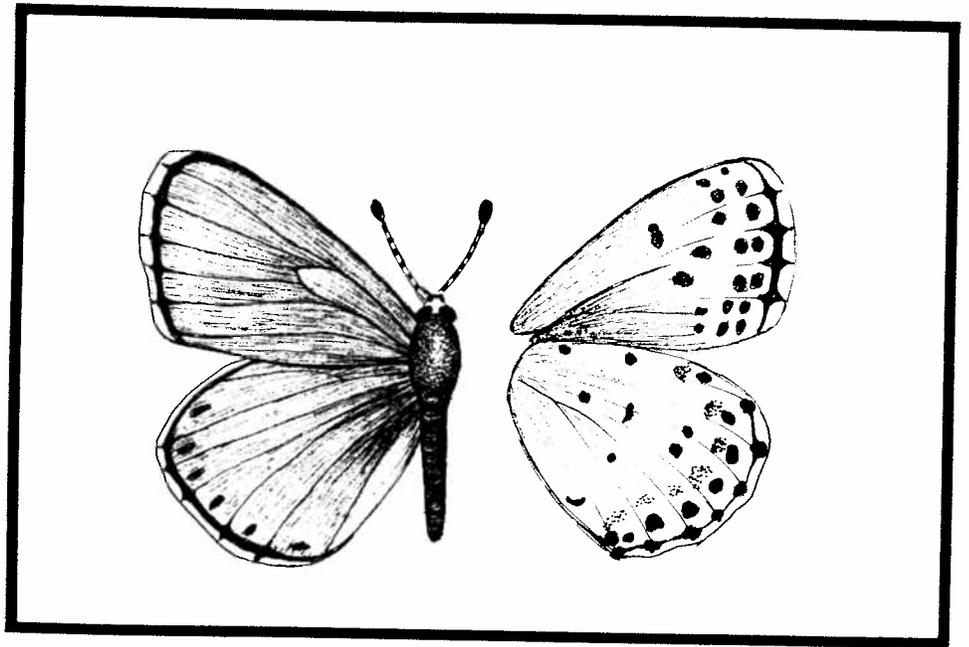


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LOTUS BLUE BUTTERFLY RECOVERY PLAN



**U.S. Fish & Wildlife Service
Portland, Oregon**

LOTIS BLUE BUTTERFLY
RECOVERY PLAN

U.S. Fish and Wildlife Service
Endangered Species Program
Portland, Oregon

Approved: *Daniel L. McMull*
Regional Director, U.S. Fish and Wildlife Service

12/26/85
Date

THIS IS THE COMPLETED LOTIS BLUE BUTTERFLY RECOVERY PLAN. IT HAS BEEN APPROVED BY THE U.S. FISH AND WILDLIFE SERVICE. IT DOES NOT NECESSARILY REPRESENT OFFICIAL POSITIONS OR APPROVALS OF COOPERATING AGENCIES, AND IT DOES NOT NECESSARILY REPRESENT THE VIEWS OF ALL INDIVIDUALS WHO PLAYED THE KEY ROLE IN PREPARING THIS PLAN. IT HAS BEEN PREPARED UNDER CONTRACT BY DR. RICHARD A. ARNOLD, DEPARTMENT OF ENTOMOLOGY, UNIVERSITY OF CALIFORNIA, BERKELEY, IN COOPERATION WITH THE U.S. FISH AND WILDLIFE SERVICE, SACRAMENTO ENDANGERED SPECIES OFFICE, TO DELINEATE REASONABLE ACTIONS THAT ARE BELIEVED REQUIRED TO PLACE THIS BUTTERFLY IN THE BEST POSSIBLE POSITION. THIS PLAN IS SUBJECT TO MODIFICATION AS DICTATED BY NEW FINDINGS AND CHANGES IN SPECIES STATUS AND COMPLETION OF TASKS DESCRIBED IN THE PLAN. GOALS AND OBJECTIVES WILL BE ATTAINED AND FUNDS EXPENDED CONTINGENT UPON APPROPRIATIONS, PRIORITIES AND OTHER BUDGETING CONSTRAINTS.

LITERATURE CITATION SHOULD READ AS FOLLOWS:

U.S. Fish and Wildlife Service. 1985. Recovery Plan for the Lotis Blue Butterfly. U.S. Fish and Wildlife Service, Portland, Oregon. 46 pp.

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Fish and Wildlife Reference Service
Informatics General Corporation
6011 Executive Boulevard
Rockville, Maryland 20852
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In Maryland: (301) 770-3000

Executive Summary

1. Point or condition when species can be considered recovered.
Presently, there is too little information to determine at what point the Lotis blue butterfly will be considered recovered. The interim recovery goal will be obtained when the single known colony is protected and three new, viable, self-sustaining populations, each on at least 2 hectares of suitable habitat, are established and protected.

2. What must be done to reach recovery?
Preserve and protect the known Lotis blue butterfly population, develop and implement management strategies, establish three new self-sustaining, viable populations each on at least 2 hectares of suitable habitat, develop public awareness of Lotis blue butterfly, and enforce laws to protect Lotis blue butterfly and habitat.

3. What specifically must be done to meet the needs of #2?
 - A. Preserve approximately 2 hectares of known habitat site from land use changes and minimize impacts from herbicides and insecticides.
 - B. Preserve hydrologic and biologic (hostplants) resources for the species.
 - C. Select, secure and rehabilitate additional habitat sites by conducting surveys for additional habitat and host plants, protecting these sites, and implementing rehabilitation efforts.

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

Proper management and protection should be continued, translocation sites monitored and yearly population monitoring should take place. Public education and law enforcement efforts should be continued.

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Lotis Blue Butterfly Recovery Plan

Part I

Introduction

Brief Overview

The lotis blue butterfly [Lycaeides argyrognomon lotis (Lintner)] (Lepidoptera: Lycaenidae), may be the rarest resident butterfly in the continental United States. It is now known from only one locality, a sphagnum bog in Mendocino County, California. During 1977-1981, only 16 adult specimens were seen in 42 days of field searching at the 2 hectare site (Arnold 1978, 1980, 1981a, and unpubl. data). This site represents the only known occupied habitat. The U.S. Fish and Wildlife Service (USFWS) listed the lotis blue butterfly as an endangered species in 1976 (41 Federal Register 22041). Its survival is threatened largely by biological and climatic factors rather than primarily by actions of man. However land use changes have the potential to destroy known habitat and potential sites.

One purpose of the Endangered Species Act of 1973, as amended, is "to provide means whereby the ecosystems upon which endangered species and threatened species depend may be conserved." This recovery plan

presents information on the lotis blue butterfly's current and former distribution, and speculates (because of limited information) on its life history and requirements for survival. Characteristics of its known habitat are described. Additional research activities are proposed to provide insight for management and recovery of this endangered species and its habitat.

Taxonomy

Lycaeides argyrognomon lotis (Lintner) is one of 12 subspecies described from North America (dos Passos 1964, Downey 1975). The type locality is Mendocino County, California (Lintner 1876).

