87	261	Exp. 4/02. SFWO log says 162 shrubs not 87.
10	Westwood Tributary Point	2000	3.4ac	Y	1	(2)	Exp. 11/02
11	Weyerhauser Tributary Point Parcel 9	2000	1.4ac	Y	2	6	Exp. 3/02
12	Metro Air Park, Sacramento Co.	2002	~2000 ac		(0)	(0)	Included in Natomas Basin HCP, 2003
13	San Joaquin Valley MSHCP	2001	896,000 ac				Duration 50 yr
14	UC Davis Campus Projects	2002	~12 ac	Y	12	157	Duration 10 yr
15	Folsom Professional Center	2003	5.6ac	Y	(7)	(24)	Duration 3 yr
16	Natomas Basin	2003	53,000+ ac				328 ac wooded or riparian. Duration 50 yr
17	Geo. Shimboff, Vacaville	2003	~0.1ac	Y	(1)	(2)	Exp. 11/04
18	Raley's Landing, West Sacramento	2006 re-iss.	18 ac	Y	18	54	18 shrubs, 54 stems > 1"

*Entries in parentheses: R. Thornton, in litt. 2006, not cross-checked **lack of an entry means no data retrieved

Many HCPs, particularly those small in scale or with limited effects on VELB habitat, conduct their VELB mitigation and conservation at Service-approved conservation banks for the species, often following the Service's VELB Guidelines. Conservation banks are discussed in section 2.3.5, below. The net effect of the VELB Guidelines on the species has been assessed as not distinguishable from neutral (no demonstrable recovery or decline: Holyoak, et al. In Press, Section 2.2.1.2), although this study did not cover conservation banks.

Several large-scale HCPs within the range of VELB and which might cover VELB are in development but not yet authorized by the Service and not fully certain to be implemented: western Placer County (270,000 ac), Solano County (577,000 ac), south Sacramento County (340,000 ac), and Yolo County (662,000 ac).

2.3.5. Conservation banks

A conservation bank is a centralized ecosystem preservation or restoration area where projects that impact a species may purchase entitlements to habitat ("credits") to offset the effects of their project (USFWS 2006). All banks are placed under permanent conservation easements and restoration is begun before credits may be sold. The FWS generally favors conservation banks over smaller ad-hoc mitigation sites. There are five conservation banks for VELB in the Central Valley (Table 2.3.5.1)

Table 2.3.5.1 – Service-approved Conservation Banks for VELB

Bank Name	Location	VELB Habitat acres / Total ac	Exit holes, adults, comments
Wildlands Sheridan	Placer Co.	57 / 655	Many holes; 3 adults in 2004
Stillwater Plains	Shasta Co.	3 / 834	2 adults (2003). Vole outbreak damaged young elderberries.
French Camp	San Joaquin Co.	64 / 84	New bank, planted 2005. Substantial natural elderberry on-site
Laguna Creek	Sacramento Co.	45 / 780	Vole outbreak in summer 2005 damaged some plants
River Ranch	Yolo Co.	73 / 76	Incl. earlier mitigation project

The Wildlands Sheridan Bank is sold out. The Elsie Gridley Multi-Species Conservation Bank (1800 ac in Solano Co.) supports some elderberry shrubs but is not approved to accept VELB mitigation.

Nearly all the VELB restoration efforts at conservation banks have been conducted following the Service's VELB Guidelines. Holyoak et al. (In Press) found the net effect of impacts and offsetting conservation under the Guidelines to be near zero: neither demonstrably positive nor negative. However, these evaluations did not include conservation banks.

We recommend that SFWO institute a review to determine whether "credit" valuations for VELB conservation banks may be inflated relative to the impacts intended to be mitigated. An informal analysis by one of us (DHW) showed that at some Central Valley conservation banks, high valuations of credits for vernal pool mitigation resulted in a net loss of wetlands despite nominal mitigation ratios well above 1:1.

2.3.6. In-lieu fund

At times when appropriate conservation banks have not been available, the FWS has allowed payment of in-lieu fees into a VELB fund managed by the non-profit Center for Natural Lands Management. Subsequently the funds are to have been used to purchase VELB habitat, for example once a local conservation bank becomes approved. As of June 7, 2006, the balance in the VELB fund was nearly $155,952 (S. Teresa, CNLM, pers. comm.), for disbursement at the Service's discretion.

2.3.7. Implementation of section 7 conservation recommendations

The Service received no federal agency comments addressing implementation of section 7 conservation recommendations for VELB.

Circa 1999, EPA and CDPR released county-specific Pesticide Interim Measures Bulletins in California, for use in voluntarily protecting endangered and threatened species. We have no information about any ESA review of these measures or any monitoring of their effectiveness. According to the CDPR website they are a program under section 7(a)(1) of the ESA (federal agencies using their authorities to further the purposes of the ESA).

The U.S. Bureau of Reclamation (BOR) has stated that some of its actions under the Conservation Program (usually considered an offshoot of the Central Valley Project Improvement Act) constitute actions of a 7(a)(1) program. We are not aware of whether BOR has taken any actions for VELB that it considers a 7(a)(1) program. The BOR does have considerable mitigation commitments for VELB.

2.3.8. Mitigation lessons.

Associated plant choices. Few if any relationships between VELB and elderberry-associated plant species were observed (Talley 2005, Talley et al. submitted). While there was a positive association between VELB and black locust, the use of this species would have long term detrimental effects and is not recommended (Section 2.2.5.5). This is not to say the composition of associated plants does not matter; instead, this may illustrate that the associated plant assemblages within the study areas did not vary widely enough to differentiate their effects on VELB occupancy (i.e., all assemblages may have been generally suitable for VELB) (e.g., Talley et al. submitted). These study areas contained fairly typical remnant riparian plant species (Talley 2005, Talley et al. submitted).

