

**Lange's metalmark butterfly**  
*(Apodemia mormo langei)*

**Antioch Dunes evening-primrose**  
*(Oenothera deltoides subsp. howellii)*

**Contra Costa wallflower**  
*(Erysimum capitatum var. angustatum)*

**5-Year Review:  
Summary and Evaluation**



**Sacramento Fish and Wildlife Field Office  
U.S. Fish and Wildlife Service  
Sacramento, California  
June 2008**

## 5-YEAR REVIEW

### Species reviewed:

Lange's metalmark butterfly (*Apodemia mormo langei*)  
Antioch Dunes evening-primrose (*Oenothera deltoides* subsp. *howellii*)  
Contra Costa wallflower (*Erysimum capitatum* var. *angustatum*)

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Antioch Dunes evening-primrose (*Oenothera deltoides* subsp. *howellii*)  
Contra Costa wallflower (*Erysimum capitatum* var. *angustatum*)

### I. GENERAL INFORMATION

#### I.A. Methodology Used to Complete the Review

Staff of the Sacramento Fish and Wildlife Office, U.S. Fish and Wildlife Service (Service), prepared this review using information from species survey and monitoring reports, the Recovery Plan for Three Endangered Species Endemic to Antioch Dunes, California (Recovery Plan) (U.S. Fish and Wildlife Service [USFWS] 1984), the Antioch Dunes National Wildlife Refuge (NWR) comprehensive conservation plan (USFWS 2002), published journal articles, and unpublished technical reports and grant proposals. Recognized experts on the species and land managers at the Antioch Dunes NWR were interviewed for their knowledge and suggestions for future recovery recommendations to assist the Lange's metalmark butterfly (*Apodemia mormo langei*), Antioch Dunes evening-primrose (*Oenothera deltoides* subsp. *howellii*), and Contra Costa wallflower (*Erysimum capitatum* var. *angustatum*) within the next five years. Survey data, the Recovery Plan, and personal communications with entomologists, botanists, and land managers were our primary sources of information used to update the species status and threats sections of this review. We used the U.S. Fish and Wildlife Service's March 27, 2006, 5-Year Review template to complete this review.

#### I.B. Contacts

**Lead Regional or Headquarters Office** – Diane Elam, Deputy Division Chief for Listing, Recovery, and Habitat Conservation Planning: 916-414-6464

**Lead Field Office** – Kirsten Tarp, Recovery Branch: 916-414-6600

#### I.C. Background

##### I.C.1. FR Notice citation announcing initiation of this review:

72 FR 7064-7084 dated February 14, 2007. We received no information from the public in response to the notice.

##### I.C.2. Listing History

###### Original Listing

	FR Notice	Date Listed	Entity Listed	Classification
Lange's metalmark butterfly	41 FR 22041	June 1, 1976	Subspecies	Endangered
Antioch Dunes evening-primrose	43 FR 17910	April 26, 1978	Subspecies	Endangered
Contra Costa wallflower	43 FR 17910	April 26, 1978	Variety	Endangered

### **I.C.3. Associated Rulemakings**

The proposed rule for critical habitat for the Lange's metalmark butterfly was never finalized; however, critical habitat was designated for Contra Costa wallflower and Antioch Dunes evening-primrose, and a final rule was issued on August 31, 1978 (USFWS 1978b). The designated critical habitat for the two plants is within the same geographical boundaries as the critical habitat proposed, but never finalized, for Lange's metalmark butterfly.

### **I.C.4. Review History**

No formal status reviews have been conducted for these three species since they were listed. However, since the original listings in 1976 and 1978, we have assessed certain aspects of the species' conservation status in the following relevant documents:

1. The revised recovery plan for the three endangered species endemic to Antioch Dunes, California (USFWS 1984);
2. The Antioch Dunes NWR comprehensive conservation plan (USFWS 2002); and,
3. The San Francisco Bay National Wildlife Refuge Complex internal section 7 consultation for restoration of the Antioch Dunes NWR, 1-1-07-F-0114 (USFWS 2007a).

### **I.C.5. Species' Recovery Priority Number at start of review**

Lange's metalmark butterfly and Antioch Dunes evening-primrose, 9: These two subspecies were considered to be confronted with a moderate degree of threats and to have a high potential for recovery.

Contra Costa wallflower, 6: This taxonomic variety was considered to be confronted with a high degree of threats, and a low recovery potential because of its specific environmental requisites for growth and the population decline noted in 2005.

Recovery priority numbers are determined based on a 1 to 18 ranking system where 1 represents the highest-ranked recovery priority and 18 represents the lowest-ranked recovery priority.

### **I.C.6. Recovery Plan or Outline**

Name of plan: Revised Recovery Plan for Three Endangered Species Endemic to Antioch Dunes, California

Date issued: April 25, 1984

Dates of previous revisions: None

## II. REVIEW ANALYSIS

### Species Descriptions

Antioch Dunes National Wildlife Refuge is located in the San Francisco Bay-Delta area along the south shore of the San Joaquin River about 40 miles northeast of San Francisco. The Antioch Dunes NWR consists of 67 acres divided into two separate parcels: the Stamm unit to the west (41 acres) and the 26-acre Sardis unit to the east (14 acres owned by the USFWS and 12 acres owned by Pacific Gas and Electric) (see attached map). The two units are separated by less than one mile and the Georgia-Pacific gypsum plant lies between the two units. Once part of an extended riverine sand dune system, the relic dune habitat at Antioch hosted a variety of endemic plants and insects (USFWS 2002). During the last 150 years the dune habitat was seriously degraded by sand removal, the overgrowth of invasive, non-native plants, and by recreational use (USFWS 1984). Few of the endemic species remain at the Antioch Dunes NWR; however, the Contra Costa wallflower, the Antioch Dunes evening primrose, and the Lange's metalmark butterfly were all given increased protection when those species were listed and when the refuge was established (USFWS 2002). Antioch Dunes NWR was the first refuge in the country established (in 1980) for the purpose of protecting endangered plants and insects. The species descriptions in the following paragraphs are summarized from information contained in the Revised Recovery Plan for Three Endangered Species Endemic to Antioch Dunes, California (USFWS 1984).

Lange's Metalmark Butterfly: Lange's metalmark butterfly is endemic to the Antioch Dunes of Contra Costa County, California, and the only known extant populations inhabit the Antioch Dunes National Wildlife Refuge. It is one of 15 subspecies of *Apodemia mormo* in the state of California. Adult Lange's metalmark butterflies are small butterflies with a wingspan of one to one and a half inches. The upper surface of the wing is mostly black with a pattern of white spots, and with the forward part of the inner forewing having a red-orange background. There is a small red-orange central patch on the upper hind wing that is unlike the white found in all of the other subspecies (Opler and Robinson 1986). The adult males and females are similar in coloration and size. The host plant for Lange's metalmark butterfly is the perennial naked stemmed buckwheat (*Eriogonum nudum* var. *auriculum*), which grows best in open areas with good drainage. Lange's metalmark butterfly uses the buckwheat as a sole food source when in the larval stage. As an adult, the butterfly uses the host buckwheat plant as a perch, and also as one of several nectar sources (USFWS 1984).

Antioch Dunes Evening Primrose: The Antioch Dunes evening-primrose is a short-lived perennial plant in the evening-primrose family (Onagraceae). It forms large tufts with coarse drooping stems 4-40 inches long, much branched. Leaves are lance-like in outline, 1-5 inches long, 0.4-1.2 inches wide, with grayish hairs. White flowers open in early evening and close in the morning, and bloom from March to September. The petals are about one inch long and the stamens are yellow. The Antioch Dunes evening primrose may be confused with *Oenothera deltoides* ssp. *cognata*, which grows in the Oakley area southeast of the Antioch Dunes (USFWS 1984).

Natural stands of the Antioch Dunes evening-primrose are found only on the riverine dune habitat located on and immediately adjacent to the Antioch Dunes NWR (USFWS 1984). This subspecies has been introduced to other locales within the San Francisco Bay area but successfully persists only at the Antioch Dunes NWR and several other locations: Tilden Regional Park in Alameda County, and within some low riverine dunes at Brannan Island State Recreational Area just east of the refuge in Sacramento County.

Contra Costa Wallflower: The Contra Costa wallflower is one of the many varieties of the western wallflower (*Erysimum capitatum*) and is a biennial or short-lived perennial sub-shrub of the Brassicaceae (mustard) family (USFWS 1984). The erect plant is unbranched and grows 6 to 18 inches in height (Dale 1986). The leaves of the Contra Costa wallflower occur in basal rosettes, are narrowly lance-shaped with toothed edges, and have two-branched hairs covering the lower 4 to 8 inches of the leaf. The attractive yellow to yellow-orange flowers grow on short stalks in a loose cluster at the ends of the main stem, with the four petals in a cross shape typical of this family (Dale 1986; Hickman 1993).

The Contra Costa wallflower is endemic to the riverine dune habitat found within and immediately adjacent to the Antioch Dunes NWR. The reproductive phenology of this species encompasses germination in October, leafing from October through December, budding in February, flowering in March (peaking in April or May), and fruiting in April (peaking in July). Seeds are wind-dispersed beginning in mid-May and peaking in September. Unlike other members of the mustard family, pollination of the Contra Costa wallflower is by a variety of unspecialized insects, including bees nesting along the open banks (USFWS 2002). The wallflower grows in soil types classified as sand to sandy loam. Precise information about the specific requirements of the Contra Costa wallflower are not well known; however, the plant has been observed growing in steep areas of unstable sand, especially on north-facing slopes adjacent to the river (USFWS 1984, 2002; S. Euing, USFWS, pers. comm. 2007). This plant has also been observed growing in a variety of conditions, including stable dunes of fine sand containing some clay and sparsely vegetated with herbs and shrubs; uneven river front bluff faces and edges; flat terrain in excavated areas; and flat hard pan areas 160 to 660 feet from the river where the hard pan is broken and loose, sandy soil is exposed (USFWS 2002).

## **II.A. Application of the 1996 Distinct Population Segment (DPS) policy**

The Endangered Species Act defines species as including any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate wildlife. This definition limits listing as DPS to only vertebrate species of fish and wildlife. Because the species under review are an invertebrate and two plants, and the DPS policy is not applicable, the application of the DPS policy to the species listing is not addressed further in this review.

## **II.B. Recovery Criteria**

### **II.B.1. Does the species have a final, approved recovery plan containing objective, measurable criteria?**

No, there are no recovery criteria listed in the Recovery Plan (see section IIB3 below).