The lotis blue butterfly is morphologically distinguished from other races of the widely distributed species, Lycaeides argyrognomon, by its size, wing color and maculation pattern. The lotis blue butterfly exhibits one of the largest wingspans of any Nearctic (New World Arctic) race of L. argyrognomon. Wingspan averages slightly less than 2.5 cm, with a range of about 1.5 to 3.2 cm. The upper wing surfaces are a deep violet-blue in the male with a crenulate black border and fringe of white scales along the outer wing margin (termen). In the female, the upper wing surface is brown, sometimes bluish-brown, with a wavy band of orange across the subtermen of the fore- and hindwings. An inconspicuous black crenulate band and fringe of white (frequently brown-white) scales lie along the termen. Ventral facies in both sexes are characterized by a grayish ground color with scattered black spots in the distal, subterminal and terminal areas. Light blue-green

scales may be present basally. A wavy band of orange spots borders the termen of the hindwings in between two rows of sinuous black lines. Illustrations may be found in Nabokov (1949), Tilden (1965), and Howe (1975).

Downey (1975) noted wide intra- and inter-populational variation in these morphological characteristics. Even though only 16 specimens of L. a. lotis were observed during field work in 1977-1981, considerable morphological variation was noted (Arnold, pers. observ.).

Habitat Requirements

Habitat requirements of the lotis blue butterfly are poorly known. Other races of L. argyrognomon utilize several legumes and larval foodplants (Table 1). J. Emmel¹ (pers. comm.) suspects that L. a. lotis may use either coast trefoil (Lotus formosissimus) or Bolander's sweet pea (Lathyrus vestitus subsp. bolanderi) as larval foodplants. In 1970 he observed a female in oviposition behavior on Lotus formosissimus. Although most adults were observed in the bog, a few of the 16 adults seen by Arnold since 1977 were found along California Highway 1 in association with a small patch of coast trefoil less than 5 meters in diameter. Only a few specimens of the Lotus were found in the bog itself, but about 10 patches of it grow around the border of the bog. These patches vary in size from less than 1 m to 5 m in

¹ Dr. John F. Emmel, Hemet, CA.

Table 1
 Suspected food plants of several
races of Lycaeides argyrognomon

<u>Race</u>	<u>Foodplants</u>	<u>Source</u>
<u>anna</u>	<u>Lupinus polyphyllus</u>	C. Kellner (pers. comm.)
	<u>Astragalus whitneyi</u>	" "
	<u>Lotus oblongifolius</u>	" "
<u>empetri</u>	<u>Empetrum nigrum</u>	Downey 1975
	<u>Ledum palustre</u>	"
	<u>Kalmia polifolia</u>	"
<u>lotis</u>	<u>Lotus formosissimus</u>	J. F. Emmel (pers. comm.) R. A. Arnold (pers. observ.)
<u>ricei</u>	<u>Lupinus sp.</u>	Downey 1975
	<u>Lathyrus torreyi</u>	"
	<u>Vicia exigua</u>	"
	<u>Lotus sp.</u>	J. F. Emmel (pers. comm.)
<u>sublivens</u>	<u>Lupinus parviflorus</u>	Downey 1975

diameter. No specimens of Bolander's sweet pea were noted in the bog. Deerweed (Lotus scoparius) was also found on drier ground adjacent to the bog site. However, no adults of the lotis blue butterfly were found in association with either the deerweed or the sweet pea. Rice's blue butterfly [Lycaeides argyrognomon ricei (Cross)] in northern California and the Anna blue butterfly [Lycaeides argyrognomon anna (W. F. Edwards)] use other Lotus species as their larval food-plants (J. Emmel and C. Kellner¹, per. comm). Lycaeides a. ricei is found in boggy meadows similar to L. a. lotis. Thus while the larval foodplant of L. a. lotis has not been positively identified, Lotus formosissimus is the primary candidate.

Habitat Description

Historically, the lotis blue butterfly has been found in wet meadows and sphagnum-willow bogs (Tilden 1965). Today the lotis blue butterfly is known only from a sphagnum bog in the Pygmy Forest, Mendocino County, California. The bog is surrounded by a closed-cone pine forest, dominated primarily by Bishop pine (Pinus muricata) with an ericaceous (Arctostaphylos, Kalmia, Gaultheria, etc.) understory. It is bisected by a Pacific Gas and Electric Company powerline right-of-way. Other tree species that occur sporadically in the overstory

¹ Mr. Clinton Kellner, Department of Zoology, University of California, Davis.

include pygmy cypress (Cupressus pygmaea) and grand fir (Abies grandis). Both species are dominant in the coastal coniferous forests of Washington and Oregon, but reach the southern limits of their distribution in Mendocino County (Munz and Keck 1968). Two other major associates in the Pygmy Forest vegetation, beach pine (Pinus contorta var. bolanderi) and Ft. Bragg manzanita (Arctostaphylos nummularia), also grow at the site.

A very dense shrub layer is present throughout the site. Dominant species in this layer include California huckleberry (Vaccinium ovatum), western Labrador tea (Ledum glandulosum), salal (Gaultheria shallon), wax myrtle (Myrica californica), California rose-bay (Rhododendron macrophyllum), western hemlock (Tsuga heterophylla) and Sitka spruce (Picea sitchensis). Other species at the site include sphagnum, sundew (Drosera rotundifolia), deer fern (Blechnum spicant), horsetail (Equisetum sp.), and sedge (Carex sp.).

One of the sedges, Carex californica, is categorized as a Very Rare and Endangered plant by the California Native Plant Society (CNPS). Two other CNPS Rare and Endangered plant species, bellflower (Campanula californica) and coast lily (Lilium maritimum), may occur at the site because both are known from freshwater swamps and bogs near the town of Mendocino (Smith et al. 1980).

The bog portion of the forest has poor drainage and deep deposits of peat. This area is characterized by waterlogged and highly acidic soils. Flowing or standing water accumulating on the soil surface

is stained dark brown with the tannins leached from the peat.

Soils at the site are formed on Pleistocene beach deposits and belong to the Noyo series. Underlying these deposits at a depth of about 30 meters is the Franciscan Formation, consisting of graywacke sandstone. These beach deposits lay on a series of five elevated marine terraces, each about 100,000 years older than the lower adjacent one. The water table is frequently within 1 to 2 m of the surface (Barbour and Major 1977).

