



**PALOS VERDES
BLUE BUTTERFLY
Recovery Plan**

PALOS VERDES BLUE BUTTERFLY
RECOVERY PLAN

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Date

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Acknowledgements should read as follows:

The Palos Verdes Blue Butterfly Recovery Plan, dated January 19, 1984, prepared by the U.S. Fish and Wildlife Service under contract with Dr. Richard A. Arnold, Department of Entomology, University of California 94720.

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Palos Verdes Blue Butterfly
Recovery Plan Executive Summary

1. Point or condition when species can be considered recovered.

To be determined. Until that time, the eight known colonies and their habitats should be protected.

2. What must be done to reach recovery?

Unknown, but objectives are proposed to determine this. Goal is to determine number and size of colonies necessary to reclassify butterfly from endangered to threatened and to delist.

3. What specifically must be done to meet needs of #2?

The number and size of colonies necessary to reclassify will be determined by research projects that include: 1) determining amount of habitat necessary to support a viable colony and 2) determining number of colonies necessary to achieve genetic diversity and long-term survival of the butterfly.

4. What management/maintenance needs have been identified to keep species recovered?

Cooperative agreements for known habitat sites, programs to increase available habitat and to decrease limiting factors, public education programs, and intense law enforcement efforts.

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PART I
INTRODUCTION

Brief Overview

The Palos Verdes blue butterfly, Glaucopsyche lygdamus palosverdesensis (Lepidoptera: Lycaenidae), was recently described as a new subspecies (Perkins and Emmel 1977). It occurs only on the Palos Verdes Peninsula, Los Angeles County, California, where it inhabits cool, fog-shrouded, seaward canyons and terraces. The U.S. Fish and Wildlife Service (USFWS) listed the Palos Verdes blue butterfly as an endangered species in 1980 (45 Federal Register 44939).

One purpose of the Endangered Species Act of 1973, as amended, is "to provide a means whereby the ecosystems upon which endangered and threatened species depend may be conserved." This recovery plan presents information on the Palos Verdes blue butterfly's current and former distribution, life history, and requirements for survival. Characteristics of its habitat are also described. A comprehensive plan is outlined to maintain and recover this endangered species and its habitat.

Taxonomy

The Palos Verdes blue butterfly is morphologically distinguished from

other races of the widely distributed species, Glaucopsyche lygdamus (Doubleday), by its size, wing color, and maculation pattern. Additionally, its larval foodplant is a locoweed (Astragalus: Leguminosae), whereas other geographically nearby G. lygdamus subspecies feed on either lupine (Lupinus spp.) or deerweed (Lotus scoparius). Other biological features which are characteristic of the subspecies palosverdesensis include its coastal sage scrub habitat and very early spring (February and March) adult flight period.

Habitat Description

The Palos Verdes Hills form a conspicuous uplift at the southwestern border of the Los Angeles Basin and constitute an isolated upland peninsula. Many older maps refer to the region as the San Pedro Hills. The Palos Verdes Hills represent a low altitude Coast Range mountainous area. They extend northwest to southeast for a distance of 15.8 km (9.8 mi) and are 6.7 to 8.3 km (4.2 to 5.2 mi) wide. San Pedro Hill, the highest peak, is 450 m (1480 ft) above sea level (Woodring et al. 1946).

The crest and greater part of the upper slopes of the hills form a rolling upland, characterized by smoothly rounded hills and wide, gently sloping valleys, whereas the lower slopes are marked by a series of 13 coastal terraces and deep canyons. Cool temperatures and fog are characteristic climatic features of the terraces and slopes inhabited by the butterfly. The average January temperature is about 12°C (54°F); the average July temperature is about 21°C (70°F).

Annual precipitation occurs primarily in winter months (Rancho Palos Verdes Planning Dept., pers. comm.).

The Palos Verdes Hills are located on a peninsula that was an island in very recent geological time and shares some interesting fauna and flora with the Channel Islands. There are at least three geographical races of resident bird species on the peninsula that are found nowhere else except the Channel Islands. These include insular races of the orange-crowned warbler (Vermivora celata), western flycatcher (Empidonax difficilis), and Allen's hummingbird (Selasphorus sasin) (Johnson 1972). The same phenomenon has been recorded for plants, in particular the green liveforever (Dudleya virens), which is endemic to the Channel Islands and Palos Verdes Peninsula (Raven 1963, Thorne 1967). Undoubtedly, other similarities between the fauna and flora of the Channel Islands and Palos Verdes Peninsula will become apparent as additional research is conducted.

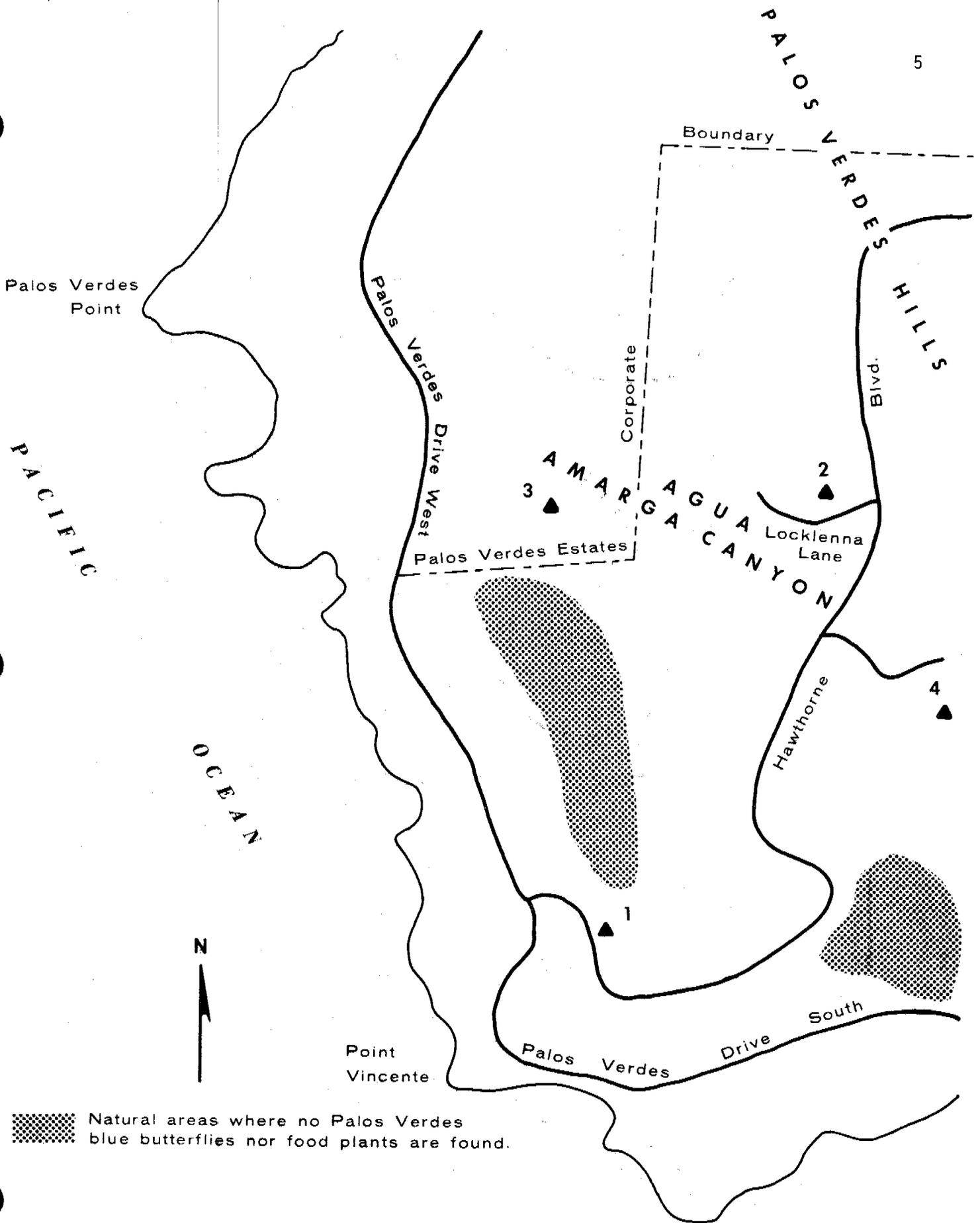
The habitat of the Palos Verdes blue butterfly is coastal scrub sage, which typically occurs on sandy marine terraces and dry rocky slopes below 915 m, (3000 ft) elevation along the southern California coastline (Mooney 1977). The coastal sage scrub community is composed of semi-shrubs, usually 0.3 to 1.5 m (1 to 5 ft) tall and characterized by a mosaic of various plants interspersed with open spaces. Dominant coastal sage scrub species of the peninsula include: California sagebrush (Artemisia californica), California encelia (Encelia californica), lemonadeberry (Rhus integrifolia), boxthorn (Lycium californicum), prickly-pear cactus (Opuntia prolifera), and

