San Bruno Elfin Butterfly
(*Callophrys mossii bayensis*)

and

Mission Blue Butterfly
(*Icaricia icarioides missionensis*)

5-Year Review:
Summary and Evaluation

Photo by Patrick Kobernus: Adult male mission blue butterfly.

Sacramento Fish and Wildlife Field Office
U.S. Fish and Wildlife Service
Sacramento, California
February 2010

5-YEAR REVIEW

San Bruno Elfin Butterfly (*Callophrys mossii bayensis*)

and

Mission blue butterfly (*Icaricia icarioides missionensis*)

I. GENERAL INFORMATION

Purpose of 5-Year Reviews:

The U.S. Fish and Wildlife Service (Service) is required by section 4(c)(2) of the Endangered Species Act (Act) to conduct a status review of each listed species at least once every 5 years. The purpose of a 5-year review is to evaluate whether or not the species' status has changed since it was listed (or since the most recent 5-year review). Based on the 5-year review, we recommend whether the species should be removed from the list of endangered and threatened species, be changed in status from endangered to threatened, or be changed in status from threatened to endangered. Our original listing of a species as endangered or threatened is based on the existence of threats attributable to one or more of the five threat factors described in section 4(a)(1) of the Act, and we must consider these same five factors in any subsequent consideration of reclassification or delisting of a species. In the 5-year review, we consider the best available scientific and commercial data on the species, and focus on new information available since the species was listed or last reviewed. If we recommend a change in listing status based on the results of the 5-year review, we must propose to do so through a separate rule-making process defined in the Act that includes public review and comment.

Species Overview:

San Bruno Elfin Butterfly (*Callophrys mossii bayensis*)

The San Bruno elfin (*Callophrys mossii bayensis*) is a small butterfly with a wingspan of 2.0 to 2.4 centimeters. In adults of both sexes, the wings are brown on the upperside, and reddish brown on the underside with a whitish, irregular median line. The adult flight period is late February to mid-April. Eggs are laid in small clusters or strings on the upper or lower surface of the larval hostplant, *Sedum spathulifolium* (stonecrop). Typical habitat is coastal grassland and low scrub of north-facing slopes within the fog belt where the larval host plant grows. All known locations are restricted to San Mateo County, California, where several populations are known from San Bruno Mountain, Milagra Ridge, the San Francisco Peninsula Watershed, and Montara Mountain (Entomological Consulting Services, Ltd. 2007).

Mission Blue Butterfly (*Icaricia icarioides missionensis*)

The mission blue (*Icaricia icarioides missionensis*) is a small butterfly with a wingspan of 2.5 – 3.6 centimeters. In males, the upper surface of the wings is iridescent blue with a black border fringed with white hair-like scales. In females, the upper surface of the wings is dark brown, marked with blue basal areas, with a margin similar to the male. In males and females, the ventral surfaces of the wings are pale grey with two rows of irregular white-ringed black spots. The adult flight period extends from late March to mid-June. Single eggs are deposited throughout the flight period on the leaves, stems, flowers, and seed pods of the larval food plants, *Lupinus albifrons* (silver lupine), *L. varicolor* (manycolored lupine), and *L. formosus* (summer lupine). Typical habitat is coastal scrubland and grassland vegetation that contains at least one of three larval host plants. Populations of the mission blue butterfly are known from southern Marin, San Francisco, and San Mateo Counties in California.

Methodology Used to Complete This Review:

This review was prepared by the Sacramento Fish and Wildlife Office (SFWO), following the Region 8 guidance issued in March 2008. We used information from the Recovery Plan, survey information from experts who have been monitoring various localities of this species. The Recovery Plan and personal communications with experts were our primary sources of information used to update the species' status and threats. We received two letters from the public in response to our Federal Notice initiating this 5-year review. This 5-year review contains updated information on the species' biology and threats, and an assessment of that information compared to that known at the time of listing or since the last 5-year review. We focus on current threats to the species that are attributable to the Act's five listing factors. The review synthesizes all this information to evaluate the listing status of the species and provide an indication of its progress towards recovery. Finally, based on this synthesis and the threats identified in the five-factor analysis, we recommend a prioritized list of conservation actions to be completed or initiated within the next 5 years.

Contact Information:

Lead Regional Office: Diane Elam, Deputy Division Chief for Listing, Recovery, and Habitat Conservation Planning, Region 8, Pacific Southwest Region; (916) 414-6464.

Lead Field Office: Kirsten Tarp, Recovery Branch; Sacramento Fish and Wildlife Office, (916) 414-6600

Federal Register (FR) Notice Citation Announcing Initiation of This Review: A notice announcing initiation of the five year review of these taxa and the opening of a 60-day period of time to receive information from the public was published [73 FR 11945]. We received two letters from the public.

Listing History:

San Bruno Elfin Butterfly

Original Listing
FR Notice: 41 FR 22041
Date of Final Listing Rule: June 1, 1976
Entity Listed: San Bruno elfin butterfly (*Callophrys mossii bayensis*), an insect subspecies.
Classification: Endangered

Mission Blue Butterfly

Original Listing
FR Notice: 41 FR 22041
Date of Final Listing Rule: June 1, 1976
Entity Listed: Mission blue (*Icaricia icarioides missionensis*), an insect subspecies.
Classification: Endangered

Associated Rulemakings:

Federal Notice 42 FR 7972 dated February 8, 1977: Proposed rulemaking of critical habitat for the San Bruno elfin and mission blue butterflies, but final rules for critical habitat for the mission blue and San Bruno elfin butterflies were never designated.

Review History: Since the original listing in 1976, no reviews have been conducted.

Species' Recovery Priority Number at Start of Review:

The recovery priority number for both the San Bruno elfin butterfly and the mission blue butterfly is 9 according to the Service's 2009 Recovery Data Call for the Sacramento Fish and Wildlife Office, based on a 1-18 ranking system where 1 is the highest-ranked recovery priority and 18 is the lowest (Endangered and Threatened Species Listing and Recovery Priority Guidelines, 48 FR 43098, September 21, 1983). This number indicates that these taxa are *subspecies* that face a moderate degree of threat and have a high potential for recovery.

Recovery Plan or Outline

Name of plan: Recovery Plan for the San Bruno Elfin and Mission Blue Butterflies (recovery plan).
Date issued: October 10, 1984

II. REVIEW ANALYSIS

Is either of the species under review listed as a DPS?

No. 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 invertebrates, and the DPS policy is not applicable, the application of the DPS policy to the species listing is not addressed further in this review.

Information on the Species and their Statuses

San Bruno Elfin Butterfly

Species Biology and Life History

The San Bruno elfin butterfly is diurnally active and univoltine (one generation reaches sexual maturity each year). The adult flight season extends from late-February to mid-April, during the later part of the rainy season in northern California, but before the onset of persistent summer fog. Adults typically appear after the first extended warm sunny period of the season, as early as the first week in February, or as late as April. The window of sunny, calm conditions during the flight season is highly variable from year to year, and adults run the risk of being grounded by inclement weather for weeks on end (Weiss 1993).

Courtship, mating and reproduction are all carried out in the immediate space around the only known larval host plant, *Sedum spathulifolium* (stonecrop). Adults feed on nearby flowering plants with small inflorescences, particularly plants in the Apiaceae (carrot) and Asteraceae (sunflower) families. Adults are highly sedentary, typically moving less than 100 meters (Arnold 1983), with a maximum recorded movement of 800 meters (Service 1984). Males perch on exposed and elevated surfaces, particularly branches of coastal brush species, and fly out to encounter passing insects, and so contact receptive females. After encountering a presumably receptive female, the male releases a pheromone (Arnold 1983). Both sexes then perch together and may ultimately copulate. Males then resume "perch/encounter" behavior, seeking subsequent mates. Both sexes may mate more than once. Females oviposit throughout the flight season; laying eggs in small clusters or strings, at a rate of several dozen a day, on the foliage of stonecrop. Eggs hatch in about a week, depending on weather conditions and microclimate.

First instar larvae bore into the smaller, more succulent, leaves of the stonecrop. Larvae are dichromatic, either red or yellow. By the time the third instar is attained, stonecrop has sprouted flowering stalks that are beginning to bloom. Third instar larvae crawl up the flowering stalks and feed on the flower heads until they mature. Larval development is generally completed by late May or early June, at which time the larvae descend to the ground and enter pupal diapause in loose soil and leaf litter. They lie dormant until the following February or March, when they emerge as adult butterflies.

The San Bruno Elfin butterfly is a facultative myrmecophile (has a mutualistic association with ants); presumably specific ant species protect the larvae from parasitoids and/or predators. In

return, the ants use their antennae to tap a larva's head and elicit a drop of honeydew, which the ants imbibe (Arnold 1983). Despite their association with ants, Arnold (1983) found a high frequency (50-80 percent) of larvae to be parasitized by a Tachinid fly (*Aplomya theclarum*).

Habitat

Typically, the distribution and dynamics of butterfly populations are influenced by larval host plant health and abundance, nectar source availability, topography, size of available habitat and its degree of isolation from other habitat, and weather (Arnold 1983; Matter *et al*. 2003). The San Bruno elfin butterfly is found in coastal chaparral, on steep north facing slopes, and in the fog-belt of the mountains near San Francisco Bay. It closely follows the narrow, fragmented distribution of its larval host plant, *Sedum spathulifolium* (Brown 1969a). *Sedum spathulifolium* is a low growing succulent that tends to be found in the shallow weathered soils associated with rocky substrates that occur at 275-325 meters elevation. *Sedum spathulifolium* occurs in both short-statured coastal scrub and grassland vegetation, and readily invades roadcuts and old quarry faces provided the aspect is correct. Local populations of the San Bruno elfin butterfly correspond closely to patches of the larval host plant, which range from a hundred square meters to several hectares in extent.

According to Weiss (1993), habitat topography may be limiting for San Bruno elfin butterfly populations in certain cases. Because of low winter sun angles, the steepest habitat areas may be in the deep shade for much of the day, limiting access by adults (Weiss and Murphy 1991). Steep, northeast-facing slopes receive direct morning light and, when winds are calm, provide excellent habitat (Weiss 1993).

Spatial Distribution and Abundance

All known locations are restricted to San Mateo County, California, where several populations are known from San Bruno Mountain, Milagra Ridge, the San Francisco Peninsula Watershed, and Montara Mountain (Entomological Consulting Services, Ltd. 2007). Each of these locations supports an array of highly local demographic units tied together by occasional adult migration (Weiss 1993). Populations may have once existed within San Francisco at Twin Peaks and Mount Davidson, but have disappeared due to urbanization (Emmel and Ferris 1972).

According to Weiss (1993), this butterfly was probably never common, because of specialized habitat requirements. It exists in local discrete populations of ten to several hundred adults at high altitudes. A thousand or more adults may exist in about 15 total subpopulations on San Bruno Mountain in a good year. Montara Mountain supports about 10 local populations, and Milagra Ridge supports about four.

On San Bruno Mountain, San Bruno elfin butterflies have been monitored continuously since 1982. In 1998, a "point-count" monitoring system was initiated. Point stakes were installed at 21 locations where San Bruno elfin butterflies are known to occur and all life-stages are monitored every 7 to10 days during the flight season. No San Bruno Elfin habitat was taken as part of the Habitat Conservation Plan. According to TRA Environmental Sciences (2007) the numbers of San Bruno elfin butterflies and habitat on San Bruno Mountain appears relatively stable at this time, and management may be limited to annual visual monitoring to evaluate habitat status.

