

RECOVERY PLAN FOR THREE ENDANGERED SPECIES
ENDEMIC TO ANTIOCH DUNES, CALIFORNIA:

Lange's Metalmark Butterfly, Contra Costa Wallflower,
and
Antioch Dunes Evening Primrose

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RECOVERY PLAN FOR THREE ENDANGERED SPECIES ENDEMIC TO ANTIOCH DUNES, CALIFORNIA. January 1980.

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*Langes Metalmark Butterfly Apodemia mormo langei Comstock
Contra Costa Wallflower Erysimum capitatum var. angustatum
(Greene) Rossbach
Antioch Dunes Evening Primrose Oenothera deltoides spp. howellii
(Munz) Klein

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RECOVERY PLAN FOR THREE ENDANGERED SPECIES
ENDEMIC TO ANTIOCH DUNES, CALIFORNIA

I. INTRODUCTION

Three Federally listed Endangered Species endemic to the unique California Antioch Dunes Area are the subject of this plan: Lange's metalmark butterfly (Apodemia mormo langei), Antioch Dunes evening primrose (Oenothera deltoides ssp. howellii) and ^{Contra}Costa wallflower (Erysimum capitatum var. angustatum)^{1/}. Since before 1952, habitat loss and modification have resulted in the decline of each of these species to the point of endangerment. Antioch Dunes is located on the edge of the San Joaquin River east and north of the City of Antioch in Contra Costa County, California, about 30 miles northeast of San Francisco (Figure 1).

The scientific community has expressed an interest in the Antioch Dunes area and the unique flora and fauna that occur there. While some preliminary survey work has been accomplished, specific management actions have been delayed because ownership is in the private sector. Concerted recovery efforts and management would begin with the completion of cooperative agreements and land acquisitions, as appropriate.

This recovery plan addresses the steps necessary to alleviate immediate threats to these species and their habitats and to increase their population numbers until extinction is not imminent due to chance catastrophe. This plan is based in part on currently available knowledge regarding these species and will be up-dated as information

^{1/} Note: Antioch Dunes evening primrose and Contra Costa wallflower are listed as endangered under State law by the California Department of Fish and Game.

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is obtained or generated on their life history parameters, their biological needs and their survivorship experience in managing the area.

Preservation of Antioch Dunes is secondarily desirable due to the presence of other unique flora and fauna. Antioch Dunes is the type locality for 24 insect taxa; ten of these are endemic, six are known only from other endangered habitats, and two (with wider ranges in pre-agricultural times) may now exist only at Antioch Dunes. Some species of insects originally known from Antioch have been extirpated from this site, such as Coelus gracilis, Anthicus antiochensis, Campsomeris pilipes, and C. toleca. Two additional plant taxa occurring there, Lilaeopsis masonii and Suisun aster (Aster chilensis var. lentis), have been proposed as endangered (Federal Register, June 16, 1976). Three enlisted reptile species reach their northernmost range extension in California at the Antioch Dunes (See Appendix 1).

Several decades ago the Antioch Dunes, averaging $\frac{1}{4}$ mile wide, extended three miles along the south bank of the San Joaquin River northeast of the city of Antioch and covered an area of approximately 500 acres. The remnants of these dunes that can support the unique ecosystem now cover an area of little more than 60 acres, or a loss of 88 percent of the original habitat. Heavy industrialization, housing development, sandmining, agriculture, weed abatement for fire control, powerline rights-of-way, off-road vehicles (ORV) and other recreational uses have caused severe habitat deterioration. Weedy plant species have invaded this area as it has become more disturbed. The introduced species compete with native species for available resources and reduce the potential for re-establishment of native species. Much of the dune area, except for a few small scattered pockets and crumbling

bluffs, is diluted with humus from the invading plant species. See Appendix 2 for a list of the exotic plants. The factors causing loss of habitat in the past continue to be a problem today.

The 1976 proposal for development of the dunes into an 84-acre waterfront park presented additional threats to the unique flora and fauna endemic to the Antioch Dunes. The recreational park, in part, would have resulted in human activities incompatible with a management plan for the survival of the endangered and other endemic biota. The State of California withdrew the project in March, 1979, because the City of Antioch did not, at that time, have adequate matching funds. The site had been stripped of vegetation and was, therefore, unsuitable for park use without extensive and expensive site renovation. Park plans included a boat docking facility, fish pier, swim lagoon, campground, picnic area, and natural science center. (See City of Antioch Resolution).

SPECIES INFORMATION

LANGE'S METALMARK BUTTERFLY (Apodemia mormo langei) was described in 1938 following intensive entomological studies on the Antioch Dunes initiated in 1931, and extending through that decade. Additional studies were conducted for a few years following World War II. The majority of data available on the biology of this species are those of Powell and Arnold (1977) and Arnold (1978). These unpublished manuscripts are the major sources of data on this taxon used in the preparation of this recovery plan.