wild buckwheat (Eriogonum fasciculatum).

Distribution

The historical distribution of the butterfly is unknown since much of the coastal sage scrub habitat on the peninsula was altered prior to the discovery of the butterfly in the 1970's. The first known population of G. l. palosverdesensis was at the type locality on Alta Vista Terrace (colony #1, Fig. 1). In 1978, the type locality of the Palos Verdes blue butterfly was developed as a residential area. Grading and other construction activities completely destroyed the habitat and extirpated the butterfly at this site.

The Palos Verdes blue butterfly is found at only a few of the remaining natural areas on the peninsula: Agua Armaga Canyon (sometimes incorrectly referred to as Agua Amarga) in Palos Verdes Estates and Rancho Palos Verdes (colony #3), Frank Hesse Memorial Park on Locklenna Lane (colony #2), Crest Road (colony #4), Portuguese Canyon (colony #5) and Phantom Drive (colony #6) in Rancho Palos Verdes, along Palos Verdes Drive East (colony #7) and San Pedro Hill (colony #8) in the Palos Verdes Hills (Figs. 1, 2). Coastal sage scrub species and annual weeds are the dominant plants at all sites.




 Natural areas where no Palos Verdes blue butterflies nor food plants are found.

Figure 1. Location of Palos Verdes blue butterfly colony sites; #1 Alta Vista Terrace, #2 Frank Hesse Memorial Park, #3 Agua Amarga Canyon, and #4 Crest Road.

Reasons for Decline

Urbanization, weed abatement practices, fire prevention practices, agriculture, displacement of native plants, and off-road vehicle (ORV) use have caused the decline of the butterfly. Accelerated residential growth on the Palos Verdes Peninsula is a very serious threat to the continued existence of the Palos Verdes blue butterfly. Approximately 60% of the peninsula is suburban; 11% is beach, bluff, or harbor; 5% is industrial; 5% is ravines and chaparral canyons; 1% is parks, reservoirs, and freshwater marsh; and the remainder is open space (pers. obs. and G. Gleason, California Coastal Commission, pers. comm.)

Life History

A synopsis of Arnold's (1981) brief description of the life history of the Palos Verdes blue butterfly is presented here.

The butterfly has only one generation per year, i.e., it is univoltine. Adult butterflies fly from about the 2nd week in February until the end of March. Adult emergence is synchronized with the peak flowering period of the larval foodplant, Astragalus trichopodus spp. leucopsis (Leguminosae). This legume grows on well-drained clay or gravelly soils, and is frequently found on rocky slopes throughout coastal areas of the peninsula.

Field observations in 1979, 1980 and 1981, indicate that adult density

is low, less than 1 individual per hectare. Because of their low density, a specialized mate-location behavior is probably employed. Because adults are always found in association with the larval foodplant, proximity to the foodplant may be the key to mate location. It is also possible that hilltopping, the phenomena of meeting mates at the top of hills, may be used by the Palos Verdes blue butterfly to find mates. This behavior, however, has not been observed.

Oviposition occurs throughout the adult flight season. Eggs are laid on the flower buds and leaves of the Astragalus. Larvae emerge in about 7 to 10 days, initially feed on the sepals and ovaries or ovules, and eventually bore into the seed pods where they forage on the developing seed and dermal tissue of the pod. There are 5 larval instars. Some instars may be tended by ants, but this has yet to be observed for palosverdesensis. Ants tending other races of Glaucopsyche lygdamus protect larvae from parasitoids (Pierce and Mead 1981). In April and May, the mature larvae exit the seed pods and crawl down to the base of the plant to pupate in the dried leaf litter.

Natural enemies and diseases of the butterfly are not presently known. Presumably some parasitoids attack the larvae, but none have yet been reared from field samples.

Because of the low density of adults, no capture-recapture studies have been performed on the butterfly. Further studies will be necessary to determine the population size, structure, and bionomics

of the remaining colonies.

Limiting Factors

Availability of suitable habitat is the primary limiting factor affecting survival of Glaucoopsyche lygdamus palosverdesensis. Because the butterfly and its larval foodplant occur at low densities and in localized populations, both are extremely vulnerable (directly or indirectly) to weed abatement and fire preventive rototilling, construction activities and encroachment by exotic plants.

The only colonies that are located on public property are Frank Hesse Memorial Park (colony #2), Palos Verdes Drive East (colony #7) and possibly part of San Pedro Hill (colony #8). The rest of the colonies are located on private property where the threat of extirpation is imminent.

Most of the colonies are less than a few square meters in size and include no more than twelve locoweed plants. The exceptions are the Palos Verdes Drive East colony that is over a hectare in size and contained 100 food plants in 1982 and the Frank Hesse Memorial Park colony that is less than a hectare but had 120 food plants in 1979.

Rototilling is the most serious threat to these colonies. All these sites are rototilled and it is this activity that has caused the low foodplant density. The number of food plants at the Frank Hesse Memorial Park colony was reduced from 120 in 1979 to zero in 1982

because of rototilling. Without the foodplant the butterfly cannot survive. Although local governmental officials have been cognizant of the presence of the butterfly on the publicly owned part of the Palos Verdes Drive East site and Frank Hesse Memorial Park since 1978, these colonies have nearly been extirpated by inappropriate habitat management.