Vaghti et al. (submitted) found that while common tree species of remnant natural areas are often used in mitigation sites, the same was not true for shrubs and herbaceous plants. All eight tree species found in remnant habitats were used in mitigation plantings. Box elder, black walnut, and Fremont cottonwood were the most frequent trees in remnant sites; Fremont cottonwood and valley oak were most frequently planted. The trees in planted sites were however 29% less abundant than in remnant forest plots. In contrast, only half of the nine shrub species found in remnant habitats were used in mitigation planting. California blackberry was the most frequent shrub in remnant sites but was not used in any of the mitigation plantings analyzed. The frequencies of *Baccharis salicifolia* (mulefat) and *Salix exigua* (narrow-leaf willow) in planted sites approached those of remnant habitats while California rose and *Salix lasiolepis* (yellow willow) were more frequent in plantings than in remnant sites. The shrubs in planted sites were 45% less abundant than in remnant forest plots. Finally, herbs, monocots and vines combined had an average frequency of 34.6% in remnant forests and an estimated average frequency of only 0.9% in the mitigation plantings (Vaghti et al. submitted).

Vaghti et al.(submitted) provided mitigation recommendations. Box elder and black walnut, which have increased in frequency in riparian remnants over the past few decades, should be planted cautiously until more is known about the causes and effects of their spread in remnant riparian areas. The continued use of Oregon ash, California sycamore, Fremont cottonwood, Valley oak and black willow in blue elderberry restoration design was supported in their study since natural recruitment of these species may be limited by altered hydrologic regimes. The use of California rose, narrow-leaf willow, and yellow willow is supported by their results. Vaghti et al. (submitted) recommended more planting of California blackberry in mitigation sites because it frequently occurs with blue elderberry in remnant areas. They recommend increased attention to herbs, monocots and vines, species that increase biodiversity (Holl and Crone 2004). In particular, the addition of blue wildrye, mugwort, sedges, California wild grape, Dutchman's pipevine and/or virgin's bower is recommended and could help suppress undesirable species (Vagthi et al. submitted).

The value of transplants.

While the variable survival of transplants in mitigation sites has raised questions about their usefulness, transplants appear to be valuable to mitigation sites by providing both mature plants and beetles (Sutter et al. 1989). Most of the mitigation sites found to be colonized in the Central Valley had received transplants believed to contain VELB larvae or pupae (Holyoak et al. in press). Seedlings made up over 90% of planted elderberry, yet only two of 41 sites that did not receive VELB larvae or pupae in transplants were colonized in the 10 years of monitoring (Holyoak et al. in press). Transplants also provide the shrub size heterogeneity needed by the VELB, which are more likely to occupy larger, older shrubs than smaller, younger ones (Talley 2005, Talley et al. In press). Ideally, of course, the project would be designed to leave remnant habitat in tact (Sutter et al. 1989), especially if the habitat is deemed valuable (e.g., sufficient size to support a population, within movement distances to the next nearest population, healthy riparian ecosystem) (Talley 2005, Talley et al. In press).

Mitigation recommendations. Several recommendations for improving mitigation practices have been made in the literature.

Plantings. A mix of elderberry transplants and seedlings of different sizes/ages are recommended to provide heterogeneity of host size for the VELB and to protect against the effects of stochastic events. Similarly, a mix of sizes/ages of associated plants and the selection of plants from nearby remnant natural areas and those natives that are limited by dispersal or germination would aid development of mitigation sites (Vaghti et al. Submitted). Furthermore, spreading plantings among sites of varying ages would be prudent, provided that the creation or enhancement of some agreed-upon total area of land is accomplished. For example, Holyoak et al. (In press) found that the year of planting an individual site affected survival of seedlings. If all plants were placed in an unsuitable site or if a site was planted mostly with seedlings during a "bad" year then the whole effort would quickly fail. On the other hand, if "spreading" plantings were interpreted to imply smaller, more fragmented mitigation areas, this could be counterproductive.

Site placement. The placement of mitigation sites affects ecosystem recovery in theoretical models; sites placed closer to occupied areas recovered faster that those randomly placed or those in which the target species was reintroduced (Huxel and Hastings 1999, Huxel et al. 2003). This seems like a good strategy for the VELB, a species that is dispersal limited and that has particular habitat requirements. In particular, because the VELB requires mature elderberry plants, introducing it to young mitigation sites may not be an optimal approach. VELB colonization of mitigation sites throughout the Central Valley took at least 7 yrs (Holyoak et al. in press) and colonization of restoration sites along the Sacramento River took roughly 10 yrs (Holyoak and Talley 2001).

Restoration goals. Restoration or mitigation goals are often poorly defined and /or do not necessarily represent the habitat requirements of the VELB (e.g., percent survival of elderberry shrubs) (Morrison et al. 2003). Because of the rarity and low occupancy rates of the VELB, a lack of VELB present colonization does not mean the site has failed. Plenty of suitable habitat areas are likely unoccupied, but it is important that they remain available for the VELB and connected to existing populations to ensure long-term, regional persistence (Hanski 1994, Collinge et al. 2001). Problems with restoration and mitigation goals may stem in part from the lack of specific recovery plan goals and the lack of the use of reference sites against which mitigation sites can be evaluated.