The San Bruno elfin butterfly population on Milagra Ridge is managed by the Golden Gate National Recreation Area (GGNRA) which is managed by the National Park Service. The population at Milagra Ridge has remained small since its discovery in the early 1980s. Prior to 1999, sampling for San Bruno elfin butterflies at Milagra Ridge was opportunistic, but due to a lack of observations in 1996 a sampling scheme for this site was set up and initiated beginning in 1999. According to the GGNRA San Bruno elfin butterfly survey reports for Milagra Ridge, observations of adult San Bruno elfin butterflies have ranged from 0 in 2006 and 2007 to 15 in 2001, and larval surveys have ranged from 0 in 2007 to 24 in 2001. According to Arnold (pers. comm. 2009) there are several additional areas on Milagra Ridge with stonecrop, but the patches may be too small to support viable colonies of San Bruno elfin butterflies.

San Bruno elfin butterfly surveys have been conducted in the San Francisco Peninsular Watershed (SFPW) in San Mateo County from 2001 to 2007 (except 2002). The watershed is owned and managed by the San Francisco Public Utilities Commission (SFPUC). The SFPW includes the area referred to in the Recovery Plan as Whiting Ridge. According to Arnold (pers. comm. 2009), there are 3 known colonies in the SFPW, but additional colonies may exist. The SFPW colonies are part of a larger complex that includes the 5 or 6 colonies on Montara Mountain and nearby peaks, including the area referred to in the Recovery Plan as Peak Mountain. Surveys on the SFPW are primarily conducted along dirt roads within the watershed. The 2007 survey concluded that fluctuations in population numbers are likely due to annual weather differences rather than changes in habitat conditions (Entomological Consulting Services, Ltd. 2008).

San Bruno Elfin butterflies have been known from the Montara Mountain area, including Peak Mountain, since the recovery plan of 1984. The Montara Mountain area is adjacent to the SFPW and a good portion of Montara Mountain is in public protection. McNee Ranch State Park covers 253 hectares on the north slopes and is contiguous with San Pedro Valley County Park which covers 526 hectares and is contiguous with the SFPW. However, some of the mountain is in private ownership, but the steepness of its slopes and access problems have kept it relatively free from development. No scheduled surveys are conducted on Montara Mountain and nearby peaks, but according to Arnold (pers. comm. 2009) viable populations of San Bruno elfin butterflies remain on Montara Mountain and nearby peaks.

Based on the TRA survey reports for San Bruno Mountain and the SFPW survey reports, the overall abundance of the San Bruno elfin butterfly at these sites appears to have remained stable. It is unclear if the decline and recent lack of observations at Milagra Ridge are due to natural variability associated with small patches of habitat or if there are other factors that have contributed to the lack of observations. Nevertheless, Milagra Ridge is relatively isolated from the San Bruno Mountain and SFPW populations, and the ability of this butterfly to recolonize the site is questionable. The abundance and stability of this species at sites on Montara Mountain and nearby peaks is unknown, but it is believed viable populations persist.

Taxonomic Classification or Nomenclature

The subspecies was discovered in 1962 (MacNeill 1963), and described by Brown (1969b). It was originally described as *Callophrys fotis bayensis*, but was later recognized to be the species *C. mossii* (Edwards) (now genus *Incisalia*). However, some lump *Incisalia* with *Callophrys*.

Genetics

The Service is not aware of any published genetic studies on the San Bruno elfin butterfly.

Species-specific Research and/or Grant-supported Activities

Other than the population surveys and restoration activities described in *Spatial Distribution and Abundance*, the Service is not aware of any species-specific research and/or grant supported activities relating to the San Bruno elfin butterfly.

Mission Blue Butterfly

Species Biology and Life History

The mission blue butterfly is diurnally active and univoltine (one generation reaches sexual maturity each year). The adult flight season extends from late March to early July, depending on location and microclimate conditions. All reproductive activities are carried out among patches of the three know larval host plants: *Lupinus albifrons* (silver lupine), *L. varicolor* (manycolored lupine), and *L. formosus* (summer lupine). Adults feed on a variety of nectar flowers, but do not tend to wander far from areas containing the larval host plants. Males fly (patrol) about or perch on elevated host plant stalks or those of the surrounding vegetation and fly out to encounter passing objects, and so contact receptive females. Females may be mated less than 24 hours after emergence. Mating occurs on the periphery of the mate location area from late morning to late afternoon and lasts on the order of one to several hours (Arnold 1983). Females oviposit throughout the flight season and lay eggs singly at the rate of several dozen a day on leaves, stems, flowers, and seed pods of the host plants. The majority of deposited eggs have been observed on new growth, particularly the upper surface of leaflets (Service 1984), and hatch in about 4 to10 days (Downey 1957; Service 1984).

The mature larvae are reddish purple or green with three purple or inconspicuous diagonal white lines on each body segment and the body is covered with short white hairs. The first and second instar larvae feed on the mesophyll of the *Lupinus* food plant. About three weeks after the larvae emerge, the second instar larvae begin an obligate diapause; most diapause in the leaf litter at the base of the food plants. The following spring, the larvae break diapause and resume feeding. Cessation of diapause varies widely, even among sibling larvae. Under laboratory conditions, this period may be as great as one month. This protracted cessation of diapause and the variation in microclimate is why newly emerged adults can be observed throughout the 8 to10 week flight period. The last instar larvae pupate on or near the base of the *Lupinus spps.* foodplant rather than in the ground or in ant nests as suggested by Downey (1957). The pupal stage lasts approximately three weeks. The pupa is green, and the abdomen is green or reddish-brown with green blotches.

Observations indicate adult male mission blue butterflies have a shorter lifespan (approximately 7 days) than do the adult females (approximately 8 days). Both males and females appear to travel similar distances at similar speeds. Thomas Reid and Associates (1982) found that adult butterflies traveled up to 2,500 meters at San Bruno Mountain, although most traveled less than 600 meters during the study.

The mission blue butterfly is a facultative myrmecophile (has a mutualistic association with ants); presumably specific ant species protect the larvae from parasitoids and/or predators. In return, the larvae secrete a sugary fluid called honeydew, from which the ants feed on (Arnold 1983). Ants may also construct chambers at the base of the host plants just beneath the surface of the soil for access to the resting larvae, as diurnal resting places for the larvae, or both (Howe 1975). Nevertheless, Arnold (1983) found that 35 percent of field collected eggs of the mission blue butterfly were parasitized by an unidentified Encryrtid wasp. Although parasitism is significant, rodents are probably the principle predator of both larvae and pupae (Arnold 1983).

Habitat

Mission blue butterflies inhabit coastal prairie grasslands, from 210 to 360 meters elevation, which are also inhabited by larval host plants. These coastal prairie grasslands are disclimax communities. That is, maintenance and regeneration of the plants characteristic of these ecosystems are dependent upon irregular perturbation processes that preclude normal succession. The *Lupinus* host plants are dependent upon natural disturbance processes, such as rockslides, mudslides and fires to establish their seedlings. In this case, coastal prairie grasslands succeed into coastal chaparral. Patchily distributed dense colonies of the *Lupinus* host plants are found at sites of natural disturbance, such as rodent burrows, mudslides, rock slides, fire, etc. throughout the coastal prairie grassland. Thus, the disturbance processes that allow for colonization of *Lupinus*, and subsequently the mission blue butterfly, are dynamic, and each colony is dynamic and relatively short-lived.

Spatial Distribution and Abundance

At the time of its listing in 1976, only two locations with populations of mission blue butterflies were known; Twin Peaks in San Francisco County and San Bruno Mountain in San Mateo County. By the time the recovery plan was published in 1984, a population in the Marin Headlands at Fort Baker in Marin County was included. Since then, several additional colonies have been located in San Mateo and Marin Counties.

The Twin Peaks Natural Area is a 31-acre preserve operated and maintained by the San Francisco Regional Park District (SFRPD). The natural area is contained within a greater open space preserve totaling about 70 acres. This “natural area” contains some of the largest tracts of remnant coastal scrub and prairie habitat within the San Francisco city limits, and supports the lupine host plants of the mission blue butterfly. The mission blue butterfly has been known to occur at the Twin Peaks Natural Area since it was first collected there and described in 1937. Surveys for the mission blue butterfly have been conducted regularly since 1979. Recent surveys suggest that the mission blue butterfly population at the Twin Peaks Natural Area is critically low, with only one larvae and zero adults observed during surveys conducted from 2005-2007. According to the recovery action plan for Twin Peaks, this decline is believed to have been caused largely by massive die-off’s of the larval host plants, due to a fungal pathogen, during the warm and wet El Nino year of 1998. In 2009, a reintroduction effort was attempted at Twin Peaks (SFPRD 2009). The reintroduction effort included habitat restoration and the release of female mission blue butterflies captured at San Bruno Mountain. The success of this reintroduction effort will not be known until the spring of 2010 when the population of mission blue butterflies at Twin Peaks can be assessed.

To date, the most concentrated population of mission blue butterflies is on San Bruno Mountain. As a result, much of the research and population data for this butterfly is based on observations made on San Bruno Mountain. The first estimate for the entire San Bruno Mountain population was conducted in 1981 under the direction of the County of San Mateo, at which time there were an estimated 1,200 mission blue butterflies. In 1983, the San Bruno Mountain Habitat Conservation Plan (HCP) was adopted. Between 1982 and 2004, butterfly populations were surveyed annually. However, wandering transect surveys conducted between 1982 and 2000 were suboptimal in their methodology and did not allow for estimates of abundance. Based on wandering transect data collected between 1982 and 2000, Longcore *et al*. (2004) concluded that the population was stable in overall total distribution. In 1998, fixed transect surveys were added to allow for estimates of abundance. The fixed transect survey results from 1998 to 2004 reveal that the mean number of individuals counted per transect did not vary from year to year, except in 2000 when counts were higher than other years. From 2005 to the present, surveys have been conducted every other year to reduce survey costs, whereby increasing the amount of money available for habitat restoration. In 2007, transect lengths were increased from 50 to 250 meters and the data indicates this species was found in relatively low densities and a wide variety of microclimates and slope exposures. Data also indicate that habitat areas on moist (typically north-facing) slopes are continually being lost to succession. As coastal scrub succession continues unchecked, without a comprehensive grazing and/or controlled burning program, habitat will continue to slowly decline in total area on San Bruno Mountain (TRA Environmental Sciences 2007).

Several colonies of mission blue butterflies have been located at the Marin Headlands since the first colony was discovered in there at Fort Baker in the early 1980s. Surveys have been conducted annually along established transects from 1994 to 2008 (except 2006) (Bennett 2009). The Marin Headlands is part of the GGNRA. In three of the four years from 1994 to 1997, the total number of adults observed along transects during the flight season exceeded 100 individuals. However from 1998 to 2002, butterfly observations declined along transects and seasonal totals of less than 30 butterflies were recorded in four of the five years. Between 2003 and 2008, there was a slight increase in mission blue butterfly observations when totals ranged from 40 to 67.

What appears to be a mission blue butterfly metapopulation is found in the southern portion of its range in San Mateo County (Figure 1) (Solvesky pers. comm. 2009). This metapopulation is a chain of distinct colonies that extend north from the San Francisco Peninsular Watershed (SFPW), along Sweeney Ridge, and ends at Milagra Ridge (Solvesky pers. comm. 2009). Although not documented, it is highly probable there is gene flow between these colonies (Solvesky pers. comm. 2009). With the exception of a bottleneck in habitat connectivity and a paved highway between Sweeney Ridge and Milagra Ridge at Skyline College, the areas between colonies remain free of urban development.