Colony #3, in Agua Armaga Canyon, is extremely small (6 m x 6 m) and has been invaded by gophers and weeds. Disruption of the substrate by gophers and competition with exotic plants stress the Astragalus of colony 3. Only 1 adult male was seen here in 1979. Six Astragalus plants were noted in 1980; however, no adults or eggs were observed here in either 1980 or 1981, and the colony may have been extirpated.

The butterfly may be limited by interspecific competition with other lycaenid butterflies for the Astragalus as a larval food resource. Adult, egg, and larval counts during 1979 to 1981, indicate that Everes amyntula (Bdv.) and Strymon melinus Hubner are 4 to 26 times more abundant than G. l. palosverdesensis at colonies #2 and #4. All three butterfly species are seed predators of Astragalus as larvae (Arnold, Douglas, and Mattoni, unpublished data). These larvae are cannibalistic, thus, only 1 larva develops within a seed pod. Intraspecific competition manifested as cannibalism between these species of butterfly larvae within a solitary seed pod, may also be a limiting factor of G. l. palosverdesensis.

Preservation Efforts

The Palos Verdes blue butterfly was recognized as a unique taxon in 1977, listed as an endangered species and its critical habitat designated in 1980 (Figs. 3, 4). As discussed earlier, the greatest threat to its survival is continued loss and alteration of habitat. However, specific management actions to protect the Palos Verdes blue butterfly have not been undertaken.

Protection and management of the butterfly's habitat will also benefit many other wildlife and plant species. Many migratory birds move through the area in the fall and spring. Several other bird species utilize the peninsula as a primary wintering site. Thus, continued destruction and alteration of the coastal sage scrub habitat will affect not only the butterfly, but also many other organisms of concern.

PALOS VERDES BLUE BUTTERFLY

Agua Amarga Canyon and Frank Hesse Park Zone

Los Angeles County, California

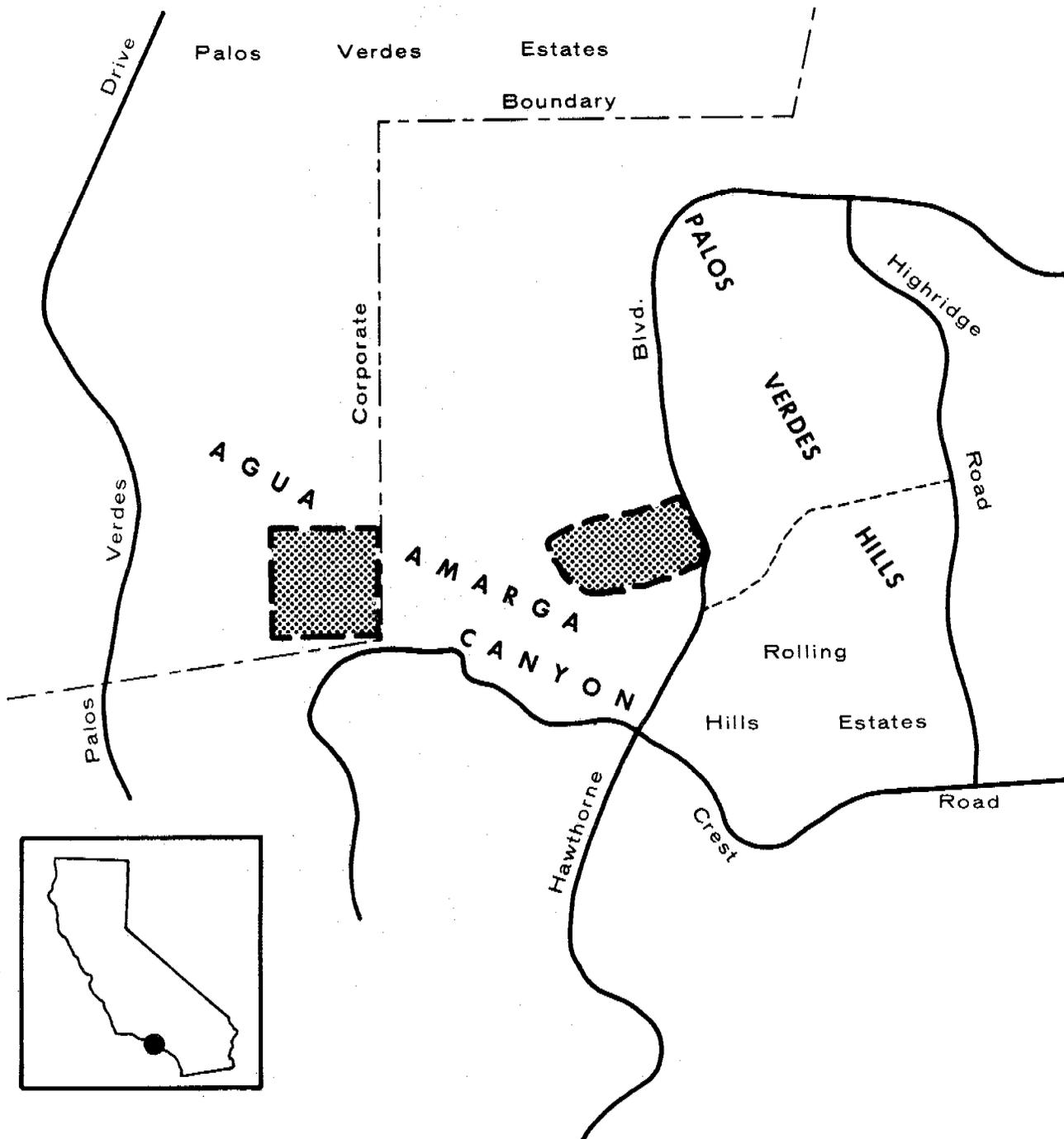


Figure 3. Location of Agua Amarga Canyon and Frank Hesse Park Zone of Critical Habitat, (see 45 Federal Register 44939-44942).