Status and Distribution

Lange's metalmark butterfly was listed as an endangered species by the Fish and Wildlife Service (FWS) in the June 1, 1976 Federal Register.

Critical habitat was proposed in the February 2, 1977 Federal Register. The actual natural acreage has been reduced to approximately 15 acres. Only two remnant sand dunes within this area are known as sites for this butterfly.

Powell and Arnold (1977) estimate each of the two butterfly populations to contain between 150-200 individuals. Densities are reported from a 1977 study as 26.4 males/ha and 15.0 females/ha. Females survive nine days or less; males are shorter lived than females (FWS 1978). A lack of scientific knowledge concerning its natural history and biological needs make this species extremely vulnerable to extinction. The only known populations are within the proposed critical habitat area designated in the February 2, 1977 Federal Register, outline in Figure 2. The potential natural range of this endemic species is limited to this unique Antioch Dunes area.

Life History and Population Dynamics

Lange's metalmark butterfly produces one brood in a season with adults emerging in early August and flying until mid or late September. The peak in population numbers is reached two to three weeks after the earlier date of emergency. Males generally emerge earlier than females.

Egg laying occurs after mating throughout the adult flight period. The gray eggs are laid at the junction of axils (stems) and on the less pubescent surface of the withered foliage on the lower half of the larval foodplant, Erigonum nudum var. auriculatum (= E. latifolium ssp. auriculatum Munz.). This plant has several local common names, including Antioch, naked or coast buckwheat and Tibinagua. The eggs are often deposited in clusters of two to four, less commonly singly. The eggs remain attached until the rainy season when the larvae emerge and crawl to the base of the plant.

The larvae do not appear until the following summer. They are nocturnal feeders and begin to feed on the new growth foliage and stems of the foodplant in May or June. Pupation occurs in June and July in the duff (dead and decaying leaves) at the base of the foodplant.

Both sexes are perchers and are capable of long distance movement between observed perches. The majority of male movements are local (less than 30 meters) and females may travel up to 400 meters (FWS 1978). The preferred perching substrate and nectar source of both sexes are buckwheat flowers. Prior to the weed control activities on the PG&E west tower parcel and sandmining on the Stamm property in the summer of 1978, Johnson (1978) reported a total Eriogonum population of 1,661 mature (flowering) plants, 1,352 rosette plants, 206 seedlings and 20 dead plants. Since recruitment (number of growing seedlings) was exceeding deaths, the population appeared to be maintaining itself. The highest density of Eriogonum occurred where the cover of filaree (an introduced annual, Erodium botrys) comprised a high percentage of ground cover and ripgut (a Mediterranean grass, Bromus diandrus) was low. Apparently seedling establishment requires more open ground, although mature plants are able to compete with ripgut. Arnold (pers. comm.) has reported that approximately 400-500 of 600 Eriogonum plants at the west tower site were destroyed by discing. About 20% of the plants on the Stamm property have been destroyed since May 1979.

Female butterflies visit a greater variety of secondary nectar sources than males. Females have been observed flying farther and in faster times than males which tend to perch or aggregate more than females. The greater fragility of the females is thought to be due to their searching for suitable sites for egg laying and more secondary

nectar sources. Neither sex usually moves far from the Eriogonum plants, but females tend to move more frequently between clumps while males remain in a single clump of buckwheat (Arnold 1977).

Mortality Factors

Specific information is lacking on Lange's metalmark butterfly mortality factors but some generalizations can be made. The primary limiting factors of food and host plant availability are becoming more critical as habitat is reduced by man-caused habitat disturbances. These reductions have resulted in a concentration of the existing animal species on the remaining host plants and, except where there has been a similar loss in the number of individuals, competition among them for resources is more keen. The buckwheat also serves as a primary nectar pollen source for many sand-nesting bees and wasps. Invasive, weedy plant species have also reduced the potential for re-establishment of native plants. Additional losses of the host buckwheat by sandmining and rototilling and discing for fire control will continue to reduce the potential butterfly population. Disced and mined areas will not support Eriogonum. Other mortality factors exist which are part of the natural evolutionary process, such as predation and temperature extremes.

A devastating wildfire in 1976 near one of the Pacific Gas and Electric east towers destroyed most of the immature stages of the butterfly and nearly eliminated the buckwheat at the site. The impact on the butterfly was severe at the time, although its ability to move from colony to colony was significant in its survival. Now, with a partial recovery of the buckwheat foodplant, butterflies have been observed the first time at this tower site since the fire.

