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FINAL REPORT
FOR
PALOS VERDES BLUE BUTTERFLY PUPAL SALVAGE
ON
PALOS VERDES AND SAN PEDRO HOUSING
SAN PEDRO, CALIFORNIA

COOPERATIVE AGREEMENT NUMBER:
N68711-02-LT-C3001

June 25,2003

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1. Introduction

The endangered Palos Verdes blue butterfly was rediscovered on the Defense Fuel Support Point (DFSP) in San Pedro, California in 1994. A Navy-owned housing development is located adjacent to DFSP, but was not surveyed for the species until negotiations were well under way to dispose of the property as surplus. The presence of the butterfly was revealed through surveys and an agreement between the U.S. Fish and Wildlife Service (USFWS) and the U.S. Navy was reached to protect most of those areas occupied by the butterfly. Outside of this protected area, however, remain patches and individuals of the butterfly's foodplant, deerweed (*Lotus scoparius*). Because Palos Verdes blue butterfly pupae may be found underneath these foodplants, the agreement specifies that efforts be made to locate and salvage any pupae before transferring the property.

This report documents extensive efforts to locate and recover pupae of the Palos Verdes blue butterfly from under and around *Lotus scoparius* plants outside of the proposed butterfly preserve in late 2002 and early 2003.

2. Methodology

The methodology was guided by the "Biological Opinion on the Formal Section 7 Consultation for the Proposed Disposal and Reuse of the Palos Verdes and San Pedro Navy Housing Areas, Los Angeles County, CA between the Department of Housing and Urban Development (HUD) and the USFWS," dated September 4, 2002.

Female Palos Verdes blue butterflies lay their eggs on either *Lotus scoparius* or *Astragalus trichopodus*. The larvae eat the foodplant and develop through a series of successively larger instars. Final instar larvae crawl from the flowerheads where they have been feeding to the duff beneath the plant to pupate. Pupae remain in the duff and soil until eclosion in early spring (Mattoni and George 2002; Mattoni 1994).

We previously have searched for pupae below plants that were to be destroyed as part of the Chevron pipeline repairs at DFSP, and have also done so to recover pupae from outdoor cages used in captive rearing (Mattoni 1999; Mattoni and George 2002; Mattoni and others 2003). Pupae can be located by sifting the soil and duff to isolate appropriately sized objects then scanning visually for pupae. This methodology has recovered pupae in both situations (Mattoni and George 2002; Mattoni and others 2003). Thorough searches in this manner should be successful in recovering any pupae that are present.

The decision of which plants should be searched can be based on the behavioral characteristics of adult female butterflies. Observations at DFSP have shown that females are less active fliers than males, they on average take shorter duration flights, and do not fly as far (Lipman and others 2003). Both sexes appear to exhibit high site fidelity, that is, they stay within patches of foodplants and do not often move between them. Males have been observed at locations quite distant from known occupied sites, but not females. These behavioral observations led to the hypothesis that females do not often traverse extensive distances outside of foodplant patches (Lipman and others 1999; Mattoni 2002).

Distance is not the only factor that influences dispersal behavior. Studies with other butterfly species have shown effects of barriers, such as dense stands of tall trees or structures, on butterfly movement across inhospitable habitat (Thomas Reid Associates 1982).

The geographic distribution of pupae found should provide evidence of habitat usage. Therefore, the recovery effort sampled sites thought to be unoccupied as well as those thought to have a high probability of occupancy.

We lack a detailed model of female Palos Verdes blue butterfly dispersal, and must therefore rely on assumptions to design the pupal recovery program. Dispersal curves are usually asymptotic, which means that although most individuals stay close to food patches, those few individuals that disperse greater distances can move quite far. We must assume that patches of foodplant, as mapped in 1999, could be occupied and should be searched for pupae. There are approximately 30 patches, which we initially assumed would represent 100–200 plants. As the results show, this assumption was low by an order of magnitude.