PALOS VERDES BLUE BUTTERFLY

Palos Verdes Drive Zone

Los Angeles County, California

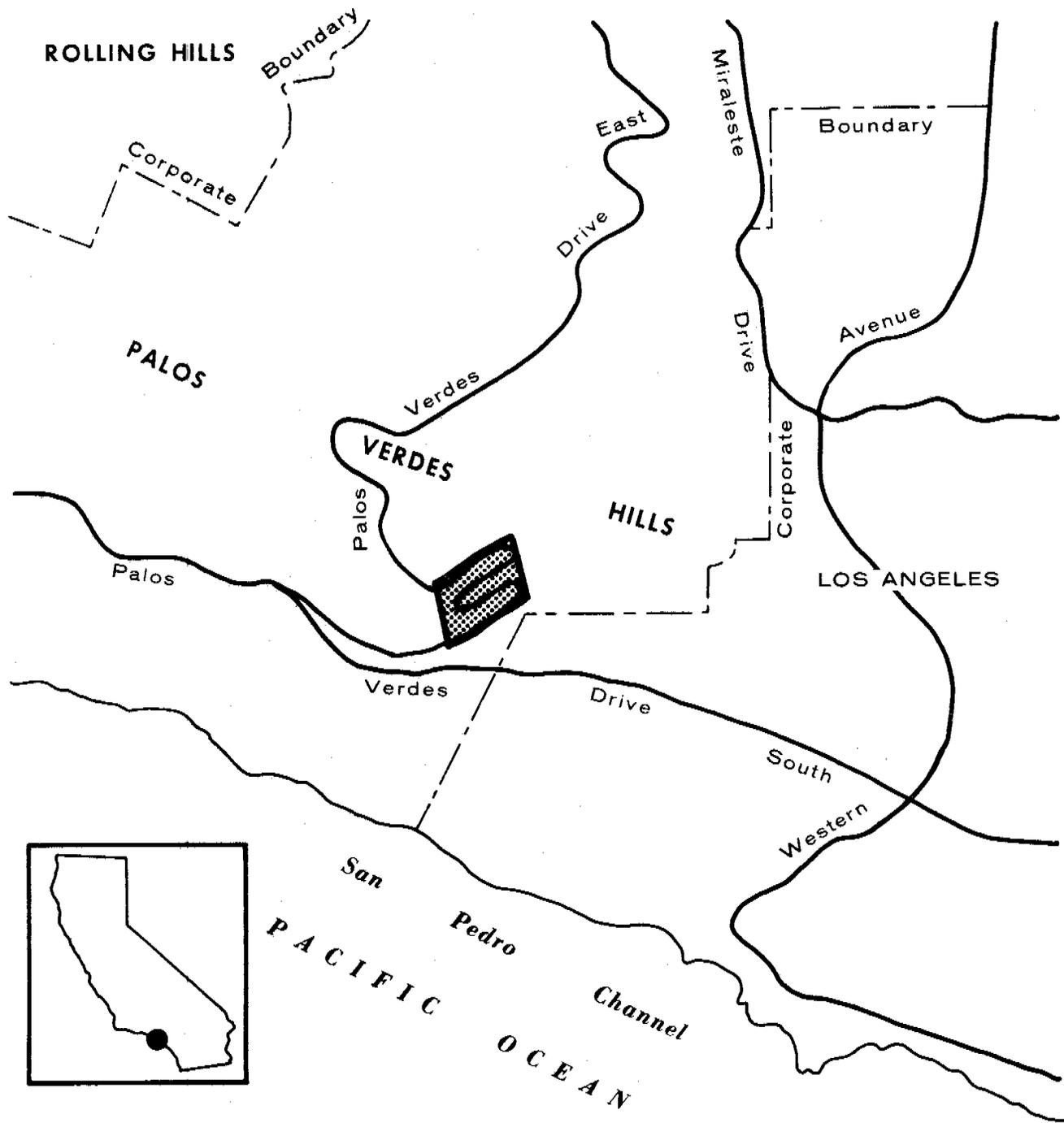


Figure 4. Location of Palos Verdes Drive Zone of Critical Habitat, (see 45 Federal Register 44939-44942).

PART II
RECOVERY

Objectives

The Palos Verdes blue butterfly is endangered because the small geographic area to which the subspecies is confined continues to be altered by urbanization. Today, only one of the eight historically known populations, the Palos Verdes Drive East Colony, is considered to be self-sustaining. Six of the other seven populations of the butterfly are probably too small in numbers and acreage to be considered self-sustaining. One colony has been extirpated. Arresting the population decline of this butterfly requires prevention of further loss and degradation of its existing habitat. The Palos Verdes blue butterfly may remain endangered because all populations are extremely localized and of sufficiently low density that natural or unnatural catastrophies could readily destroy them. However, the primary objective of this recovery plan is to maintain and restore the existing Palos Verdes blue butterfly populations and determine what numbers and distribution of the colonies are necessary to reclassify it to threatened status and/or delist the species. Until that time, the seven extant Palos Verdes blue butterfly colonies and their habitat must be protected through an integrated program of habitat preservation, management, rehabilitation, and if necessary, captive breeding to augment population numbers and maintain genetic diversity.

Man is chiefly responsible for the butterfly's decline through habitat modification or destruction. Urban development and related activities have degraded and rendered much of its original range uninhabitable by the Palos Verdes blue butterfly. Therefore, this recovery plan will achieve its primary objective if man-induced mortality factors can be reduced sufficiently to maintain and restore the habitat of existing G. l. palosverdesensis populations in a self-sustaining condition. Preservation, protection, rehabilitation and management of the coastal sage scrub habitat on the Palos Verdes Peninsula will be necessary to accomplish this objective.

Step-down Outline

Prime Objective: To protect and enhance the seven known populations of Palos Verdes blue butterfly and their habitats, augment populations and/or reintroduce butterflies into suitable historic habitat, enhance genetic variability and population viability, quantify population and habitat criteria necessary for reclassifying or delisting the taxon and eventually to reclassify or delist the butterfly. Research specific to achieve these objectives will be necessary.

1. Preserve, protect and manage existing requisite larval and adult habitat.
 11. Preserve Frank Hesse Memorial Park (FHMP) Colony.
 12. Preserve Agua Armaga Canyon (AAC) Colony.
 13. Preserve Palos Verdes Drive East (PVDE) Colony.
 14. Preserve Crest Road Colony.
 15. Preserve Portuguese Canyon Colony.
 16. Preserve Phantom Drive Colony.
 17. Preserve San Pedro Hill Colony.
 18. Survey additional sites on Palos Verdes Peninsula for presence of Astragalus and PVBB populations.
2. Manage and enhance known PVBB populations.
 21. Investigate and initiate habitat improvement methods as appropriate.
 211. Remove undesirable exotic plants from PVBB habitats.
 212. Propagate and transplant Astragalus and other characteristic coastal sage scrub plants at appropriate sites.

2121. Determine propagation techniques for larval foodplants.
2122. Determine the most ecologically compatible and cost-effective techniques for habitat improvements.
213. Determine physical and climatic factors of habitat sites and relate to habitat improvement actions.
22. Conduct additional research on Palos Verdes blue butterfly autecology.
 221. Role of ants in protection of larvae from predators and parasites.
 222. Population structure.
 223. Adult behavior.
 224. Determine the effect of predators, parasitoids, and other limiting factors on the Palos Verdes blue butterfly.
23. Conduct autecological research on bionomics of Astragalus trichopodus leucopsis.
 231. Determine life history.
 232. Determine mortality factors.
 233. Determine environmental and physical limiting factors.
 234. Determine if community processes affect survivorship of PVBB or its foodplants.
24. Evaluate data and incorporate findings into long-term management plans for known sites.
3. Re-establish habitat and butterflies at sites of former PVBB populations.