ANTIOCH DUNES EVENING PRIMROSE (Oenothera deltoides ssp. howellii) is an attractive, short-lived perennial with large, white flowers. It was first described by Munz (1949) based on specimens collected by Alice Eastwood and John Howell in 1936. Klein (1962) elevated the variety to the rank of subspecies. Fearing the extirpation of this Antioch Dunes endemic, staff members of the Regional Parks Botanical Garden in Berkeley, California have transplanted it and studied its life cycle in cultivation (Roof, 1969). The California Native Plant Society has also investigated cultivation potential of this species.

Status and Distribution

The Antioch Dunes evening primrose was listed as an endangered species by the U.S. Fish and Wildlife Service in the April 26, 1978 Federal Register. Critical habitat was determined in the August 31, 1978 Federal Register (see Figure 2). Once relatively common in the Antioch Dunes area, this taxon's natural range has been reduced to 60 acres which is now known as the last remaining native habitat for the species. Johnson (1978) reported Oenothera population totals as 872 flowering plants, 376 small plants with few or no flowers, 184 rosette plants, and 97 dead plants. No small seedlings were observed. Arnold (pers. comm) has noted that the plant readily recolonizes disced and mined sites and the PG&E east tower site now has many new seedlings. The potential natural range of this endemic species is said to be limited to the unique Antioch Dunes Area. It is unknown at this time if the natural limitation may be Delhi soil (sand) which is more widely distributed than the dunes proper.

Life History, Population Dynamics and Habitat Requirements

Evening primrose has been grown in the botanical gardens in Tilden Regional Park in Berkeley, Brannan Island State Park in Sacramento County and on Brown's Island in Contra Costa County (see Knight letter of comment). The plants thrived at the Berkeley site until eradicated at the time a marina was constructed. Despite the apparent lack of annual sand replenishment, many plants are surviving at Brannan Island State Park. Although indications are good now, insufficient time has elapsed to evaluate the Brown's Island seeding (see letter).

Although the Antioch Dunes evening primrose was first described as a perennial, in cultivation at the Regional Parks Botanical Garden it has proved to be a biennial (Roof, 1969). This taxon flowers through the daylight and evening hours in April and May and produces many light, wind-borne seeds (August 31, 1978 Federal Register). Arnold (pers. comm) believes that bees are the primary pollinating agent at Antioch, and while hawkmoths are present at the site, he has not documented their role as pollinating vector through nocturnal studies. At the Botanical Garden it was observed to bloom throughout the daylight hours as well as nocturnally in the months of March, April, May and even briefly in September. Further field studies need to be conducted in the taxon's natural habitat to more precisely determine the phenology of flowering, pollination and seedset.

In cultivation new evening primrose seedlings develop vigorously the first spring into large tufts or rosettes approximately one foot in diameter. They may bloom during this first spring although they bloom most profusely during their second spring when the tufts grow to approximately three feet in diameter. After producing an abundance

of seed capsules, these large plants die during the second winter. A few plants live into the third year but most of these will die during this period.

Where observed in cultivation, Antioch Dunes evening primrose seedlings do not grow where adult plants have achieved maturity unless fresh sand is deposited. If seedlings germinate where adult plants have grown, they will senesce before reaching a height of approximately six inches. This taxon appears to grow only in a pure sand medium. It has been suggested that the adult plants use up the nutrients in their microhabitat and unless fresh sand is regularly deposited, insufficient nutrients remain to support a new cohort (Roof, 1969). How this principle applies to the natural setting of Antioch Dunes requires additional study.

Mortality Factors

In dune ecosystems undisturbed by man, fresh sand is normally deposited or eroded (exposed) by wind action. The Antioch Dunes area has been so disturbed by mining, agriculture, and urban and industrial development that fresh sand may not be available in large enough quantities and areas to support adequate populations of Antioch Dunes evening primrose. Without this support, the species may never be totally delisted. Further studies must be conducted to determine the nutrient status and habitat requirements, such as substrate stability necessary for the maintenance of populations of this species and its associated pollinators.

As the Antioch Dunes have been impacted by human activities, exotic plant species have colonized disturbed areas. Such weedy species stabilize dune slopes preventing the deposition or uncovering of fresh sand necessary for the establishment of evening primrose seedlings.

Johnson (1978) found Oenothera rosettes only in open areas although mature Oenothera plants were found in dense stands of ripgut (Bromus diandrus). Competition between weedy exotics and the Antioch Dunes evening primrose may further reduce the essential resources available for the primrose. Reduction in total acreage of the Antioch Dunes area has also limited the resources necessary to support the pollinators of this species. The necessary movement of sand in the area is more constrained now compared to the past because of less sand being available and changing wind current patterns as a result of new building and sand mining pits and banks.

Johnson (1978) reported that almost all of the Oenothera plants she observed "were infested with (chrysomelid?) beetles which in attaching to leaves and flower buds reduce reproductive output". Several families of beetles feed on the petals and pollen of the flowers and the seed pods.