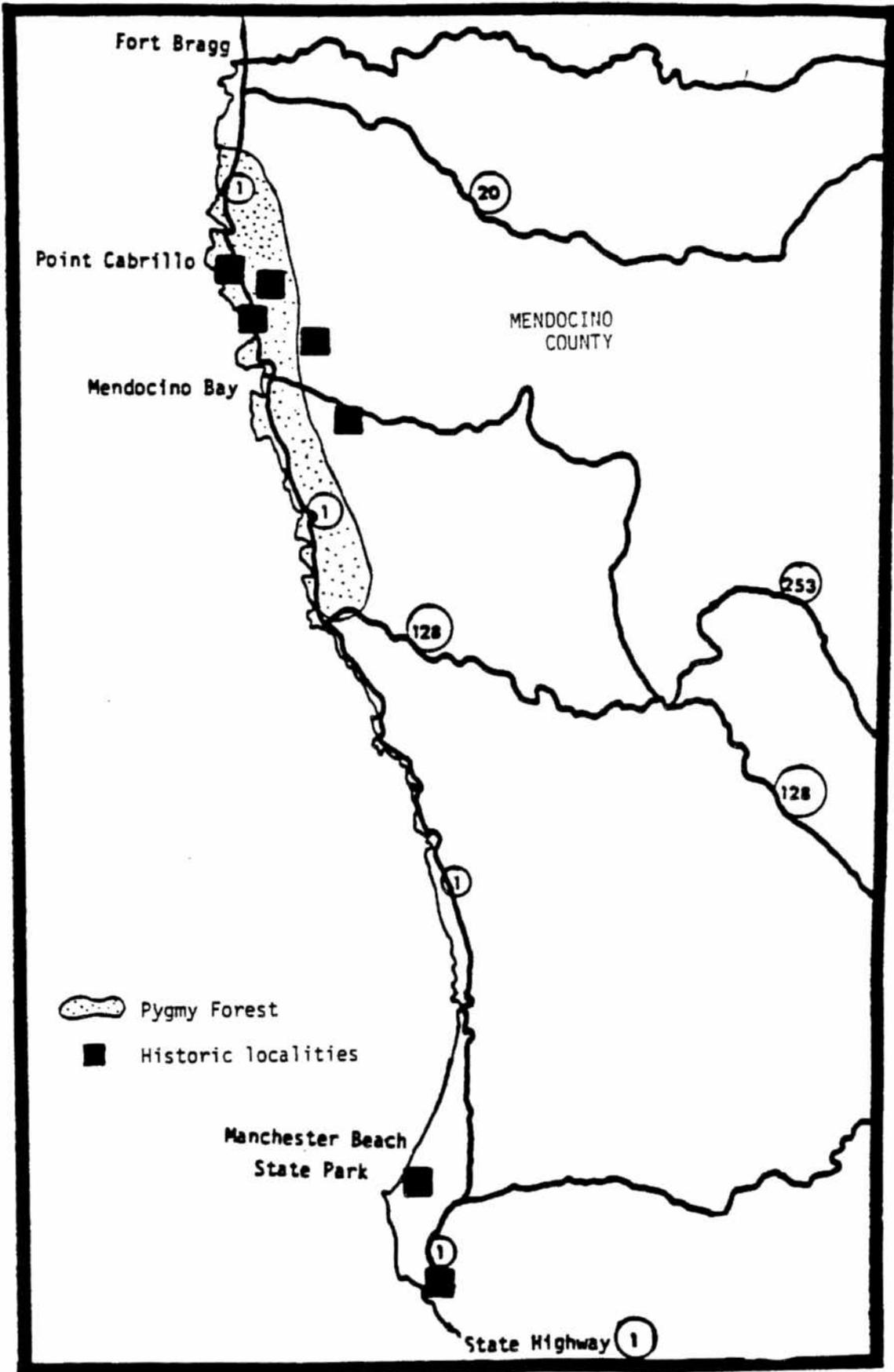
Past and Present Distribution

Historically, the lotis blue butterfly has been found at several coastal localities (Figure 1) in Mendocino, northern Sonoma and possibly northern Marin Counties (Tilden 1965; J. Helfer¹, pers. comm.). Unfortunately, museum records generally do not indicate precise enough data to accurately locate these additional sites. No records for Sonoma County were noted in collections at the Essig Museum of Entomology (University of California, Berkeley), California Academy of Sciences, Los Angeles County Museum, nor in the personal collection of Dr. John Emmel.

Since 1977, the lotis blue butterfly has been known from one area about 4.3 kilometers north of the town of Mendocino, Mendocino County, California. Arnold (1978, 1980) searched several other wet

¹ Mr. Jacques Helfer, Naturalist, Mendocino County.

Figure 1. Historic Collection of Lotis Blue Butterfly.



areas on California State Park lands, lands near Jackson State Forest and private lands in coastal Mendocino and Sonoma Counties but did not locate additional colonies of the butterfly. Areas examined were historical collection sites and sites that appeared to provide the habitat of the lotis blue butterfly. Many of the collection sites are either in, or on the periphery of, the Pygmy Forest. However, these and other surveyed sites lacked the assemblage of bog plants, such as sphagnum and sundew, and the probable larval foodplant, Lotus formosissimus, characteristic of its present locality. Until the larval foodplant is positively determined, it may be impractical to continue searching for additional sites.

Life History

Little is known about the life history of the lotis blue butterfly, thus information is extrapolated from closely related species. Because the larval foodplant is not confirmed, no rearings of this butterfly have been conducted. Museum records suggest that the butterfly has a protracted single generation (univoltine), with adult flight occurring from mid-April to early July. Most collection records are from mid-May to mid-June.

Other Nearctic races of L. argyrognomon are also univoltine (Downey 1975). It is generally believed that eggs are laid during the adult flight season and newly hatched larvae begin feeding immediately. The second instar larvae begin diapause (resting stage during larval development), which is broken sometime during the following spring.

Larval development is generally completed 4-6 weeks after feeding is resumed. Larvae of other Nearctic races of L. argyrognomon feed on leaves, flowers, and seed pods. The pupal stage probably lasts no more than a few weeks. The lotis blue butterfly probably undergoes a similar sequence of events. However, C. Kellner (pers. comm.) noted that L. a. anna, in the Trinity and Sierra Nevada Mountains, has an obligate egg diapause. Additional research will be necessary to deduce specific life history features of the Lotis blue butterfly.

Reasons for Decline and Threats to Survival

The lotis blue butterfly appears to be a naturally rare insect with low population densities, although this cannot be confirmed. The limited number of specimens in museum collections and personal observations by lepidopterists preclude an accurate assessment of the abundance of the lotis blue butterfly prior to its listing as an endangered species. Based on discussions with several lepidopterists who collected or observed the lotis blue butterfly prior to 1975, it is apparent that even then the butterfly occurred at a very low density. Seven specimens are the most any collector took on a single day, although another 12-15 specimens were observed on that same day (J. Emmel, pers. comm.).

The reasons this butterfly may have declined are largely speculative or limited to circumstantial evidence. Lotis blue butterfly may have declined because of natural biological factors (high larval mortality, succession of plant community, etc.). Climatic factors or a change in

land management practices since the arrival of European man to California may also have affected the butterfly. The drought during 1976-1977 caused the water table in Mendocino County to drop below its normal level (local residents, pers. comm. with Arnold¹). The sphagnum bog dried out and no specimens of the suspected larval foodplant were noted within the confines of the bog. Lotis blue butterflies were not observed that year.