31. Survey potential habitat on the Palos Verdes Peninsula and determine suitability for reintroduction.
 311. Alta Vista Terrace.
 312. Other sites as determined by survey.
32. Secure and/or protect selected habitat site(s).
33. Rehabilitate selected coastal sage scrub habitat sites.
 331. Remove exotic flora and fauna or other deleterious materials.
 332. Introduce necessary biological components of Palos Verdes blue butterfly habitat.
34. Obtain PVBB stock for introduction from existing colonies or through captive propagation, if necessary, and introduce into rehabilitated sites.
35. Establish a captive breeding program, if appropriate, to provide PVBB stock for new habitat sites and to augment existing colonies.
 351. Determine need for captive breeding facility.
 352. Cultivate Astragalus trichopodus leucopsis for laboratory rearing of PVBB.
 353. Create an artificial diet for efficient laboratory rearing of PVBB.
 354. Refine PVBB rearing techniques by using other Glaucopsyche lygdamus subspecies.
 355. Collect PVBB stock from Palos Verdes Drive East Colony to provide brood stock.
 356. Operate captive breeding facility.
36. Develop and implement management plans for restored sites.

4. Determine status and success of PVBB management.
 41. Develop suitable survey methods to estimate population numbers, distribution, and trends.
 42. Survey PVBB populations and their habitats.
5. Determine number and size of colonies necessary to reclassify PVBB to threatened status and to delist.
 51. Determine factors necessary to support a viable PVBB colony.
 52. Determine number of colonies necessary to achieve genetic diversity and long-term survival of PVBB.
 53. Reclassify PVBB when and as appropriate.
6. Increase public awareness of PVBB through education and information programs.
 61. Establish information signs at Frank Hesse Memorial Park and offer interpretive tours of the site.
 62. Prepare TV and radio spot programs.
 63. Prepare audio-visual program display on rehabilitation and restoration processes.
 64. Prepare brochure on PVBB preservation and recovery program.
7. Utilize laws and regulations to protect PVBB.
 71. Enforce applicable laws, regulations and ordinances.
 72. Evaluate the need for additional laws, regulations or ordinances.

Narrative1. Preserve, protect and manage existing requisite larval and adult habitat

The Palos Verdes blue butterfly is presently known from only a few sites on the Palos Verdes Peninsula. Further degradation of the habitat at these sites must be prevented and requisite larval and adult foodplants must be maintained to provide adequate conditions for the remnant butterfly populations.

Current Palos Verdes blue butterfly colonies can best be protected by agreements among the concerned parties or easements. Further degradation and development of the known sites can be prevented through cooperative agreements, memoranda of understanding, or conservation easements among USFWS, California Department of Fish and Game (CDFG), U.S. Air Force (USAF), respective landowners, and city governments. Land Protection Plans are needed for all sites.

The primary concern at all existing colonies should be to maintain requisite larval and adult resources. All management plans should include the following measures that will conserve the Palos Verdes blue butterfly: minimize rototilling for fire prevention; minimize use of herbicides, insecticides, and other toxic substances; and minimize ORV activity.

11. Preserve Frank Hesse Memorial Park (FHMP) Colony.

Rancho Palos Verdes city officials have indicated an interest in cooperating with the USFWS to protect, manage, and rehabilitate the coastal sage scrub habitat and Palos Verdes blue butterfly colony at Frank Hesse Memorial Park (J. Emeterio, Rancho Palos Verdes Planning Dept., pers. comm.). Rototilling, a fire and weed control practice, annually decimates the limited Astragalus population at the site. Proposed recreational development of this site could adversely impact the remaining Astragalus and G. lygdamus palosverdesensis. City and fire district officials need to be informed about recreation and fire preventive activities which are compatible with preservation of the butterfly and its habitat. Proper design and placement of recreational facilities could greatly enhance protection and management of the butterfly and its habitat. A cooperative agreement among USFWS, California Department of Fish and Game, City of Rancho Palos Verdes, and fire district officials should be negotiated and would alleviate many protection problems.

12. Preserve Agua Armaga Canyon (AAC) Colony.

The higher elevations and flatter regions of Agua Armaga Canyon (colony #3) comprise a 90% completed single-family housing development (S. M. Lavitt, Rancho Palos Verdes Planning Dept., pers. comm.). The remainder of the canyon, including the Palos Verdes blue butterfly colony site, is zoned "open-space hazard" because of the possibility of landslides. Although the entire canyon is privately owned,

it will probably not be further developed because of this zoning. However, a cooperative agreement or other management document should be consummated among USFWS, CDFG, private property owners, and the cities of Rancho Palos Verdes (RPV) and Palos Verdes Estates (PVE).

13. Preserve Palos Verdes Drive East (PVDE) Colony.

The S-curve or switchback area on Palos Verdes Drive East is also zoned as "open-space hazard" (S. M. Lavitt, Rancho Palos Verdes Planning Dept., pers. comm.). Portions of this site and much of the land to the south is owned by the City of Rancho Palos Verdes as parkland. Off-road vehicles (ORV's) presently use much of the area. In 1981, Arnold, Douglas, and Mattoni (unpublished data) determined that the butterfly colony here was much larger than previously believed (Fig. 2). A significant portion of the colony occupies a terrace north of the S-curve that is zoned for residential development. Preliminary grading and construction activities were observed in February and March 1981. A cooperative agreement among USFWS, CDFG, Rancho Palos Verdes, private property owners, and fire district officials should be formalized to protect the areas designated as open-space-hazard. ORV activity should be curtailed or limited to specific areas which are not essential for the Palos Verdes blue butterfly.

14. Preserve Crest Road Colony.

The colony at Crest Road (#4) occurs on private land. Cooperative agreements among USFWS, CDFG, Rancho Palos

Verdes, California Coastal Commission, private property owners and fire district officials should be formalized to protect this area.

15. Preserve Portuguese Canyon Colony.

The Portuguese Canyon Colony (#5) also occurs on private land and needs to be preserved through cooperative agreements.

16. Preserve Phantom Drive Colony.

The Phantom Drive Colony (#6) also occurs on private land and needs to be preserved through cooperative agreements.

17. Preserve San Pedro Hill Colony.

The colony on San Pedro Hill (#8) probably extends into the U.S. Air Force Military Reservation. The boundaries of the colony on the San Pedro Hill Military Reservation should be determined. Also a cooperative agreement or other management document should be finalized among USFWS, CDFG and the Air Force to protect the Palos Verdes blue butterfly and its habitat.

18. Survey additional sites on Palos Verdes Peninsula for presence of Astragalus and PVBB populations.

A comprehensive ground survey of the undeveloped portions of the Palos Verdes Peninsula is needed to determine if undiscovered populations of Astragalus and Palos Verdes blue butterflies exist. The rugged terrain of much of the area may require aerial surveys or low level aerial photography of the peninsula. Surveys should be conducted in late February, which is the peak blooming period of the Astragalus.