Periodic rototilling and discing as a fire protection measure and recreational ORV use in the area are also impacting the evening primrose and its habitat. While destroying mature and immature plants, discing may open up new areas of habitat for Oenothera seeding establishment.

CONTRA COSTA WALLFLOWER (Erysimum capitatum var. angustatum), a biennial member of the Brassicaceae or mustard family, was described as a new species Cheiranthus angustatus by E.L. Greene (1896), based on specimens from the banks of the San Joaquin River in the interior of California. Rosbach (1958) changed the scientific name to Erysimum capitatum var. angustatum. Studies on the biology of this species were conducted by the staff of the Regional Parks Botanical Garden on plants cultivated in the Garden and Johnson (1978) surveyed the Antioch Dunes population.

Status and Distribution

The Contra Costa wallflower was listed as an endangered species by the U.S. Fish and Wildlife Service in the April 26, 1978 Federal Register. Critical habitat was determined in the August 31, 1978 Federal Register (see Figure 2).

Endemic to the Antioch Dunes, Contra Costa wallflower habitat totalled several hundred acres a few decades ago; it is now limited to but a few acres. Dr. Paul Opler, Office of Endangered Species, U.S. Fish and Wildlife Service, found only 28 representatives when he visited the dunes on February 18, 1976. Johnson (1978) found a total of 174 fruiting plants and 60 rosettes. Since Erysimum is a biennial, all of the fruiting plants die and the next year's reproductive individuals are produced from the rosettes. Johnson's data indicated that this population had decreased since number of deaths (174) had far exceeded the number of individuals in the rosette stage (60). The 1979 plant count indicates plant numbers are comparable to 1978 survey results, indicating a stable population. However, two years is insufficient time for finalizing such conclusions. The potential natural range of this endemic species is limited to the unique Antioch Dunes area.

The wallflower has been planted in the Tilden Regional Park in Berkeley. Until recently this population was thriving; latest surveys indicate the plant is under some unknown stress (see Knight's letter of comment).

The Contra Costa wallflower has responded vigorously to cultivation at the Regional Parks Botanical Garden (Roof, 1969). In cultivation it does not require biennial deposition of fresh sand as does the Oenothera, and seedlings have moved from the sandy bed where adult individuals were planted to several black soil or gravelly locations within the garden.

Rossback (1958) described this species as restricted to stabilized dunes of fine sand and some clay dust with sparse herbs and shrubs, or less often with pasture grasses, herbs and scattered Quercus agrifolia. These observations are supported by Johnson's (1979) field data. It was observed that reproducing individuals occurred principally on uneven sites in Antioch Dunes (river-fronting cliff faces and edges). However, the largest number of rosettes occurred on the excavation dunes fronting the river. This area was highly disturbed by paths and had bare sand available for colonization. Erysimum was not found more than 4 m inland from the river bluffs and therefore appeared to have a more restricted habitat than the Antioch Dunes evening primrose which is found more than 100 m inland from the river.

In contrast, Fish and Wildlife Service botanists have recorded the wallflower in disturbed areas of stabilized dunes. In virtually all areas where observed, the species occupied very unstable slopes which were not well vegetated. Species on such areas are often better able to compete with aggressive weeds under these conditions. The plant has been found approximately 160 meters from the shoreline near PG&E's tower site.

More information is needed on the reproductive biology and habitat requirements for this species to further define recovery efforts necessary for its conservation.

Mortality Factors

The invasion of weedy exotics into disturbed habitats where Contra Costa wallflower might otherwise colonize appears to be a major factor contributing to its decline. Major destruction and alteration of habitat by human activities are reducing the habitat available for this species.

Wildfires have the potential for destroying the area's native plant community; however, periodic weed abatement (rototilling and discing) by the Riverview Fire Protection District has impacted this species and its habitat. Recreational uses of the area (ORV, hiking, fishing) have serious potential impacts and do reduce the species recoverability.

II. PLAN OBJECTIVE

The prime objective of the Recovery Plan is the protection of the Antioch Dunes ecosystem to permit restoration of the Lange's metalmark butterfly, Contra Costa wallflower, and Antioch Dunes evening primrose to delisted status by 1990. Protecting the limited habitat from negative human impact is of the greatest importance. The human impacts having the greatest potential for adversely affecting the species include sand mining, weed control, private and commercial specimen collection, extensive/intensive recreation such as ORV activities, and commercial private developments. Without implementation of this plan, especially the habitat protection/acquisition and control phase, extinction of these species and a number of associated species can be expected. The acreages involved in acquisition of the Sardis and Stamm-Starr properties and the cooperative agreements on the Pacific Gas and Electric (PGE) and Kaiser Gypsum (KGC) properties (Figure 3) are outlined in Table 1.