At the time the Recovery Plan was written, there was insufficient information regarding the species' population trends and stability to develop specific recovery criteria. The recovery plan defers establishing downlisting and delisting criteria for the three endangered species until after necessary data are collected and analyzed (USFWS 1984). In place of criteria, a prime objective was determined: "to prevent the further loss at the Antioch Dunes for the Lange's metalmark butterfly, Antioch Dunes evening-primrose, and Contra Costa wallflower; to protect introduced populations of each species and their habitats; and to determine the number of populations which are necessary for reclassifying each species" (USFWS 1984). Three primary actions were established as the practical means to reach the objective and these actions were outlined in the Recovery Plan. Since the recovery plan was issued, at least 80 percent of the supporting recovery actions were implemented, and now are either completed or are still ongoing (USFWS 2002, 2006a). However, in spite of these activities, the population trends for these species indicate that all three are declining. A discussion of each of the primary actions included in the Recovery Plan and progress made towards each of those primary actions is provided below.

*Primary Action 1. Protect Antioch Dunes ecosystem and essential habitat for Lange's metalmark butterfly, Antioch Dunes evening-primrose, and Contra Costa wallflower.* The first action listed in the Recovery Plan is to protect the Antioch Dunes ecosystem by developing and implementing a management plan for a refuge established through the acquisition and protection of the two properties where the majority of the three endangered species were found. These two properties, consisting of 55 acres, were purchased in order to establish the Antioch Dunes NWR in 1980. The Antioch Dunes NWR includes an approved expanded boundary and now totals 67 acres, of which 55 acres are owned by USFWS; the other 12 acres are owned by Pacific Gas and Electric (PG&E). Pacific Gas and Electric maintains large power transmission towers on these 12 acres within the Antioch Dunes NWR boundaries, and through a cooperative agreement has allowed refuge personnel access to this property in order to conduct surveys and other management activities. A management plan for the Antioch Dunes NWR was originally completed in 1987 by the Service, but was replaced in 2002 with a revised comprehensive conservation plan (USFWS 2002). This comprehensive conservation plan is currently being implemented by the refuge biologists and land managers and was written as an adaptive strategy, subject to periodic review and revision. In 1986, a chain link fence was installed around the refuge boundaries to preclude trespassing. This fence became necessary when increased human traffic at the refuge began to negatively affect the remnant dune habitat and the three endangered species (USFWS 2002).

The next supporting recovery actions are for the Antioch Dunes NWR to establish a memorandum of understanding (MOU) with each private landowner that conducts activities which may affect the refuge. These landowners were specified as PG&E, the Georgia-Pacific gypsum processing plant, and the McCullough-Kemwater North American Company (which produced custom water treatment applications and is now closed). As previously mentioned, Antioch Dunes NWR and PG&E have maintained a cooperative agreement which allows refuge personnel to conduct management activities on the PG&E owned lands within the refuge boundaries. Access by verbal agreement is presently allowed on the Georgia-Pacific and McCullough properties, which have been historically surveyed by the refuge personnel (C. Smith, USFWS, *in litt.* 2006).

The final supporting actions for Primary Action 1 include identification of other essential habitat and developing an MOU with the landowner to develop protective alternatives and actions. Since listing, the only new habitat identified for conservation is the property owned by the Pioneer Companies, Inc., and currently occupied by the McCullough-Kemwater North American Company. All three of the Antioch Dunes species have been surveyed on this property (USFWS 2005). Currently, this property is for sale and the Service is considering alternatives that include purchasing this valuable habitat.

*Primary Action 2. Restore Antioch Dunes ecosystem, and increase numbers and improve habitat for Lange's metalmark butterfly, Antioch Dunes evening-primrose, and Contra Costa wallflower.* The initial supporting actions for Primary Action 2 are essentially the same for all three endangered Antioch Dunes species, and include conducting annual census of population and habitat; captive breeding (Lange's metalmark butterfly) or propagation and outplanting (Antioch Dunes evening-primrose, Contra Costa wallflower); developing and implementing a habitat restoration plan; and conducting studies of the biology of the species which include life history (Lange's metalmark butterfly), autecological studies (Antioch Dunes evening-primrose, Contra Costa wallflower), habitat requirements (Lange's metalmark butterfly), population biology (Lange's metalmark butterfly), and reproductive studies (Antioch Dunes evening-primrose, Contra Costa wallflower). Out-planting buckwheat host plants is also needed for Lange's metalmark butterfly. All of these actions have been ongoing and are discussed below in section IIC.

Another group of supporting actions includes rebuilding the natural dune substrate and topography to the degree feasible by negotiating with the Army Corps of Engineers (Corps) and the Port of Stockton for sandy dredged material, preparing the sites for deposition of dredged material, and surveying the sites for candidate and listed species in order to ameliorate any negative effects. Several sources of sand were used in restoration efforts since listing the three species. Dredged material was found to contain a substantial amount of fine non-silica sediment which proved to stabilize too quickly for use as a substitute for the original dune sand (C. Smith *in litt.* 2007). Antioch Dunes NWR staff recently located several sources of local high-silica content sand that should prove useful in the restoration; however, although funding sources are being sought for purchasing and delivering the sand, current plans tentatively include testing the composition of the imported

sand prior to using it to supplement the refuge. (C. Smith *in litt* 2007; L. Terrazas, USFWS, pers. comm. 2008).

Other actions include removal of a vineyard and removal of other non-native invasive vegetation throughout the Antioch Dunes NWR. The vineyard was removed in 1983 and removal of non-native invasive vegetation has been an ongoing effort (see section IIC for updated status on the restoration).

*Primary Action 3. Initiate information and education programs.* Supporting actions for this include erecting interpretive signs, printing and distribution of leaflets describing the Antioch Dunes NWR's unique dune ecosystem and the need for restoration, and the development of an environmental education program. These actions were completed in the early 1980s; however, the public awareness effort is a dynamic and ongoing process.

## **II.B.2. Adequacy of Recovery Criteria.**

### **II.B.2.a. Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat?**

No, the Recovery Plan does not list specific criteria that serve as a measure of the success of the recovery effort. However, actions intended to address the Recovery Plan's Primary Actions include continuous surveys that have revealed population trends for all three species since 1984. In addition, there has been a variety of published scientific research articles and unpublished information on the life history or ecology of the three species since 1984.

### **II.B.2.b. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria?**

*Yes*  
 *No*

There are no recovery criteria. The Recovery Plan's objectives in some ways address the five threat factors, but they are not criteria for downlisting or delisting.

## **II.B.3. List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information. For threats-related recovery criteria, please note which of the 5 listing factors\* are addressed by that criterion. If any of the 5-listing factors are not relevant to this species, please note that here.**

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\* A) Present or threatened destruction, modification or curtailment of its habitat or range;  
B) Overutilization for commercial, recreational, scientific, or educational purposes;  
C) Disease or predation;  
D) Inadequacy of existing regulatory mechanisms;  
E) Other natural or manmade factors affecting its continued existence.

No, there are no recovery criteria listed in the Recovery Plan, as discussed above in section IIB1.

## **II.C. Updated Information and Current Species Status**

### **II.C.1. Biology and Habitat**

A large part of what was known about the life history and ecology of the Lange's metalmark butterfly when the animal was listed in 1978 and when the recovery plan was published in 1984 was based on the published research of Dr. Richard Arnold and Dr. Jerry Powell (Powell 1978; Arnold 1978, 1983; Arnold and Powell 1983). Much of the biological information used in listing and for the recovery plan for the Antioch Dunes evening-primrose came from Roof (1969), Johnson (1978), Klein (1970), and personal communications with Klein. Information for the Contra Costa wallflower came from Roof (1969), Johnson (1978), and Howard (USFWS 1984). Since listing and publication of the Recovery Plan, a number of studies and surveys were conducted that updated various aspects of the biology of the three endangered Antioch Dunes species. The results of those studies are summarized in the paragraphs that follow.

#### **II.C.1.a. Abundance, population trends (e.g., increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:**

##### *Population Trends and Abundance:*

##### Lange's Metalmark Butterfly

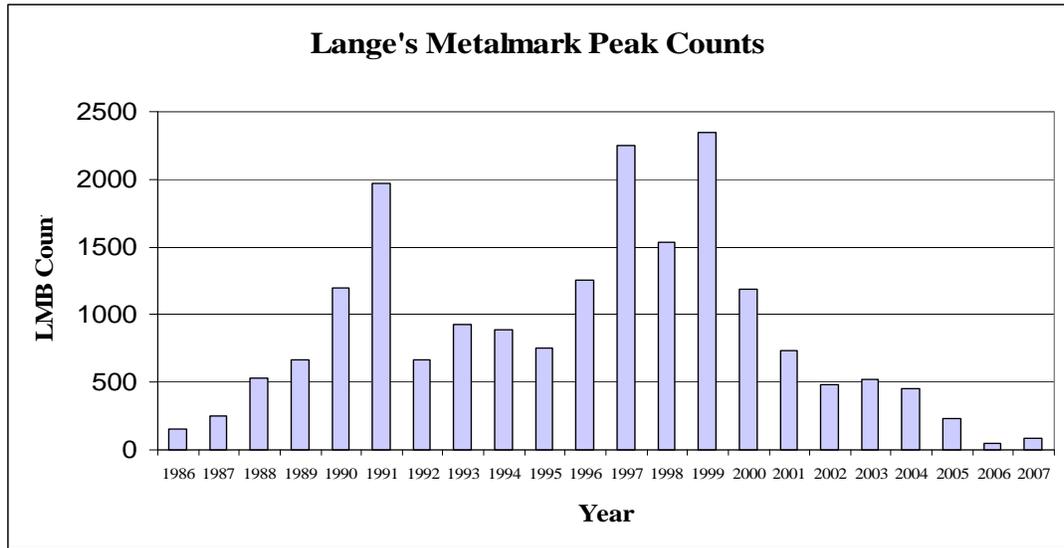
Since 1953 the Lange's metalmark butterfly has only been found within and immediately adjacent (within 150 yards) to the Antioch Dunes NWR boundaries, although the historic range may have included an area of dunes as far east as Oakley (5 miles east of the refuge) (Arnold 1980; USFWS 2007b). Typically, adult Lange's metalmark butterflies are found during annual summer surveys in patchy groupings closely associated with mature buckwheat stands at both the Stamm and Sardis Unit (USFWS 2002, 2007b). The two populations of butterflies inhabiting the two refuge units do not appear to readily fit into a mainland-island model of a metapopulation (where a central, large population serves as a source of colonists to inhabit outlying patches of habitat or satellites that are prone to extinction), although when the habitat supported a larger population this may have been the case (Ehrlich and Hanski 2004; R. Arnold, Entomological Consulting Services, pers. comm. 2008; G. Pratt, U.C. Riverside, *in litt.* 2007, 2008). Rather, the two populations appear to be functioning as separate populations consisting of fragmented groupings of individuals without a mainland or "mother" population and having only minimal gene flow between them (R. Arnold, pers. comm. 2008). The distance between the two units is less than a mile, and the habitat between the units is inhospitably covered in gypsum dust or industrial buildings; however unlikely it may appear, it is possible that some degree of gene flow does occur between the populations of the Lange's

metalmark butterflies as was observed 20 years ago during Dr. Arnold's mark-recapture studies where at least one marked individual traversed the gap between the two units (R. Arnold, pers. comm. 2008). Dr. Arnold found that the Lange's metalmark butterflies travel greater distances than other local species in the Lycaenidae family, with one male having been recorded traveling just over 1 mile (Arnold 1980). No study has since been accomplished to record either the dynamics of the two populations or gene flow between the two units.