2. Manage and enhance known PVBB populations.

Colonies at Frank Hesse Memorial Park and Agua Armaga Canyon support less than optimal numbers of the butterfly because of the loss and alteration of habitat. Reestablishment of more foodplant (Astragalus trichopodus leucopsis), control of numerous weeds, and curtailment of rototilling for fire and weed abatement should improve conditions and expand available habitat. However, the small size of all these sites dictates that extensive short and long-term management will be necessary to enhance and maintain the habitat of these butterfly colonies.

21. Investigate and initiate habitat improvement methods as appropriate.

The preservation of all the known butterfly colonies depends upon management and restoration of their respective habitats. Several interim management actions, such as removal of exotic plants, should be implemented while research is conducted to determine the most cost-effective techniques for long-term habitat improvement.

211. Remove undesirable exotic plants from PVBB habitats.

Rototilling creates temporary fire breaks but also promotes the growth of annual weeds. This corridor of annual weeds may be a greater fire hazard than the native coastal sage scrub vegetation. Rototilling gives the annual weeds a competitive advantage over the native vegetation, especially the Astragalus food plant. Weeding these sites by hand would both reduce the fire danger and increase the survivorship of the Astragalus.

212. Propagate and transplant Astragalus and other characteristic coastal sage scrub plants at appropriate sites.

Initial transplants of Astragalus may be necessary to reestablish this native plant in more disturbed areas. Propagation of Astragalus will be necessary to provide sufficient numbers for transplanting.

2121. Determine propagation techniques for larval foodplants

Culture techniques for A. t. leucopsis are unknown and must be determined prior to supplementing the wild population of buckwheat.

2122. Determine the most ecologically compatible and cost-effective techniques for habitat improvements.

Propagation and transplant methods for Astragalus and other characteristic coastal sage scrub plants need to be investigated to determine cost-effective habitat restoration techniques. For long-term protection and management purposes, it would be desirable for USFWS, CDFG and fire district officials to agree upon the creation of a permanent peripheral fire break surrounding the colonies. This action would prevent the annual rototilling of Astragalus plants and permit re-establishment of the native flora.

213. Determine physical and climatic factors of habitat sites and relate to habitat improvement actions.

Physical (soil conditions, slope, pH, etc.) and climatic (precipitation, temperature, fog and wind patterns) factors of the habitat should be characterized so that habitat manipulation will be compatible with the prevailing conditions at the site.

22. Conduct additional research on Palos Verdes blue butterfly autecology.

Adequate knowledge of the butterfly's life history is required to insure the greatest chance of a successful recovery effort. The work of Arnold (1981) as well as Arnold and Mattoni (unpublished data) should be supplemented by additional field and laboratory studies.

221. Role of ants in protection of larvae from predators and parasites.

Ants are known to reduce the degree of parasitism in larvae of other Glaucopyge lygdamus populations (Pierce and Mead 1981). The relationship of G. l. palosverdesensis larvae and ants must be elucidated. If ants have an effect on the survivorship of the Palos Verdes blue butterfly, then their ecology must be known in order to decrease mortality of the butterfly.

222. Population structure.

Capture-recapture studies have not been performed because of the low-density of adults at each colony. Research is needed to augment the meager information

that exists regarding population size and structure.

223. Adult behavior.

Reproductive behavior of the Palos Verdes blue butterfly should be determined. Knowledge of adult Palos Verdes blue butterfly behavior will be required prior to any attempts at artificial propagation. Information is needed on mating, foraging and oviposition.

224. Determine the effect of predators, parasitoids, and other limiting factors on the Palos Verdes blue butterfly.

Work is needed to identify predators, parasitoids and other limiting factors to determine what, if any, additional actions are necessary to minimize their effects.

23. Conduct autecological research on bionomics of *Astragalus trichopodus leucopsis*.

The ecology and natural history of the butterfly's larval foodplant, *Astragalus trichopodus leucopsis*, is poorly known. Horticultural, autecological, and population studies should be initiated so that proper management activities can be implemented for the foodplant.

231. Determine life history.

Enhancement of the butterfly's larval foodplant is an integral part of the overall recovery of the Palos Verdes blue butterfly. Seed dispersal, germination, and other aspects of the life history of A. t.

leucopsis should be determined so that this resource may be properly managed.

232. Determine mortality factors.

Factors contributing to the mortality of the larval foodplant should be identified, evaluated, and minimized as appropriate.

233. Determine environmental and physical limiting factors.

Factors that are currently limiting the distribution and/or numbers of A. t. leucopsis should be identified so that potential transplant sites can be identified. Edaphic conditions, slope, exposure, etc. should be investigated.

234. Determine if community processes affect survivorship of PVBB or its foodplants.

Besides an autecological study of the food plant, a synecological study of the coastal sage scrub vegetation should be completed. This will allow us to determine whether community processes such as succession affect the survivorship of the Palos Verdes blue butterfly or its foodplant.

24. Evaluate data and incorporate findings into long-term management plans for known sites.

Knowledge of the ecology of the Palos Verdes blue butterfly, its larval foodplant, and possible symbionts should be incorporated into management plans to improve recovery prospects.

3. Re-establish habitat and butterflies at sites of former PVBB populations.

The colony on Alta Vista Terrace was extirpated when the habitat was destroyed by a housing development. Unfortunately, insufficient acreage may remain to adequately restore the habitat on this terrace. Recovery of the Palos Verdes blue butterfly will require the restoration of former colony sites or other areas that could support the butterfly within its historic range.

31. Survey potential habitat on the Palos Verdes Peninsula and determine suitability for reintroduction.

Several large, publicly owned areas on the peninsula support the coastal sage scrub habitat. These areas are zoned "open-space recreational" by the Rancho Palos Verdes Planning Department (S. M. Lavitt, pers. comm.). Also, the habitat occurs in several privately owned areas zoned open-spaced-hazard. One or more of these sites may potentially be suitable for reestablishment of the butterfly, its larval foodplant, ants and other habitat components.

311. Alta Vista Terrace.

Because this area has been identified as a former colony site, it should receive priority for rehabilitation efforts if sufficient acreage remains to eventually support a viable colony.

312. Other sites as determined by survey.

Other sites on the peninsula that could support a Palos Verdes blue butterfly colony should be identified and their suitability as a reintroduction site examined.

32. Secure and/or protect selected habitat site(s).

Efforts should be made to protect habitat within the best potential reintroduction sites. Habitat could be secured through memoranda of understanding, leases, easements, or acquisition.

33. Rehabilitate selected coastal sage scrub habitat sites.

Sites for introduction of Palos Verdes blue butterfly may require rehabilitation. Habitat modification may be required to minimize or eliminate factors that would be detrimental to the butterfly, its larval foodplant, nectar sources, or tending ant species.

331. Remove exotic flora and fauna or other deleterious materials.

Exotic components of the community should be removed and replaced with native organisms whenever possible.

332. Introduce necessary biological components of Palos Verdes blue butterfly habitat.

When the habitat has been restored and deleterious elements identified and removed, necessary biological components of the Palos Verdes blue butterfly community should be introduced. These components shall include the butterfly, larval foodplants, nectar sources and other requisite plants, and tending ant species.