Reference sites. Many restoration projects rely on reference sites or states as a metric of success. A reference could be an extant site considered to be desirable, a past or theoretical state with desirable characteristics, or some combination of the two. The use of a reference state helps to elucidate goals for a project (i.e., we know what we are striving for) and provides direction for efforts (i.e., we know which variables are important and how they need to change) (Aronson et al. 1995). The use of a reference site also allows us to learn more about the ecosystem, including important structural forces and interactions, and acts as a “control” against which to compare variations in our mitigation/restoration site (Aronson et al. 1995, Harris 1999). Practitioners working in other ecosystems, such as wetlands, commonly use references sites so it seems to be a feasible requirement for setting and assessing goals. Because ecosystems are dynamic, however, one intial set of static goals may not be reasonable (Pickett and Parker 1994), therefore flexibility should be incorporated into the strategy and goals.

Reporting compliance. Particular data which were required to be reported (by the VELB Compensation or Conservation Guidelines) varied from being usable in 8 to 95% of reports, depending on the variable considered (Holyoak et al. In press). Measures were frequently not quantified and varied greatly between reports. Standardized data to collect and methods of collection are needed, with easy and uniform data formats. Simple, universal, and mandatory electronic reporting (on-line fill-in form) could greatly increase information tracking and compliance in mitigation monitoring.

Adaptive management. An adaptive management strategy incorporates alternative plans and goals to account for unpredictable and/or undesirable outcomes. For example, a strategy that includes short term goals that can be assessed somewhat frequently so that contingency plans can be put into play if needed (Morrison et al. 2003). The incorporation of research with mitigation or restoration is another form of adaptive management where multiple treatments can be applied, assessed and switched from unsuccessful ones if necessary (Zedler and Callaway 2003). In this way, the site of interest receives the best practices and lessons are learned for future efforts. Little has been learnt from mitigation practices so far because of a lack of goals, direction and hypothesis testing.

2.4. Thoroughness of recovery criteria

In this section we assess whether current recovery criteria include the best available and most up-to-date information on the biology of the species and its habitat, and whether they take into account control of threats to the species (i.e., the five listing factors).

2.4.1. The goal of recovery plans is to propose actions and measurable criteria that will ensure the sustainability and persistence of a species so that the species may be delisted. At the time of listing (1980) and production of the recovery plan for the VELB (1984), there was "…insufficient information on the life history, distribution, and habitat requirements of the valley elderberry longhorn beetle to make such precise recommendations." (USFWS 1984; pg 21). Instead "interim actions" referred to as "recovery objectives" were proposed. Formal recovery criteria, per section 4 of the ESA, still need to be established for the species. Furthermore, in general the 1984 recovery plan must now be considered overly general and out of date.

The 1984 Recovery Objectives were as follows:

1. Preserve and protect known habitat sites to provide adequate conditions for the VELB.
2. Survey Central Valley rivers for remaining VELB colonies and habitat and incorporate findings into short and long-term management programs.
3. Provide protection to remaining VELB habitat within its suspected historic range
4. Determine number of sites and populations necessary to eventually delist the species.

2.4.2. Progress in attaining recovery objectives. See Section 2.5.2.

2.4.3. Development of Recovery Criteria. There still remains much uncertainty about factors that promote occupancy, abundance and persistence of the VELB. Before recovery criteria can be defined, more information is needed; much of which is needed in response to new threats and to perform reliable predictions about sustainable populations. Below are information needs that would facilitate the writing of clear and reliable recovery criteria for the VELB:

1. Determine a more precise distributional range of the VELB and its relationship with *D. c. californicus.* This includes observations of adult males and genetic analysis of specimens known to have originated from sites of interest (i.e., the use of larvae from stems or adults that were seen emerging).

2. Evaluate host plant preferences of the VELB. This includes sorting out elderberry taxonomic uncertainties (to some reasonable level) and determining the extent to which host plant preference is random, environmentally driven or genetically (phenotypically) driven. This information may elucidate mechanisms behind the relationship between VELB and elderberry.

3. Assess trends in the conservation status of the VELB. There is still no clear indication whether the VELB is either recovering or still in decline (aside from losses due to continued habitat loss). Incorporate data on habitat trends at finer spatial (drainage, population cluster) and temporal (annual or 5-year changes).

4. Identify and target collection of the minimum information needed to begin quantitative

population viability analysis of VELB at the scale of drainages or throughout its range.

5. Determine the effects of invasive plants on elderberry and VELB. This may include the effects of and recovery after plant removal efforts.

6. Determine the effects of invasive animals, especially the known threats from the Argentine ant and European earwigs. This may include the testing of the efficiency of control efforts (e.g., the effects of irrigation types or watering regimes, controlling invader populations at the source).

7. Assess the population effects on VELB of other natural enemies such as parasitoids.

8. Determine the effects of pesticide use on VELB individuals and populations. This information should be researched in the field with statistical design to provide a valid sample to extrapolate throughout the range.

9. Use the information above to establish estimates of sustainable population sizes and numbers, land area needed, and contingency plans in the event of unexpected changes.

Updating the Conservation Guidelines or other such regulatory guidance also might offer potential to improve VELB conservation practice, and would benefit from the information identified above.

2.5. Information about three delisting factors.

2.5.1 Does the VELB appear to be extinct? The VELB is not extinct. Sightings of adults and recent exit holes, well within the VELB's range, occur each year (CNDDB 2006).