<u>Property</u>	<u>Number Acres</u>
Stamm-Starr	44.34
Sardis	14.35
Pacific Gas and Electric	12.15
Kaiser Gypsum Company	10.00 (estimated)
Total Habitat to be managed	80.84

Table 1. Acreages and land ownerships of properties within the Antioch Dunes habitat area.

JOB OUTLINE

Objective: Protect and restore the Antioch Dunes ecosystem to permit recovery of the Lange's metalmark butterfly, Antioch Dunes evening primrose and Contra Costa wallflower to delisted status by 1990.

1. Provide protection of essential habitat for Lange's metalmark butterfly, Antioch Dunes evening primrose and Contra Costa wallflower.
 11. Acquire property to provide essential habitat.
 111. Sardis-Little Corral property (purchase)
 112. Stamm property (purchase)
 113. Pacific Gas & Electric (agreement)
 114. Kaiser Gypsum Company (agreement)
 12. Designate critical habitat for Lange's metalmark butterfly.
2. Manage populations of Lange's metalmark butterfly, Antioch Dunes evening primrose and Contra Costa wallflower.
 21. Conduct studies to determine biological requirements of these species and Antioch buckwheat
 211. Determine population biology of these species and Antioch buckwheat.
 212. Determine habitat requirements for these species and Antioch buckwheat.
 213. Determine methods to control competition from exotic plants.

22. Formulate management and strategy plans for the recovery of these species.
 221. Formulate preliminary management and strategy plans.
 222. Formulate long term management and strategy plans.
23. Implement management and strategy plans determined in #21 and #22.
3. Monitor population of Lange's metalmark butterfly, Antioch Dunes evening primrose and Contra Costa wallflower and their habitats.
 31. Assess numbers, reproductive success and distributions of these populations.
 32. Assess status of dune habitat in general area.
4. Develop public relations strategies to foster public awareness and support for recovery plan implementation.
 41. Prepare, print and distribute information leaflets.
 42. Develop interpretive program(s).
 43. Construct and erect interpretive sign on the area.

ACTION PLAN NARRATIVE*

The prime objective of this Recovery Plan is the protection of the Antioch Dunes ecosystem to permit restoration of the Lange's metalmark butterfly, Contra Costa wallflower and Antioch Dunes evening primrose to delisted status by 1990. Four major areas of activity are necessary for the recovery of these species: 1) providing protection of their essential habitat, 2) protecting their populations, 3) monitoring the populations of these and other key species associated in the area; and 4) developing public information strategies. Criteria for down-listing these species to Threatened status, and eventual delisting, will be developed when necessary data is collected and analyzed.

Essential Habitat

Critical Habitat for the Antioch Dunes evening primrose and the Contra Costa wallflower was designated in the August 31, 1978 Federal Register. The same area was proposed as Critical Habitat for Lange's metalmark butterfly in the February 2, 1977 Federal Register. A final rulemaking needs to be made on the proposed Critical Habitat for Lange's metalmark butterfly by the FWS (13).

Since essential habitat for these endangered species occurs on private lands, cooperative agreements and/or land purchase are necessary for protection of their essential habitats. It is recommended that the FWS acquire (by agreement, lease or acquisition) the properties of Sardis-Little Corral (111), Stamm-Starr (112), Pacific Gas and Electric (113) and Kaiser Gypsum Company (114) for this purpose.

* Numbers in parenthesis refer to Action Diagram steps.

While the City of Antioch has an earlier proposal for a waterfront park in the area of the essential habitat, the plan was dropped in March 1979 for economic reasons. Initial efforts by FWS to preserve this area were referenced as in keeping with the City's Open Space designation. However, on June 22, 1976, the City had changed the designation in the Stamm property to Heavy Industrial. To correct the confusion surrounding the issue of potential land use, the City passed Resolution 79/192 (copy enclosed) stating the current land classification and the fact that it is not the City's intent to encourage preservation of the Stamm property as open space.

Population Protection

More information is needed on the species' biological and ecological requirements to permit management (2) and eventual restoration of Lange's metalmark butterfly, Contra Costa wallflower and Antioch Dunes evening primrose to delisted status (21). Studies on the population biology of these species as well as Antioch buckwheat should be undertaken to determine methods for increasing and securing population numbers (211). Specific information is needed on the habitat requirements to permit restoration of the habitat (where necessary) for the recovery of these species (212). In particular, studies are needed on the effects of the weedy exotics that have invaded the essential habitat and the methods to eradicate them. Through these studies, methods would be developed to decrease competition from exotic vegetation (213) by enhancing the native flora and fauna of the Antioch Dunes. The California Department of Fish and Game and the FWS should administer and supervise such biological studies.