Suppression of fire and other practices that cause disturbance of the forest may affect the distribution and abundance of the foodplant, and hence the abundance of the butterfly. As noted earlier, the only probable larval foodplant, which grows in limited abundance near the site, is Lotus formosissimus. This plant is more abundant along roadcuts and graded areas. Several small, scattered patches of the plant occur along forest edges, on drier sites adjacent to the bog, and in forest clearings. Since 1977, the abundance of Lotus at these localized patches has declined. This appears to be correlated with an increase in the amount of shade at the site since 1977 as a result of the growth of trees (Arnold, unpubl. obser.). The Lotus is a perennial that is a denizen of locally disturbed areas. As succession of the vegetation proceeds, this plant decreases in abundance.

¹ Dr. Richard Arnold, entomologist, University of California, Berkeley.

Logging of the forest may also affect the abundance of the foodplant and the butterfly because of changes in water relations, the building of roads, and also subsequent urbanization of logged areas. Foodplant distribution is not necessarily the key to the abundance of the Lotis blue butterfly because the butterfly has not been found in all of the areas that contain coast trefoil. Some as yet unknown interaction of the butterfly's biology with its foodplant may be more important than foodplant distribution alone in determining the distribution of the lotis blue butterfly.

The lotis blue butterfly is extremely vulnerable to further loss or alteration of its habitat because of its limited distribution and small population size. Potential threats to the Lotis blue butterfly and its habitat include logging, peat mining, powerline corridor maintenance or replacement, use of herbicides or insecticides, and impoundment or drainage of water. At present the site is in a near-natural condition but it is so small it is susceptible to even very localized disturbance. Although most of the flora consists of native species, several annual exotic grasses are abundant and may require removal as they threaten to displace native vegetation. A few exotic forbs grow at the site, but their numbers are small enough that control should consist of occasional weeding.

Collection of any life stage of the butterfly (egg, larva, pupa, adult) could be detrimental because of its limited numbers. Even after management and recovery actions are implemented, the butterfly's numbers will probably remain low and variable. For whatever reason, these butterflies are only sometimes observed.

Part II
Recovery

Objectives

Interim objectives of the lotis blue butterfly recovery plan are to 1) protect the butterfly and its habitat on the existing 2 hectare site, 2) establish three new, viable self sustaining populations of the lotis blue butterfly at sites each with at least 2 hectares of suitable habitat, and 3) determine the extent of the population and size of the secure habitats necessary before the species can be considered for reclassification to threatened status and eventual delisting. There is insufficient information on the life history, distribution and habitat requirements of the lotis blue butterfly. A primary requirement of this recovery plan is to gain sufficient information concerning the butterfly's population biology, habitat requirements, and distribution to define management needs and the direction that recovery efforts should take. The information acquired will be necessary for determining the numbers and distribution necessary to more clearly define reclassification and delisting criteria.

Meeting all the objectives of the recovery plan will be extremely difficult because this butterfly is so scarce. Presently, there is too little information to determine at what point the lotis blue butterfly will be considered recovered and, hence, qualified for

delisting. The restricted current range of the lotis blue butterfly suggests that extinction may always be a threat.

At present, recovery actions for the lotis blue butterfly must contend with three major problems: 1) the butterfly's extremely limited distribution and low abundance, 2) inadequate knowledge of its autecology, and 3) an incomplete understanding of factors that led to its decline. These problems make the butterfly vulnerable to extinction through chance environmental events despite timely implementation of recovery and management activities. This recovery plan emphasizes protection of the only known habitat in conjunction with basic ecological research designed to improve our understanding of the population biology and habitat requirements of the lotis blue butterfly.

Step-down Outline

The interim objectives of this recovery plan are to 1) protect the lotis blue butterfly (LBB) and its habitat on existing habitat of about 2 hectares; 2) establish three new, viable, self-sustaining populations each on at least 2 hectares of suitable habitat; and 3) determine the population size and size of secure habitats necessary for reclassification to threatened status and eventual delisting.

1. Preserve and protect the known lotis blue butterfly populations and any newly discovered and/or reestablished sites.
 11. Conduct vegetation studies at colony site(s) to identify other management needs.
 111. Investigate synecology of wet meadows, bog, and forest.
 112. Investigate autecology of larval and adult foodplants, once these are identified.
 113. Identify vegetation management needs.
 12. Maintain resources for larvae and adults at the site(s).
 121. Minimize use of insecticides and herbicides.
 122. Minimize other activities that are incompatible with vegetation and habitat maintenance and management.
 13. Develop and implement management strategies, and revise as necessary.

14. Survey known LBB colony(ies) habitat annually to determine population status, and revise management strategies accordingly.
 141. Study other Lycaeides argyrognomon races to develop and test monitoring methods for LBB.
 142. Survey known habitat annually.
 15. Survey additional sites within the historical range of the LBB for presence of potential larval foodplants, habitat, and LBB populations.
2. Establish three new, self-sustaining, viable populations each on at least 2 hectares of suitable, secure habitat.
21. Select habitat sites.
 22. Secure habitat sites.
 23. Rehabilitate selected, secure habitat sites.
 231. Remove exotic flora and fauna.
 232. If needed, reintroduce necessary biological components of lotis blue butterfly habitat as identified by ecological studies.
 24. Provide LBB stock for reintroduction to selected sites.
 241. Obtain LBB from the existing colony for direct reintroduction and/or to serve as broodstock.
 242. Furnish LBB stock via captive breeding program (if necessary).

2421. Determine the necessity and feasibility of captive propagation.
 2422. Rear individuals of surrogate Lycaeides argyrognomon subspecies to refine rearing techniques before LBB captive breeding is attempted.
 2423. Devise an artificial diet for efficient lab rearing of LBB.
 2424. Rear the LBB from eggs laid by stock captured at the known colony.
-
25. Transplant individuals of surrogate L. argyrognomon subspecies to refine techniques for establishing new butterfly populations.
 26. Reintroduce LBB into secure habitat.
-
3. Conduct ecological studies to develop additional management recommendations and to determine criteria for reclassification and delisting.
 31. Determine larval and adult host plants and assess status.
 32. Describe LBB's egg, larval, pupal morphology, and physiological requirements.
 33. Describe the life table, sex ratio, and population size of the known LBB colony and any new sites.
 34. Identify predators, parasitoids, and larval symbionts.
 35. Describe adult behavior, mating, foraging, oviposition, etc.
 36. Determine habitat requirements and utilization.
 37. Decide if more populations are necessary for recovery.

4. Develop public awareness of LBB.
 41. Provide audio-visual programs for public display.
 42. Erect interpretive signs on state park lands.