2.5.2 Have any or all of the recovery criteria listed in the VELB recovery plan (USFWS 1984) been met?

Recovery criteria have yet to be defined and have been pending the availability of more information about the biology and ecology of the VELB. The 1984 recovery objectives have been partially met. However, the extension of knowledge about the VELB leading to identification of a wider range and further threats has made the recovery plan and the more specifically focused objectives therein out of date. However, the general objectives of this 22-year old plan show the durability of the basic tenets of conservation biology – protect and restore habitat, address threats, reestablish populations. Here we review some of the progress made on selected 1984 recovery objectives.

2.5.2.1. Recovery Objectives 1 and 4. The first recovery objective states "Preserve and protect known habitat sites to provide adequate conditions for the VELB." Listing led to protective regulation of most habitat for the VELB, as well as substantive habitat preservation efforts, both in areas of known occupancy and throughout its suspected historic range at the time of listing. The loss of known and potential habitat continues, however, while the ability of mitigation sites to functionally compensate for lost area remains uncertain. Furthermore, resistance to conservation efforts for fear of land use restrictions and penalties has resulted in the loss of habitat and elderberry shrubs on private and public lands.

The known locations at the time of listing were the American River Parkway, Putah Creek and the Merced River. The American River Parkway appears to offer adequate protections for elderberry and VELB. With the exception of a small amount of privately owned land, it is a public use area with utility maintenance activities and recreational activities consisting of biking, hiking, horse back riding and river access. The trails, access roads and associated management activities tested (e.g., dust, pruning) do not appear to harm elderberry or VELB populations (e.g., Klasson et al.. 2005, Talley 2005, Talley et al. 2006, Talley et al. in press). There are multiple VELB mitigation sites also located along the Parkway, owned and/or managed by Sacramento County Parks- at least one of which in the Woodlake area has been colonized by VELB from surrounding populations. There is occasional and sporadic loss of branches and shrubs to firewood collection and brush fire by campers, but these actions are prohibited.

The riparian and upland ecosystems along Putah Creek have multiple ownership, most of which is private property and most of that is agriculture. Of the public areas and the few private parcels where access was granted (Talley 2005), the current practices appear adequate. Public areas include reserves (University of California Stebbins Cold Canyon and Putah Creek Riparian Reserve), public right of way and parkland owned by Solano County (Solano Co. Lake Park) and Yolo County (Putah Creek Nature Park), and access to the river (fishing accesses in Solano Co). Similar activities occur in these public areas as along the American River so are assumed to not harm VELB or elderberry, and all have had evidence of the beetle (Talley 2005). Solano County Lake Park has a campground, but the campground was left wooded, rules about wood collection and campfires are enforced and rangers are well informed about the VELB, as is evidenced by the relatively high VELB density in this park. This park was listed as essential habitat for VELB in the recovery plan and the continued presence of VELB here illustrates the continuing benefit that such a natural park provides for the VELB. There are at least three VELB mitigation sites along Putah Creek, two near Winters (one of which was colonized by VELB) and one in Davis by Mace Blvd. The condition of habitat on the private land where access was permitted appeared to be similar to the public areas- relatively undisturbed by daily activities. The landowners who granted access were conservation minded in general (e.g., involved in local conservation groups, river task forces, spoke openly about land conservation). The condition of VELB and its habitat on private land where access was not granted is uncertain. Glimpses from adjacent properties and local rumors indicate either similar conditions or the removal of elderberry for fear of repercussions.

Recent studies of the VELB have not included the Merced River so current condition and protections of habitat there are uncertain. Much of the lower Merced River is private agricultural land, with parkland (e.g., state recreation areas) and public river accesses in several places. There are at least 5 riparian restoration efforts (Dept. of Water Resources) that focus on salmon habitat but that may include restoration or mitigation of elderberry if restoration actions warrant it (and the Reclamation Board allows it). Conservation may not be a success in McConnell State Recreation Area, despite this area being named for protection in the recovery plan. Barr (1991) noted elderberry in poor health within a couple of the recreation areas in the lowest reach and no recent evidence of VELB in areas where previous sightings had occurred, including the McConnell State Recreation Area where exit holes were recorded from 1984 (USFWS 1984, CNDDB 2006). The most upstream record of VELB was just north of Cressey (Halstead 1990). Barr (1991) searched elderberry upstream of this point and found no evidence of VELB and noted that no elderberry was observed upriver between Henderson Park (between Snelling and Merced Falls) and the New Exchequer Dam. Studies and protection of VELB along this river system are needed. Within this region is the San Joaquin River Parkway, a somewhat protected area in the same vein as the American River Parkway, but surveys for VELB do not appear to have been conducted (San Joaquin River Conservancy 2005).

Recovery objective 4 is extremely similar to number 1, and simply calls for preserving and protecting any newly discovered VELB habitat. Applied throughout the range of the VELB as currently understood, not as high a proportion of remaining habitat has been preserved as in the American River and Putah Creek systems, although efforts by the National Wildlife Refuge system and others are rapidly increasing the amount of habitat preserved and protected for the beetle.