Due to the current critical endangerment of these species as a result of their low population numbers and severe disruption of their habitats, there is an urgent need to develop and implement preliminary and long term management and strategy plans for their recovery. These plans would include the butterfly's larval host plant, Antioch buckwheat (22, 23). Preliminary plans should address fire and weed management techniques which have been detrimental to the species, public access impacting the species and control of competing exotic plants. An immediate management task should be the protection of existing dunes and the possible reconstruction of dune habitat to provide needed habitat. Activities occurring in the adjacent areas should be monitored to prevent or minimize detrimental impacts to the essential needed habitats for these species (32).

Long term management and strategy plans based on the data obtained in the biological studies of these species should be formulated (222), and be updated as additional information becomes available. The final objective for long term management plans will be to prevent the need for once again placing any of the area's species on the endangered species list as a result of mismanaging the Antioch Dunes ecosystem.

Because these endangered species occupy the same habitat area but may have different biological requirements, care must be taken not to carry out any recovery actions that, while beneficial to one, may be detrimental to one or more of the others. This same concern should apply to other endemic species even though not presently listed or under consideration.

Monitoring Population of Lange's Metalmark Butterfly, Antioch Dunes
Evening Primrose, Contra Costa Wallflower and Antioch Buckwheat

As preliminary and long-term management plans are implemented, populations of the aforementioned species should be monitored to determine the progress of the recovery actions (3). The status and distribution of populations would be monitored to include actual numbers and reproductive success of these species (31). Management and strategy plans should be periodically updated based upon this information to ensure the best methods for recovery of these species. The status of the dune habitat in and around the general area should be monitored (32) to determine the effectiveness of management actions.

Public Relations Strategies

Public awareness and support for recovery plan implementation should be developed through information programs (4). Information leaflets would be prepared, printed and made available for public distribution (41). Other interpretive programs should be developed (42) to include tours, slide shows and class presentations. The possibility of erecting an interpretive sign on the area (43) should be considered. Such a sign would include a brief history of the Antioch Dunes ecosystem and list regulations governing the use of the area by the public.

GROUP PRIORITY	NAME OF ACTION	PLAN DESIGNATION	LEAD	RESPONSIBILITY COOPERATORS	TARGET DATE	ESTIMATED COST (\$1,000)	OTHER
						FY1 FY2 FY3	
C. INVESTIGATIVE							
1.	Determine and apply methods to control exotic plants	213	CDF&G	CNPS, FWS	-	3	3
2.	Determine population biology and habitat requirements for Lange's metalmark butterfly, Antioch Dunes evening primrose, Contra Costa wallflower and Antioch buckwheat	211, 212	CDF&G	CNPS, FWS	-	5	-
3.	Monitor numbers, reproductive success and distribution of these populations	31	CDF&G	CNPS, FWS	2	2	2
4.	Monitor status of dune habitats in the general area	32	CDF&G	FWS	1	-	1

- TNC - The Nature Conservancy
- CDF&G - California Department of Fish and Game
- CNPS - California Native Plant Society
- PGE - Pacific Gas and Electric
- KGC - Kaiser Gypsum Company