5. Utilize existing laws and regulations protecting the LBB.
 51. Enforce land use plans and ordinances to protect LBB habitat.
 52. Monitor agency compliance with Section 7 of the Endangered Species Act, as amended, concerning the lotis blue butterfly.
 53. Enforce all laws prohibiting the take of the lotis blue butterfly.
 531. Enforce state and Federal laws.
 532. Evaluate success of law enforcement.
 533. Propose appropriate new regulations or revisions.

Narrative

1. Preserve and protect the known lotis blue butterfly population and newly discovered and/or established sites.

The lotis blue butterfly is now known from only one site.

The Service should investigate the feasibility of an agreement with the landowner of the lotis blue butterfly's habitat and the owners of the adjacent lands to insure the preservation of lotis blue butterfly's habitat. A Land Protection Plan should be developed to investigate all options to protect habitat within the historic range.

Coordination with local governments, including California Coastal Commission and nearby land owners, will be necessary to insure preservation of the site. Any changes in land use practices at the site should be deferred until foodplants and habitat requirements are identified and are better understood.

Preservation and protection of the lotis blue butterfly site include maintenance of the vegetation at the site, prevention of land use changes and minimizing the use of herbicides and insecticides on or within drift distance of the site. It is absolutely vital to the success of this recovery plan that the only known habitat for LBB be preserved.

11. Conduct vegetation studies at colony site to identify other management needs.

Once the larval host plant is identified, an analysis is needed to determine the successional stage in the plant community that is most beneficial to the butterfly. This will determine the type of management needs and activities that are appropriate.

111. Investigate synecology of wet meadows, bog, and forest .

Determination of the time scale of the successional sequence from bog to wet meadow to forest is necessary for long-term management.

112. Investigate autecology of larval and adult foodplants, once these are identified.

This information is needed to manage these plants and also to augment populations of these plants on the site, if necessary.

113. Identify vegetation management needs.

Utilizing the ecological information concerning the interactions of plants and the insect, a vegetation management program should should be developed. The major focus of the management program should be to provide habitat for the butterfly on a continuing basis.

12. Maintain resources for larvae and adults at the site.

Possible host and nectar plants that may be utilized by the butterfly should be maintained at the site. This would

preclude land use changes and non-specific use of herbicides and insecticides nearby.

121. Minimize use of insecticides and herbicides .

The aerial, non-specific applications of herbicides and insecticides pose a great threat to the Lotis blue butterfly. Drift from this kind of application has the potential to cause the extinction of this particular subspecies. If the application of a pesticide nearby is absolutely necessary, then it should be done by hand on specific targets. Pacific Gas and Electric (PG&E), which owns a right-of-way through the habitat, will be a key participant in this task. Coordination among PG&E, FWS and the landowners will be important.

122. Minimize other activities that are incompatible with vegetation and habitat maintenance and management.

Other activities which may severely affect the maintenance of the habitat include overdraft of the aquifer and "brushing" or fire control activities which may remove or disturb the host plant. These should be minimized as much as possible. Again PG&E will be a key participant and inter-party coordination will be vital to the success of this task.

13. Develop and implement management strategies, and revise as necessary.

Once sufficient biological information is gathered it will be possible to make an appraisal of more specific recovery activities needed. At this stage management strategies utilizing the pertinent information should be developed and subsequently implemented. Assessment and revision of management strategies must necessarily be a continual process as new information is gathered on this species. As management strategies are developed for individual areas and/or colonies they should be expeditiously implemented to conserve and properly manage essential habitat.

14. Survey known LBB colony(ies) habitat annually to determine population status, and revise management strategies accordingly.

The precarious nature of the only known lotis blue butterfly colony requires continued monitoring to assess its status. As management actions are implemented, periodic monitoring should be undertaken to determine the success of these activities. It would be advisable to study other subspecies of Lycaeides argyrognomon, that inhabit wet meadows or bogs, to develop and refine monitoring techniques for the lotis blue butterfly.

141. Study other *Lycaeides argyrognomon* races to develop and test monitoring methods for LBB.

Because the lotis blue butterfly occurs in such low numbers, significant survey methods are difficult to design. An appropriate survey method is needed that will indicate population distribution and trends. Such a method should be developed and tested using other races of *Lycaeides argyrognomon*.

142. Survey known habitat annually.

An annual survey of the known habitat is needed to determine the status of the butterfly and to determine the priority of actions necessary to protect and recover the subspecies.

15. Survey additional sites within the historical range of the lotis blue butterfly for presence of potential larval foodplants, habitat and LBB populations.

Infrared and conventional aerial photography are useful in identifying wet meadow and boggy habitat sites. These could then be examined by ground surveys to verify presence/absence of the butterfly or its larval and adult foodplants. Herbaria records of the three potential larval foodplants (*Lotus formosissimus*, *L. scoparius*, and *Lathyrus vestitus*) have been collated from University of California (including the Jepson Herbarium), California Academy of Sciences, and Los Angeles County Museum of Natural History. Other institutions

also should be consulted for records of these plants within the historical range of the lotis blue butterfly. The new sites should be visited during the flight season of the butterfly. Additional surveys of suitable habitat should be conducted at Point Arena, Pygmy Forest, Russian Gulch State Park, Van Damme State Park, Big River, and Big Lagoon. These sites represent historic collection localities and suitable or potentially suitable habitat locations within the estimated range of the species.

2. Establish three new, self-sustaining, viable populations each on at least 2 hectares of suitable, secure habitat.

Several localities along the Mendocino coastline resemble the habitat at the known colony site and could serve as sites for the reintroduction of the lotis blue butterfly. These areas are near historical collection sites of the lotis blue butterfly and are within its historical range. Sites will undoubtedly be small and may be on public or private lands. Agreements with owners should be developed to implement this task.

21. Select habitat sites.

Sites will be identified and described by task 15. Potential habitat areas should be selected from those sites identified in task 15 within the historic range of the species on the basis of potential for rehabilitation of the habitat and the ability to secure the site from destruction.

22. Secure habitat sites.

Once the biological and habitat requirements of the lotis blue butterfly are better known, appropriate areas that satisfy these requirements should be evaluated as butterfly habitat. Appropriate sites should be secured by agreements with property owners. The Land Protection Plan process may play a part in task completion.

23. Rehabilitate selected, secure habitat sites.

Selected sites may need to be rehabilitated before reintroduction of the butterfly can take place.

231. Remove exotic flora and fauna.

Removal of non-native flora and fauna may be necessary to provide appropriate habitat for host plants or symbiotic ant associates.

232. If needed re-introduce necessary biological components of lotis blue butterfly habitat as identified by ecological studies.

It may be necessary to re-introduce the host plant of the lotis blue butterfly, symbiotic ant species, or other biological components to the reintroduction sites to provide habitat for the butterfly.

24. Provide LBB stock for reintroduction to selected sites.

Establishing new colonies of the lotis blue butterfly will be

difficult because the species is scarce. The feasibility of two different methods of colony establishment will be examined: 1) transplanting adults from the extant site to new colony areas, 2) establishing a laboratory colony (captive breeding) of the lotis blue butterfly to provide stock for release to the new colony sites. This includes releasing adults that are reared from eggs laid by females captured from the existing colony. The use of surrogate species to develop rearing techniques will be considered prior to implementing this task.