2.5.2.2. Recovery Objective 2. (Surveys of Central Valley Rivers for remaining VELB colonies have increased (USFWS 1984, Halstead and Oldham 1990, Barr 1991, Halstead and Oldham 2000, Collinge et al. 2001, Talley 2005) but extensive surveys seem to be lacking from the southern part of the range. Additionally, longer-term surveys are needed to determine population trends through time and with changing land use and environmental conditions. The linkage between surveys and incorporation into management plans is improving with the increase in use of Habitat Conservation Plans (Section 2.3.4). Survey information in mitigation plans is limited due to the frequency of off-site mitigation (i.e., surveys of a project site do not tell much about conditions in the mitigation site or bank). Additionally, surveys of remnant natural reference sites are not currently required under the Conservation Guidelines, and so information about reference site conditions is lacking. The lack of consistent or multi-year surveys, also limits the information needed for formulating management plans. Localized management efforts that involve collaborations among regulatory, resource management, academic, and public and private stakeholders have the highest potential for the development of effective, efficient, well-supported plans but are most often assembled for large-scale restoration efforts (e.g., River Partners 2002, SBSPRP 2006). Right now there is only one such collaboration aimed at developing a land management plan that is consistent with the habitat requirements of VELB. This collaboration includes resource managers, utility companies, regulatory agencies, public works agencies and academics (Talley and Holyoak at U.C. Davis). This collaboration has contributed resources and input to a large portion of recent VELB research (Klasson et al. 2005, Talley 2005, Talley et al. 2006, Holyoak et al. in press, Vaghti et al. Submitted), has increased communication among stakeholders, and is currently working on a scientifically-based habitat management plan for the American River Parkway. More of these collaborations would continue to advance management practices, education and research.

2.5.2.3. Recovery Objective 3. (Determine ecological requirements and management needs of VELB.) Progress has been made on some of the detailed objectives under this category of the recovery plan – e.g., salient features of autecology, life history, techniques of habitat restoration. However, dramatic gaps and gray areas remain in our understanding of the species, particularly with respect to vital areas such as population dynamics – fecundity, survival of different life stages, factors affecting mortality – and dispersal. Such information is vital for the formulation of recovery criteria, such as the number of sites and size and numbers of populations, needed to eventually delist the species; therefore the important task of determining recovery criteria has not been accomplished. Models may be needed to assess outcomes of population persistence under varying scenarios of changing land use (both loss and addition), climate and stochasticity. While some of the biological, ecological and spatial data needed to parameterize such models now exist, lacking are longer-term data sets needed to capture natural population fluctuations and turnover. The closest thing to a long term data set that now exists is the Collinge et al. (2001) study which resurveyed the same sites used in Barr's 1991 study 6 years later. This work has been extremely valuable and reveals the need for more frequent, preferably annual, surveys that cover longer time periods. In 6 years, only 3-6 generations of the VELB may have emerged and this is within the amount of time that VELB inhabits one shrub or habitat patch. To get an idea of inter-generational fluctuations and patch turnover, longer, more intensive surveys are needed in at least a statistical subset of areas.

2.5.2.4. Recovery objective 5. This recovery objective called for the reestablishment of VELB at rehabilitated sites within the historical range. See sections 2.2.1.2 and 2.3.1, above, for discussion of VELB establishment at restoration and mitigation sites. It is probable that VELB establishment at rehabilitated sites not yet occupied (or naturally occurring suitable but unoccupied sites) could be achieved or at least hastened by translocating occupied shrubs.

Many restoration and mitigation sites are relatively young, compared to the time scale of VELB and elderberry recruitment, maturity, and population dynamics (years vs. decades). It will take considerable time to gain certainty about the ability of rehabilitated sites to support and foster the recovery of the VELB.

2.5.3 Were there errors in the original data supporting the listing decision or in the interpretation of those data? The VELB has been found in locations throughout its presumed historic range, while the listing document stated that it was present along 3 rivers (American River, Putah Creek and Merced River) in less than 10 localities (USFWS 1980). Evidence suggests that this was the best available information at the time of listing. (A contention that the listing should have addressed VELB from Kern County appears to be incorrect; see section 2.1.3.1, Historic understanding of VELB range). Subsequent surveys revealed a larger distribution that was thought at the time of listing, but it was thought that the VELB was still threatened by extinction due to its biology and life-history strategies in the face of extensive loss of habitat (USFWS 1984, Barr 1991). The VELB is the rarest form of rare species (Rabinowitz 1981), having a small range, specialized habits, and low local population numbers. Its limited geographic range includes only a portion of the Central Valley, from Tehama Co. to Fresno Co as best we can tell at this point. It has narrow habitat requirements, requiring one type of host plant – elderberry (*S. mexicana* and to a lesser extent *S. racemosa*) – and predominantly occupies riparian ecosystems. And, it is found in small local populations—generally with 1-2 exit holes per occupied shrub or per site and occupancy rates of 2-10% of shrubs or 25% of sites (Collinge et al. 2001, Talley 2005, Talley et al. In press). The reason for listing was the loss and development of nearly 90% of historic riparian habitat in the Central Valley; estimates that have been confirmed in recent studies (GIC 2003). Remaining remnant areas are fragmented, impinged upon by land use practices (e.g., pesticide use, flow regulation, urban development) and undergoing exotic species invasions; most of the threats mentioned in the listing document and recovery plan and more. Scientific research on the VELB has recently increased and it can be expected and hoped that new information on the species will continue to come to light.

2.6. SUMMARY.

Updated biological information. The range of the Valley elderberry longhorn beetle as based on records of adult males with classic VELB coloration (predominantly red with black spots) is smaller (Tehama to Fresno Co) than the range based on the presence of exit holes. More surveys of adults would however be needed to determine the accuracy of the range – or a geographic genetic study of the subspecies and genetic analysis of larvae or, if possible, frass. While there are areas of overlap of the VELB and the CELB, the two appear to be distinct units based on coloration and core of their distribution. Metapopulations of the VELB occur within drainages and have many of the characteristics of classic metapopulations – for example, small local densities, low occupancy rates, short migration distances. The patterns of VELB distribution are similar across rivers with stochasticity (chance) and isolation playing a large role in determining occupancy. Information about natural history and behavior also help explain distribution patterns.