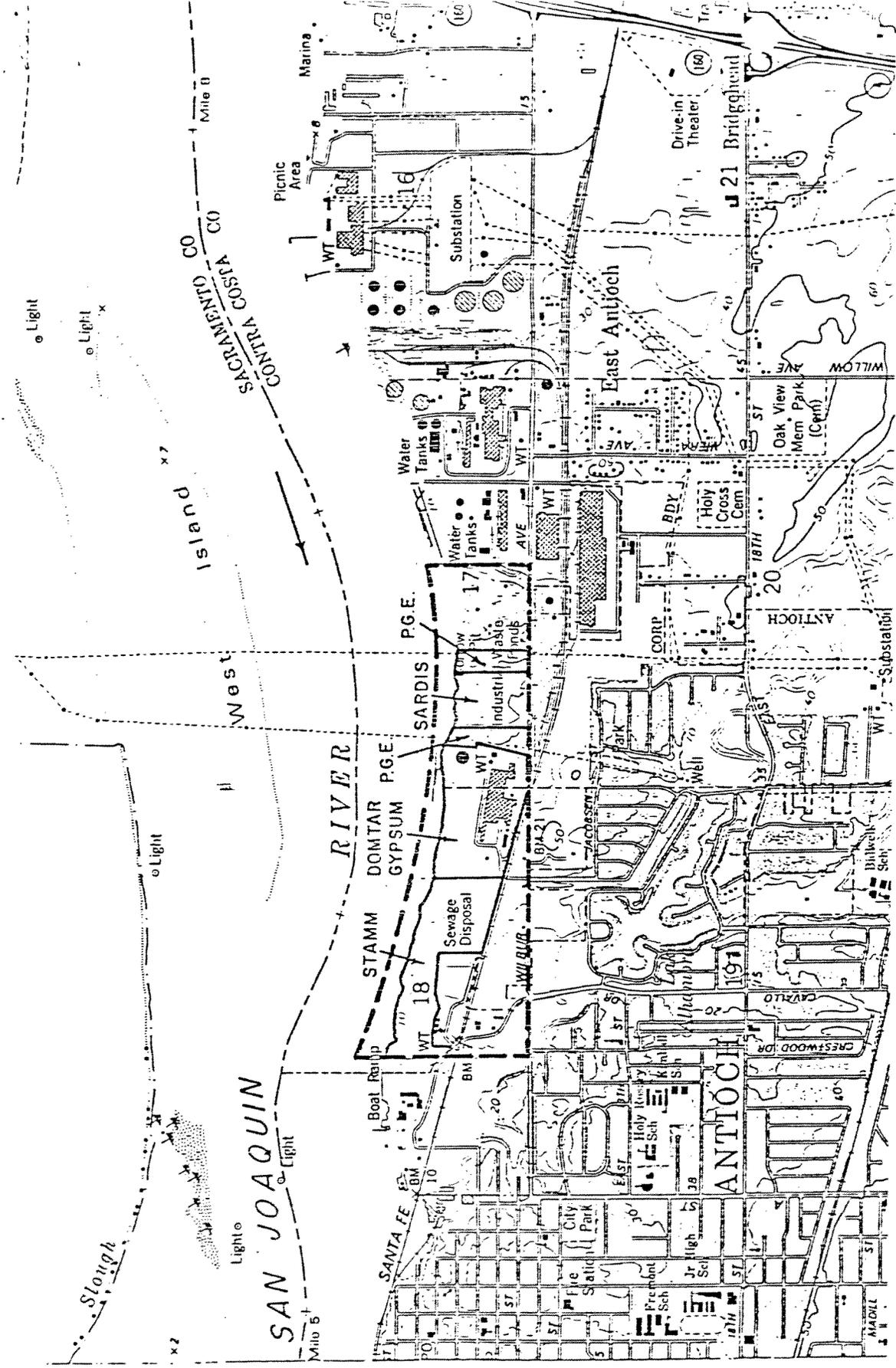


Figure 2. Proposed Critical Habitat for Lange's metalmark butterfly and designated Critical Habitat for Antioch Dunes evening primrose and Contra Costa wallflower; Contra Costa County, T.2N., R.2E., SW 1/4 Sec. 17, E 2/3 of S 1/3 Sec. 18. (Federal Register, Vol. 42, NO. 26, February 8, 1977.)

APPENDIX 1. LITERATURE CITED

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APPENDIX 2

Partial List of Unique Flora and Fauna of the Antioch Dunes

Endangered Species

Oenothera deltooides ssp. howellii (Antioch Dunes evening primrose)

Erysimum capitatum var. augustatum (Contra Costa wallflower)

Apodemia mormo langei (Lange's metalmark butterfly)

Proposed Endangered Species

Lilaeopsis masonii

Aster chilensis var. lentis (Suisun aster)

Insect Species of Interest

Assumed extirpated from Antioch Dunes, their type locality:

Coelus gracilis

Anthicus antiochensis

Campsomeris pilipes

Campsomeris toleca

Type locality for 24 insect species described thus far - 10 of which are endemic.

Reptile Species of Interest (northernmost range extensions)

Arizona elegans (glossy snake)

Uta stansburiana (side-blotched lizard)

Aniella pulchra (legless lizard)

Other Plant Species of Interest

Undescribed subspecies of Lupinus albifrons

Eriogonum latifolium var. auriculatum (host plant for Apodemia mormo langei)

APPENDIX 3

Known Exotic Plant Species Occurring at Antioch Dunes (from Johnson, 1978)

- Amaranthus retroflexus L., green amaranth, iah, occ
Asparagus officinalis L., garden asparagus, iah, occ
Avena fatua L., wild oats, iah, ab
Brassica geniculata (Desf.) J. Ball, mustard, iah, occ
Brassica nigra (L.) Koch., black mustard, iah, occ
Bromus diandrus Roth., ripgut, iah, ab
Bromus mollis L., soft chess, iah, ic
Carduus pycnocephalus L., Italian thistle, iph, fq
Centaurea solstitialis L., star thistle, iah, c
Chenopodium album A. Nels., pigweed, iah, occ
Conyza bonariensis (L.) Cronq., horseweed, iah, c
Cytisus monspessulanus L., French broom, is, lc
Datura meteloides DC., jimson weed, iph, occ
Erodium botrys (Cav.) Bertol., filaree, iah, ab
Festuca sp., fescue, iah, lc
Foeniculum vulgare Mill., sweet fennel, iph, occ
Hoffmanseggia densiflora Benth., pignut, iah, f
Lactuca scariola L., prickly lettuce, iah, c
Lotus formosissimus Greene, lotus, iph, lc
Lotus purshianus (Benth) Clem. & Clem., lotus, iah, lc
Lycopersicon esculentum Mill., tomato, iah, f
Marrabium vulgare L., horehound, iph, occ
Melilotus indicus, yellow melilot, iah, ab
Nenium oleander, oleander, is, f
Nicoriana glauca Grah., tobacco tree, it, occ
Olea europa L., olive, it, f
Paspalum dilatatum Poir., dallis grass, iph, occ