Monitoring of the Lange's metalmark butterfly population by calculating the flight season "peak population count" from weekly visual counts has been continuously and annually completed at the Antioch Dunes NWR since 1986 (see figure 1 below and USFWS 2007b). Previously, population monitoring was conducted using a mark-recapture method for 8 years during the period of 1977 to 1983 (Arnold 1983; USFWS 2002). However, the two survey methods do not give comparable results and only peak count surveys are continuing at this time (USFWS 2002). Surveys are conducted by five to ten staff and trained volunteers over a seven-week period from early August to late September every year (USFWS 2006b). Results from these surveys reveal a large fluctuation in total butterfly numbers from year to year. Large fluctuations in the population of some butterfly species inhabiting Mediterranean climates caused by larval or pupal diapause (prolonged existence in a life stage) have been found to be specific adaptations to survive prolonged drought; however, although diapause is a possible explanation for the Lange's fluctuations in populations, it has by no means been sufficiently studied (Powell 1986). Examples of the fluctuations are apparent in reviewing the survey results: in 1986 the peak numbers for the Lange's metalmark butterfly were just over 120; five years later in 1991 the numbers increased to almost 2,000; in 1995 the numbers dropped to about 750; and in 1999 the peak count of butterflies reached the highest level ever recorded at 2,342 butterflies (USFWS 2006b). Since 1999, however, the total numbers have consistently decreased, and in 2005 a total peak count of only 232 butterflies was counted, which alerted Antioch Dunes NWR staff to contact professional lepidopterists to assess the cause of the decrease.

In the summer of 2006, Dr. Jerry Powell (University of California (U.C.) Berkeley) and Dr. Travis Longcore (The Urban Wildlands Group) separately visited the Antioch Dunes NWR to assess the habitat condition as it might affect the Lange's metalmark butterfly. Both consultants agreed that the apparent cause of declining butterfly numbers was due to invasive grasses and weedy plants that grow so thickly throughout the refuge that the butterfly's host plants are being suppressed, particularly by winter vetch (*Vicia villosa*) (USFWS 2007a). The peak count survey in that same summer of 2006 revealed an even greater decrease in peak numbers, with only 45 individuals counted during the peak of the survey period (USFWS 2007). The peak count in 2007 revealed 89 adult individuals, showing a continuation of extremely low adult emergence. The extinction of the Lange's metalmark butterfly is a marked possibility if restorative actions are not taken to increase the numbers and health of the butterfly's host plant (Arnold 1983; USFWS 2007a).

**Figure 1. Lange's metalmark butterfly peak counts since 1986.**



A census of the butterfly's buckwheat host plant was conducted between 1977 and 1985. Demographic shifts of both buckwheat plants and butterflies within management units (Sardis, Stamm, PG&E east, and PG&E west) at the Antioch Dunes NWR were recorded and provided sufficient evidence to correlate the size of the Lange's metalmark butterfly population with the density and health of the buckwheat stands (Arnold 1986). This was particularly notable at the Sardis Unit where a consistent annual decrease in observed habitat quality (marked by increasing cover with invasive weedy plants and decreasing number of host buckwheat plants) was concurrent with a decrease in the percentages of total Lange's metalmark butterflies caught at the Sardis Unit during the surveys (Arnold 1986). Similar habitat correlations were found in Massachusetts where the density of the frosted elfin butterfly (*Callophrys irus*) was shown to depend on the density of the host plant, wild indigo (*Baptisia tinctoria*) (Albanese et al. 2007). The wild indigo plant, like the naked stem buckwheat, grows in disturbed sandy habitat, which is being threatened by changes in land use and by the invasion of non-native plants. Further, the study demonstrates that the extent of non-native plant cover indirectly affects butterfly density by having a direct negative effect on the host plant, a situation very similar to that at the Antioch Dunes NWR (Albanese et al. 2007).

Because of the dramatic population decline noted during the 2005 and 2006 surveys, immediate and decisive action was taken to propagate and maintain a captive population of the Lange's metalmark butterfly in accordance with the recovery plan and the USFWS captive propagation policy (USFWS 1984, USFWS 2000, USFWS 2007a). A protocol specific for the Lange's metalmark butterfly was completed in July 2007, and during the end of the adult flight season a total of 9 females were captured and taken to two separate facilities in southern California, Moorpark College (Jana Johnson and Travis Longcore, Urban Wildlands) and Temecula (Dr. Gordon Pratt, U.C. Riverside), where over 300 eggs were oviposited on potted nursery cultivated host plants (provided through

partnership with the San Diego Zoological Society and the San Francisco Bay NWR). In the winter of 2007-2008 larvae began emerging from eggs at both locations. A re-introduction or release protocol is contracted for completion by the end of May 2008 and is intended to direct the efforts for maintaining a captive butterfly stock and for releasing a portion of the individuals back to the wild.

In summary, when the subspecies was listed, the Federal Register listing indicated that there were an undetermined number of populations inhabiting a few acres north of Wilbur Road (presumably within the refuge). Currently, the Lange's metalmark butterfly is known to exist as two populations, one at the Stamm and one at the Sardis Unit of the Antioch Dunes NWR. These populations have been found to be capable of some degree of genetic exchange in the past, but it appears doubtful that there is a significant gene flow presently. The overall population trend for the species has fluctuated greatly since listing at both units; however, the trend has shown a significant overall consistent decrease since 1999 and has not yet given an indication of stability or recovery. Population sizes of Lange's metalmark butterflies were shown to be correlated to the health and density of host plants, as seen in other species of butterflies. The imminent threat of extinction led to the decision to perform captive propagation of the butterfly.

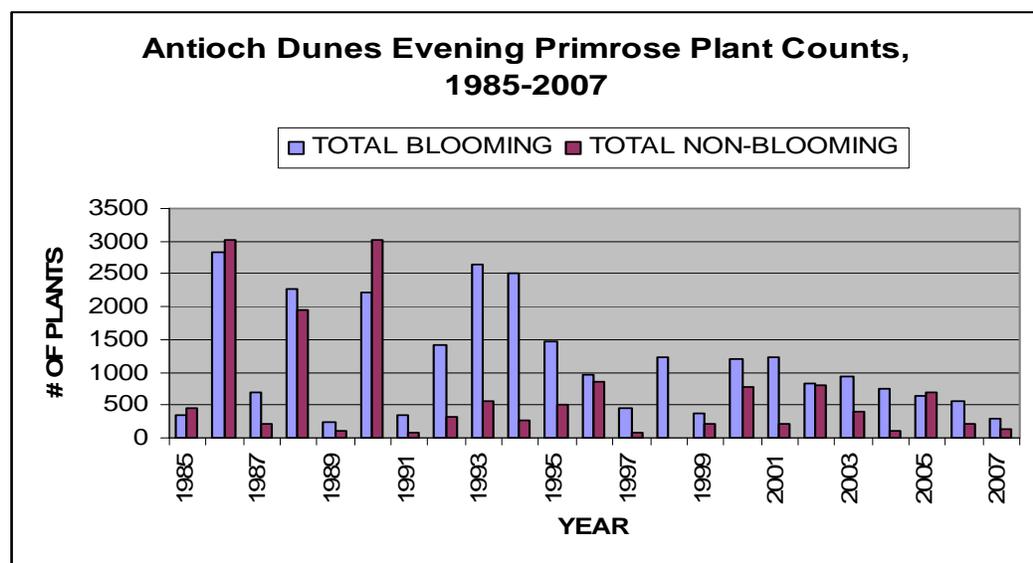
#### Antioch Dunes Evening-Primrose

The two endangered plants have also been continuously surveyed by refuge biologists since 1984. Surveys for the Antioch Dunes evening-primrose are conducted during their peak blooming time in May. Blooming and non-blooming plants are counted separately. From 1984 to 1991, total count surveys were conducted every other year at the Stamm Unit (where the majority of Antioch Dunes evening-primrose are growing), while rough estimates from transects were performed during the odd years (USFWS 2002). The estimates proved to under-represent the total population and, after a dramatic population decline in 1991, total count surveys were performed every year thereafter (USFWS 2002). The population of Antioch Dunes evening-primrose was apparently stable from 1984 until 1992 at between 4,000 and 5,000 individuals (acknowledging that low counts on odd years are under-estimates). However, the 1992 count revealed a decrease to less than 2,000 individuals. This prompted out-planting of nursery grown seedlings at the Antioch Dunes NWR, which appeared to favorably reverse the declining population and kept the population at between 2,000 and 3,000 individuals until 1997, when another dramatic decline occurred. In 1997 the total count revealed about 455 plants, the lowest number of Antioch Dunes evening-primrose counted during an overall 11-year downward population trend (USFWS 2002).

Since the 1997 decrease, the Antioch Dunes evening-primrose total counts have again fluctuated year to year but reflect an overall decreasing trend up to 2006, when a total of 776 plants were counted at all locations (See figure 2 below and USFWS 2006c). The latest survey completed in the 2007 season showed the continuation of a decline in Antioch Dunes evening-primrose numbers, with only 400 individual plants for both units combined (this number does not include the

Kemwater property, which appeared to have fewer than 50 plants at the time of the survey). (S. Euing, USFWS, pers. comm., 2007; USFWS 2007c). The decreasing trend is particularly notable at the Sardis Unit where out-planting survival is minimal after 3 years and natural germination is significantly hindered by invasive plant cover (USFWS 2006c). Although the Antioch Dunes evening-primrose population appears to be stable at the Stamm Unit, it is not yet a self-sustaining population in that natural germination is virtually eliminated by the intrusion of non-native invasive plants, making artificial out-planting of seedlings and consistent management a necessary measure to maintain the stable population (USFWS 2006c).