34. Obtain PVBB stock for introduction from existing colonies or through captive propagation, if necessary, and introduce into restored sites.

Because of low population numbers, it may be necessary to

artificially propagate Palos Verdes blue butterfly to obtain reintroduction stock.

35. Establish a captive breeding program, if appropriate, to provide PVBB stock for new habitat sites and to augment existing colonies.

The feasibility of using butterfly stock generated via captive breeding and plant stock grown under greenhouse conditions should be investigated for reintroduction attempts. If numbers of wild stock are sufficient, artificially propagated stock should not be used.

351. Determine need for captive breeding facility.

If wild stocks are greatly depleted, the butterfly will need to be artificially propagated. A survey will be necessary to determine if enough butterflies could be removed from existing colonies to augment numbers in remaining colonies. If enough butterflies are not available, a captive breeding program will be necessary.

352. Cultivate *Astragalus trichopodus leucopsis* for laboratory rearing of PVBB.

It will be necessary to cultivate *A. t. leucopsis* in order to provide food for larval Palos Verdes blue butterfly.

353. Create an artificial diet for efficient laboratory rearing of PVBB.

Some progress has been made in the development of an artificial diet to expedite laboratory rearing of the

butterfly (Arnold, Mattoni and Morton, unpublished data). However, major refinements are needed before the diet can be utilized for the large-scale captive breeding that will be necessary to augment existing population numbers or introduce individuals into restored sites.

354. Refine PVBB rearing techniques by using other *Glaucopsyche lygdamus* subspecies.

Because of the rarity of *G. l. palosverdesensis*, other, more widely-distributed subspecies should be utilized to refine rearing techniques.

355. Collect PVBB stock from Palos Verdes Drive East Colony to provide brood stock.

Brood stock should be genetically heterogeneous to insure optimum viability of transplant stock. The Palos Verdes Drive East colony is the only population large enough to provide brood stock.

356. Operate captive breeding facility.

After rearing techniques are refined, an artificial diet is developed, and the foodplants cultivated, operation of the captive breeding facility can begin. The decision as to whether such a facility is necessary, will be made contingent upon completion of task 351.

36. Develop and implement management plans for restored sites.

Management plans should be developed and implemented as soon as possible.

4. Determine status and success of PVBB management.

The precarious nature of the few known colonies requires continued annual monitoring to assess their status and determine the success of habitat management actions.

41. Develop suitable survey methods to estimate population numbers, distribution, and trends.

Survey techniques will need to be developed so that population estimates are as accurate as possible and so that any manipulation of individuals during the survey is not harmful to the Palos Verdes blue butterfly.

42. Survey PVBB populations and their habitats.

All colonies should be surveyed annually. Habitat status, particularly the abundance and condition of foodplants, should also be monitored annually.

5. Determine number and size of colonies necessary to reclassify PVBB to threatened status and to delist.

An attempt should be made to determine the Palos Verdes blue butterfly distribution and number of colonies necessary to reclassify the butterfly to threatened status and to delist the butterfly. Numbers and distribution should be great enough to insure the continued existence of the butterfly and not just to maintain the current status.

51. Determine factors necessary to support a viable PVBB colony.

The number of individuals and their required habitat for a viable Palos Verdes blue butterfly colony should be

determined. Models should incorporate long-term requirements of butterfly, foodplants, and ant species.

52. Determine number of colonies necessary to achieve genetic diversity and long-term survival of PVBB.

Requirements for the long-term survival of the Palos Verdes blue butterfly should be emphasized. Number and size of colonies, proximity to each other, genetic exchange among colonies, genetic diversity within colonies and within the subspecies are subjects that should receive critical examination. Electrophoretic studies may be necessary to evaluate heterogeneity of colonies and genetic exchange.

53. Reclassify PVBB when and as appropriate.

When the necessary level of population and habitat recovery has been achieved, the Palos Verdes blue butterfly can be considered for reclassification.

6. Increase public awareness of PVBB through education and information programs.

Efforts to preserve the Palos Verdes blue butterfly could be greatly facilitated by outdoor education activities which inform the public of the butterfly's endangered status. All colonies are located within the urban sprawl of Los Angeles, substantially increasing the need for developing and implementing such a program.

61. Establish information signs at Frank Hesse Memorial Park and offer interpretive tours of the site.

Interpretive tours of the Frank Hesse Memorial Park site, after it has been rehabilitated, and educational literature

would greatly enhance public awareness and appreciation for the coastal sage scrub habitat and its unique biota.

62. Prepare TV and radio spot programs.

TV and radio programs could focus the attention of the large, local human population on the Palos Verdes blue butterfly and threats from habitat alteration.

63. Prepare audio-visual program display on rehabilitation and restoration processes.

Audio-visual programs could be presented to concerned civic groups, schools, and local government organizations to encourage their concern for the butterfly and its habitat. Such programs would also be used by Service or CDFG personnel while holding public meetings in the area.

64. Prepare brochure on PVBB preservation and recovery program.

Brochures could be made available to nearby landowners, schools, service groups, local government agencies and other interested parties.

7. Utilize laws and regulations to protect PVBB.

Current numbers of the Palos Verdes blue butterfly are precariously low and all applicable laws and regulations to protect this endangered species and its habitat must be strictly enforced.

71. Enforce applicable laws, regulations and ordinances.

Provisions of the Endangered Species Act of 1973, as well as applicable State and local regulations must be strictly enforced.

72. Evaluate the need for additional laws, regulations or ordinances.

The status of the butterfly and its habitat should be periodically reviewed with the intent of identifying needed laws, regulations or ordinances.

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PART III
IMPLEMENTATION SCHEDULE

Table I, which follows, is a summary of scheduled actions and costs for the Palos Verdes blue butterfly recovery program. It is a guide to meet the objectives of the Palos Verdes Blue Butterfly Recovery Plan, as elaborated upon in Part II, the Narrative section. This table indicates the priority in scheduling tasks to meet the objectives, the agencies that are responsible to perform the tasks, a time table for accomplishing these tasks, and finally, the estimated costs to accomplish these tasks. Implementing Part III is the action of the recovery plan, that when accomplished, will bring about the recovery of this Endangered species.

GENERAL CATEGORIES FOR IMPLEMENTATION SCHEDULES

Information Gathering - I or R (research)

1. Population status
2. Habitat status
3. Habitat requirements
4. Management techniques
5. Taxonomic studies
6. Demographic studies
7. Propagation
8. Migration
9. Predation
10. Competition
11. Disease
12. Environmental contaminant
13. Reintroduction
14. Other information

Acquisition - A

1. Lease
2. Easement
3. Management agreement
4. Exchange
5. Withdrawal
6. Fee title
7. Other

Management - M

1. Propagation
2. Reintroduction
3. Habitat maintenance and manipulation
4. Predator and competitor control
5. Depredation control
6. Disease control
7. Other management

Other - O

1. Information and education
2. Law enforcement
3. Regulations
4. Administration

RECOVERY ACTION PRIORITIES

- Priority 1. An action that must be taken to prevent extinction or to prevent extinction or to prevent the species from declining irreversibly.
- Priority 2. An action that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction.
- Priority 3. All other action necessary to provide for full recovery of the species.