We inspected the duff and upper soil under all *Lotus scoparius* plants in large patches, all plants along the boundaries with DFSP, and all plants within 30 m of a recorded observation of adult Palos Verdes blue butterflies. A random subsample of all remaining plants was searched. If pupae were located under any plant, all other foodplants were searched within 30 m.

For each plant, duff was swept gently into a dustpan and inspected by hand. Soil and duff were shaken lightly, which causes lighter items to rise to the surface. Soil and duff were also sifted through screens that have openings smaller than pupae. Plants were removed if they were dead, or if they inhibited access to soil and duff around the base of the plant. In such instances, the plant was removed and left on site. The size of all plants was recorded, and in the event pupae were discovered, local habitat conditions were documented.

Figure 1. Soil was carefully inspected below each deerweed plant. Here a dead plant has been removed to provide access.

3. Results

We searched 1,078 plants across the housing areas, constituting 1,746 square feet, between November 2002 and February 2003. The majority of plants were located in area D-1 (926), with others searched in areas A-1, B-2, and at the San Pedro housing (Table 1).

Table 1. Distribution and size of *Lotus scoparius* plants searched at San Pedro and Palos Verdes housing areas.

Location	Number of Plants	Total Area (sq. ft.)	Total Volume (cu. ft.)
Palos Verdes Housing			
A-1	135	274	750
B-1/B-2	4	16	36
D-1	926	1,379	3,862
San Pedro Housing			
Dog Park	13	77	159
Total	**1,078**	**1,746**	**4,807**

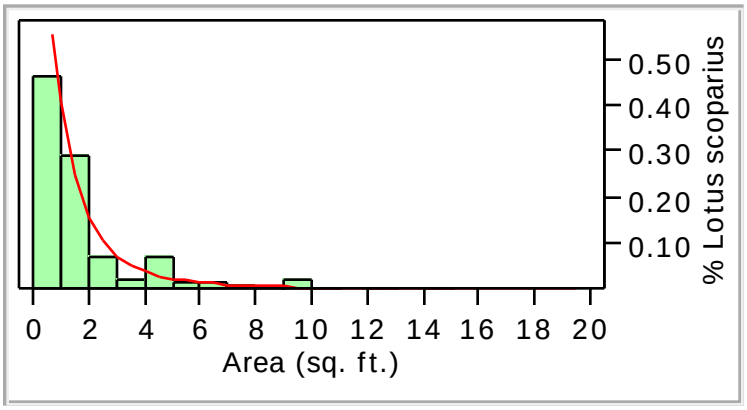

Figure 2. Distribution of the per plant area of individual *Lotus scoparius* plants, with lognormal fit.

The area and volume of plants are highly correlated because the growth form of the plants is roughly spherical. Approximately 90% of plants less than 10 inches across were alive (n≈345), while approximately 90% of larger plants were dead, leaving only roughly 415 of the 1,078 plants alive. The area of individual *Lotus scoparius* plants followed a lognormal distribution, with 80% of plants measuring less than 2 square feet (Figure 2). Insect larvae, probably of a buprestid beetle, were found boring in the woody stems of many dead deerweed plants.

Figure 3. Beetle larva (probably Buprestidae) found in the woody stems of *Lotus scoparius* plants.

Only two Palos Verdes blue butterfly pupae were located during over 200 hours of careful searching (Figure 5a). The first was found along the boundary of area A-1 adjacent to dense deerweed that was known to be occupied (Figure 4). The second was found under a lone deerweed plant located in area D-1, directly across the street from area E-3 (Figure 4). These represented quite different conditions, one with over 50% deerweed cover within 10 and 20 meters, the other with less than 5% cover within the same area. The first pupae weighed less than 50mg, and was therefore not considered viable (Mattoni and others 2003). The second was close to 100 mg and was included in the captive rearing program.