**Figure 2. Antioch Dunes evening primrose annual counts since 1985.**



Small occurrences of Antioch Dunes evening-primrose are still found at properties abutting the Sardis Unit (PG&E West, Georgia-Pacific, PG&E East including Kemwater). Antioch Dunes evening-primrose was successfully out-planted in 1978 at Brown’s Island, adjacent to the Antioch Dunes NWR, and earlier at Brannan Island State Recreational Area. These two sites are not regularly surveyed. The last formal survey at Brennan Island occurred in 1989 (Brannan Island State Recreation Area 1989), and the three occurrences there appeared to be successfully self-sustaining with a total of 702 plants (Brannan Island State Recreation Area 1989). Antioch Dunes evening-primrose is still present at Brannan Island although numbers of individual plants have significantly decreased since the last survey in 1989. A late spring 2007 survey conducted by Service biologists at Brannan Island revealed that there were 84 total individual plants. This occurrence of Antioch Dunes evening-primrose is protected by fencing, but this protection has reduced disturbance (in the form of foot traffic and mowing) to the area and allowed the overgrowth of invasive annual grasses to compete for space with the Antioch Dunes evening-primrose. Previously, the area was routinely mowed and this disturbance and elimination of grasses appeared to allow the maturation of the Antioch Dunes evening-primrose

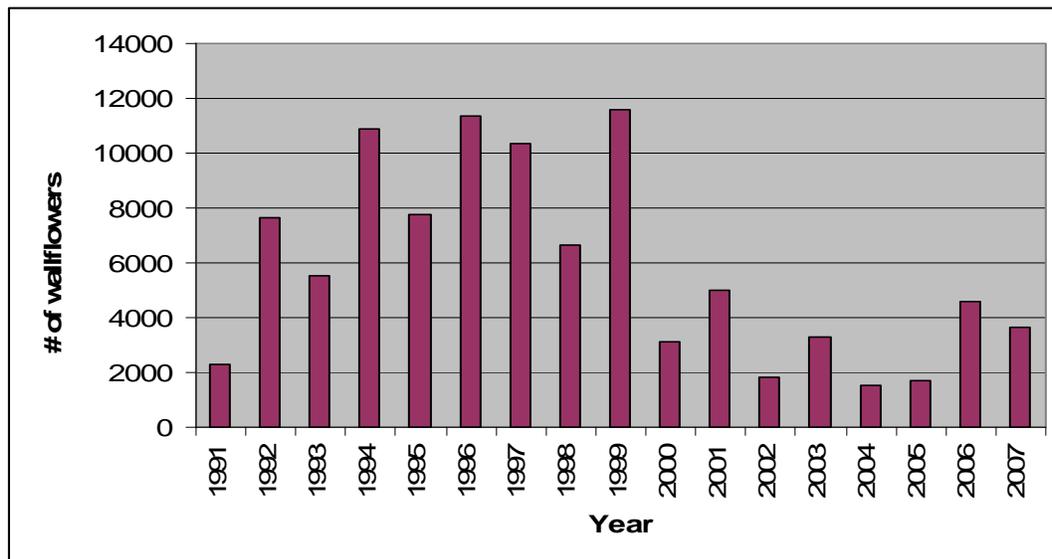
occurrences. Antioch Dunes evening-primrose was also growing well in the area where the sandy soil next to the boardwalk was routinely disturbed by human traffic (S. Walters, State of California Department of Parks and Recreation, pers. comm. 2007; D. Blankinship, California Department of Fish and Game, pers. comm. 2007).

In summary, when the subspecies was listed, only 15 acres of the original 500-acre dune habitat was remaining and there was a population of 872 flowering plants and 376 small plants just within the single occurrence at the Sardis Unit. The populations of other occurrences at the Stamm Unit, and introduced colonies at Brannan and Brown Island, were not counted. Currently, there are 3 major known occurrences consisting of about 500 total individuals. The overall population of the primrose does not appear to be stable and self-sustaining, while the trend in the population dynamic has been declining since listing.

#### Contra Costa Wallflower

The Contra Costa wallflower is counted during its peak blooming period, usually in April. Total counts were conducted annually since 1984. The overall trend from 1984 to 1999 was increasing with 11,564 plants counted in 1999, which represents the highest number of individual plants counted since the surveys began, and was attributed to exceptionally high rainfall during that year (USFWS 2002). However, the 2000 survey revealed a dramatic decrease from over 11,000 individuals to 3,127 individuals, the overall trend reversed and decreased until the last survey performed in 2006. The 2005 count was 1,681 individual plants, while the 2006 count revealed a significant increase to a total of 4,581 individuals (USFWS 2006d). This new increase in the Contra Costa wallflower population is attributed to favorable climatic conditions (increase in precipitation in winter 2005-2006) and restoration efforts (out-planting success, seeding methods) (USFWS 2006d). However, the latest survey in April 2007 revealed a slight decrease from the previous year to 3,641 total individual plants (see figure 3 below) (S. Euing, pers. comm. 2007; USFWS 2007d).

**Figure 3. Contra Costa wallflower annual plant count since 1991.**



In summary, when the species variety was listed, only ten percent of the original riverine dune habitat remained and a single occurrence of Contra Costa wallflower inhabited the remaining dunes consisting of a total of about 28 individual plants. Currently, there is a single occurrence consisting of approximately 4,000 total individuals. The overall population trend for the species has been somewhat stable since listing; however, the populations are not yet considered self-sustaining because of the negative effects of the invasive grasses and forbs which continue to reduce the availability of optimal open habitat.

*Population Stabilization Methods:*

Seeds from the Antioch Dunes evening-primrose, Contra Costa wallflower, and buckwheat host plants for Lange's metalmark butterfly are collected by Antioch Dunes NWR staff during maximum fruiting from May through October and stored until planting (potted) in nurseries. Nursery stocks of Antioch Dunes evening-primrose, Contra Costa wallflower, and the naked stem buckwheat have been maintained since 2000. The nursery for Antioch Dunes evening-primrose and Contra Costa wallflower is operated by refuge staff and is located at the San Francisco Bay NWR greenhouse, while the buckwheat is grown at the privately owned, commercial North Coast Native Nursery in Petaluma. Nursery stock is drawn upon for out-planting only when restoration efforts have been completed and open sandy areas are available. Directly sowing seed mixtures of these three plants and other native plants at the Antioch Dunes NWR has also proven successful when sown in restored sandy habitat (USFWS 2006c, 2006d). Removing coyote brush (*Baccharis pilularis*) promotes the growth of buckwheat plants and also allows direct sunlight to stimulate the growth of Contra Costa wallflowers that are otherwise shaded by the cover of the coyote brush (USFWS 2006d). Recent out-planting of Antioch Dunes evening-primrose, Contra Costa

wallflower, and buckwheat has proven to be initially successful. As an example, many Contra Costa wallflower seedlings planted in February 2007 were already established and blooming in late March 2007 (S. Euing, pers. comm. 2007). As insurance against possible extinction due to some catastrophic event, seeds are periodically sent to the collection of the Rancho Santa Ana Botanic Garden in eastern Los Angeles County (USFWS 2005).

**II.C.1.b. Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):**

Genetic research completed by both Dr. Powell and Dr. Arnold (1983) and by Dr. Arnold alone (1983, 1986) has revealed the advent of genetic related problems (deleterious genetic phenomena) in the Lange's metalmark butterfly population at the Antioch Dunes NWR. These problems are discussed in detail in the five-factor analysis section (Factor E) below.

No genetic studies have been performed on the Contra Costa wallflower or the Antioch Dunes evening-primrose since listing.

**II.C.1.c. Taxonomic classification or changes in nomenclature:**

There have been no changes to the taxonomy of the Lange's metalmark butterfly since the butterfly was first described in 1938 by John Adams Comstock. The Lange's metalmark butterfly is a subspecies of the Mormon metalmark butterfly (*Apodemia mormo*). The Mormon metalmark is distributed throughout the western United States and northwestern Mexico. Mormon metalmarks are members of the family Riodinidae (Opler and Wright 1999).

Neither the Antioch Dunes evening-primrose nor the Contra Costa wallflower have been subject to any taxonomic changes since listing (Hickman 1993).

**II.C.1.d. Spatial distribution, trends in spatial distribution (e.g., increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g. corrections to the historical range, change in distribution of the species' within its historic range, etc.):**

The distribution and range of all three Antioch Dunes species have changed little since listing. The Lange's metalmark butterfly, as described earlier, has shifted its population dense areas within the Antioch Dunes NWR corresponding to the availability of host plants that are not encumbered by invasive plant overgrowth (Arnold 1986). Distributions and abundances of host plants for the Lange's metalmark butterfly should increase annually with implementation of the refuge's restoration effort (USFWS 2007a).

### **II.C.1.e. Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):**

In 1908, records indicate that the bulk of the unique riverine dune habitat at Antioch was approximately one-sixth of a mile wide and amounted to 190 acres (Howard and Arnold 1980). Today Antioch Dunes NWR consists of approximately 67 acres of remnant dune habitat, most of which is covered by non-native grasses and forbs (USFWS 2007a). The Antioch Dunes NWR is the only protected remnant dune habitat from the 190 acres recorded in 1908. Sand has been imported on several occasions to assist in the recovery of the habitat. In 1991, PG&E assisted the Service in transporting sand into the refuge and by May of 1992, about eight thousand cubic yards of sand was placed over an area of approximately 4.5 acres (1.18 acres in Stamm unit and 3.33 acres in Sardis unit) sculpted by tractors into dune-like hillocks to create new dune habitat (Thelander 1994; USFWS 2002). By 1993, native plants had been planted on all of these new dunes. However, invasive non-native grasses and forbs have consistently established themselves over the past decades over the entire refuge landscape, with a noted increase in proliferation during the last decade (see section IIC.).

The Recovery Plan (USFWS 1984) describes specific habitat associations for the three endangered species at the Antioch Dunes. Basic habitat associations for the three Antioch Dunes species is described in section II (Species Descriptions). As previously mentioned, in the absence of continuous aggressive maintenance, these invasive plants degrade the quality of open dune habitat that supports the three Antioch Dune species (USFWS 2007a).