Habitat quality influences occupancy patterns and characteristics of habitat quality include not only elderberry abundance but also other characteristics of shrubs (age, nutrient content), characteristics of the local and broad environment (associated plants, topography, relative elevation, geomorphologic zone) and the abundance of invasive VELB predators and elderberry competitors. Additionally, different variables affect the various spatial aggregations of the VELB (e.g., local aggregations vs. whole metapopulation). The habitat requirements of elderberry (soil type, relative elevation) also indirectly influences beetle occupancy. Riparian habitat is of higher quality than non-riparian habitat for the VELB. Because chance (vs. habitat quality) can play a role in whether or not a shrub is occupied, unoccupied habitat is as important as occupied for the persistence of VELB metapopulations. Several rivers throughout the Sacramento River valley area appear to be suitable habitat for the VELB, but land uses that include some amount of protection (parks, reserves, natural areas) more commonly have the beetle present.

From the little time series data available, we see that VELB occupancy rates of sites and shrubs may remain similar but there are declines in the number of sites containing elderberry and the density of elderberry within sites resulting in a net decline of VELB.

Identification of threats. Current restoration efforts have not compensated for even a fraction of lost historic riparian ecosystems, but they do enhance and expand upon remaining habitat and might eventually provide habitat for persistent and sustainable metapopulations. Current mitigation efforts seem to compensate for amounts of elderberry shrubs and stems lost to development but the quality and persistence of the stands is uncertain, and there are declines in the total number of VELB-occupied sites and in the number of riparian sites . Loss or gain of actual land area is also unknown. Compliance with mitigation reporting and possibly site maintenance decreases with site age, and the information included in reports is often unusable making assessments of mitigation success difficult.

Through section 7 the Service has authorized impacts to roughly 40,000 to 50,000 elderberry stems large enough to harbor VELB, or to roughly 12,000 to 15,000 elderberry shrubs, through over 500 biological opinions since the time of listing. There have been a small number of jeopardy, draft jeopardy, and critical habitat opinions. Unauthorized impacts also occur but are unquantified (other than indirectly in GIS studies). Service tracking of take under programmatic consultations appears to be lagging.

Overutilization of the VELB did not appear to be a major threat in the Recovery Plan (1984) and remains about the same today. A much bigger threat comes from invasive invertebrates, such as the Argentine ant and European earwigs. Both are relatively common in riparian and other moist habitats throughout the Central Valley and will opportunistically feed on VELB eggs and larvae while they lie exposed and vulnerable on the surface of elderberry shrubs. While in low densities, they do not appear to be a larger threat than some native predators (e.g., lizards, wasps, birds), but when in high densities, such as near irrigation, their impacts increase dramatically.

Inadequacy of regulatory mechanisms. Then Endangered Species Act is the only act that directly protects the VELB and its host plant. While the Clean Water Act protects wetlands connected to navigable waters, upper riparian areas such as where elderberry and the VELB occur are not covered.

Other factors. Vulnerability to chance extinction due to low and fragmented populations, invasive plant and animal species, use of pesticides, regulation of flood and flow regimes, and inadequate mitigation techniques all pose substantial risks to VELB populations.

Land use practices such as routine maintenance of recreation areas and utilities, and flow regulation, involve factors such as elderberry trimming, dust from access roads and freeways, and altered flooding and water availability. All have been or are under investigation. Lessons for improving mitigation techniques, from site design, monitoring and reporting, are given.

Conservation efforts. Pro-active habitat protection and restoration initiatives, primarily, and mitigative efforts such as through HCPs and section 7, secondarily, have acquired over 45,000 acres of potential habitat for the VELB and completed initial restoration of roughly 5,000 acres of that. While this is very small compared to historical impacts (pre-listing), the total appears to compare favorably to the level of impacts authorized under section 7. Other important conservation efforts include invasive non-native species control programs.

Still needed are studies of genetics to determine dispersal distances and mixing among populations including the CELB, and longer-term data sets to distinguish natural fluctuations from anthropogenic effects. Surveys in the southern half of the VELB's range (the San Joaquin River valley) are needed to complement the array of findings from the northern portion of the range. Additionally, studies of the ecology, genetics, chemistry and taxonomy of elderberry would increase understanding the habitat preferences of the VELB and improve restoration and mitigation efforts. Investigations into the effects on VELB and elderberry of known and potentially harmful invasive species are needed. New data should then be used to parameterize metapopulation models which can be used to make predictions about population persistence given a variety of land use, habitat quality, stochastic and climate scenarios. Standardized and simplified data collection procedures for the monitoring of mitigation sites would allow for increased compliance and the comparison of data sets from different locations, times and practitioners.

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4. Appendix I. Verbatim excerpt from a 2006 Biological Opinion summarizing the status and baseline information about the VELB.

Status of the Species

Valley Elderberry Longhorn Beetle

Legal Status - On August 8, 1980, the valley elderberry longhorn beetle was listed as a threatened species (45 **FR** 52803). Critical habitat for this species was designated and published at 50 CFR §17.95.

Reasons for decline and threats to survival - Historical loss of habitat, between 85 and 89 percent, led to the threatened status of the species. The beetle continues to be threatened by habitat loss and fragmentation, but predation by the non-native Argentine ants (*Linepithema humile*) (Holway 1998; Huxel 2000; Huxel and Hastings 1999; Ward 1987) poses a new and serious threat, particularly adjacent to irrigated areas and residential areas where Argentine ants become well established. Non-native plant invasion, improper burning regimes, off-road vehicle use, rip-rap bank protection projects, wood cutting, and livestock grazing (USFWS 1984) also threaten the species. Because the majority of pesticides target insects, pesticide drift and contamination may additionally threaten the species.