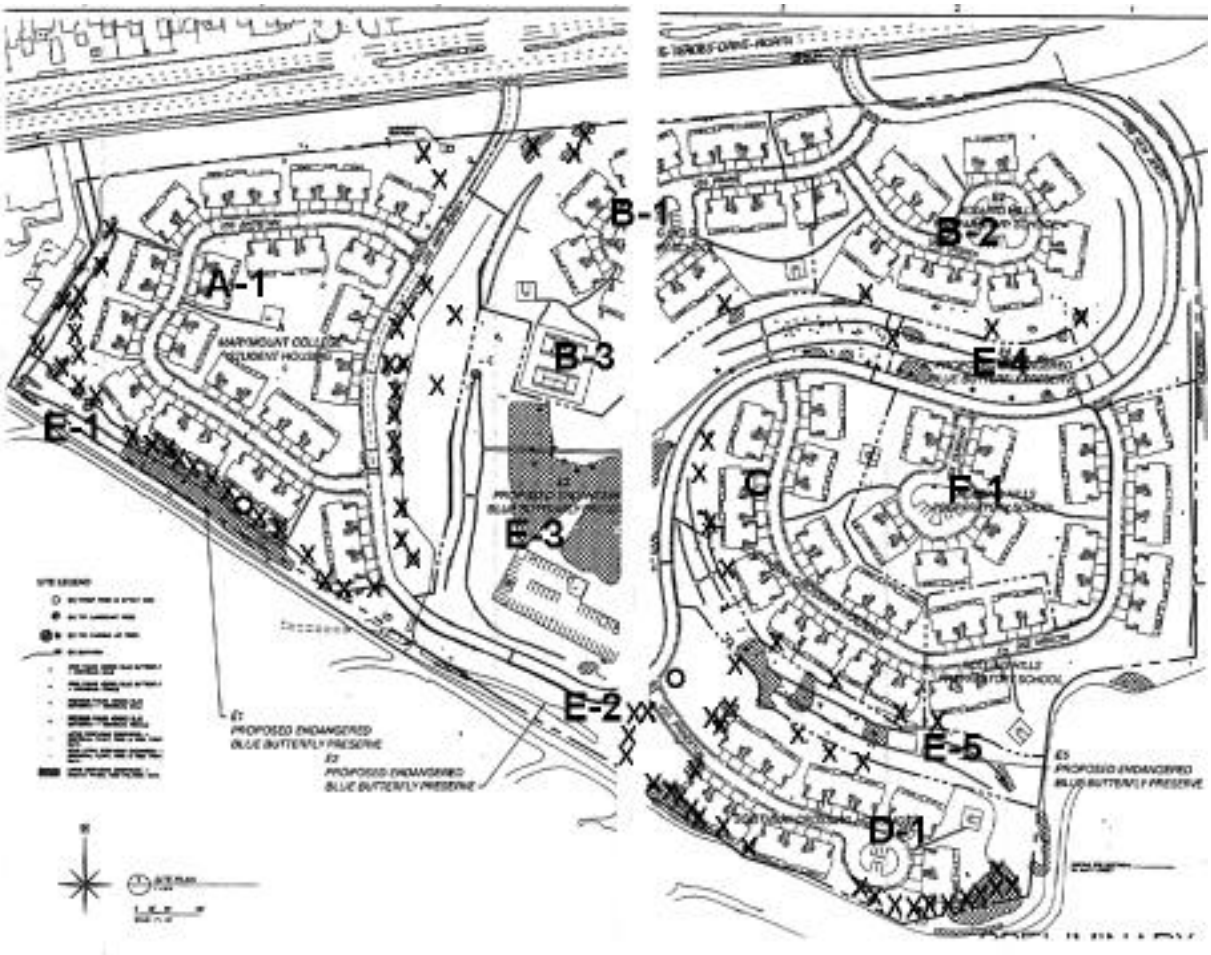

Figure 4. Locations of deerweed (*Lotus scoparius*) searched at Palos Verdes housing (X). Sites where Palos Verdes blue butterfly pupae were found are marked by "O".