#### Lange's Metalmark Butterfly

Within the Antioch Dunes NWR, the Lange's metalmark butterfly population size is correlated with the density and health of the stands of its buckwheat host plant (Arnold 1986). The buckwheat host plants, in turn, require adequate sandy soil free of the overgrowth of invasive weedy plants and grasses.

#### Antioch Dunes Evening-Primrose

Many evening-primrose species generally prefer to grow in nearly pure sand and can be regarded as psammophytes (sand-loving plants). Roof (1969) determined that, under cultivation, the Antioch Dunes evening-primrose seedlings will only re-establish within areas with depositions of new sand and this, he speculated, was due to the depletion of scarce nutrients in sandy areas previously occupied by earlier generations of the Antioch Dunes evening-primrose (USFWS 1984). However, Bruce Pavlik's (1979) research with Eureka Dunes (Inyo County) evening-primrose species revealed that germination of psammophytes depends on the optimal coincidence of three factors: burial depth, moisture, and critical temperature regime (Pavlik 1979). This idea is supported by observations that disturbances to areas of the Antioch Dunes NWR, like disking, tend to produce numerous evening-primrose seedlings without sand refreshment (USFWS 1984). Greene (1995) found that the Antioch Dunes evening primrose does not readily

propagate when surrounded by non-native weedy plants and determined that removing weeds around the primrose plants enhanced germination. A study by Jones & Stokes Associates in 2000 compared soil taken from areas at the Antioch Dunes NWR supporting healthy populations of Antioch Dunes evening-primrose and Contra Costa wallflower to soil taken from areas where these plants were not supported. The study found that soil conditions supporting the rare plants did not differ from non-supporting soils in nitrogen content, as expected, but differed in the percentage of organic matter present (USFWS 2002). Apparently, non-native plants cannot survive and cannot compete with endemics in the nutrient poor and highly permeable sandy soil in which endemic plants thrive (USFWS 2002).

### Contra Costa Wallflower

Most Contra Costa wallflowers are found on north-facing slopes (USFWS 1984, 2005). Contra Costa wallflower was described as the most adaptable of wallflowers to be cultivated at the Botanic Garden at Tilden Regional Park, and was found to grow tolerably well without periodic sand refreshment in cultivation (USFWS 1984). Apparently, the Contra Costa wallflower does not require sandy soil conditions to grow in a controlled garden environment. However, the overall soil related factors necessary for Contra Costa wallflower to establish in the wild are not known (USFWS 1984).

## **II.C.2. Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms**

### **III.C.2.a. Present or threatened destruction, modification or curtailment of its habitat or range:**

When first listed in 1976 and 1978 the primary threat identified for the three species was the alteration of habitat from industrial and agricultural development (USFWS 1976, 1978a). This included sand mining, conversion to vineyards, and disking soil for maintenance. In addition, dust from the Georgia-Pacific gypsum plant adjacent to the Antioch Dunes NWR was considered a threat. The Georgia-Pacific industrial gypsum processing plant that is situated on river-front property between the Stamm and Sardis Units produces air-borne gypsum dust from various activities. The dust was believed to threaten the plants at the Antioch Dunes NWR not only because of the layers of dust that build up on the plants may reduce the exposure to sunlight and decrease photosynthesis, but also because the changes in soil composition that accompany the addition of gypsum minerals (calcium and sulfates) may affect the growth of plants (USFWS 2002). There is currently no evidence that the gypsum dust is adversely affecting any of the three species; however, Moorpark Zoo is conducting trials on the effect of the gypsum dust on butterfly larvae of a species closely related to Lange's metalmark, the Behr's metalmark butterfly (*Apodemia virgulti*). At least one study demonstrated that dusts may adversely increase transpiration through the cuticle of insect larvae and cause desiccation and abrasion of the cuticle (Wigglesworth 1944). Verbal agreements with Georgia-Pacific allow access to their property for species

surveys, and annual meetings with the Georgia-Pacific representatives and Antioch Dunes NWR staff have conveyed to the company the possible negative effects of the gypsum dust on the refuge plants and the butterfly. As a result, Georgia-Pacific has made attempts to reduce airborne gypsum dust beyond the standards for air pollution control by keeping the gypsum wetted down when possible during production activities. Refuge staff have noted that gypsum dust settles primarily on the Sardis unit and that the efforts of Georgia-Pacific to further reduce airborne gypsum dust is notable, but the dust still is entering the unit. (C. Smith, pers. comm., 2008).

Since listing the following additional threats were identified:

*Recreation and Pedestrian Traffic:* Even after being established as a National Wildlife Refuge in 1980, public use of the Antioch Dunes NWR had a large negative impact on the three species. This occurred in the form of trampling due to the heavy foot traffic crossing over the refuge, and an occasional wildfire inadvertently set during illegal camping use of the Antioch Dunes NWR. Foot traffic was excessive and existing plants were directly damaged by being stepped on and torn. This trampling is not beneficial to individual plants although the disturbance may improve some habitat characteristics, such as damaging invasive plants. Off-road vehicle use of the dunes was reported to have caused a reduction in host buckwheat plant numbers also (Arnold 1978). These problems were significantly reduced when a gated, chain-link fence was installed in 1986, although occasional wildfires still occur at the refuge (USFWS 2002). Recreational use of the Antioch Dunes NWR and pedestrian traffic are no longer considered to be significant threats. The Antioch Dunes NWR is not continuously monitored by staff or law enforcement agents. Trespassers still illegally access the refuge and inadvertently trample rare plants (USFWS 2002); however, a bigger threat from trespassing is from inadvertently started wildfires (see below). On several occasions a trespasser's campfire was found by USFWS investigators to have started wildfires (L. Terrazas, *in litt.* 2007).

*Wildfires:* The Lange's metalmark butterfly life history is closely tied with the host buckwheat plant. At any time of the year one of the butterfly's life stages can be found in or around the host plant (Arnold 1980). This makes the butterfly particularly susceptible to wildfires, which mainly occur during the summer and fall when the butterfly may be in either the late-instar larval form, the pupal form at the base of the dried leaves of the host plant, as adults depending on a few species of flowering plants for nectar, or as eggs attached to leaves (USFWS 2002). Likewise, the Contra Costa wallflower and Antioch Dunes evening-primrose are perennial plants that have life stages vulnerable to fire. This includes the period from germination during the beginning of the wet season in December through the deposition of seeds in mid-summer. Historical evidence, however, indicates that the native plants may recover rather quickly from a wildfire, while the Lange's metalmark butterfly is more seriously affected (USFWS 2002; S. Euing, *in litt.* 2007; L. Terrazas, *in litt.* 2007).

The occurrences of wildfires at the Antioch Dunes NWR have been tracked and recorded since 1980, including date, location, acreage affected, and best determination of the cause of the wildfire (USFWS 2002; L. Terrazas, *in litt.* 2007). At least 25 wildfires were recorded since 1980 that were started either by accident or by acts of arson, and the average acreage burned from these wildfires was 3.72 acres per fire. Although the number of annual wildfires has decreased since the installation of the chain-link fence around the refuge and the prohibition of camping and campfires, we consider the deleterious effects of any fire as a threat primarily to the Lange's metalmark butterfly. Examples of the damages caused by wildfires include:

1. A wildfire at the PG&E east tower site at the Sardis Unit in 1976 destroyed most of the butterfly larvae and much of the buckwheat stand (USFWS 1984). The burned area was eventually recolonized by Lange's metalmark butterfly after the host buckwheat plants resprouted and matured. However, at that time the population of the butterfly was estimated to be about 400 individuals with the majority of butterflies densely inhabiting the unaffected Stamm Unit (Arnold 1980). With the current population distribution and low numbers of butterflies a single wildfire like this one could have a more serious and lasting effect.
2. The most recent wildfire occurred in the summer of 2006 that was started by an unknown cause adjacent to the outside railroad and fence boundary at the southeastern portion of the Stamm Unit. It appeared that the fire may have been ignited by sparks from a passing train. This fire destroyed nearly 11 acres including areas with buckwheat stands very close to the area where the highest numbers of butterflies were counted in the surveys during 2006 (USFWS 2007). The numbers of butterflies in this area was much lower in 2007, and after one year the area is already repopulated with non-native grasses and filaree (*Erodium* sp.) (USFWS 2007b; L. Terrazas, *in litt.* 2007).

Wildfires are still considered a serious threat to the Lange's metalmark butterfly, especially during summer months when a substantial portion of Lange's metalmark butterfly habitat is surrounded by dried thatch and many individual butterflies in any life stage (larvae or adults) could quickly be destroyed. With the recent decline in population size and the currently limited distribution of this butterfly, a single wildfire could have devastating effects to the butterfly if it were located in the densely populated area of the Sardis Unit.

*Invasive Plants:* Invasive plants have been recorded as one of the primary threats to all three species, primarily because the ultimate result of invasive plants is loss of habitat (USFWS 2002). The proliferation of non-native invasive plants has been increasingly rapid over the last decade, a phenomenon that can be observed in comparing successive historical photos of the Antioch Dunes NWR. The invasive plant infestation is so widespread now that there is not one section of the Antioch Dunes NWR where non-native plants can not be found, with heavy and choking coverage of these non-natives being common. The most common

invasive non-native grasses and forbs found at the refuge include rip gut brome (*Bromus diandrus*), winter vetch, (*Vicia villosa*), and star thistle (*Centaurea solstitialis*) (USFWS 2007a). The problems created by these plants are complex and inter-related; these plants grow very quickly and out-compete the native plants for sunlight, space, moisture, and nutrients (USFWS 2002). These invasive plants also stabilize what remains of the sand dune ecosystem, in effect, eliminating the natural disturbance regime caused by the wind shifting the sandy environment in which the Antioch Dunes evening-primrose, Contra Costa wallflower, and the Lange's metalmark butterfly host buckwheat plants thrive. Winter vetch, in particular, degrades the dune habitat because the roots fix nitrogen; therefore, this plant further promotes the growth of invasive plants. Other negative effects of the invasive plants include:

A decrease in nectar sources: These include the host buckwheat plant, as well as Douglas ragwort (*Senecio douglasii*) and divergent snakeweed (*Gutierrezia divergens*). These native plants also suffer from the overgrowth of invasive plants, as described previously, in that they will not re-establish without suitable open, sandy soil conditions (USFWS 1984). The lack of nectar plants for the Lange's metalmark butterfly is considered a threat to this species and is tied directly to the threat caused by invasive plants.