The SFPW is owned and managed by the San Francisco Public Utilities Commission (SFPUC). To assess potential impacts to the butterflies due to public use of a service road, a monitoring program was initiated in 2001. Food plant cover data from the publicly-used road is compared with similar data from other service roads in the watershed, which do not experience public use, to detect potential impacts on the endangered butterflies and their food plants due to trail usage by the public. Surveys at the SFPW have been conducted every year since 2003, primarily along dirt fire roads within the watershed. Counts on 18 mission blue butterfly transects are conducted

on the publicly-used road to compare with counts from 14 transects conducted along roads that are not used by the public. A total of 81 mission blue adults were tallied in 2007. Evaluation of food plant cover data in different portions of the SFPW indicates that public use of the Ridge Trail is not adversely affecting the endangered butterflies or their food plants at this time (Entomological Consulting Services, Ltd. 2007). While vegetation mowing and periodic road blading does temporarily impact the food plants and life stages of the butterfly, these management practices also create conditions favorable for expansion of the larval food plant, which improves habitat quality for this butterfly (Entomological Consulting Services, Ltd. 2007).

Sweeney Ridge and Milagra Ridge are managed by the GGNRA. A rather large colony occurs between Sweeney Ridge and Milagra Ridge at Skyline College, San Mateo County College District. The population of mission blue butterflies at Milagra Ridge has been surveyed annually along established transects since 1995. According to the 2007 GGNRA survey report for Milagra Ridge, the mission blue butterfly population has experienced dramatic fluctuations in observations since 1995, in part due to an unidentified fungal outbreak in 1998 that killed and reduced lupine patches by as much as 80 percent. The fungal pathogen still exists in the soil today, but many of the lupine patches have naturally reestablished and butterfly numbers have increased accordingly. This fungal pathogen could be the same pathogen found at Twin Peaks that also killed lupine host plants in 1998.

Because there are no geographic barriers to movement defining the northern and southern limits of its range, hybridization zones may occur between the closely related mission blue butterfly (*I. i. missionensis*) and the pardalis blue butterfly (*I. i. pardalis*). The pardalis and mission blue subspecies have been differentiated from one another by phenotypic characteristics. The pardalis blue butterfly tends to have the outermost (submarginal) row of dark spots on the ventral hindwing somewhat arrowhead shaped, pointed toward the base; while the submarginal spots of the mission blue butterfly are less prominent and usually much smaller (Shapiro and Manolis 2007). Pardalis blue butterflies are found in grassland habitats immediately north and south of the mission blue butterfly habitats. Oakwood Valley in the Marin Headlands has been proposed as a northern hybrid zone. Based on phenotypic characteristics, Arnold and Lindzey (2003) determined that 68 percent of the individuals sampled at Oakwood Valley in the Marin Headlands were mission blue butterflies. In addition, Arnold and Lindzey (2003) compared the phenotypic differences between museum specimens of the pardalis blue butterfly and museum specimens of the mission blue butterfly and found that individuals from San Francisco and San Mateo Counties were predominantly (88 percent and 77 percent, respectively) mission blue butterflies. However, it should be noted that 6 percent and 13 percent of these respective samples were individuals that appeared to be the pardalis blue butterfly, while 6 percent and 10 percent of the specimens appeared to be individuals whose appearance is intermediate between the mission blue and pardalis blue butterfly. These results indicate that mission blue butterflies, in the middle of their range (San Francisco County), can exhibit phenotypic characteristics that more closely resemble the pardalis blue butterfly than the mission blue butterfly. Conversely, these results could indicate that the range of the pardalis blue butterfly overlaps that of the mission blue butterfly. Because of this, determining where hybrid zones occur may present a difficult challenge based on phenotypic characteristics alone. To our knowledge, no potential hybrid zones in the southern portion of the range have been studied. It is unclear if the differences in phenotypic expressions between pardalis blue and mission blue butterflies are a result of genetic, environmental, or other factors. Additional study is required to conclusively delineate the northern and southern boundaries of the Mission blue.

The ability to formulate and compare population trend data and the overall abundance of the mission blue butterfly from year to year and from site to site is not possible at this time. For instance, Longcore *et al.* (2003) notes that the wandering transects used to survey for mission blue butterflies on San Bruno Mountain from 1982 to 2000 violated most tenets of survey design and provide no replication for comparison. In addition, butterflies are notoriously variable in abundance from year to year and wide fluctuations may obscure secular trends (Pollard 1988). However, Longcore *et al.* (2003) was able to use occupancy modeling to determine that the overall population of mission blue butterflies at San Bruno Mountain remained stable from 1982 to 2000. Another factor confounding the ability to accurately calculate population trends using current sampling techniques (i.e. fixed transects) is that the larval host plants of the mission blue butterfly are early successional species. For example, at the Marin Headlands in Marin County, the fixed transects used to sample mission blue butterflies were established to coincide with the presence of the lupine host plants (i.e. not random) and over the years, the patches of lupine within the transects have succeeded from coastal prairie grassland (capable of supporting lupine host plants) to coastal chaparral (not capable of supporting lupine host plants) (Bennett 2009). Although succession and the subsequent loss of lupine patches within transects might indicate a reduction in habitat quality, Bennett (2009) notes that patches of lupine now exist outside of the fixed transects, in areas formerly void of the plants, in relationship to disturbances that have occurred outside of the fixed transects. Another sampling difficulty associated with mission blue butterflies is the use of egg count surveys. Egg count surveys may not be an accurate indicator of presence or abundance because the eggs of the mission blue butterfly may be confused with the more common Acmon blue butterfly (*Plebejus acmon*) (Gordon Pratt, University of California Riverside, pers. comm. 2007).

Taxonomic Classification or Nomenclature

The holotype mission blue butterfly (*Icaricia icarioides missionensis*) was described from Twin Peaks, San Francisco County, California (Hovanitz 1937). This taxon appears to be a phenotypic intermediate between darkly marked "inland" populations referred to as *I. i. pardalis* and populations on the immediate coast, which sport extremely pale ventral wing surfaces referred to as *I. i. pheres*.

Genetics

The Service is not aware of any published genetic studies of the mission blue butterfly.

Species-specific Research and/or Grant-supported Activities

Other than the population surveys, habitat restoration activities, and the reintroduction effort at Twin Peaks Natural Area, described in *Spatial Distribution and Abundance*, the Service is not aware of any species-specific research and/or grant supported activities.

Habitat Management

Based on the data collected on the mission blue butterfly on San Bruno Mountain which was collected from 1982 to 2000, the distribution of this species within the areas surveyed was stable (Longcore *et al*. 2004). However, Longcore *et al.* (2004) found that the occupancy within certain cells or specific areas showed negative trends. The amount of grasslands within the conserved

habitat on San Bruno Mountain decreased by an estimated 122 acres or 8.6 percent between 1982 and 2004 (TRA Environmental Sciences 2007). Core habitat for endangered species on San Bruno Mountain has been protected from invasive plant species over the span of the San Bruno Mountain Habitat Conservation Plan. But the success of these efforts has been attenuated by landscape changes that are the result of the expansion of coastal scrub into grasslands, especially on north-facing slopes; and the influx and expansion of herbaceous and invasive exotics weeds within the native grasslands, especially on drier and lower elevation slopes.

The San Bruno Mountain Habitat Conservation Plan identified the need to control the expansion of invasive exotic and native plant species because it was written with the recognition that this threat was occurring at a high rate. There was a significant expansion of coastal scrub and the resulting loss of grassland, approximately 541 acres, on San Bruno Mountain between 1932 and 1981. Gorse (*Ulex europaea*) expanded by 282 acres and blue gum eucalyptus by 49 acres during this same period. Portuguese broom (*Cystus striatus*), French broom (*Genista monspessulana),* and several other weeds also likely were established and/or expanded their distribution at the site. It was estimated that the mission blue butterfly and the callippe silverspot butterfly could have been extirpated from San Bruno Mountain within 5-20 years due to the projected loss of grassland habitat (Thomas Reid Associates 1982).

Management efforts conducted since 1982 under the San Bruno Habitat Conservation Plan have reduced gorse by approximately 290 acres and blue gum eucalyptus by approximately 45 acres. Invasive plant management also has been conducted on French broom, Portuguese broom, and Monterey pine (*Pinus radiata*). Thomas Reid Associates (2004) reported controlling 49 species of invasive plants on San Bruno Mountain as of 2003. Although this is an increase in the number of plants being managed since the section 10(a)(1)(B) permit was issued in 1983, the nature of the threat, the displacement of larval food plants by invasive plant species, remains the same as it was when the San Bruno Mountain Habitat Conservation Plan was prepared in 1982. Invasive plant control has been and continues to be the focal point of habitat management on San Bruno Mountain.

The San Bruno Mountain Habitat Conservation Plan has not focused on controlling the spread of coastal scrub into grassland for several reasons (County of San Mateo 2007): 1) lack of available funding and/or in-kind services; 2) air quality regulations have restricted opportunities for controlled burns; 3) lack of maintained fire breaks and decreased fire break management; and 4) lack of grazing infrastructure that would allow testing and reintroduction of grazing to maintain fore breaks and/or reduce brush and invasive species.

III. FIVE FACTOR ANALYSIS

The following five-factor analysis describes and evaluates the threats attributable to one or more of the five listing factors outlined in section 4(a)(1) of the Act.

Factor A. Present or threatened destruction, modification or curtailment of its habitat or range:

When the recovery plan was published in 1984, loss of habitat from commercial development,

road construction, county park development, and quarrying represented the greatest threat of destruction, modification, or curtailment to the habitat of the San Bruno elfin butterfly. Due to the larval host plant's affinity for steep, rocky, north facing slopes and the fact that much of the remaining habitat is located on publicly protected lands, suburban development and habitat fragmentation does not represent an imminent threat to the San Bruno elfin butterflies' remaining habitat or range at this time. Although the threat level is low, colonies in the Montara Mountain area appear to be the most susceptible to suburban development due to the large number of privately held parcels in the area. The San Bruno Mountain HCP does not authorize the take of this species as a result of development. Public infrastructure construction and improvement projects probably represent the greatest threat San Bruno elfin butterfly habitat. The proposed highway realignment of State Route 1 in San Mateo County in the early 1980s was planned in the immediate vicinity of the San Bruno elfin butterfly colonies on Montara Mountain. However, in November of 1996, the voters of San Mateo County passed a ballot initiative to amend the San Mateo County Local Coastal Program, substituting a tunnel in place of the inland bypass. The tunnel alternative does not affect the San Bruno elfin butterfly population on Montara Mountain. In addition, the colonies on the SFPW are subject to infrastructure maintenance and improvement projects related to maintaining water resources.

From 1995 to 2020, the human population is projected to increase by 18 percent for the San Francisco Bay hydrologic region (California Department of Water Resources 1998). According to the California Department of Forestry, from 2000 to 2020, the human population in the Bay Area region is expected to grow by 29 percent (5.3 million people to 6.8 million people), and by 60 percent from 2000 to 2040 (5.3 million people to 8.4 million people) (California Department of Finance 1998). San Bruno Mountain is a popular site for hiking, picnicking, and other passive forms of recreation. Therefore, the number of human visitors will increase with concomitant adverse effects on the San Bruno elfin and mission blue butterflies. The effects to one or both of these species from pollution, especially nitrification, density dependent trampling, and release of exotic species are discussed in factor E; and poaching is discussed in Factor B.

At the time of listing in 1976, only two areas were known to be inhabited by the mission blue butterfly (Twin Peaks and San Bruno Mountain). Since its listing and the publication of the recovery plan in 1984, several new areas inhabited by the mission blue butterfly have been discovered. These include locations in the Marin Headlands (including the Fort Baker colony) and locations in San Mateo County managed by the GGNRA, in the SFPW managed by SFPUC, at Skyline College, and on several small parcels on private land near the City of Pacifica. However, owing to the lack of sightings of the adults during the normal flight season since 2004, it is possible the mission blue butterfly is either on the verge of being extirpated from the Twin Peaks Natural Area, or has already been extirpated. Attempts at reestablishing this population are ongoing (SFPRD 2009).