241. Obtain LBB from the existing colony for direct reintroduction and/or to serve as brood stock.

Transplanting adult lotis blue butterflies from the extant site to new colony areas is feasible if the size of the population is large enough to support such an enterprise. Critical evaluation of the ability of the existing population to sustain such removal will be made. Transplanting adults may also be a viable alternative if the butterfly suffers a high mortality in the laboratory rearing or captive breeding programs.

242. Furnish LBB stock via captive breeding program (if necessary).

Developing a captive breeding program for the lotis blue butterfly may be difficult because lycaenid butterflies have yet to be bred in captivity. Furthermore, because

the lotis blue butterfly is univoltine, it may take many years to build up a sizeable laboratory population. Nevertheless, it may be essential that a captive breeding program be developed so that the lotis blue butterfly can be introduced into areas to form new colonies.

2421. Determine the necessity and feasibility of captive propagation.

If surveys show low population numbers and few habitats, rehabilitation of habitats may depend on captive propagation. A decision on this task should await more thorough field surveys.

2422. Rear individuals of surrogate Lycaeides argyronomon subspecies to refine rearing techniques before LBB captive breeding is attempted.

Other, more abundant races of Lycaeides argyrognomon or closely allied species should be utilized as surrogates to refine techniques of laboratory rearing and captive propagation.

2423. Devise an artificial diet for efficient lab rearing of LBB.

Rearing of herbivorous insects under laboratory conditions is facilitated by the use of artificial diets. Preliminary artificial diets have been

developed for two endangered butterflies, Palos Verdes blue (U.S. Fish and Wildlife Service 1984) and Lange's metalmark (Apodemia mormo langei) (Arnold 1981b). Refinements are necessary before these diets can be utilized for large-scale captive breeding; however, the preliminary findings are applicable to the development of an artificial diet for Lycaeides argyrognomon lotis. Growing suitable host plants in a greenhouse may be an alternative to artificial diets, should the artificial diet be unacceptable to the caterpillars.

2424. Rear the LBB from eggs laid by stock captured at the known colony.

It is possible to capture ovipositing females and rear their eggs in the laboratory. This often increases the number of adults over those that would survive to the adult stage in nature.

25. Transplant individuals of surrogate L. argyrognomon subspecies to refine techniques for establishing new butterfly populations.

Transplantation of butterfly colonies should be thoroughly studied with a surrogate subspecies of L. argyrognomon before any transplantation is attempted with lotis blue butterfly. Such experiments with transplantation only will be done within the known historical range of the surrogate subspecies and outside the known historical range of the LBB.

26. Reintroduce LBB into secure habitat.

The habitat should be prepared and secured before reintroduction of the butterfly. Close monitoring is required for any reintroduction of the butterfly.

3. Conduct ecological studies to develop additional management recommendations and to determine criteria for reclassification and delisting.

The work of Arnold (1978, 1980, 1981a) should be supplemented by additional field and laboratory studies. Continued surveys of northern Sonoma County plus southern and central Mendocino County coastal regions are necessary to establish whether or not other historic or undiscovered colonies of lotis blue butterfly still exist.

Additional autecological research is needed to discover larval and adult foodplants, describe the lotis blue butterfly's life history identify predators, parasitoids, and other mortality factors, as well as possible larval symbionts. Utilizing this information, we can begin to define recovery for this species.

Synecological studies of bog, wet meadow, and forest habitats will be needed in conjunction with autecological studies on larval and adult foodplants, once they are identified, to better understand the vegetation dynamics at these sites. Findings from these studies should be incorporated into management programs.

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Following achievement of interim objectives it will be necessary to evaluate the efficacy of those steps and determine further actions necessary for reclassification or to achieve final recovery of the LBB. It will be necessary to evaluate the health of the three new populations as well as the existing Mendocino County habitat. If it is concluded that the extant populations are not sufficient to delist the species, additional new populations may be required.

31. Determine larval and adult host plants and assess status.

Larval and adult food plants for the butterfly are as yet unknown. Their identity and status need to be determined in order that research into management of the lotis blue habitat can go forward. The number, distribution, and vigor of host plants at a habitat site is vital for maintenance of LBB. These factors must be carefully evaluated to determine the quality of the habitat.

32. Describe the LBB's egg larval, pupal morphology, and physiological requirements.

Lotis blue butterfly egg, larval and pupal morphology needs to be described. This would facilitate the study of all life stages of the animal.

33. Describe the life table, sex ratio and population size of the known LBB colony and any new sites.

The description of these parameters of the lotis blue butterfly colony will require intensive study over the summer flight

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season. This information is needed to determine when to collect ovipositing females (for captive breeding) as well as to provide a baseline of information for future monitoring purposes.

34. Identify predators, parasitoids and larval symbionts.

These ecological factors need to be identified and investigated before any management activities are undertaken. Management activities may affect size, presence and population of parasitoids and predators. If larval symbionts (most likely ants) are discovered, their requirements should also be investigated.

35. Describe adult behavior, mating, foraging, oviposition, etc.

As the result of low density of adults at the only known colony, recapture-recapture studies, which have provided valuable information on other endangered butterflies (Arnold 1980), have not been performed. Because the butterflies are so scarce, little information is available on the butterfly's habitat requirements and utilization. It would be advisable to perform capture-recapture studies on other races of Lycaeides argyrognomon and use the findings on density, vagility and population size to gain insight on the population biology of L. a. lotis. Rice's, Anna and Empetrum (L. a. empetri [Freeman]) blue butterflies are bog or wet meadow inhabitants that might serve as useful surrogates.

36. Determine habitat requirements and utilization.

Habitat requirements are known only by inference from the few

collections made at the present site and from inference from other subspecies. These requirements need to be determined for proper management to take place.

37. Decide if more populations are necessary for recovery.

Upon completion of evaluations detailed in Tasks #41-46, it must be decided whether additional new habitat sites are needed and how they can be established. The number, size and location of new recovery sites must be determined. If interim objectives appear sufficient to recover the species, recommendations will then be made regarding reclassification.

4. Develop public awareness of LBB.

Efforts to preserve the lotis blue butterfly could be greatly facilitated by gaining public support through outdoor education activities that inform the public of the butterfly's endangered status.

41. Provide audio-visual programs for public display.

Many residents and visitors to Mendocino County are greatly concerned with conservation of the area's natural resources and would welcome information on the lotis blue butterfly. Audio-visual programs could be utilized to provide information to local residents and state park visitors.

42. Erect interpretive signs on state park lands.

Three state parks lie within 30 kilometers of the only known

colony. Information signs near the bogs in these parks would inform visitors and local residents of the unique nature of the flora and fauna present in the bog/meadow habitats where the lotis blue butterfly is found.