Extensive destruction of California's Central Valley riparian forests has occurred during the two centuries as a result of expansive agricultural and urban development (Katibah 1984; Roberts *et al.* 1977; Thompson 1961). As of 1849, the rivers and larger streams of the Central Valley were largely undisturbed, supporting continuous bands of riparian woodland four to five miles in width along some major drainages such as the lower Sacramento River, and generally about two miles wide along the lesser streams (Thompson 1961). A large human population influx occurred after 1849, however, and the subsequent clearing of riparian forests for fuel and construction made land available for agriculture (Thompson 1977). Natural levees bordering the rivers, once supporting vast tracts of riparian habitat, became prime agricultural land (Thompson 1961). As agriculture expanded in the Central Valley, needs for increased water supply and flood protection spurred water development and reclamation projects. Artificial levees, river channelization, dam building, water diversion, and heavy groundwater pumping has further reduced riparian habitat to small, isolated fragments (Katibah 1984). In recent decades, these riparian areas have continued to decline as a result of ongoing agricultural conversion as well and urban development and stream channelization. As of 1989, there were over 100 dams within the Central Valley drainage basin, as well as thousands of miles of water delivery canals and streambank flood control projects for irrigation, municipal and industrial water supplies, hydroelectic power, flood control, navigation, and recreation (Frayer *et al*. 1989). Riparian forests in the Central Valley have dwindled to discontinuous strips of widths currently measurable in yards rather than miles.

Based on a 1979 California Department of Fish and Game riparian vegetation distribution map, only about 102,000 acres out of an estimated 922,000 acres of Central Valley riparian forest remain (Katibah 1984). This represents a decline in acreage of approximately 89 percent (Katibah 1984). More extreme figures were given by Frayer *et al.* (1989), who reported that approximately 85 percent of all wetland acreage in the Central Valley was lost before 1939; and that from 1939 to the mid-1980s, the acreage of woody riparian forests declined from
65,400 acres to 34,600 acres. Although these studies have differing findings in terms of the number of acres lost (most likely explained by differing methodologies), they attest to a dramatic historic loss of riparian habitat in the Central Valley.

As there is no reason to believe that riparian habitat suitable to the beetle (*e.g.,* elderberry shrubs) would be destroyed at a different rate than other riparian habitat, we can assume that the rate of loss for beetle habitat in riparian areas has been equally dramatic. Further, although no comparable information exists on the historic loss of non-riparian beetle habitat such as elderberry savanna and other vegetation communities where elderberry shrubs also occur (*e.g.,* oak or mixed chaparral-woodland, or grasslands adjacent to riparian habitat), all natural habitats throughout the Central Valley, however, have been heavily adversely affected within the last 200 years (Thompson 1961), and we can therefore assume that non-riparian beetle habitat also has suffered a widespread decline. The significant loss of riparian and non-riparian habitats in the Central Valley of California strongly suggests that the range of the beetle has been reduced and its distribution greatly fragmented.

While habitat loss is clearly a large factor leading to the species' decline, other factors are likely to pose significant threats to the long term survival of the beetle. Only approximately 20 percent of riparian sites with elderberry observed by Barr (1991) and Collinge *et al*. (2001) support beetle populations. Jones and Stokes (1988) found that only 65 percent of 4,800 riparian acres on the Sacramento River have evidence of beetle presence. The fact that a large percentage of apparently suitable habitats are unoccupied suggests that the beetle is limited by factors other than habitat availability, such as habitat quality or limited dispersal ability.

Existing data suggests that beetle populations, specifically, are affected by habitat fragmentation. Barr (1991) found that small isolated habitat remnants were less likely to be occupied by beetles than larger patches, indicating that beetle subpopulations are extirpated from small habitat fragments. Barr (1991) and Collinge *et al.* (2001) consistently found beetle exit holes occurring in clumps of elderberry bushes rather than isolated bushes, suggesting that isolated shrubs do not typically provide long-term viable habitat for this species. The beetle, a specialist on elderberry plants, tends to have small population sizes, and to occur in low densities (Barr 1991; Collinge *et al.* 2001). With extensive riparian habitat loss and fragmentation, these naturally-small beetle populations are broken into even smaller and more isolated populations. Once a small beetle population has been extirpated from an isolated habitat patch, the species may be unable to re-colonize this patch if it is unable to disperse from nearby occupied habitat. Insects with limited dispersal and colonization abilities may persist better in large habitat patches than small patches because small fragments may be insufficient to maintain viable populations and the insects may be unable to disperse to more suitable habitat (Collinge 1996). Recent research indicates that isolated habitats unoccupied by the beetle remain so (Barr 1991; Collinge *et al.* 2001).

Habitat fragmentation can be an important factor contributing to species declines for a number of reasons. Habitat fragmentation divides a large population into two or more small populations that become more susceptible to extirpation from random demographic, environmental, and/or genetic events (Shaffer 1981; Lande 1988; Primack 1998). Small, isolated subpopulations have a limited potential for dispersal and colonization, and likewise their remaining habitats are more vulnerable to outside influences due to an increase in the edge:interior ratio (Primack 1998).

Two areas along the American River in the Sacramento metropolitan area have been designated as critical habitat for the beetle. These designated areas of critical habitat are the American River Parkway Zone, an area along the lower American River at Goethe and Ancil Hoffman Parks, and the Sacramento Zone, an area located approximately one-half-mile from the American River downstream from the American River Parkway Zone. In addition, an area along Putah Creek, Solano County, and the area east of Nimbus Dam along the American River Parkway, Sacramento County, are considered essential habitat, according to the Recovery Plan for the beetle (Service 1984). These critical and essential habitat areas support large numbers of mature elderberry shrubs with extensive evidence of use by the beetle.