As a result of the San Bruno Mountain HCP, take of the mission blue butterfly and its habitat on San Bruno Mountain was authorized under section 10(a)(1)(B) of the Act. As a result of the HCP, approximately 14 percent of the total mission blue butterfly habitat is allowed to be taken by development. As of June 2009, 19.64 acres of habitat that is allowed to be developed under the HCP remains undeveloped.

Public infrastructure development projects pose a high to moderate threat to the mission blue butterfly. For example, the SFPW is managed to provide water, sewage, and power services to

1.6 million customers and utility improvement and repair projects within the watershed are likely and may conflict with the mission blue butterfly and habitat.

Although the large majority of remaining mission blue butterfly habitat is protected by various regulatory mechanisms, government agencies, and is on public land, unoccupied suitable habitat may exist on private land. According to a 2007 TRA Environmental Sciences, Inc. report, over 300 summer lupine plants, with Lycaenid eggs of an unknown species, capable of providing mission blue butterfly habitat, occurred at a proposed project site near the City of Pacifica, San Mateo County. No adult mission blue butterflies were observed during the course of 10 visits. However, 15 percent of the summer lupine biomass was pulled and/or dug out of the ground through an act of vandalism on two separate occasions, including the two largest summer lupines with Lycaenid eggs. No other plants appeared disturbed.

Present or threatened destruction, modification, or curtailment of the habitat or range of the mission blue and San Bruno elfin butterflies due to private development projects no longer pose as serious of a threat to these species as they did at the time of listing. However, public infrastructure development projects remain a significant threat. All mission blue and San Bruno elfin butterfly populations found on GGNRA properties are relatively safe from development activities that would destroy, modify or curtail habitat.

The outbreak of an unknown fungal pathogen that infected lupine host plants during the El Nino year of 1998 at Milagra Ridge and Twin Peaks represents a threat to the mission blue butterfly throughout its range. Although many of the lupine host plant patches, and the mission blue butterfly population along with them, have reestablished themselves at Milagra Ridge and have been reestablished at Twin Peaks, the fungus remains present in the soil. The potential spread and outbreaks of this pathogen poses a greater threat to small and isolated populations. Careful attention should be paid to the health and condition of lupine host plants during the next El Nino event. Surveyors should also be aware of this pathogen and precautions should be taken to ensure it is not spread to currently uninfected sites.

Factor B. Overutilization for commercial, recreational, scientific, or educational purposes:

Overutilization for commercial, recreational, scientific, or educational purposes was not considered a threat in the 1976 final listing rule (41 FR 22044) nor when the recovery plan was published in 1984. There is no mention of poaching activities at San Bruno Mountain or any of the other locations mentioned by the recovery plan. However, illegal take of the San Bruno elfin or mission blue butterflies is considered a threat currently. San Bruno elfin and mission blue butterflies are known to have been illegally collected. A convicted poacher had large numbers of callippe silverspot butterflies and mission blue butterflies in his collection (U.S. Attorney's Office 1994). The same poacher stated that collecting San Bruno elfin butterflies was also easily accomplished. Small populations of moths and butterflies are vulnerable to harm from collection of adults (Gall 1984). Collectors may not always realize if they are depleting the population of butterflies or moths to below a threshold limit for the survival or recovery population (Collins and Morris 1985). For example, the extirpation of the large copper butterfly (*Lycaena dispar)* in Great Britain was preceded by heavy bouts of collecting (Duffey 1968, 1977). Adult specimens of the San Bruno elfin and mission blue butterflies 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). Poachers may

use various methods to escape detection or to evade prosecution (Thelander 1994).

Factor C. Disease or predation:

At the time of listing we did not identify disease or predation as a threat to either the San Bruno elfin or mission blue butterflies (41 FR 22044).

According to Arnold (1983), a high frequency of the San Bruno elfin butterfly larvae were parasitized by a Tachinid fly. Although a facultative myrmecophile, parasitism rates might be higher if ants did not tend to larvae.

Rodents are probably the principle predator of both larvae and pupae of mission blue butterflies (Arnold 1983). Nevertheless, Arnold (1983) found that 35 percent of field collected eggs of the mission blue butterfly were parasitized by an unidentified Encryrtid wasp and third and forth instar larvae are parasitized by either a Tachinid fly or a Braconid wasp. Although a facultative myrmecophile, the extent to which ants reduce predation is not fully understood. Unfortunately, this relationship may be disrupted by the presence of the exotic Argentine ant (*Linepthema humile*), whose invasions have spread worldwide and often decimate native ant populations through intense aggression and competition for resources (Ward 1987; Human and Gordon 1997). Currently, both native ants and Argentine ants have been observed within mission blue butterfly habitat in the Marin Headlands. The extent of the Argentine ant invasion at the site and their effect on mission blue butterfly abundance is currently unknown.

Factor D. Inadequacy of existing regulatory mechanisms:

At the time of listing we stated that no regulations pertaining to the protection and conservation of the San Bruno elfin and mission blue butterflies existed (41 FR 22044).

Federal Protections:

Endangered Species Act: The Endangered Species Act of 1973, as amended (Act), is the primary Federal law that provides protection for the San Bruno elfin and mission blue butterflies since the designation of these species as endangered in 1976. Section 7(a)(2) requires Federal agencies to consult with the Service to ensure any project they fund, authorize, or carry out does not jeopardize a listed species. To jeopardize the continued existence of a species means to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild. If it is determined the proposed project will not result in jeopardy to the affected listed species, the Service may require the agency to implement reasonable and prudent measures, along with the terms and conditions, to minimize the amount of incidental take. Incidental take is the take of a listed species that are incidental to, but are not the purpose of an otherwise lawful activity. If a Federal agency is not involved in the project, and federally listed species may be taken as part of the project, then the project proponent must obtain an incidental take permit pursuant to section 10(a)(1)(B) of the Endangered Species Act.

National Environmental Policy Act: The National Environmental Policy Act (NEPA) [42 U.S.C. 4321 et seq.] was signed into law on January 1, 1970. The Act establishes national environmental policy and goals for the protection, maintenance, and enhancement of the environment and it provides a process for implementing these goals within the Federal agencies.

The NEPA also establishes the Council on Environmental Quality (CEQ). Title I of NEPA contains a Declaration of National Environmental Policy, which requires the Federal government to use all practicable means to create and maintain conditions under which man and nature can exist in productive harmony. Section 102 requires Federal agencies to incorporate environmental considerations in their planning and decision-making through a systematic interdisciplinary approach. Specifically, all Federal agencies are to prepare detailed statements assessing the environmental impact of and alternatives to major federal actions significantly affecting the environment. These statements are commonly referred to as environmental impact statements (EISs). Section 102 also requires Federal agencies to lend appropriate support to initiatives and programs designed to anticipate and prevent a decline in the quality of mankind's world environment. All federally listed species that may be affected by a Federal project must be addressed by the environmental assessment and environmental impact statements. (Environmental Protection Agency 2008). Prior to implementation of such projects with a Federal nexus, NEPA requires the agency to analyze the project for potential impacts to the human environment, including natural resources. In cases where that analysis reveals significant environmental effects, the Federal agency must propose mitigation alternatives that would offset those effects (40 C.F.R. 1502.16). These mitigations usually provide some protection for listed species. However, NEPA does not require that adverse impacts be fully mitigated, only that impacts be assessed and the analysis disclosed to the public.

The Lacey Act*:* The San Bruno elfin and mission blue butterflies are 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, and 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.

Golden Gate National Recreation Area: Golden Gate National Recreation Area (GGNRA) was created in 1972 and is managed by the National Park Service. Both the San Bruno elfin and mission blue butterfly populations found at Milagra Ridge and the mission blue butterfly population at Marin headlands are managed by the GGNRA. The following is the National Park Service's Policy on Management of Threatened or Endangered Plants and Animals:

> The (National Park) Service will survey for, protect, and strive to recover all species native to national park system units that are listed under the Endangered Species Act. The Park Service will fully meet its obligations under the NPS Organic Act and the Endangered Species Act to both proactively conserve listed species and prevent detrimental effects on these species. To meet these obligations, the (National Park) Service will cooperate with both the U.S. Fish and Wildlife Service and the NOAA Fisheries to ensure that National Park Service actions comply with both the written requirements and the spirit of the Endangered Species Act. This cooperation should include the full range of activities associated with the Endangered Species Act, including consultation, conferencing, informal discussions, and securing all necessary scientific and/or recovery permits; undertake active management programs to inventory, monitor, restore, and maintain listed species' habitats; control detrimental nonnative species; manage detrimental visitor access; and reestablish extirpated populations as necessary to maintain the species and the habitats upon which they depend; manage designated critical

habitat, essential habitat, and recovery areas to maintain and enhance their value for the recovery of threatened and endangered species; cooperate with other agencies to ensure that the delineation of critical habitat, essential habitat, and/or recovery areas on park-managed lands provides needed conservation benefits to the total recovery efforts being conducted by all the participating agencies; participate in the recovery planning process, including the provision of members on recovery teams and recovery implementation teams where appropriate; cooperate with other agencies, states, and private entities to promote candidate conservation agreements aimed at precluding the need to list species; and conduct actions and allocate funding to address endangered, threatened, proposed, and candidate species.

The National Park Service will inventory, monitor, and manage state and locally listed species in a manner similar to its treatment of federally listed species to the greatest extent possible. In addition, the (National Park) Service will inventory other native species that are of special management concern to parks (such as rare, declining, sensitive, or unique species and their habitats) and will manage them to maintain their natural distribution and abundance. The (National Park) Service will determine all management actions for the protection and perpetuation of federally, state, or locally listed species through the park management planning process, and will include consultation with lead Federal and state agencies as appropriate.

San Bruno Mountain Habitat Conservation Plan: As a result of the 1982 amendment to the Act, allowing for the "incidental take" of listed species by nonfederal entities, the first ever Habitat Conservation Plan (HCP) was prepared and approved for San Bruno Mountain. The HCP allows limited development of endangered species habitat in exchange for implementation of a long-term program, funded by development, to protect and enhance the remaining portions of the Mountain as habitat. The HCP does not allow for the "take" of any San Bruno elfin butterflies or their habitat as a result of development activities. The HCP allows for the take of mission blue butterfly habitat on San Bruno Mountain. As of June 2009, there were 19.64 acres of mission blue butterfly habitat that is authorized to be taken as a result of development activities, yet remain undeveloped.

State and Local Protections

California Endangered Species Act: The California Endangered Species Act (CESA) does not provide protection to insects (sections 2062, 2067, and 2068, California Fish and Game Code).

The California Environmental Quality Act: The California Environmental Quality Act (CEQA) requires full public disclosure of the potential environmental impact of proposed projects. The public agency with primary authority or jurisdiction over the project is designated as the lead agency and is responsible for conducting a review of the project and consulting with other agencies concerned with resources affected by the project. 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.

San Francisco Public Utilities Commission: The San Francisco Public Utilities Commission (SFPUC) is a public agency of the City and County of San Francisco that provides water, sewage, and power services to 1.6 million customers. The SFPUC Natural Resources Division is responsible for the management of 25,495 hectares (63,000 acres) of watershed lands, including the Peninsula Watershed, which encompasses 9,308 hectares (23,000 acres) and several populations of San Bruno elfin and mission blue butterflies. According to the Peninsula Watershed Management Plan: Final Environmental Impact Report dated December 1999, a secondary management goal is to "Preserve and enhance the ecological and cultural resources of the watershed." In addition, one of the management actions defined in the plan is to "Inventory and map butterfly habitat." As a result, San Bruno elfin and mission blue butterflies and their associated habitats have been surveyed within watershed each year from 2001 to 2007 (except 2002) (Entomological Consulting Services 2008).