5. Utilize existing laws and regulations protecting the LBB.

Law enforcement would be more of a monitoring of activities and implementation of land use policy on or near the site. Because of the extremely low abundance, "taking" is a potentially serious problem. Laws that protect the butterfly should be enforced to protect the continued existence of the species.

51. Enforce land use plans and ordinances to protect LBB habitat.

The cooperation of Mendocino County and the California Coastal Commission is needed to designate this area as an Environmentally Sensitive Habitat (California Coastal Act of 1976) and to protect it from destruction through unacceptable land uses.

52. Monitor agency compliance with Section 7 of the Endangered Species Act, as amended, concerning the lotis blue butterfly.

Agency compliance with Section 7 consultations is an integral part of any recovery program. Federal agencies should not only insure that their actions are not likely to jeopardize the continued existence of the butterfly, but should also contribute to the recovery of the species. Agencies should therefore be encouraged to accept conservation recommendations which are provided during consultation.

53. Enforce all laws prohibiting the take of the lotis blue butterfly.

All existing laws and regulations should be enforced for the protection of the lotis blue butterfly and its habitat. All Federal actions which fall under the purview of Section 7 of the ESA should be reviewed through consultation with the Fish and Wildlife Service. Habitat maps and regulation summaries should be distributed to all Department of Fish and Game field personnel and appropriate personnel of other agencies, so they will be aware of the lands where the lotis blue butterfly exists, and the activities which are in violation of the laws and regulations. Each county where the lotis blue butterfly exists should be notified of these laws. The laws should be reviewed and revised periodically for maximum effectiveness.

531. Enforce state and Federal laws.

All Federal and State laws pertaining to the protection and conservation of lotis blue butterfly should be used to further the recovery effort.

532. Evaluate success of law enforcement.

Additional or more extensive efforts to enforce existing laws protecting the lotis blue butterfly may be needed. Periodic evaluations will provide an assessment of needed modifications in this area.

533. Propose appropriate new regulations or revisions.

Revisions in existing regulations may be necessary to enhance conservation efforts of the lotis blue butterfly.

If revisions are not adequate to further conservation and recovery goals, new legislation may be proposed.

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Part III
Implementation Schedule

The following table is a summary of scheduled actions and estimated costs for the Lotis blue butterfly recovery program. It is a guide to meet the objectives of Lotis Blue Butterfly Recovery Plan, as elaborated in Part II. This table indicates the general category for implementation duration of the tasks, which agencies are responsible to perform the tasks, and lastly, the estimated costs to accomplish these tasks. Implementing Part III is the action of the recovery plan, that when accomplished, should bring about the recovery of this endangered species.

GENERAL CATEGORIES FOR IMPLEMENTATION SCHEDULE

Information Gathering - I or R

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

1 = An action that must be taken to prevent extinction or to prevent the species from declining irreversibly.

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.

3 = All other actions necessary to provide for full recovery of the species.

PART III
IMPLEMENTATION SCHEDULE
LOTIS BLUE BUTTERFLY RECOVERY PLAN

General Category	Plan Task	Task Number	Priority Number	Duration ¹ of Task (yrs.)	Responsible Agency		Other Agency	Estimated Costs (\$1,000)			Comments and Notes
					Region	FWS Program		FY1	FY2	FY3	
R3	Investigate synecology of wet meadows, bog & forest.	111	2	3	1	SE		3	3	3	
R3	Investigate antecology of larval & adult food plants, once these are identified.	112	2	3	1	SE		3	3	3	
M7	Identify vegetation management needs.	113	2	3	1	SE		1	1	1	
M3	Minimize use of insecticides and herbicides nearby.	121	1	Continuous	1	SE	PG&E	2	2	2	
M3	Minimize other activities that are incompatible with vegetation and habitat maintenance and management.	122	1	Continuous			CDFG* PG&E	1	1	1	
M7	Develop, implement, revise management strategies.	13	2	1	1	SE*	CDFG				
R1	Study other <u>Lycaeides argyrognomon</u> races to develop and test monitoring methods for LBB.	141	2	3	1	SE		3	3	3	
R1	Survey known and potential habitat annually.	142	1	Continuous	1	SE	CDFG*	1	1	1	

PART III
IMPLEMENTATION SCHEDULE
LOTIS BLUE BUTTERFLY RECOVERY PLAN

General Category	Task Plan	Task Number	Priority Number	Duration ¹ of Task (yrs.)	Responsible Agency		Other Agency	Estimated Costs (\$1,000)			Comments and Notes
					Region	FWS Program		FY1	FY2	FY3	
M7	Survey additional sites	15	2	Continuous	1	SE	CDFG*	3	3	3	
A3	Select habitat sites.	21	2	1		SE		2	2	2	
A3	Secure habitat sites.	22	2	2	1	SE	CDFG	To Be Determined			Will require additional effort beyond FY-3.
M3	Remove exotic flora, fauna.	231	2	Continuous	1	SE*	CDFG	1	1	1	
M3	If needed, reintroduce necessary biological components of LBB habitat as identified by ecological studies.	232	2	Continuous	1	SE*	CDFG	1	1	1	Costs and scheduling TBD following further research.
M2	Obtain LBB from existing colony for reintroduction and/or to serve for broodstock.	241	2	3	1	SE*		To Be Determined			Initiated only if determined necessary. Effort beyond FY-3 may be needed.
P7	Determine the necessity and feasibility of captive propagation.	2421	2	3	1	SE		3	3	3	

PART III
IMPLEMENTATION SCHEDULE
LOTIS BLUE BUTTERFLY RECOVERY PLAN

General Category	Task Plan	Task Number	Priority Number	Duration ¹ of Task (yrs.)	Responsible Agency		Other Agency	Estimated Costs (\$1,000)			Comments and Notes
					Region	Program		FY1	FY2	FY3	
R7	Rear individuals of surrogate <u>Lycaeides argyrognomon</u> subspecies to refine rearing techniques before LBB captive breeding is attempted.	2422	2	3	1	SE		To Be Determined			
R7	Devise an artificial diet for efficient lab rearing of LBB.	2423	2	1	1	SE		3			
R7	Rear the LBB from eggs laid by stock captured at the known colony.	2424	2	2	1	SE		To Be Determined			
R13	Transplant individuals of surrogate <u>L. argyrognomon</u> subspecies to refine techniques for establishing new butterfly populations.	25	2	3	1	SE		To Be Determined			
M5	Reintroduce LBB into secure habitat.	26	2	3	1	SE		To Be Determined			