Lack of pollinators: The invasion of non-native grasses and forbs has significantly reduced the open area available for the propagation of native plants and apparently has resulted in a decrease in the density and diversity of native plants, including the endemic species (USFWS 2002). As a result, it was believed that the lack of specialized pollinators caused by the lack of plant diversity could, in turn, result in degradations in seed production and viability in the Antioch Dunes evening-primrose (USFWS 2002). Recent surveys for the Lange's metalmark butterfly have incidentally revealed a variety and abundance of bee and fly species that are apparently serving as pollinators for many flowering plants (S. Euing, *in litt.* 2007). However, no studies have been conducted to identify that there exists the requirement for specialized pollinators for the primrose or that there is a reduction in diversity of plant species. Thus, this threat remains only a possible threat to the evening primrose.

Past efforts to eradicate non-native invasive plants have had only temporary success because shortages of funding and trained personnel prevented a consistent and concerted effort (USFWS 2007a). Recently, a more aggressive eradication effort is underway, which includes removal of stabilized top soil with a small tractor to expose the underlying sandy substrate. Use of herbicides is relegated to areas where none of the three listed species is found (USFWS 2007a). In February 2008 three sections of the southern portion of the Stamm Unit, which had previously been covered with a vineyard, were fenced to produce three equal-sized enclosures. These enclosures will be used in a study by a graduate student from U.C. Berkeley to test the effects of two grazing regimes on controlling invasive plants. This area is devoid of the listed plants although there is one stand

of buckwheat host plant that is now protected by a secondary fence. Cows will be used in the grazing experiment (L. Terrazas pers. comm. 2008).

**II.C.2.b. Overutilization for commercial, recreational, scientific, or educational purposes:**

Illegal take of the Lange's metalmark butterfly was not considered a serious threat when the species was listed in 1976 and when recovery plan was written in 1984 (USFWS 1976, 1984). There is no mention of any poaching activities at the Antioch Dunes NWR for any of the three Antioch Dunes species in the recovery plan (USFWS 1984). However, illegal take of the Lange's metalmark butterfly is considered a present-day threat. This is primarily due to the finding that small populations of moths and butterflies are vulnerable to harm from collection of adults (Gall 1984). A population may be reduced below sustainable numbers by removal of females, reducing the probability that adults will find mates (Allee effect) and that new colonies will be founded. The Lange's metalmark butterfly now is particularly vulnerable by loss of females to collection, because females fly for longer periods than males in search of egg-laying sites (USFWS 1984). Collectors may not always realize they are depleting colonies of butterflies or moths to below threshold limits for the survival or recovery of the colony (Collins and Morris 1985). Adult specimens of this species are highly valued by private collectors, and an international market exists for illegally collected specimens, as well as other listed and rare butterflies (Ehrlich 1984; Collins and Morris 1985; U.S. Attorney's Office 1994). One collector, who later pleaded guilty to violation of the Lacey Act, captured and killed a Lange's metalmark butterfly in the early 1980s and traded the specimen to another collector (U.S. Attorney's Office 1994, C.D. Nagano, USFWS, pers. comm., 2007).

**II.C.2.c. Disease or predation:**

Although several insect species were mentioned as capable of causing damage to the plant species, disease and predation were not believed to present a serious threat to any of the three Antioch Dunes species at the time of listing (USFWS 1976, 1978a), or when the recovery plan was written (USFWS 1984). It still does not appear that predation or disease pose a major threat to any of the three Antioch Dunes listed species. However, the following predators are known to exist; excessively destructive infestations by any of these insects have not been recorded at the Antioch Dunes NWR, yet remain a possible threat:

Lange's metalmark butterfly: Arnold (1980) found that larvae of the Lange's metalmark butterfly were parasitized by tachinid flies (Tachinidae, order Diptera) and by parasitic wasps (Braconidae and Encyrtidae, order Hymenoptera).

Antioch Dunes evening-primrose: Up to 50 percent of the Antioch Dunes evening-primrose population was infested with small mirid bugs (family Miridae of the insect order Hemiptera) in the early 1980s (USFWS 1986). Although these bugs were controlled by

application of tobacco solution, a similar infestation remains a threat to both the Antioch Dunes evening-primrose and the Contra Costa wallflower. The most damaging insect pest known that can predate Antioch Dunes evening-primrose is the chrysomelid beetle (family Chrysomelidae) in the genus *Altica*, commonly called the “flea beetle” (USFWS 2002).

Contra Costa wallflower: There are three moths that are known to predate on Contra Costa wallflower: A fairy moth (*Chalceopla simpliciella*), an egg-eating moth (*Calculus* sp.), and the diamond back moth (*Plutella xylostella*).

#### **II.C.2.d. Inadequacy of existing regulatory mechanisms:**

When listed there were no regulatory mechanisms protecting any of the three Antioch Dunes species (USFWS 1976, 1978a, 1984). Since listing there have been several regulatory mechanisms for the protection of the species.

#### **Federal Protections**

**Endangered Species Act:** The Endangered Species Act of 1973, as amended (Act), is the primary Federal law that provides protection for the Lange’s metalmark butterfly, Antioch Dunes evening-primrose, and Contra Costa wallflower. Since the designation of these three species as endangered in 1976 and 1978, several projects have undergone review under section 7 of the Act. These projects were considered beneficial to all three species as they involved implementation of management activities and restoration activities outlined in the recovery plan and the conservation plan (USFWS 1984, 2002, 2007a).

**The Lacey Act:** The Lange’s metalmark butterfly is protected by the Lacey Act (P.L. 97-79), as amended in 16 U.S.C. 3371. The Lacey Act makes unlawful the import, export, or transport of any wild animals whether alive or dead taken in violation of any U.S. or Indian tribal law, treaty, or regulation, as well as the trade of any of these items acquired through violations of foreign law. The Lacey Act further makes unlawful the selling, receiving, acquisition or purchasing of any wild animal, alive or dead. The designation of “wild animal” includes parts, products, eggs, or offspring.

**Clean Water Act:** Section 404 of the Clean Water Act may afford some protection to Antioch Dunes evening-primrose and Contra Costa wallflower. The U.S. Army Corps of Engineers (Corps) issues permits for the discharge of dredged or fill material into navigable waters of the United States. The Corps interprets “the waters of the United States” expansively to include not only traditional navigable waters, but also other defined waters that are adjacent or hydrologically connected to traditional navigable waters. Before issuing a 404 permit to a project applicant that may affect federally listed species, the

Corps is required under section 7 of the Endangered Species Act to consult with the Service.

**National Wildlife Refuge Designation:** Since designation of the Antioch Dunes NWR in 1980, all three of the Antioch Dunes species have been located primarily within the boundaries of the refuge. The designation as a National Wildlife Refuge gives the species located within refuge boundaries a certain degree of protection mandated by Executive Order 12996 (Management and General Public Use of the National Wildlife Refuge System, 1996), the National Wildlife Refuge System Administration Act (1966), and the Refuge Recreation Act (1962, amended 1966).

**Executive Order 12996:** This Executive Order for Management and several Public Use of the National Wildlife Refuge System was signed by President Clinton on March 25, 1996. This Executive Order set new direction and ensured new opportunity for wildlife-dependent recreational uses. Executive Order 12996 accomplished several important firsts for the System:

1. For the first time, this Executive Order defined a conservation mission for the Refuge System to preserve a national network of lands and waters for the conservation and management of the fish, wildlife, and plants of the United States for the benefit of present and future generations. This mission sets the National Wildlife Refuge System apart from all other Federal lands.
2. The Executive Order defined six compatible wildlife-dependent recreational activities (hunting, fishing, wildlife observation, photography, environmental education and interpretation) as priority uses of the System, and directed the Secretary to provide expanded opportunities for these activities.
3. The Executive Order defined four guiding principles for management of the System: habitat conservation, public use, partnerships, and public involvement. Of these, the conservation of habitat is the foundation upon which all sustained use is dependent.
4. The Executive Order directed the Secretary of the Interior, in carrying out trustee and stewardship responsibilities, to undertake several actions in support of management and public use of the System.
5. The Executive Order also directed the Secretary to ensure that the biological integrity and environmental health of the system are maintained and that the system grows in a manner that supports its mission.
6. The Executive Order provided for the identification of existing wildlife-dependent uses that will continue to occur as lands are added to the system.

**The National Wildlife Refuge System Administration Act:** This Act serves as the “organic act” for the National Wildlife Refuge System; it consolidated the various categories of lands administered by the Secretary of the Interior through the Service into a single National Wildlife Refuge System. The Act establishes a unifying mission for the Refuge System, a process for determining compatible uses of refuges, and a requirement for preparing comprehensive conservation plans. This Act states first and foremost that the mission of the National Wildlife Refuge System be focused on wildlife conservation. This Act identifies six priority wildlife-dependent recreation uses, clarified the Secretary’s authority to accept donations of money for land acquisition, and placed restrictions on the transfer, exchange or other disposal of lands within the Refuge System. Most importantly, this Act reinforces and expands the “compatibility standard” of the Refuge Recreation Act (see below). The Refuge Administration Act authorizes the Secretary to “permit the use of any area within the System for any purpose, including but not limited to hunting, fishing, public recreation and accommodations, and access whenever he [or she] determines that such uses are compatible with the major purposes for which such areas were established”.

**Refuge Recreation Act:** The Recreation Act requires that any recreational use on areas of the National Wildlife Refuge System be “compatible” with the primary purpose(s) for which the area was acquired or established. Because the Antioch Dunes NWR was established for the protection of Lange’s metalmark butterfly, Antioch Dunes evening-primrose, and Contra Costa wallflower, any recreational activity allowed at the refuge cannot interfere with the efforts to restore self-sustaining populations of these listed species. Currently, the only recreational use of the refuge is for docent-led educational tours.

### **State and Local Protections**

**The California Endangered Species Act (CESA):** The California Endangered Species Act (California Fish and Game Code, section 2080 *et seq.*) does not provide protection to insects (sections 2062, 2067, and 2068, California Fish and Game Code). However, the Antioch Dunes evening-primrose and Contra Costa wallflower are both listed as endangered under CESA. In addition to CESA, the State’s authority to conserve plants is comprised of three other pieces of legislation: the Native Plant Protection Act (NPPA, Division 2, Chapter 10, section 1908), the California Environmental Quality Act (CEQA), and the Natural Community Conservation Planning Act (NCCPA) (Tibor 2001).