San Francisco Recreation and Parks Department: Twin Peaks is managed by the San Francisco Recreation and Parks Department (SFRPD). This area is managed as part of SFRPD's Natural Areas Program. The holotype specimen for the mission blue butterfly was collected here in 1937 by William Hovantz. Observations of adult mission blue butterflies have not been confirmed here since 2004 and recent surveys suggest the mission blue butterfly is either on the verge of being extirpated, or has already been extirpated. According to the recovery action plan for Twin Peaks, this decline is believed to have been caused largely by massive die-off's of larval host plants during the warm and wet El Nino year of 1998.

Summary of Regulatory Mechanisms

Habitat loss, due to human development, was considered the greatest threat to the survival of the mission blue butterfly at the time of its listing and when the recovery plan was issued in 1984. Today, the vast majority of remaining mission blue and San Bruno elfin butterfly habitat is protected from private development by Federal, State, and/or local regulatory mechanisms. The current regulatory mechanisms governing the existing mission blue and San Bruno elfin butterfly populations appear to be adequate to protect the species from activities that may impact their survival. However, privately owned parcels that contain habitat for these two butterfly species are subject to unchecked development if no regulatory mechanisms are triggered. In addition, future public infrastructure improvement projects may adversely affect these species and permanently destroy habitat. However, public improvement projects will likely require that an incidental take permit be obtained via section 7 or 10(a) of the Act. Nevertheless, incidental take permits could allow for take in the form of habitat loss. For instance, a biological opinion was issued for the proposed highway realignment of State Route 1 in San Mateo County that allowed for the take of the San Bruno elfin butterfly and its habitat near Montara Mountain area, regardless of the fact that the recovery plan requires there to be 5 populations on Montara Mountain for the species to be down listed from endangered to threatened.

Factor E. Other natural or manmade factors affecting its continued existence:

At the time of listing, exotic plants were identified as a threat to the mission blue butterfly. No threats were identified under this category when the San Bruno elfin butterfly was listed. The following natural or manmade factors threaten these species:

Small Population Size

The precise sizes of the mission blue butterfly populations are unknown. However, it is safe to say urbanization has drastically reduced and fragmented habitat, thereby drastically reducing the number and sizes of extant populations. The populations that do persist, persist on islands of habitat surrounded by a sea of urbanization, which may impede gene flow, immigration, emigration, and recolonization. In addition, populations may drop to significantly low levels during certain years resulting in a decrease in genetic variability or heterozygosity (Spielman *et al*. 2004) and an increased threat of extinction due to stochastic events (Avise 2004). Another possible effect of reduced population densities and fragmentation on the mission blue and the San Bruno elfin butterflies is the Allee effect caused by asynchronous reproduction. The Allee effect, where population growth rate decreases at low population densities, is increasingly recognized as a significant feature of many species' population dynamics (McCarthy 1997; Courchamp *et al*. 1999; Stephens and Sutherland 1999; Dennis 2002). Reproductive asynchrony, which occurs when individuals are reproductively active at different times within a larger population-level reproductive period, as is the case with the mission blue butterfly, can decrease the number of males a female overlaps with in time, which decreases the average probability of mating per male/female pair that does overlap, and may leave some females completely isolated in time (Calabrese and Fagan 2004). This loss of reproductive potential, which is exacerbated by protandry, reduces a population's growth rate at lower densities. Reproductive asynchrony is most important in strongly seasonal populations with a defined breeding period (e.g., univoltine butterflies) (Calabrese *et al*. 2008).

Non-native invasive plants, Succession, Livestock Grazing, and Fire

Non-native grasses and forbs that have invaded California grasslands and the conversion to coastal scrub are serious threats to the two listed butterflies due to their ability to become more abundant while outcompeting or becoming more abundant than the larvae foodplant and nectar plants. European annual grasses and forbs have displaced native forbs in California native grasslands, and in turn, have contributed to the decline of the mission blue butterfly (Biswell 1956; Murphy and Ehrlich 1989). This invasion was facilitated by widespread and intensive grazing (Fleischner 1994). Some of the exotic grasses and forbs that have invaded grasslands of the San Francisco Bay area are *Lolium multiflorum* (Italian ryegrass), *Avena barbata* (slender oats), *Bromus diandrus* (ripgut), *B. madritensis rubens* (red brome), *B. hordaceus and B. mollis* (softchess), *Carduus pycnocephalus* (Italian thistle), *Centaurea solstitialis* (yellow star thistle), *Cirsium vulgare* (bull thistle), *Ehrharta erecta* (ehrharta), *Erodium* species (filaree), *Hypochaeris radicata* (cat's ears), *Medicago polymorpha* (burclover), *Oxalis pes-caprae* (yellow oxalis, *Plantago lanceolata* (English plantain), *Rumex acetosella* (sheep sorrel), *Silybum marianum* (blessed milk thistle), and *Brassica* species and *Sisymbrium* species (mustards) (Amme 2002). Thatch produced as a result of the build up of dead exotic plants may eliminate or prevent native plant species from growing in an area, and invasive species may adversely alter soil chemistry and structure. Although many exotic forbs are used by mission blue butterfly as

nectar sources, they outcompete and replace native nectar plants, and larval foodplants. Some California grasslands revert to coastal scrub in the absence of a disturbance mechanism to prevent it. Fire and grazing may reverse coastal scrub invasion.

Soil fertility may influence nonnative plant invasion, as invasive species often are better competitors for soil nutrients than native species (Allen *et al*. 1998). Soils in urbanized and agricultural regions are being fertilized by excess nitrogen generated by human activities. Burning of fossil fuels, production of fertilizer, and cultivation of nitrogen-fixing crops now add as much nitrogen to global terrestrial ecosystems as do all natural processes combined (Vitousek *et al.* 1997) resulting in niche conditions where aggressive non-native vegetation crowd out the larval food plants.

Native and exotic plant invasion may change the behavior of the mission blue butterfly and San Bruno elfin butterfly by the modification of fundamental aspects of grassland habitat. The invasion and dominance by these plants likely changes the structure of the low-lying grassland which is detrimental to the four listed animals who utilize open habitat. Butterfly species may be sensitive to changes in habitat structure such as edges of grasslands (Reis and Debinski 2001; Schultz and Crone 2001), hilltops (Shields 1967; Lederhouse 1982); forest edges (DeVries *et al*. 1999; Haddad 1999); perches taller than the surrounding habitat (Rutowski 2000); and microtopographic changes that provide protection from wind and access to basking spots (Thomas *et al.* 1986). These effects may affect or alter reproductive related behaviors such as mate searching, territorial defense, predator avoidance, oviposition and nectaring (Clench 1966; Heinrich 1986; Shreeve 1986; Stutt and Wilmer 1998; Ide 2002; Bewaerts and Van Dyck 2004). The larval foodplants may be reduced in abundance and/physical size (Wiklund 1984; Karban 1997; Floater and Zalucki 2000), or oviposition may decline if the taller plant species alter the preferred egg-laying environment (Williams 1981; Thomas *et al*. 1986).

Grassland quality and butterfly diversity may be related to each other, because floristically degraded grasslands tend to be less diverse and contain lower relative butterfly diversity than undisturbed native grassland (Pollard *et al.* 1998; Maes and Van Dyck 2001; Collinge *et al*. 2003). Although a lack of floral diversity is often assumed to be the link between grassland degradation and low butterfly diversity, changes in vegetative structure have been linked with population decline and extinction of grassland butterflies. Due to an increase in the overall sward height with respective to the native condition, the silver spotted skipper (*Hesperia comma*) (Thomas *et al*. 1986; Thomas and Jones 1993) and the Adonis blue butterfly (*Polyommatus bellargus*) declined in abundance due to decreased larvae survival and a lack of suitable oviposition sites.

In grasslands dominated by tall grass species, some butterfly species drop their eggs while in flight or after alighting on the ground if the larvae foodplant is physically obscured or has senesced, resulting in the larvae having to search for their foodplant (Scott 1986; Kopper *et al.* 2000). However, in grasslands that are naturally dominated by shorter grass species and larvae foodplants are conspicuous, shading and visual obstruction of the foodplants by taller invasive native and exotic plants may significantly alter butterfly behavior related to survival and reproduction, particularly in animals that directly oviposit on their foodplant. The invasion and dominance of taller grass species resulted in the loss of the larvae foodplants of the Bay checkerspot butterfly (Weiss 1999), while, in the case of the endangered Fender's blue butterfly, a subspecies closely related to the mission blue butterfly, the larvae foodplants were still present,

but not as effectively detected by ovipositing females (Severns 2009). Grassland conversion caused by the invasion of invasive non-native plants is perhaps the most significant and imminent threat to the callippe silverspot butterfly population on San Bruno Mountain. A number of shrub species also have invaded grassland habitats at San Bruno Mountain over the past 40 years. These include gorse, various brooms, and even native shrubs. For example, gorse increased in acreage 140 percent from 1972 to 1986 on San Bruno Mountain (Thomas Reid Associates 1987). Shrubs shade out native grassland forbs and grasses, including Johnny jump up.

Although examples have not been found that specifically identify non-native invasive plants as a threat to the San Bruno elfin butterfly, its dependence on a single host plant to complete its lifecycle makes it susceptible to habitat loss from non-native invasive species. Known habitat should be monitored regularly for reductions in stonecrop cover due to non-native invasive plants. Stonecrop is also susceptible to habitat succession caused by both native and non-native plants.

In the absence of grazing and fire, coastal prairie grassland habitats are being lost to shrub and tree encroachment (Ford and Hayes 2007). The San Bruno Mountain HCP documented a significant expansion of coastal scrub and corresponding loss of grassland, approximately 541 acres between 1932 and 1981. Vegetation surveys from San Bruno Mountain and the Marin Headlands show that native flowering broadleaf perennials, including the lupine host plants, are directly threatened by advancing coastal chaparral caused by a lack of disturbance. From 2003 to 2007, approximately 6 percent of the annual San Bruno Mountain HCP budget has been used to create and manage habitat restoration islands and additional development funded and grant funded restoration projects have been conducted. The GGNRA organizes volunteer groups and school programs to restore habitat and teach the local communities about the mission blue butterfly. Restoration work on San Bruno Mountain and on GGNRA lands has consisted of manual removal, herbicide, and/or mowing to protect native plant communities from exotic invasive plants and to mimic successional processes.

The overgrowth of exotic invasive plants was recognized as a threat at the time of listing, when the recovery plan was written, and remains one of the most serious present-day threats to the mission blue butterfly. Exotic invasive species have also been recognized as a threat to other listed butterflies (Service 1984 and 1998; Adams 2004; Severns 2007). Management actions, including manual removal and/or the use of herbicides to limit the spread of exotic plants and to reduce chaparral encroachment, have been implemented at several locations, including San Bruno Mountain and areas managed by the GGNRA. However, these treatments do not reduce the causes of exotic species invasions or chaparral encroachment. Until the appropriate natural disturbances and disturbance cycles are returned, exotic invasive species and chaparral encroachment will threaten the mission blue butterfly.

