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SALVAGE OF INDIVIDUAL PUPAE AS A MITIGATION MEASURE FOR LOSS OF PALOS VERDES BLUE BUTTERFLY HABITAT

Additional key words: *Glaucopsyche lygdamus palosverdesensis*, Lycaenidae, environmental impact assessment, endangered species

The federally endangered Palos Verdes blue butterfly (*Glaucopsyche lygdamus palosverdesensis*) had been presumed extinct for 10 years when Mattoni (1994) rediscovered it on the Defense Fuel Support Point (DFSP) in San Pedro, California. This single military installation constitutes the only consistently occupied locality for the species. *G. l. lygdamus* is vulnerable to extinction. The population is exceedingly small; we estimate that the brood of adult butterflies each year since 1994 is fewer than 300, with some years fewer than 50 (Longcore and Mattoni 2003).

Surveyors located *Glaucopsyche lygdamus palosverdesensis* on a U.S. Navy-owned housing development adjacent to DFSP while negotiations were under way to dispose the housing property as surplus to allow redevelopment. The recipient of the property (U.S. Department of Housing and Urban Development) and the U.S. Fish and Wildlife Service (USFWS) reached an agreement to protect most of those areas on the housing property occupied by the butterfly ("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, September 4, 2002"). Outside of the protected area, however, patches and individuals of deerweed (*Lotus scoparius*), one of the butterfly's larval foodplants, remained. The agreement therefore specified that efforts be made to locate and salvage any pupae under these foodplants before transferring the property. The disposition of the pupae was to a captive rearing program, so the term "salvage" is more appropriate than "translocation," which is defined as "deliberate and mediated movement of wild individuals or populations from one part of their range to another" (IUCN 1998:6, see also Oates 1992, New 1997). This short note documents the logistics and results of locating and salvaging pupae of this sensitive taxon as a mitigation measure, which we implemented at the direction of the U.S. Navy, consistent with the Biological Opinion. We have been unable to locate published reports of the salvage of individual butterfly pupae as a mitigation measure.

Female Palos Verdes blue butterflies oviposit on either *Lotus scoparius* or *Astragalus trichopodus*. Larvae pupate in the duff and soil beneath the plants (Mattoni 1994, Mattoni and George 2002), which is similar to that reported for many other lycaenids (see New 1993, Wagner 1995, Weeks 2003). Earlier we recovered six pupae from a search under foodplants in a 0.5 ha area to be destroyed as part of fuel pipeline repairs at DFSP (Mattoni 1999), and also have recovered hundreds of pupae from the duff and soil in outdoor cages used for captive rearing (Mattoni and George 2002, Mattoni et al. 2003).

At the housing site, we inspected the duff and top 10 cm of soil under all *Lotus scoparius* plants in patches (three or more plants together), all plants within 30 m of recorded observations of adult Palos Verdes blue butterflies, and a random subsample of all remaining plants. If pupae were located under any plant, we searched all other foodplants 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, and sifted through screens. We removed dead plants, and plants that inhibited access to soil and duff around the base. We recorded the size of all plants, and when pupae were discovered we documented local vegetation.

We searched 1,078 plants, representing 162 m^2 of vegetative cover, between November 2002 and February 2003. We located only two Palos Verdes blue butterfly pupae during 200+ hours of searching. We found the first adjacent to a dense patch of deerweed where we had seen adult *G. l. palosverdesensis* and the second under a lone deerweed plant. These represented quite different conditions, one with over 50% deerweed cover within 20 m of the plant, the other with less than 5% deerweed cover within the same area. We deduce from this that single plants outside of patches can serve as oviposition sites for Palos Verdes blue butterflies. The first pupa was considered dead (> 50 mg; Mattoni et al. 2003). The second pupa (presumed viable at ~100 mg) was collected for inclusion in the captive rearing program for the species (Mattoni et al. 2003). While only two *G. l. palosverdesensis* pupae were located, we

found hundreds of pupae of other species, predominantly moths. We believe that it is unlikely that pupae were missed, given previous success at locating pupae under plants (Mattoni 1999) and the hundreds of other lepidopterous pupae found, unless pupae were located deeper than 10 cm and far outside the canopy of the larval foodplant. In outdoor tent rearing cages, pupae are found near the plant, not at the edges of the cage as would occur if last instar larvae were dispersing to pupation sites away from the plant.

The effort to locate and recover individual pupae is time-consuming and tedious, with limited long-term benefit. We do not believe that it is an efficient form of mitigation, and propose two alternatives. If endangered sites are within dispersal distance of suitable habitat for a species, one alternative would be to remove the foodplants 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 foodplants. The resources that would have been consumed locating individual pupae could be used to create or enhance more habitat, a strategy that has been demonstrated to be successful for this and other lycaenids (New 1997, Longcore and Mattoni 2003, Mattoni et al. 2001). Because a proportion of pupae may diapause for multiple years in this species (Mattoni et al. 2003) and many others (Scott 1986), a site could be kept clear of foodplants for more than one year to increase the number of adults that emigrate. A second alternative would be to translocate the plants, along with the duff and soil, without searching for pupae, to a site either occupied by the butterfly or targeted for reintroduction. Twelve pupae were sufficient to establish a new population of the lycaenid *Hamearis lucina* (Oates 1992), so such an approach could be successful. In this manner all pupae could be removed from the development site, meeting the goal of the Biological Opinion that "take" be minimized. Salvage of plants from development sites and their translocation to restoration sites would have the additional benefit of stocking newly-created habitats with many epiphytic species that are otherwise slow to colonize restorations (Bowler 2000).

We conclude that the survival and recovery of the Palos Verdes blue butterfly would be better served by another form of mitigation than recovery of individual pupae, even if more pupae were located per unit effort. Ongoing habitat enhancement is essential to the survival of this butterfly. Its microdistribution fluctuates from year to year with the maturation and senescence of patches of foodplant (Longcore and Mattoni 2003). Mitigation should be directed more toward the provision of future habitat, while minimizing loss of individuals at sites allowed to be destroyed either by 1) removing foodplant before the flight season and forcing emigration of eclosing butterflies if suitable habitat is adjacent, or 2) translocating pupae en masse by carefully moving plants, soil, and duff to a new site.

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