Antioch Dunes evening-primrose and Contra Costa wallflower were state-listed as endangered in 1978. CESA and NPPA prohibit the unauthorized take of State-listed threatened or endangered plant species. Unlike the take prohibition in the Federal Endangered Species Act, the State prohibition includes plants; however, landowners are exempt from this prohibition for plants taken through habitat modification.

**The California Environmental Quality Act (CEQA):** The CEQA (chapter 2, section 21050 *et seq.* of the California Public Resources Code) requires government agencies to consider and disclose environmental impacts of projects and to avoid or mitigate them where possible. Under CEQA, public agencies must prepare environmental documents to disclose environmental impacts of a project and to identify conservation measures and project alternatives. Through this process, the public can review proposed project plans and influence the decision-making process through public comment. However, CEQA does not guarantee that such conservation measures will be implemented. Section 15065 of CEQA guidelines requires a finding of significance if a project has the potential to “reduce the number or restrict the range of a rare or endangered plant or animal” (including insects). Species that are eligible for listing as rare, threatened or endangered but are not so listed are given the same protection as those species that are officially listed with the State. Once significant impacts are identified, the lead agency has the option to require mitigation for effects through changes in the project or to decide that overriding considerations make mitigation infeasible. In the later case, projects may be approved that cause significant environmental damage, such as destruction of endangered species. Protection of listed species through CEQA is, therefore, at the discretion of the lead agency. CEQA provides that, when overriding social and economic considerations can be demonstrated, project proposals may go forward, even in cases where the continued existence of the species may be jeopardized, or where adverse impacts are not mitigated to the point of insignificance.

**County and City Ordinances:** The Service is not aware of any specific county or city ordinances or regulations that provide direct protection for the three Antioch Dunes species, although the city of Antioch provides some degree of outreach support (C. Smith, *in litt.* 2007).

**II.C.2.e. Other natural or manmade factors affecting its continued existence:**

When listed there were no threats identified under this category for the three Antioch Dunes species (USFWS 1976, 1978a). The following threats have since been identified:

*Extirpation due to low population numbers*

There are several important factors to consider in the management and recovery of rare species with population numbers that fall below a low threshold size. This appears to apply particularly to the Lange’s metalmark butterfly among the three Antioch Dunes NWR endangered species. The first factor is that, in general, rare species demonstrate decreased genetic variability or heterozygosity (Spielman et al. 2004). Another important factor is that any species existing in a small and geographically centralized population is threatened by extinction through

“stochastic” demographic fluctuations and other density-dependent effects (Avisé 2004). Following are more details of these considerations:

Loss of heterozygosity. The Service is concerned that the genetic integrity of the Lange’s metalmark butterfly, as well as the evening primrose and the wallflower, at the Antioch Dunes NWR may be compromised by their decreasing population sizes (USFWS 2007b, 2007c, 2007d). Small populations of organisms, both plant and animal, are at an increased risk of extinction (Avisé 2004; Spielman et al. 2004). The extinction risk is increased as a result of several factors, primarily that small or declining populations are subject to inbreeding (mating between closely related individuals) with a subsequent loss of genetic diversity or heterozygosity (a measure of genetic variation within a population) (Spielman et al. 2004). The following salient points apply to small or declining populations:

- Many, but not all, threatened or rare species are shown to have a significant decrease in genetic diversity (as measured by molecular markers) when compared to closely related taxa that are more common (Frankham et al. 2002, Avisé 2004).
- In populations of less than a few thousand individuals, heterozygosity, or genetic variation, is lost faster to genetic drift (random variation in gene frequency between generations) than can be replaced by mutations (Reed 2007).
- Inbreeding, and the resultant loss of genetic heterozygosity, was shown to reduce the reproductive capacity and survival of almost all well-studied species (Spielman et al. 2004).
- A loss of genetic heterozygosity diminishes the evolutionary potential available to a species for dealing with environmental changes (Avisé 2004).

There is a theoretical minimum number of individuals per generation that would be able to protect the population from the loss of heterozygosity that results from inbreeding, genetic drift, or other factors (Simberloff 1988). This minimum is often referred to as the “minimum effective population” size. Recent work suggests that this minimum number varies among species and depends on assumptions used in the population model (Avisé 2004). However, the numbers calculated for the minimum effective population size can serve only as crude guidelines for population management (Avisé 2004). Dr. Arnold considered 400 as the minimum effective population size for the Lange’s metalmark butterfly at the Antioch Dunes NWR in 1983 (USFWS 2002). Arnold (1983, 1986) pointed out that the advent of deleterious genetic phenomena in the Lange’s metalmark butterfly population at the Antioch Dunes NWR was observable in recent changes to the demography and morphology of the butterfly population. These changes include a decrease of about 4 weeks in the duration of the flight period since that period was historically recorded, a 10 to 15 percent decrease in wing size compared to historical collections (1930s), a 7-year decrease in the fecundity of

females from 1977 to 1983 as indicated by a decrease in egg production, and a concurrent drop in the effective population. Dr. Arnold postulated that these changes were circumstantial evidence that the Lange's metalmark butterfly population might have been suffering from the loss of heterozygosity, since each of these same problems was previously described as genetically based in other species (Arnold 1983). Later, with another butterfly species, researchers found that inbreeding of only seven generations was found to cause enough of a loss of heterozygosity to jeopardize the population's survival (Zulstra et al. 2000). During the 1985 flight season Dr. Arnold manually transferred 12 males and 24 females from the Sardis Unit to the Stamm Unit, and transferred 12 other butterflies from the Stamm Unit to the Sardis Unit, in order to artificially duplicate a corridor of genetic flow between the two isolated units (Arnold 1986). His goal was to ameliorate the presumed adverse genetic effects of these two small isolated populations. However, since 1985 no further research has been completed to monitor the results of the artificial gene flow conducted by Dr. Arnold in 1985 or to record further genetic-based changes in the Lange's metalmark butterfly population.

No work or observations have been conducted on the genetic heterozygosity of the evening primrose or the wallflower at the Antioch Dunes NWR.

Other effects of low population size. Certain density dependent effects not directly related to genetics but stemming from low population numbers are considered a threat to the Lange's metalmark butterfly population. These effects include reduced reproduction potential that results from the lack of necessary social interactions, or the difficulty in finding a mate. Also included are other density-dependent behavioral and ecological factors, and have been collectively known as "Allee effects", first described in 1954 (Andrewartha and Birch). Another example of a density-dependent factor that may reduce a population's fitness is the consequences of asynchronous reproduction (male and female sexual maturity is offset in time) which may be favorable in greater population densities but deleterious in low densities (Awise 2004; Calabrese and Fagan 2004). Low populations of any organism are also threatened by extinction through a single catastrophic event, such as an abnormally violent storm, a prolonged drought, or other climatic event; or from an infectious disease; or from stochastic demographic fluctuations (Awise 2004). The threats presented in the preceding sentence apply to the evening primrose and the wallflower, in addition to Lange's metalmark butterfly, since their combined extant range is either confined to the 60 acres refuge or to those properties abutting the refuge boundaries. The one exception is the small isolated population of the primrose at Brannan Island and the purported population at Brown Island.

#### *Extirpation due to few populations/restricted range*

Low number of populations of any organism are also threatened by extinction through a single catastrophic event, such as an abnormally violent storm, a prolonged drought, or other climatic event; or from an infectious disease; or from "stochastic" demographic fluctuations (Awise 2004). The threats presented in the

preceding sentence apply to the evening primrose and the wallflower, in addition to Lange’s metalmark butterfly, since their combined extant range is either confined to the 60 acres refuge or to those properties abutting the refuge boundaries. The one exception is the small isolated population of the primrose at Brannan Island and the purported population at Brown Island.

*Use of herbicides*

Herbicides are part of the comprehensive and aggressive management strategy developed to ensure a successful habitat restoration effort on the Antioch Dunes NWR (USFWS 2002). In particular, selective use of specialized herbicides are needed to remove non-native invasive plants where they are growing in close association with Antioch Dunes evening-primrose, Contra Costa wallflower, or buckwheat host plants (C. Smith *in litt.* 2007). However, at present herbicides are not used in the vicinity of any of these plants because the effect of these herbicides on the Lange’s metalmark butterfly at different life stages is not known. A toxicology study to determine the effect of various concentrations of herbicides used at the Antioch Dunes NWR on the larvae of the Lange’s metalmark butterfly is currently being conducted at Washington State University using a proxy subspecies, Behr’s metalmark butterfly (*Apodemia mormo* ).

**II.C.2.f. Summary of Current Threats:**

Threat Factor	Lange’s Metalmark Butterfly	Antioch Dunes Evening-Primrose	Contra Costa Wallflower
A. Habitat loss or alteration	Non-native invasive plants Wildfires	Non-native invasive plants	Non-native invasive plants
B. Overutilization	Not considered a threat	Not considered a threat	Not considered a threat
C. Disease or predation	Not considered a threat	Not considered a threat	Not considered a threat
D. Inadequacy of regulatory mechanisms	Not considered a threat with ESA listing and NWR designation	Not considered a threat with ESA listing and NWR designation	Not considered a threat with ESA listing and NWR designation
E. Other natural or human-caused factors	Extirpation due to small population size and few populations; herbicide use	Extirpation due to few populations; herbicide use	Extirpation due to few populations; herbicide use

**II.D. Synthesis**

When listed in 1976 and 1978, there were small occurrences of Lange’s metalmark butterfly, Antioch Dunes evening-primrose, and Contra Costa wallflower in the Antioch

Dunes area of Contra Costa County occupying the remaining 10 percent of the original riverine sand dune habitat. The populations of all three species have either declined since then or have not been able to produce self-sustainable populations. All three of the Antioch Dunes listed species will soon become extinct if aggressive and systematic recovery measures are not implemented at the Antioch Dunes NWR. Specifically, the proliferation and overgrowth of invasive, non-native grasses and forbs, such as rip-gut brome, star thistle, and vetch, affect nearly every acre of the Antioch Dunes NWR. Endemic plants at the Antioch Dunes NWR depend on sandy, dune habitat that is constantly disturbed and replenished by winds, and these endemics cannot compete with invasive plants. Over the last two decades, invasive plants have dominated the remaining natural riverine dune habitat and have successively degraded this habitat by stabilizing the shifting sand dunes with organic sediment and dense vegetation, by eliminating natural seed germination of the rare native plants, and by encumbering native rare plants with competition for space. Aggressive eradication of these invasive plants and follow-up maintenance to ensure that they do not re-establish will be an ongoing and dedicated effort for many years to come if the recovery of the three Antioch Dunes species is to succeed.