The 1984 recovery plan included livestock grazing as a threat to the survival of the mission blue butterfly due to encouraging the growth of weedy annuals and other exotic plants in the grasslands and reducing the amount of chaparral. The negative effects of uncontrolled, year-long livestock grazing are well known. They include soil compaction, degraded riparian habitat, poor water quality, erosion, the elimination of native perennial grass, and wildlife habitat degradation. The effects of eliminating grazing can be just as damaging, where undecomposed annual grass mulch smoothers and eventually eliminates the native perennial grasses as well as wildflowers

(Menke 1989). Studies have shown that optimal grazing may increase the density of native plants that support butterfly populations (Heitschmidt and Stuth 1991). DeVries and Raemakers (2001) found that grazing appeared to benefit butterfly species from open grassland, but emphasize the need for research and experimentation as to the appropriate stocking rate and grazing intensity. However, the impact of grazing on insects has been judged beneficial or detrimental, depending on the species' habitat requirements (Fleischner 1994; Oates 1995). A stewardship grazing plan was developed for San Bruno Mountain. The plan estimated it would cost $150,000 to implement a small -scale pilot program over a 3 year period. The cost of fully implementing a stewardship grazing program would be much more costly.

Studies have found that prescribed burning in late spring reduces alien annual plant seed production and the resulting size of the seedbank, increases perennial grass seedling establishment due to litter removal and lowered competition, and reduces annual plant density and competition with perennial grasses the following year (Menke 1992). However, when the natural fire regime is altered, even highly fire-adapted plant communities can become vulnerable to competition from exotic invasive plants (Keeley 2003). The San Bruno Mountain HCP recognizes the potential future need for fire to preserve grassland habitats, but does not contain a comprehensive policy on the use of fire or fire suppression. Fire is a relatively affordable management tool, but can have unforeseen, adverse consequences if mismanaged. In addition, the level of urbanization around San Bruno Mountain creates a conflict between using fire to manage chaparral and the air quality issues the smoke creates for adjacent communities.

Recreation

Recreation impacts pose a substantial threat to mission blue butterfly habitat. One of the threats listed in the Recovery Plan was off-road vehicles (ORVs). Although recreational ORVs are prohibited on all of the publically managed land with mission blue butterflies, illegal use by ORVs continues. One of the contributing factors to the apparent extirpation of this butterfly at Twin Peaks is heavy recreational use by off -trail hikers, mountain bikers, and motor bike activity, all of which are prohibited.

Climate Change

Climate change poses a serious threat to the San Bruno elfin and mission blue butterflies. The global average temperature has risen by approximately 0.6 degrees centigrade during the 20th Century (International Panel on Climate Change 2001, 2007; Adger *et al* 2007). There is an international scientific consensus that most of the warming observed has been caused by human activities (International Panel on Climate Change 2001, 2007; Adger *et al.* 2007), and that it is "very likely" that it is largely due to increasing concentrations of greenhouse gases (carbon dioxide, methane, nitrous oxide, and others) in the global atmosphere from burning fossil fuels and other human activities (Cayan *et al.* 2005, Adger *et al*. 2007). Eleven of the twelve years between 1995 and 2006 rank among the twelve warmest years since global temperatures began being recorded in 1850 (Adger *et al*. 2007). The warming trend over the last fifty years is nearly twice that for the last 100 years (Adger *et al*. 2007).

Under a high emissions scenario, the International Panel on Climate Change estimates that global temperatures will rise another four degrees centigrade by the end of this Century; even under a low emissions growth scenario, the International Panel on Climate Change estimates that the

global temperature will go up another 1.8 degrees centigrade (International Panel on Climate Change 2001). The increase in global average temperatures affects certain areas more than others. The western United States, in general, is experiencing more warming than the rest of the Nation, with the 11 western states averaging 1.7 degrees Fahrenheit warmer temperatures than this region's average over the 20th Century (Saunders *et al*. 2008). Hayhoe *et al*. (2004) estimated temperatures in California would increase by 1.35 to 1.6 degrees Celsius by midcentury and 2.3 to 3.3 degrees Celsius by the end of the century under low emission scenarios and by 1.5 to 2 degrees Celsius by midcentury and 3.8 to5.8 degrees Celsius by end of century under high emission scenarios.

Global climate change increases the frequency of extreme weather events, such as heat waves, droughts, and storms (International Panel on Climate Change 2001, 2007; Lenihan *et al.* 2003; California Climate Action Team 2006). Extreme events, in turn, may cause mass mortality of individuals and significantly contribute to determining which species will remain or occur in natural habitats. As the global climate warms, terrestrial habitats are moving northward and upward, but in the future, range contractions are more likely than simple northward or upslope shifts. Since climate change threatens to disrupt annual weather patterns, it may result in a loss of their habitats and/or prey, and/or increased numbers of their predators, parasites, and diseases. Where populations are isolated, a changing climate may result in local extinction, with range shifts precluded by lack of habitat.

The precise impacts of climate change to the San Bruno elfin and mission blue butterflies are unknown. However, seasonal rains that are too early or too late may result in larval development being out of phase with their host plants (i.e., host plants senesced prior to larvae entering diapause). Changes in temperature could shift the development period of the butterfly so that it is out of sync with its host plants. Forister and Shapiro (2003) observed that the mean date of first flight for 16 out of 23 butterfly species in northern California had moved towards an earlier date over 31 years. In four species the shift was significant and in two species the shift was approximately a month earlier (Forister and Shapiro 2003).

Table 1. Summary of threats to the San Bruno elfin and mission blue butterflies attributable to the five listing factors outlined in section 4(a)(1) of the Act.

Threat Factor	San Bruno Elfin	Mission Blue
A. Habitat loss or alteration	• Public infrastructure development • Private development	• Public infrastructure development • Private development
		• Host plant fungus
B. Overutilization	• Illegal collection	• Illegal collection
C. Disease or predation	• Insect parasitism • Rodent predation on larvae	• Insect parasitism • Rodent predation on larvae
D. Inadequacy of regulatory mechanisms	• NA	• NA
E. Other natural or human caused factors	• Small population size • Exotic-invasive plants • Recreation impacts • Climate change • Habitat loss due to succession	• Small population size • Exotic-invasive plants • Recreation impacts • Climate change • Habitat loss due to succession

III. RECOVERY CRITERIA

Recovery plans are not regulatory documents and are instead intended to provide guidance to the Service, States, and other partners on methods of minimizing threats to listed species and on criteria that may be used to determine when recovery is achieved. There are many paths to accomplishing recovery of a species and recovery may be achieved without all criteria being fully met. For example, one or more criteria may have been exceeded while other criteria may not have been accomplished. In that instance, the Service may judge that over all criteria, the threats have been minimized sufficiently, and the species is robust enough, to reclassify the species from endangered to threatened or delist the species. In other cases, recovery opportunities may have be recognized that were not known at the time the recovery plan was finalized. These opportunities may be used instead of methods identified in the recovery plan. Likewise, information on the species may be learned that was not known at the time the recovery plan was finalized. The new information may change the extent that criteria need to be met for recognizing recovery of the species. Overall, recovery of species is a dynamic process requiring adaptive management and judging the degree of recovery of a species is also an adaptive management process that may, or may not, fully follow the guidance provided in a recovery plan.

The 1984 Recovery Plan is a final and approved plan. However it does not contain defined, objective, measurable recovery criteria for down-listing the San Bruno elfin butterfly or the mission blue butterfly from endangered to threatened or for delisting. Although the recovery plan does not contain formal recovery criteria, it does contain primary and secondary objectives and states when reclassification can be considered. The recovery plan defers to "later" for determining the colony sizes and habitat area necessary to insure the long-term survival of the two butterfly species. A discussion of each primary and secondary objectives in the recovery plan and progress towards each of these objectives, as well as when reclassification can be considered is provided below.

> *The primary objective of the recovery plan for the San Bruno elfin and mission blue butterflies is to maintain and enhance existing populations of these endangered species throughout their range.*
>
> *The secondary objectives of the recovery plan are to rehabilitate ecosystems that have been altered by exotic plant introductions, ORV activity or urbanization.*
>
> *Reclassification of the San Bruno elfin butterfly to threatened status can be considered when secure, self-sustaining colonies of this species are established and/or re-established on Milagra Ridge, Montara Mountain, Peak Mountain, and Whiting Ridge, and when colonies on San Bruno Mountain are secure. Numbers of colonies necessary for reclassification of the San Bruno elfin butterfly to threatened are 7 on San Bruno Mountain, 5 on Montara Mountain (including Peak Mountain and Whiting Ridge), and 2 on Milagra Ridge.*
>
> *Reclassification of the mission blue butterfly to threatened status can be considered when secure, self-sustaining colonies of this species are established and/or reestablished on Twin Peaks and Fort Baker (one colony at each site) and when colonies on San Bruno Mountain (as noted in the HCP) are secure.*

Attempts to rehabilitate mission blue butterfly habitat by removing exotic plants and chaparral have occurred on San Bruno Mountain, on GGNRA lands in the Marin Headlands, and Twin Peaks. Nevertheless, mission blue butterfly habitat on moist and north-facing slopes on San Bruno Mountain is continually being lost to coastal scrub succession (TRA Environmental Sciences 2007) and the level of funding available to conduct habitat rehabilitation activities on San Bruno Mountain has not been adequate to maintain and offset loss to succession and invasive species.

Three San Bruno elfin butterfly "colonies" have been discovered at the SFPW since the publication of the Recovery Plan and should be incorporated into the recovery criteria. However, based on low survey numbers from 2006 and 2007 it is not known if the Milagra Ridge population remains viable. The populations on San Bruno Mountain appear to be stable, and with the implementation of the HCP, the populations are secure. Based on the mission and purpose of the National Park Service, populations located on GGNRA properties are secure. Populations near Montara Mountain are subject to adverse affects from public infrastructure development projects, but are otherwise relatively secure.

New mission blue butterfly "colonies" have been discovered at the SFPW, Milagra Ridge, Sweeney Ridge, Skyline College, and the Marin Headlands since the publication of the Recovery Plan and should be incorporated into the recovery criteria. The number of individuals at each of these sites is not known. The location of hybrid zones should be defined to ensure protection of mission blue butterfly colonies near the hybrid zones. The Twin Peaks population may have been extirpated and a restoration and reintroduction effort was initiated in April 2009, the results of which will not be known until the spring of 2010 when larvae would be expected to emerge.

The terms "secure", "colonies", and "self-sustaining" need to be clearly defined in order for this to be a measurable criterion" To date, this has not occurred. In addition, several San Bruno elfin butterfly "colonies" have been discovered at the SFPW since the publication of the Recovery Plan and should be incorporated into the recovery criteria.

Summary

Measureable criterion for the number of locations, the number of individuals at each location, indicators of the sustainability of the species at each location, and criteria to evaluate each threat need to be defined. Since its listing, the primary threat to the mission blue butterfly has changed from loss of habitat due to private development and exotic plant species to loss of habitat due to succession and exotic plant species. Reducing the loss of habitat from succession and exotic plants will require sustainable funding sources and/or manpower and/or the reintroduction of grazing and/or fire into the system.

IV. SYNTHESIS:

San Bruno Elfin Butterfly

Since its listing in 1976, three additional colonies of San Bruno elfin butterfly have been located on the SFPW. Although the number of known San Bruno elfin butterfly populations has increased since the final listing rule was written and the population on San Bruno Mountain appears to have remained stable. The population at Milagra Ridge is small and fragile and its ability to persist into the future is not known. The current status of the Montara Mountain population and associated colonies is unknown, but according to Arnold (pers. comm. 2009) viable colonies persist. Current threats include public infrastructure development (except on San Bruno Mountain where take as a result of development is not permitted), poaching, small population size, the effects of reduced host and nectar plant density due to exotic invasive plants and forbs, and the undetermined effects of global climate change. Although the number of known colonies and the known distribution has increased and the threat of suburban and urban development no longer pose as high of a threat, the amount of area occupied by the host plant has not been noted to be increasing and the sustainability of the Milagra Ridge population calls into question the ability of any of the smaller and isolated populations to sustain themselves in perpetuity without reintroduction efforts in the event of extirpation. Therefore, due to an increase in the number of known colonies, the potential loss of the Milagra Ridge population, no noted expansion in habitat, the apparent stability of the San Bruno Mountain colonies, and the relative security of remaining habitat, we believe that overall, the species has remained relatively stable since its listing in 1976, yet we believe the San Bruno elfin butterfly still meets the definition of endangered, and recommend no status change at this time.