Implementation Schedule - Palos Verdes Blue Butterfly

Table I. Summary of Scheduled Actions and Costs - Palos Verdes Blue Butterfly Recovery Program

General Category	Plan Task	Task Number	Priority	Duration, ¹ (Yrs.)	Responsible Agency ²		Estimated Cost (\$1,000)	Comments
					FWS Region	Other Agency		
HABITAT PRESERVATION								
A3	Preserve Frank Hesse Memorial Park (FHMP) Colony	11	1	1	1	*SE	3 0 0 0	
							RPV fire district	
A3	Preserve Agua Armaga Canyon (AAC) Colony	12	1	1	1	*SE	3 0 0 0	
							RPV PVE	
A3	Preserve Palos Verdes Drive East (PVDE) Colony	13	1	1	1	*SE	3 0 0 0	
							RPV fire district private land- owners	
A3	Preserve Crest Road Colony	14	1	1	1	*SE	0 10 0 0	
							RPV fire district private land- owners	

General Category	Plan Task	Task Number	Priority	Duration ¹ of Task (Yrs.)	Responsible Agency ²		Estimated Cost (\$1,000)			Comments				
					FNS	Other Agency	FY 1	FY 2	FY 3					
A3	Preserve Portuguese Canyon Colony	15	1	1	1	*SE	RPV fire district private land-owners	0	10	0	0	0		
A3	Preserve Phantom Drive Colony	16	1	1	1	*SE	RPV fire district private land-owners	0	10	0	0	0		
A3	Preserve San Pedro Hill Colony	17	1	1	1	*SE	USAF fire district	0.5	0	0	0	0		
R1	Survey additional sites on Palos Verdes Peninsula for presence of <u>Astragalus</u> and PVBB populations	18	2	2	1	*SE	PVE RPV CCC2 USAF CDFG	0	3	2	1	1	1	
BASIC RESEARCH														
R13	Determine propagation techniques for laurel foodplants	2121	2	1	1	*SE	CDFG	0	0	0	2	2		
R3	Conduct additional research on PVBB autecology	22	1	4	1	*SE	CDFG	7.5	6	6	6	6		

General Category	Plan Task	Task Number	Priority	Duration of Task (Yrs.)	Responsible Agency		Estimated Cost (\$1,000)			Comments	
					FWS	Other Agency	FY 1	FY 2	FY 3		
R3	Conduct autecological research on bionomics of <u>A. l. Leucopis</u>	23	1	3	1	*SE	CDPFG	2	3	2	
R1	Develop suitable survey methods to estimate population numbers, distribution, and trends	41	1	1	1	*SE	CDPFG	5	0	0	
R6	Determine number and size of colonies necessary to reclassify PVBB to Threatened status and to delist	5	3	2	1	*SE	CDPFG	0	0	3	
REESTABLISH POPULATIONS											
R1	Survey potential habitat on the Palos Verdes Peninsula and determine suitability for reintroduction	31	3	2	1	*SE	PVE RPV CCC2 USAF CDPFG	0 0 0 0 0	1 1 1 1 1	1 1 1 1 1	
A7	Secure and/or protect selected habitat site(s)	32	3	3	1	*SE	CDPFG RPV PVE, CCC1 CCC2, USAF	To Be Determined			
M3	Rehabilitate selected coastal sage scrub habitat sites	33	3	2	1	*SE	CDPFG	Task to begin in FY4 or FY5.			
M2	Obtain PVBB stock for introduction from existing colonies or through captive propagation, if necessary, and introduce into rehabilitated sites	34	3	1			CDPFG	Task to begin in FY5 or FY6.			

General Category	Plan Task	Task Number	Priority	Duration ¹ of Task (Yrs.)	Responsible Agency ²		Estimated Cost (\$1,000)			Comments	
					Region	FWS Program	Other Agency	FY 1	FY 2		FY 3
R7	Establish a captive breeding program, if appropriate, to provide PVBB stock for new habitat sites and augment existing colonies	35	3	3	1	SE	*CDFG	0	1	0	
R1	Determine need for captive breeding facility	351	3	1	1	SE	*CDFG	0	1	0	
M7	Develop and implement management plans for restored sites	36	3	Continuous	1	SE	*CDFG	0	1	0	
MANAGEMENT											
M3	Remove undesirable exotic plants from PVBB habitats	211	2	1	1	SE	*CDFG PVE	0 0	1 1	0 0	
R4	Determine the most ecologically compatible and cost-effective techniques for habitat improvement	2122	2	1	1	SE	*CDFG CCCI CCC2	0 0 0	1 1 1	0 0 0	
M3	Determine physical and climatic factors of habitat sites and relate to improvement actions	213	2	1	1	SE	*CDFG	0	1	0	

General Category	Plan Task	Task Number	Priority	Duration ₁ of Task (Yrs.)	Responsible Agency ₂		Estimated Cost (\$1,000)			Comments
					FMS	Other Agency	FY 1	FY 2	FY 3	
M7	Evaluate data and incorporate into long-term management plans	24	2	Continuous	1	*SE	0	1	1	
							0	1	1	
II	Survey PVBB populations and their habitats	42	1	Continuous	1	*SE	0	1	1	
EDUCATION										
01	Increase public awareness of PVBB through education and information programs	6	2	3	1		0	2	2	
							0	2	2	
							0	2	2	
							0	1	1	
							0	1	1	
LAW ENFORCEMENT										
02	Utilize laws and regulations to protect PVBB	7	1	1	1	*LE	0.5	1.5	1.5	
							0.5	0.5	0.5	

* Indicates agency with lead responsibility
 1 Continuous - Once funded, tasks will continue from year to year
 2 PVBB - Palos Verdes Blue Butterfly
 CCC1 - California Coastal Commission
 CCC2 - California Coastal Conservancy
 CDFG - California Department of Fish and Game
 CR - Crest Road
 FHP - Frank Hess Memorial Park
 PVDE - Palos Verdes Drive East

PVE - Palos Verdes Estates
 PD - Phantom Drive
 PC - Portuguese Canyon
 RPV - Rancho Palos Verdes
 USAR - U.S. Air Force
 SE - U.S. Fish and Wildlife Service (Endangered Species)
 LE - U.S. Fish and Wildlife Service (Law Enforcement)

AGENCIES FROM WHOM COMMENTS WERE REQUESTED

California Department of Fish and Game - Sacramento, California
California Department of Parks and Recreation - Sacramento, California
California Coastal Commission - Long Beach, California
California Coastal Conservancy - Oakland, California
Office of Coastal Conservancy - Oakland, California
Office of City Manager - Rancho Palos Verdes, California
U. S. Air Force - Rancho Palos Verdes, California
U. S. Fish and Wildlife Service - Washington D.C.; Portland, Oregon