The threat of non-native, invasive plants is a new threat identified since listing of these three species. Other newly identified threats to the three listed species include wildfires, which have continued to destroy all three species in spite of the installation of fencing to exclude trespassers who may inadvertently or purposefully ignite fires. Because all three species are represented by small and fragmented populations, they are threatened by the loss of genetic heterozygosity and are susceptible to extinction by a single catastrophic climatic event, from an infectious disease, or from stochastic demographic fluctuations. The primary threat identified at listing, habitat loss due to industrial and agricultural development, has been eliminated with the designation of the Antioch Dunes NWR in 1980, where almost all occurrences of the three species are located. However, gypsum dusting of the rare plants and Lange's metalmark butterfly larvae from the adjacent Georgia-Pacific gypsum plant, which may inhibit plant growth and may injure or kill butterfly larvae, is still considered a problem that should be addressed.

Surveys of the three species have been consistently performed since 1984 and reveal a declining trend for all three species. Most notable is the Lange's metalmark butterfly population, which has dramatically declined from over 2,000 individuals in 1999 to 45 individuals in the 2006 peak count survey. Remedial actions are now underway to save the Lange's metalmark butterfly population through controlled propagation in accordance with the Recovery Plan, Service policy, and the Lange's metalmark butterfly protocol for captive rearing (Longcore et al. 2007). Out-planting and seed broadcasting of Antioch Dunes evening-primrose, Contra Costa wallflower, and naked stemmed buckwheat have proven successful in preventing extirpation of these plants, but has not yet established self-sustaining populations.

Therefore, based on continuing threats to the three Antioch Dunes species related to habitat alteration by non-native, invasive plants and the risk of extirpation inherent in small, declining populations, we consider that Lange's metalmark butterfly, Antioch Dunes evening-primrose, and Contra Costa wallflower still meet the Act's definition of endangered, and are in danger of extinction throughout their range.

### III. RESULTS

#### III.A. Recommended Classification:

**Downlist to Threatened**

**Uplist to Endangered**

**Delist** (*Indicate reasons for delisting per 50 CFR 424.11*):

*Extinction*

*Recovery*

*Original data for classification in error*

**No change is needed**

#### III.B. New Recovery Priority Number

Lange's metalmark butterfly: 3

Antioch Dunes evening-primrose: 3

Contra Costa wallflower: 3

Prior to this status report, the Lange's metalmark butterfly was assigned a priority number of 9 (moderate threats, high recovery potential). This determination was made before the 2006 population survey revealed the sharp population decline culminating a slow declining trend since 1999 (USFWS 2007a). A new priority number of 3 (high threats, high recovery potential) is recommended for the following reasons: high threats now include the interference of life history stages by the overgrowth of invasive plants. The recovery potential of this subspecies is high because restoration efforts are being completed to provide host plants, and a controlled propagation plan has been implemented using proven effective methods (USFWS 2007a).

Prior to this status report, the Antioch Dunes evening-primrose was assigned a priority number of 9 (moderate threats, high recovery potential). A priority number of 3 is now recommended (high threats, high recovery potential). High threats now include the overgrowth of invasive plants and the small population size. The recovery potential remains high because of the success observed in out-planting and seed broadcasting and the recent implementation of aggressive habitat restoration activities.

Prior to this status report, Contra Costa wallflower was assigned a priority number of 6 (high threat, low recovery potential). A priority number of 3 is now recommended (high threats, high recovery potential). Both the threat level and recovery potential for Contra Costa wallflower, like those of Antioch Dunes evening-primrose, were determined in this status review to be high, for the same reasons as those given above for Antioch Dunes evening-primrose.

#### IV. RECOMMENDATIONS FOR FUTURE ACTIONS

*Continue restoration of riverine dune habitat at Antioch Dunes NWR:* The Lange's metalmark butterfly will not survive unless suitable mature naked stemmed buckwheat stands are maintained within suitable sandy soil clear of invasive grasses and weeds (USFWS 2007a). The two endangered plants, Antioch Dunes evening-primrose and Contra Costa wallflower, likewise require open, sandy, and disturbed soil for proper growth and regeneration. Restoration involves a concerted effort that includes the eradication of invasive plants, maintaining and out-planting nursery stocks of seedlings of rare plants with annual plantings, and importing a suitable grade of sand to the Antioch Dunes NWR that will replace the sand lost during past mining operations. Restoration efforts should follow the Service's current guidelines (e.g., USFWS 2007a). Grazing is a land management practice that could ultimately benefit the ADNWR because a large part of the organic bulk waste of invasive grasses and forbs is removed and digested by the grazing animal. Ongoing experimental grazing at the Antioch Dunes NWR may soon reveal how to establish the seasonality and duration of a proper grazing regime, among other parameters, that would best suit the needs at the refuge. Uncontrolled fires remain a serious threat to all three species during the summer when built-up thatch from dead and dying plants will readily burn. The maintenance of fuelbreaks, the eradication/removal of invasive plants, and the addition of imported sand will serve as primary means of reducing fire risks.

*Conduct controlled propagation of the Lange's metalmark butterfly until natural populations at Antioch Dunes NWR are at a self-sustainable level:* The Recovery Plan recommended that controlled rearing of Lange's metalmark butterfly should be performed to safeguard against extinction of the natural population. In that regard, the current effort of controlled propagation for the Lange's metalmark butterfly described in section II.C.1.a. above should be continued until a self-sustainable population is established at both the Stamm and Sardis Unit. The required size of such a population has not yet been determined, but should be revealed as the controlled propagation studies proceed.

*Continue research into life history, habitat requirements, and population studies, including annual population monitoring surveys:* Any new information on the life history and habitat requirements of the three Antioch Dunes species is invaluable to the proper management of these species at the Antioch Dunes NWR. Some planned research now includes a toxicological study on the effects of different herbicides used at the refuge on the eggs and larvae of the Lange's metalmark butterfly (using a common, closely related, non-listed subspecies of metalmark butterfly). In addition, controlled propagation efforts should reveal vital life history information of the Lange's metalmark butterfly, including the capability of the larvae to undergo diapause for extended periods.

*Acquire the McCulloch/Kemwater property abutting the eastern boundary of the Sardis Unit of the Antioch Dunes NWR:* This parcel of land contains Antioch Dunes evening-primrose, Contra Costa wallflower, and the naked stem buckwheat plant, which are a continuation of the occurrences found within the PG&E eastern tower easement located on the easternmost border of the refuge. This property is currently for sale and would provide a buffer for the refuge from industrial activities just to the east of the Sardis Unit. In addition, adding this

property to the Antioch Dunes NWR would ensure that future development on this property would not threaten the three listed species.

*Consider revising the Recovery Plan for the three endangered species endemic to Antioch Dunes, California:* The 1984 Recovery Plan does not provide criteria by which to measure success of the recovery actions. Recovery actions need to be updated to conform to the most recent population surveys, population trend analysis, seed banking estimates, and life history research. Measurable criteria for downlisting and delisting need to be determined.

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**U.S. FISH AND WILDLIFE SERVICE**  
**5-YEAR REVIEW of Lange's metalmark butterfly/*Apodemia mormo langei***

Current Classification: Endangered  
Recommendation resulting from the 5-Year Review

- Downlist to Threatened**
- Uplist to Endangered**
- Delist**
- No change is needed**

Appropriate Listing/Reclassification Priority Number, if applicable 3

Review Conducted By Sacramento Fish and Wildlife Office staff

FIELD OFFICE APPROVAL:  
**ACTING**

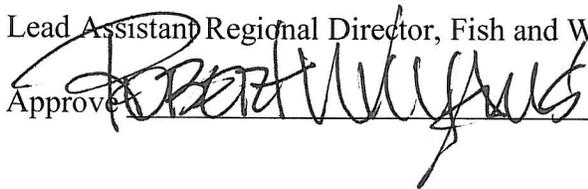
Lead Field Supervisor, Fish and Wildlife Service

Approve  Date July 13, 2007

REGIONAL OFFICE APPROVAL:

**Acting**

Lead Assistant Regional Director, Fish and Wildlife Service

Approve  Date 7/10/08

**U.S. FISH AND WILDLIFE SERVICE**  
**5-YEAR REVIEW of Antioch Dunes evening primrose/*Oenothera deltoides* subsp. *howellii*.**

Current Classification: Endangered  
Recommendation resulting from the 5-Year Review

- Downlist to Threatened
- Uplist to Endangered
- Delist
- No change is needed

Appropriate Listing/Reclassification Priority Number, if applicable   3  

Review Conducted By Sacramento Fish and Wildlife Office staff

FIELD OFFICE APPROVAL:  
**ACTING**

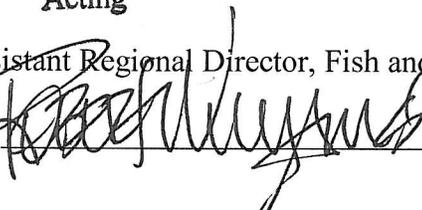
Lead Field Supervisor, Fish and Wildlife Service

Approve  Date July 13, 2007

REGIONAL OFFICE APPROVAL:

**Acting**

Lead Assistant Regional Director, Fish and Wildlife Service

Approve  Date 7/10/08

**U.S. FISH AND WILDLIFE SERVICE**  
**5-YEAR REVIEW of Contra Costa wallflower/*Erysimum capitatum* var. *angustatum*.**

Current Classification: Endangered  
Recommendation resulting from the 5-Year Review

- Downlist to Threatened
- Uplist to Endangered
- Delist
- No change is needed

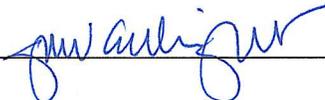
Appropriate Listing/Reclassification Priority Number, if applicable   3  

Review Conducted By Sacramento Fish and Wildlife Office staff

FIELD OFFICE APPROVAL:

ACTING

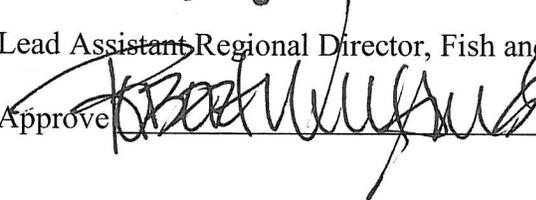
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Approve  Date July 13, 2007

REGIONAL OFFICE APPROVAL:

**Acting**

Lead Assistant Regional Director, Fish and Wildlife Service

Approve  Date 7/10/08