Mission Blue Butterfly

At the time of its listing in 1976, two populations of mission blue butterfly were known. The number of known locations and the range of the species have substantially increased since its listing. Since then, new colonies have been discovered in the north of its range at the Marin Headlands and in the south of its range at the SFPW, Sweeney Ridge, Milagra Ridge, and Skyline College. However, it is not clear if the colonies discovered in the north of the range and in the south of the range should each be considered discrete populations or metapopulations. However, the population at Twin Peaks may have been extirpated due to a reduction in host plant density caused by a fungal pathogen exacerbated by an El Nino event and recreation impacts that directly affected host plants. The initial success of the reintroduction efforts will not be known until spring of 2010. Current threats include permanent and temporary loss of habitat due to public infrastructure development, poaching, small population size, isolation, the effects of reduced host plant density due to exotic invasive plants and forbs and an unknown fungal pathogen, grassland succession to chaparral, recreational impacts that reduce habitat quality and quantity, and the undetermined effects of global climate change. Although the threat of urban and suburban development has been reduced and the number of known colonies has increased, the threats of grassland succession to chaparral, host plant competition with exotic invasive plant species, and small population sizes remain substantial threats to this species, and the ability of this species to persist, unaided by human intervention and management, is unlikely. Therefore, we believe the mission blue butterfly still meets the definition of endangered, and recommend no status change at this time.

V. RESULTS

San Bruno Elfin Butterfly

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*
_X__ No change is needed

New Recovery Priority Number _9

No change is recommended at this time to the recovery priority number for the San Bruno elfin butterfly.

Mission Blue Butterfly

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*
_X__ No change is needed

New Recovery Priority Number _9

No change is recommended at this time to the recovery priority number for the mission blue butterfly. The number of known colonies and known distribution have increased since the species was listed in 1976. However, the Twin Peaks population is believed to have been extirpated. Although some of the original threats to the mission blue butterfly have been reduced, such as suburban and urban development, there are still a moderate number of threats either directly to the butterfly or to the habitat supporting the animal. The most notable of these threats are grassland succession to chaparral, host plant competition with exotic invasive plant species, recreational impacts, and infrastructure repair and enhancement projects.

VI. RECOMMENDATIONS FOR FUTURE ACTIONS:

San Bruno Elfin Butterfly

1) Protect in perpetuity San Bruno elfin habitat on properties near Montara Mountain.

2) Create a San Bruno elfin butterfly working group to:
    a. Develop a consistent monitoring and surveying scheme.
    b. Coordinate synchronized and scheduled monitoring of all colonies.
    c. Map all currently known habitat locations, including size and extent of host plant cover.

Mission Blue Butterfly

1) Ensure the area between Sweeney Ridge and Milagra Ridge is maintained as suitable mission blue butterfly habitat, specifically the unprotected land around Skyline College.

2) Evaluate the success of translocation efforts at Twin Peaks. Based on the results of the evaluation, determine if additional translocation efforts are necessary.

Create a mission blue butterfly working group to:
    a. Develop a consistent monitoring and surveying scheme.
    b. Coordinate synchronized and scheduled monitoring of all colonies.
    c. Map all currently known habitat locations, including size and extent of host plant Cover.
    d. Define the species range, including hybrid zones.

Both Species

1) Develop measureable recovery criterion, including colony sizes and dynamics necessary for a population to be self-sustaining in perpetuity.

2) Search for new locations in the SFPW.

3) Develop management plans for all habitat locations based on the findings of the working group.

4) Create local captive propagation facility if determined necessary by the working group.

5) Create plan for population augmentation and reintroduction if determined necessary by the working group.

VII. REFERENCES:

Literature Cited

Adams, D. 2004. Habitat assessment of the endangered Myrtle's silverspot butterfly. Thesis, San Francisco State University, San Francisco, California.

Adger, N., P. Aggarwal, S. Agrawala, J. Alcamo, A. Allali, O. Anisimov, N. Arnell, M. Boko, O. Canziani, T. Carter, G. Cassa, U. Confalonieri, R. Cruz, E. de Alba Alcaraz, W. Eastreling, C. Field, A. Fischlin, B. Fitzharris, C.G. Garcia, C. Hanson, H. Harasawa, K. Hennessy, S.Huq, R. Jones, L. K. Bogataj, D. Karoly, R. Kliein, Z. Kundzewicz, M. Lal, R. Lasco, G. Love, X. Lu, G. Magrin, L.J. Mata, R. McLean, B. Menne, G. Midgley, N. Mimura, M.Q. Mirza, J. Moreno, L. Mortsch, I. Niang-Diop, R. Nichols, B. Novaky, L. Nurse, A. Nyon, M. Oppenheimer, J. Palutikof, M. Parry, A. Patwardhan, P. R. Lankao, C. Rosenzweig, S. Schneider, S. Semenov, J. Smith, J. Stone, J van Ypersele, D. Vaughan, C. Vogel, T. Wilbanks, P.Wong, S. Wu, and G. Yohe. 2007. Working Group II Contribution to the Intergovernmental Panel on Climate Change Fourth Assessment Report. Climate Change 2007: Climate change impacts, adaptation and vulnerability. Brussels, Belgium.

Allen, E.B., A.G. Sirulnik, L. Egerton-Warburton, S.N. Kee, A. Butnerowicz, P. E. Padgett, P.J. Temple, M.E. Fenn, M.A. Poth, and T. Meixner. 2000b. Air pollution and vegetation change in southern California shrublands. Paper read at Planning for Biodiversity in Southern California: Bringing Research and Management Together, February 29–March 3, at Pomona, California.

Amme, D. 2002. San Bruno Mountain Stewardship Grazing Plan. Prepared for Thomas Reid Assocaites.

Arnold, R. A. 1983. Ecological studies of six endangered butterflies (Lepidoptera, Lycaenidae): island biogeography, patch dynamics, and design of habitat preserves. University of California Publications in Entomology 99:1-161.

Arnold, R. A. and S. Lindzey. 2003. Taxonomic identity of the *Plebejus icariodes* population at Oakwood Valley, Marin County, California. National Park Service Report, Golden Gate National Recreation Area.

Avise, J. C. 2004. Molecular Markers, Natural History, and Evolution. Sinauer Associates, Publisher, Sunderland, Massachusetts. 684 pp.

Bennett, S.R. 2009. Vegetation analysis of mission blue butterfly monitoring transects in the Marin Headlands. National Park Service Report, Golden Gate National Recreation Area.

Berwaerts, K. and H. Van Dyck. 2004. Take-off performance under optimal and suboptimal thermal conditions in the butterfly *Parage aegeria*. Oecologia 141: 536-545.

Biswell, H.H. 1956. Ecology of California grasslands. Journal of Range Management 9:19–24.

Brown, R. M. 1969a. Larva and habitat of *Callophrys fotis bayensis*. Journal of Research on the Lepidoptera 25:188-201.

Brown, R. M. 1969b. A new subspecies of *Callophrys fotis* from the San Francisco Bay area. Journal of the Lepidoptera Society 23:95-96.

Calabrese, J. M. and W. F. Fagan. 2004. Lost in time, lonely, and single: reproduction asynchrony and the Allee effect. American Naturalist 164:25-37.

Calabrese, J., M. L. Ries, S. F. Matter, D. M. Debinski, J. N. Auckland, J. Roland, and W. F. Fagan. 2008. Reproductive asynchrony in natural butterfly populations and its consequences for female matelessness. Journal of Animal Ecology 77:746-756.

California Climate Action Team. 2006. Climate Action Team Report to Governor Schwarzenegger and the Legislature. California Environmental Protection Agency, Sacramento, California.

California Department of Finance. 1998. County Population Projections with Age, Sex and Race/Ethnic Detail July 1, 1990 – 2040 in 10 year Increments. Sacramento, California

California Department of Water Resources. (CDWR) 1998. The California water plan update. DWR Bulletin 160-98.

Cayan, D., M. Dettinger, I. Stewart, and N. Knowles. 2005. Recent changes towards earlier springs: early signs of climate warming in western North America? U.S. Geological Survey, Scripps Institution of Oceanography, La Jolla, California.

Clench, H. K. 1966. Behavorial thermoregulation in butterflies. Ecology 47: 1021-1034.

Collinge, S.K., K.L. Prudic, and J.C. Oliver. 2003. Effects of local habitat characteristics and landscape context on grassland butterfly diversity. Conservation Biology 17: 178-187.

Collins, N.M. and M.G. Morris. 1985. Threatened swallowtail butterflies of the world: the IUCN Red Data Book. International Union for the Conservation of Nature and Natural Resources, Cambridge, Great Britain.

Courchamp, F., T. Clutton-Brock, and B. Grenfell. 1999. Inverse density dependence and the Allee effect. Trends in Ecology and Evolution 14**:**405–410.

Dennis, B. 2002. Allee effects in stochastic populations. Oikos 96:389–401.

DeVries, M.F. and I. Raemakers. 2001. Does extensive grazing benefit butterflies in coastal dunes? Restoration Ecology 9:179-188.

DeVries, P.J. and R.W. Thomas. 1999. Species diversity in spatial and temporal dimensions of fruit-feeding butterflies from two Ecuadorian rainforests. Biological Journal of the Linnean Society 68: 333-353.

Downey, J. C. 1957. Infraspecific variation and evolution in populations of *Plebejus incarioides* (Bdv.) Ph.D. Dissertation. University of California, Davis. 120 pp.

Duffey, E. 1968. Ecological studies on the large copper butterflies, *Lycaena dispar batavus*, at Woodwalton Fen NNR, Huntingdonshire. Journal of Applied Ecology 5:69-96.

____ 1977. The reestablishment of the large copper butterfly *Lycaena dispar batavus* on Woodwalton Fen NNR, Cambridgeshire, England 1969-73. Biological Conservation 12:143-158.

Ehrlich, P.R. 1984. The structure and dynamics of butterfly populations. Pages 25-40 *In* R.I. Vane-Wright and P.R. Ackery, eds. The Biology of Butterflies. Academia Press, London.

Emmel, J. F. and C. D. Ferris. 1972. The biology of *Callophrys fotis bayensis*. Journal of the Lepidoptera Society 26:237-244.

Entomological Consulting Services, Ltd. 2007. 2007. Monitoring report for the endangered San Bruno Elfin and Mission Blue butterflies at the Bay Area Ridge Trail project site in the San Francisco Peninsula Watershed. Prepared for the San Francisco Public Utilities Commission.

Environmental Protection Agency. 2008. Basic information on the National Environmental Policy Act (NEPA). Available online at http://www.epa.gov/compliance/basics/nepa.html accessed on June 24, 2009.

Fleischner, T. L. 1994. Ecological costs of livestock grazing in Western North America. Conservation Biology 8:629-644.

Floater, G.J., and M. P. Zalucki. 2000. Habitat structure and egg distribution in the processionary caterpillar *Ochrogaster lunifer*: lessons for conservation and pest management . Journal of Applied Ecology 37: 87-99.

Ford, L. D. and G. F. Hayes. 2007. Northern coastal scrub and coastal prairie. Pages 180-207. *In* M. G. Barbour, T. Keeler-Wolf, and A. A. Schoenherr, eds. Terrestrial vegetation of California. University of California Press, Berkeley.