- Picris echioides L., bristly ox-tongue, iah, lc
- Prunus sp., almond, it
- Pyracantha crenato-serrata (Hance.) Rehd., pyracantha, is
- Robinia pseudo-acacia L., black locust, it, lc
- Rosa pisocarpa A. Gray, rose, is, f
- Rubus procerus P.J. Muell., himalaya berry, is occ
- Rumex conglomeratus Murr., rumex, iah, f
- Rumex crispus L., curly dock, iph, cq
- Salsola kali L. var. tenuifolia Tausch., tumbleweed, iah, c
- Setaria lutescens (Weigel) F.T. Hubb, millet, iah, f
- Silene gallica L., campion, iah, occ
- Solanum nigrum L., nighshade, iah, f
- Sonchus asper L., rough sowthistle, iah, occ
- Sonchus oleraceus L., sowthistle, iah, occ
- Tribulus terrestris L., puncture vine, iah, occ
- Tamarix sp., tamarisk, it, f
- Vitis vinifera L., cultivated grape, is, f
- Xanthium strumarium L. var. canadense (Mill.) T. & G.,
cocklebur, iph, occ

KEY

- | | |
|----------------|---------------------|
| h = Herb | t = Tree |
| s = Shrub | c = Common |
| p = Perennial | ab = Abundant |
| b = Biennial | lc = Locally common |
| a = Annual | occ = Occasionally |
| n = Native | f = Few plants |
| i = Introduced | |

APPENDIX 4

MANAGEMENT SUGGESTIONS FOR ANTIOCH DUNES EVENING PRIMROSE, CONTRA COSTA WALLFLOWER AND ANTIOCH BUCKWHEAT 2/

A. Rototill the ripgut areas on the east and west tower sites before the grasses head out.

- Pro:
- 1) would leave an open area for Oenothera (and other species such as Croton, Senecio, Lupinus, and Eriogonum) to invade.
 - 2) would lower the input of grass seeds to the area for next year's crop.
 - 3) would require only minimal labor costs.

- Con:
- 1) may not be able to get rototilling machine on wet soil before grasses head out.
 - 2) may not be able to be done early enough in rainy season to allow establishment of Oenothera.
 - 3) would destroy Oenothera seedlings already established in area

B. Scythe the grasses by hand one or two times during the rainy season to cut down their growth and prevent seeding.

- Pro:
- 1) would be able to be done when soil was set.
 - 2) would not destroy the lower rosettes of Oenothera seedlings already present.

- Con:
- 1) would be time-consuming and costly unless done by volunteers.
 - 2) would leave a mulch that might shade Oenothera seedlings.
 - 3) would leave grass roots intact which might then regenerate tops and continue to extract soil moisture otherwise available to Oenothera seedlings.

2/ From: Johnson, A.F. 1978. Report on Antioch Dunes Threatened Plant Species. Unpublished paper. Cal. Dept. of Fish and Game, Sacramento.

C. Set up a grid of plots at these sites (and at sites among the present populations of the rare species) which are weeded periodically to keep down the grass populations. There could be a graduated series of plots with different weeding frequencies to determine which was the most labor-efficient.

Pro: 1) this would directly favor the Oenothera seedlings by removing both sun and root competitions.

2) treatment plots could be subsequently used as sampling plots thereby reducing the need to establish separate study areas.

Con: 1) probably too labor-intensive to use over a large area.

2) might cause trampling of seedlings or soil compaction if weeding was performed too frequently.

D. To increase the population of Erysimum, cliff edge sites would be weeded of ripgut and a stand of iceplant (Mesembryanthemum edule) on the lee of the excavation dunes could be extirpated carefully so as not to disturb surrounding plants.

Sampling site [†] rare plants. To monitor the effect of these treatments a grid of sample plots should be established both in areas where the rare plants are presently established to follow population trends and in areas of treatments to follow invasion. Some of these sample plots could also be treatment plots that are weeded at varying frequencies.

Note Comments received during the Agency Review of the Draft Recovery

Plan:

Reference to A: No rototilling (discing) except at appropriate borders.