Life History and Distribution - The beetle is dependent on the elderberry, its host plant, which is a locally common component of the remaining riparian forests and savannah areas and, to a lesser extent, the mixed chaparral-foothill woodlands of the Central Valley. Use of the elderberry shrubs by the animal, a wood borer, is rarely apparent. In most cases, the only exterior evidence of the shrub's use by the beetle is an exit hole created by the larva just prior to the pupal stage. Observations made within elderberry shrubs along the Cosumnes River, in the Folsom Lake area, and near Blue Ravine in Folsom indicate that larval galleries can be found in elderberry stems with no evidence of exit holes; the larvae either succumb prior to constructing an exit hole or are not far enough along in the developmental process to construct an exit hole. Beetle larvae appear to be distributed in stems which are 1.0 inch or greater in diameter at ground level. The *Valley Elderberry Longhorn Beetle Recovery Plan* (USFWS 1984), Barr (1991) and Section 2.1.2.1 contain further details on the valley elderberry longhorn beetle's life history.

When the beetle was listed as threatened in 1980, the species was known from fewer than ten localities along the American River, the Merced River, and Putah Creek. By the time the *Valley Elderberry Longhorn Beetle Recovery Plan* was prepared in 1984, additional occupied localities had been found along the American River and Putah Creek. As of 2005, the California Natural Diversity Database (CNDDB 2005) contained 190 occurrences for this species in 44 drainages throughout the Central Valley, from a location along the Sacramento River in Shasta County, southward to an area along

Caliente Creek in Kern County (CNDDB 2005). Population densities of the beetle are probably naturally low (Service 1984). It has been suggested, based on the spatial distribution of occupied shrubs (Barr 1991), that the beetle is a poor disperser (Collinge *et al*. 2001). Low density and limited dispersal capability may cause the beetle to be vulnerable to the negative effects of the isolation of small subpopulations due to habitat fragmentation.

Environmental Baseline

Valley Elderberry Longhorn Beetle

Species presence in the proposed project site – Occupied and suitable habitat for the beetle exists on the proposed project site in the form of 329 elderberry shrubs. Elderberry shrubs with stems one inch or greater in diameter that provide suitable habitat are found in and adjacent to the action area. Evidence of the beetle in the form of exit holes was obvious on some of the on-site elderberry shrubs. The proposed project site contains components that can be used by the beetle for breeding, resting, mating, a movement corridor, and other essential behaviors. Therefore, the Service believes that this listed species is reasonably certain to occur within the action area because of the biology and ecology of the animal, the presence of suitable habitat in and adjacent to the proposed project site, as well as the recent observations of this listed species.

Status of the species in the proposed action area - A number of studies have focused on riparian habitat loss along the Sacramento and American Rivers, which support some of the densest known populations of the beetle. Approximately 98 percent of the middle Sacramento River's historic riparian vegetation was believed to have been extirpated by 1977 (DWR 1979). The California Department of Water Resources (DWR) estimated that native riparian habitat along the Sacramento River from Redding to Colusa decreased from 27,720 acres to 18,360 acres between 1952 and 1972, representing a 34 percent decline (McGill 1975; Conrad *et al.* 1977). The average rate of riparian loss on the middle Sacramento River was 430 acres per year from 1952 to 1972, and 410 acres per year from 1972 to 1977. In 1987, riparian areas as large as 180 acres were observed converted to orchards along this river (McCarten and Patterson 1987). These rates of riparian habitat loss are likely similar for other riparian systems in the region.

The Service believes that the beetle, though wide-ranging, is in long-term decline due to widespread alteration and fragmentation of its riparian habitats, and to a lesser extent, its upland habitats, by human activities. Long-term protection of habitat for the beetle would be provided by the creation and protection of conservation areas and the implementation of various protective measures.

Factors affecting the species in the action area - The beetle is imperiled by a variety of human-caused activities, primarily urban development, water supply/flood control projects, land conversion for agriculture. These activities have contributed to the notable loss and fragmentation of the beetle's habitat. Between 1980 and 1995, the human population in the Central Valley grew by 50 percent, while the rest of California grew by 37 percent . The Central Valley's population was 4.7 million by 1999, and it is expected to more than double by 2040. The American Farmland Trust (1999) estimates that by 2040, more than 1 million cultivated acres will be lost to development and 2.5 million more put at risk (Ritter 2000). With this growing population in the Central Valley, increased development pressure is likely to result in continuing loss of riparian habitat.

A number of State, local, private, and unrelated Federal actions have occurred within the project area and adjacent region affecting the environmental baseline of these species. Some of these projects have been subject to prior section 7 consultation. Based on an informal review, the Service has issued approximately 103 biological opinions to Federal agencies on proposed projects in Sacramento County that have adversely affected the beetle since 1994. This total does not reflect the formal consultations that were withdrawn, those that are suspended, those that have insufficient information to conclude an effects analysis, those that were amended, or ones that the Service issued a conference opinion. Although these proposed projects in Sacramento County have eliminated beetle habitat, the offsetting compensating measures are designed to minimize the effects of take of these species resulting in both negative and positive effects to the species. The trend, however, for the species within the county is most likely downward.

The actions listed above have resulted in both direct and indirect effects to beetle habitat within the region, and have contributed to the loss of beetle populations. Although a reduction of the beetle population has not been quantified, the acreage of lost habitat continues to grow.

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