PART III
IMPLEMENTATION SCHEDULE
LOTIS BLUE BUTTERFLY RECOVERY PLAN

General Category	Plan Task	Task Number	Priority Number	Duration ¹ of Task (yrs.)	Responsible Agency		Other Agency	Estimated Costs (\$1,000)			Comments and Notes
					Region	FWS Program		FY1	FY2	FY3	
R14	Determine larval and adult foodplants.	31	2	2	1	SE	CDFG*	3	3	3	
R14	Describe LBB's egg, larval, and pupal morphology.	32	2	2	1		CDFG	3	3	3	
R1	Describe the life table, sex ratio and population size of LBB colony.	33	2	2	1		CDFG	2	2	2	
R9	Identify predators, parasitoids and larval symbionts.	34	2	2	1		CDFG	2	2	2	
R14	Describe adult behavior, mating, oviposition, etc.	35	2	2	1		CDFG	2	2	2	
R3	Determine habitat requirements and utilization.	36	2	3	1		CDFG	2	2	2	
R14	Decide if more populations are necessary for recovery.	37	2	1	1	SE*	CDFG				2 2

PART III
IMPLEMENTATION SCHEDULE
LOTTIS BLUE BUTTERFLY RECOVERY PLAN

General Category	Task Plan	Task Number	Priority Number	Duration ¹ of Task (yrs.)	Responsible Agency		Other Agency	Estimated Costs (\$1,000)			Comments and Notes
					Region	Program		FY1	FY2	FY3	
01	Provide audio-visual programs for public display.	41	3	Continuous	1	SE		1	1	1	
01	Erect interpretive signs on state park lands.	42	3	1	1		CDPR			1	
02	Enforce land use plans and ordinances to protect LBB habitat.	51	1	Continuous	1		CDFG* Mendocino Co.	1	1	1	
02	Monitor agency compliance with Section 7 consultations concerning the Lotis blue butterfly.	52	2	Continuous	1	SE		1	1	1	
02	Enforce all laws	531	2	Ongoing	1	LE		.5	.5	.5	
02	Evaluate success of law enforcement	532	2	Continuous	1	LE		To Be Determined			

PART III
IMPLEMENTATION SCHEDULE
LOTIS BLUE BUTTERFLY RECOVERY PLAN

General Category	Task Plan	Task Number	Priority Number	Duration ¹ of Task (yrs.)	Responsible Agency		Other Agency	Estimated Costs (\$1,000)			Comments and Notes
					Region	FWS Program		FY1	FY2	FY3	
02	Propose new regulations	533	2	Continuous	1	LE					To be determined

* Lead agency

¹Ongoing = The action is now being implemented and will continue on an annual basis.
Continuous = The action will be implemented on an annual basis once the action is begun.

Abbreviations

- SE = U.S. Fish and Wildlife Service (Endangered Species)
- LE = U.S. Fish and Wildlife Service (Law Enforcement)
- CDFG = California Department of Fish and Game
- CCC = California Coastal Commission
- PG&E = Pacific Gas and Electric
- CDPR = California Department of Parks and Recreation

PART IV
Appendix

Agencies Asked for Review Comments:

Director
California Department of Fish and Game
1416 Ninth Street
Sacramento, CA 95814

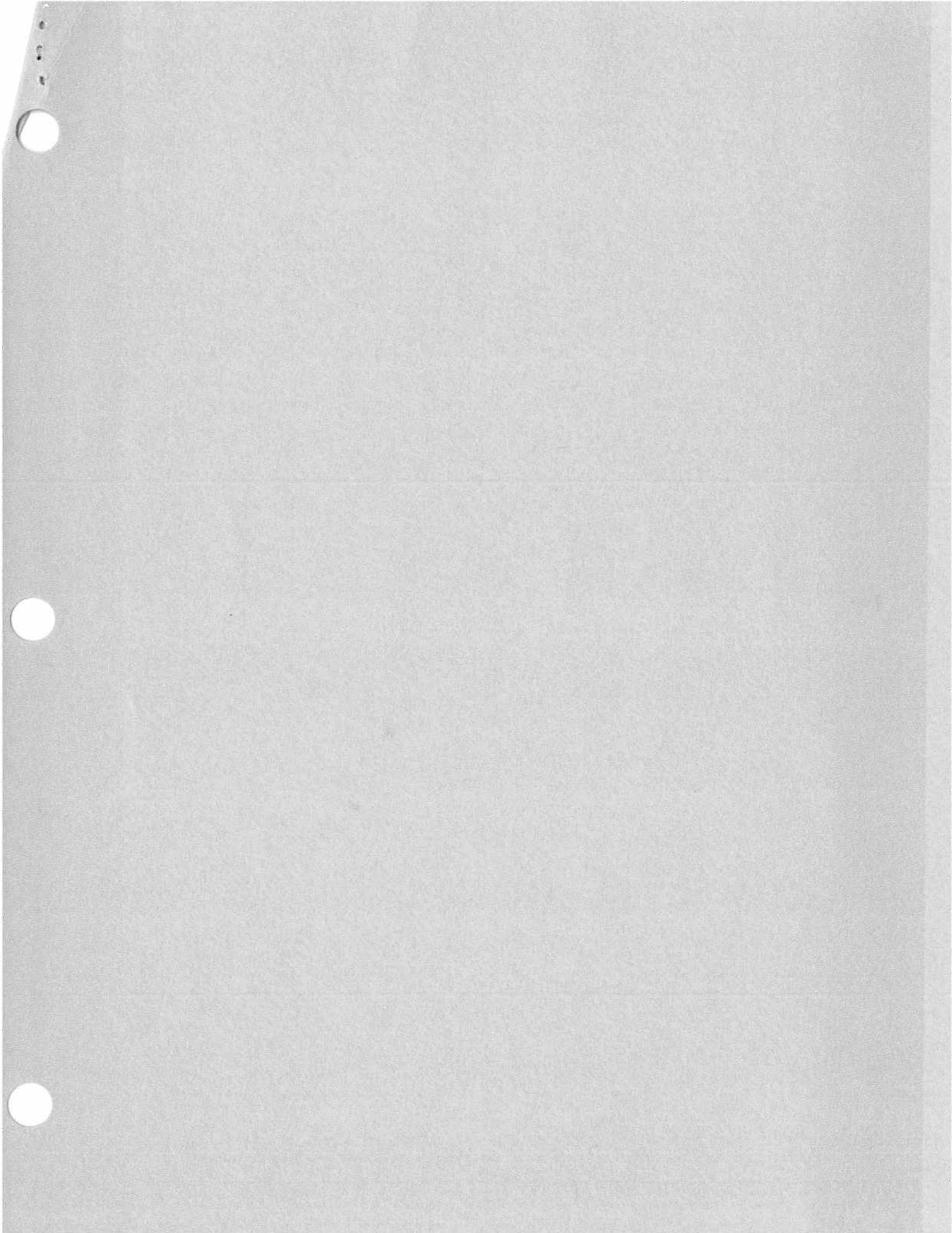
Pacific Gas and Electric
3400 Crow Canyon Road
San Ramon, CA 94583

Mr. Michael Fischer
California Coastal Commission
631 Howard Street
San Francisco, CA 94105

Mr. Dan Garvin
Mendocino County Planning Department
Courthouse
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California Department of Parks and Recreation
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Dr. Harry Ohlendorf
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