Figure 5. a) Palos Verdes blue butterfly pupa recovered at Palos Verdes housing, b) assortment of pupae found under deerweed at Palos Verdes housing (different scale).

The search was successful in locating the pupae of many other insect species, including many moth pupae (Figure 5b). Hundreds of pupae were collected, many of which were not viable. In addition to pupae, searchers encountered a number of live insects, including many European earwigs (*Forficula auricularia*), silverfish (Zygentoma), centipedes (Chilopoda), millipedes (Diplopoda), spiders (Araneae), and sand roaches (*Arenivaga* sp.).

4. Discussion

The pupal salvage effort produced exceedingly low results for a large effort. The number of pupae located per hour was far lower than for similar efforts (Mattoni 1999), for which there are several possible explanations. First, it is possible that Palos Verdes blue butterfly never occupied the sites surveyed. This is the likely explanation for many of the isolated plants, but it is certainly not true for some areas. Specifically, adult butterflies previously had been observed in the dense foodplant patch in the southeast corner of area D-1 (Figure 6). The second explanation is that the success of the 2002 brood was low, and few caterpillars and pupae survived, leaving few to be found. The weather in 2002 was poor for larval development, and predation from earwigs on pupating larvae likely reduced populations further (Mattoni and George 2002; Mattoni and others 2003). We suspect that low population size is the explanation for not finding pupae in area D-1, especially in light of the extremely low number of adults observed during the 2003 flight season. A third explanation is that pupae were present, but not located in the searches. This seems unlikely, given previous success at

locating pupae under plants (Mattoni 1999), and the hundreds of other lepidopterous pupae found.

No statistical inference can be made about the habitat characteristics necessary to support Palos Verdes blue butterfly from the two data points. The first pupa was located in an area where occupancy would be expected. It was under a plant that was contiguous with a larger patch of foodplant, where butterflies had been observed in the past. The second pupa was more of a surprise, located under a single plant, and not within an area of dense foodplant. It was, however, within 150 feet of an occupied area. The location of the second pupa does illustrate that single plants are recognized and serve as oviposition sites for Palos Verdes blue butterflies.

Figure 6. Despite expectations, no pupae were found in this dense patch of deerweed in the southeastern corner of Palos Verdes housing area D-1.

Pupal salvage is time-consuming and tedious, with limited long-term benefit. We do not believe that it is an efficient form of mitigation. A better alternative would be to remove the hostplants by hand before the adult flight period, leaving the pupae in the duff and soil. Eclosing adult butterflies would then be forced to disperse to find nectar sources and hostplants. This alternative approach would work when appropriate habitat is available within several hundred yards of the habitat to be destroyed. This more economical action would then allow for creation or enhancement of more butterfly habitat to provide mitigation for the lost habitat, while avoiding direct "take" of the listed species. While some small fraction of pupae may remain in diapause, this number is likely to be quite small for Palos Verdes blue butterfly. Other species that remain in diapause for many years would not be amenable to this alternative method.

The search for pupae at the Palos Verdes and San Pedro housing areas yielded a description of the size distribution, and by extension the presumed demographic structure, of *Lotus*

scoparius. The exponential drop in the number of plants for each successively larger size class illustrates the short lifespan of the species. As we have noted before, the short lifespan of *Lotus scoparius* means that habitat for Palos Verdes blue butterfly must be managed so that new seedlings of this hostplant are provided each year (Mattoni 2002).

We conclude that the survival and recovery of the Palos Verdes blue butterfly would be better served by another form of mitigation than pupal salvage. Ongoing habitat enhancement is essential to the survival of the butterfly. Its microdistribution fluctuates from year to year with the maturation and senescence of patches of *Lotus scoparius*. Mitigation should be directed more toward the provision of future habitat, while minimizing loss of individuals from habitat to be destroyed by removing foodplant before the flight season and forcing emigration of eclosing butterflies.

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