Forister M.L. and A.M. Shapiro. 2003. Climatic trends and advancing spring flight of butterflies in lowland California. Global Change Biology 9(7): 1130-1135.

Gall, L.F. 1984. The effects of capturing and marking on subsequent activity in *Boloria acronema* (Lepidoptera:Nymphalidae), with a comparison of different models that estimate population size. Biological Conservation 28:139-154.

Haddad, N.M. 1999. Corridor use predicted from behaviors at habitat boundaries. American Naturalist 153: 215-227.

Katharine, H., D. Cayanc, C.B. Fieldd, P.C. Frumhoffe, E.P. Maurerf, N.L. Millerg, S.C. Moserh, S.H. Schneideri, K.N. Cahilld, E.E. Clelandd, L. Daleg, R. Drapekj, R.M. Hanemannk, L.S. Kalksteinl, J. Lenihanj, C.K. Lunchd, R.P. Neilsonj, S.C. Sheridanm, and J.H. Vervillee. 2004. Emissions pathways, climate change, and impacts on California. Proceedings of the national Academy of Sciences 101: 12422-12427.

Heinrich, B. 1986. Thermogregulation and flight activity of a satyrine, *Coenonympha inornata* (Lepidoptera: Satyridae). Ecology 76: 593-597.

Heitschmidt, R. K. and J. W. Stuth. 1991. Grazing management: an ecological perspective. Timber Press, Portland, Oregon.

Hovanitz, W. 1937. Concerning the *Plebejus icarioides rassenkreiss*. Pan-Pacific Entomologist 13:63-98.

Howe, W. H. 1975. The butterflies of North America. Doubleday, New York.

Human, K. G. and D. M. Gordon. 1997. Effects of Argentine ants on invertebrate biodiversity in northern California. Conservation Biology 11:1242-1248.

Ide, J. 2002. Seasonal changes in the territorial behavior of the satyrine butterfly *Lethe diana* are mediated by temperature. Ethology 20: 71-78.

International Panel on Climate Change. 2001. Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change [Houghton, J.T., Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, X. Dai, K. Maskell, and C.A. Johnson (editors)]. Cambridge University Press, Cambridge, United Kingdom and New York, New York. 881 pp. Available at http://www.ipcc.ch/

_____ 2007. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Alley, R., T. Berntsen, N.L. Bindoff, Z. Chen, A. Chidthaisong, P. Friedlingstein, J. Gregory, G. Hegerl, M. Heimann, B. Hewitson, B. Hoskins, F. Joos, J. Jouzel, V. Kattsov, U. Lohmann, M. Manning, T. Matsuno, M. Molina, N. Nicholls, J. Overpeck, D. Qin, G. Raga, V. Ramaswamy, J. Ren, M. Rusticucci, S. Solomon, R. Somerville, T.F. Stocker, P. Stott, R.F. Stouffer, P. Whetton, R.A. Wood, D. Wratt. 21 pp. Available at http://www.ipcc.ch/.

Karban, R. 1997. Neighbourhood affects a plant's risk of herbivory and subsequent success. Ecological Entomology 22: 433-439.

Keeley, J. E. 2003. Fire and invasive plants in California ecosystems. Fire Management Today 63:18-19.

Kopper, B.J., R.E. Charlton, and D.C. Margolies. 2000. Oviposition site selection by the regal fritillary, *Speyeria idalia*, as affected by proximity of violet host plants. Journal of Insect Behavior 13:651–665.

Lederhouse, R.C. 1982. Territorial defense and lek behavior of the black swallowtail butterfly *Papilio polyxenes*. Behavioral Ecology and Sociobiology 10: 109-118.

Lenihan, J.M., R. Drapek, D. Bachelet, and R. P. Neilson. 2003. Climate change effects on vegetation distribution, carbon, and fire in California. Ecological Applications 13:1667-1681.

Longcore, T., D. Murphy, D.H. Deutschman, R. Fisher, and R. Redak. 2003. Monitoring and management of Quino checkerspot butterfly (*Euphydryas editha quino*) in San Diego County. County of San Diego, San Diego.

Longcore, T., C. S. Lam, and J. P. Wilson. 2004. Analysis of butterfly survey data and methodology from San Bruno Mountain Habitat Conservation Plan (1982–2000). 1. Status and trends. University of Southern California GIS Research Laboratory and Center for Sustainable Cities, Los Angeles, California.

MacNeill, C. D. 1963. *Callophrys fotis* (Strecker) from the San Francisco Bay area. Pan-Pacific Entomologist 39:60.

Maes, D. and H. Van Dyck. 2001. Butterfly diversity loss in Flanders (north Belgium): Europe's worst case scenario? Biological Conservation 99: 263-276.

Matter, S.F., J. Roland, N. Keyghobadi, K. Sabourin. 2003. The effects of isolation, habitat area and resources on the abundance, density and movement of the butterfly *Parnassius smintheus*. American Midland Naturalist 150:26-36.

McCarthy, M.A. 1997 The Allee effect, finding mates and theoretical models. Ecological Modelling**.** 103:99–102.

Menke, J. W. 1989. Management controls on productivity. Pages 173-200 *In* L. F. Huenneke and H. A. Mooney, eds. Grassland structure and function: California annual grassland. Kluwer Academic Press, Dordrecht, Germany.

Menke, J. W. 1992. Grazing and fire management for native perennial grass restoration in California grasslands. Fremontia 20:22-25.

Murphy, D.D. and P.R. Ehrlich. 1989. Conservation biology of California's remnant native grasslands. Pages 201–211 in L.F. Huenneke and H.A. Mooney, editors. Grassland structure and function: California annual grassland. Kluwer Academic Publishers, Dordrecht, Netherlands.

Oates, M. R. 1995. Butterfly conservation within the management of grassland habitats. Pages 98-112 *In* A. S. Pullin, ed. Ecology and conservation of butterflies. Chapman and Hall, London, England.

Pollard, E. 1988. Temperature, rainfall and butterfly numbers. Journal of Applied Ecology 25:819-828.

Pollard, E., I.P. Woiwood, J.N. Greatorex-Davies, T.J. Yates, and R.C. Welsch. 1998. The spread of coarse grasses and changes in numbers of Lepidoptera in a woodland nature reserve. Biological Conservation 84: 17-24.

Ries, L. and D.M. Debinski. 2001. Butterfly responses to habitat edges in the highly fragmented prairies of Central Iowa. Journal of Animal Ecology 70:840–852.

San Francisco Parks and Recreation Department. 2009. Recovery action plan for the endangered mission blue butterfly (*Icaricia icarioides missionensis)* at Twin Peaks Natural Area. Submitted to Sacramento Fish and Wildlife Office on May 2, 2009.

San Mateo County. 2007. San Bruno Mountain Habitat Management Plan 2007. San Mateo County Parks.

Saunders, S., C. Montgomery, and T. Easley. 2008. Hotter and drier The West's changing climate. Rocky Mountain Climate Organization. Denver, Colorado.

Schultz, C.B. and E.E. Crone. 2001. Edge-mediated dispersal behavior in a prairie butterfly. Ecology 82: 1879-1892.

Scott, J.A. 1986. The butterflies of North America: a natural history and field guide. Stanford University Press, Stanford, California. 583 pp.

Severns, P.M. 2007. Exotic grass invasion impacts fitness of an endangered prairie butterfly, *Icaricia icarioides fenderi*. Journal of Insect Conservation 17:1372-1385.

_____ 2009. Exotic grass invasion impacts fitness of an endangered prairie butterfly, *Icaricia icarioides fenderi*. Journal of Insect Conservation 12(6): 651-661.

Shapiro, A.M. and T.D. Manolis. 2007. Field guide to butterflies of the San Francisco Bay and Sacramento Valley Regions. University of California Press. Berkeley, California. Pages 161-162.

Shields, O. 1967. Hilltopping: an ecological study of summit congregation behavior of butterflies on a southern California hill. Journal of Research on the Lepidoptera 6:69–178.

Shreeve, T.G. 1986. Egg-laying by the speckled wood butterfly *Pararge aegeria*: the role of female behavior, host plant abundance, and temperature. Ecological Entomology 11: 229-236.

Spielman, D., B.W. Brook, R. Frankham. 2004. Most species are not driven to extinction before genetic factors impact them. Proceedings from the National Academy of Sciences 101(42): 15261-15264.

Stephens, P.A. and Sutherland, W.J. 1999. Consequences of the Allee effect for behavior, ecology and conservation. Trends in Ecology and Evolution 14**:**401–405.

Stutt, A.D., and P. Willmer. 1998. Territorial defense in speckled wood butterflies: do the hottest males always win? Animal behavior 55: 1341-1347.

Thelander, C.G. 1994. Life on the edge, a guide to California's natural resources. Wildlife. Biosystems Books, Santa Cruz, California. 550 pp.

Thomas, C.D., and T.M. Jones. 1993. Partial recovery of a skipper butterfly (*Hesperia comma*) from population refuges: lessons for conservation in a fragmented landscape. Journal of Animal Ecology 62: 472-481.

Thomas, J.A., C.D. Thomas, D.J. Simcox, and R.T. Clarke. 1986. Ecology and declining status of the silver-spotted skipper butterfly (Hesperia comma) in Britain. Journal of Applied Ecology 23: 365-380.

Thomas Reid Associates. 1982. Endangered species survey San Bruno Mountain biological study. Unpublished report to the San Mateo County Steering Committee for San Bruno Mountain.

_____ 1987. San Bruno Mountain Area Habitat Conservation Plan Activities Report - 1987. County of San Mateo, Palo Alto, California.

_____ 2004. Maps of the vegetation types on San Bruno Mountain. Palo Alto, California,

U.S. Attorney's Office. 1994. *United States v. Richard J. Skalski, Thomas W. Kral, and Marc L. Grinnell, Case No. CR932013, 1993*. Department of Justice, San Jose, California.

TRA Environmental Sciences. 2007. San Bruno Mountain Habitat Management Plan. Prepared for the County of San Mateo.

U.S. Attorney's Office. 1994. United States v. Richard J. Skalski, Thomas W. Kral, and Marc L. Grinnell, Case No. CR932013, 1993. Department of Justice, San Jose, California.

U. S. Fish and Wildlife Service. 1984. Recovery plan for the San Bruno elfin and mission blue butterflies. U. S. Fish and Wildlife Service, Portland, Oregon. 81 pp.

_____. 1998. Recovery Plan for Seven Coastal Plants and the Myrtle's silverspot butterfly. Portland, Oregon.

Vitousek, P.M., H.A. Mooney, J. Lubchenco, and J.M. Melillo. 1997. Human domination of Earth's ecosystems. Science 277: 494-499.

Ward, P. S. 1987. Distribution of the introduced Argentine ant (*Iridomyrmex-Humilis*) in natural habitats of the lower Sacramento Valley and its effects on the indigenous ant fauna. Hilgardia 55:1-16.

Weiss, S. B. 1993. The San Bruno elfin, *Incisalia mossii bayensis* (Brown). Pages 141-142 *In* T. R. New, ed. Conservation biology of Lycaenidae (butterflies). Occasional paper of the IUCN Species Survival Commission No. 8.

_____. 1999. Cars, cows, and checkerspots butterflies: nitrogen deposition and management of nutrient-poor grasslands for a threatened species. Conservation Biology 13: 1476-1486.

Weiss, S. B. and D. D. Muphy. 1991. Thermal microenvironments and the restoration of rare butterfly habitats. Pages 50-60 in J. Berger (editor), Environmental restoration. Island Press, Covelo, California.

Wicklund, C. 1984. Egg laying patterns in butterflies in relation to their phenology and the visual apparency and abundance of their host plants. Oecologia 63:23–29.

Williams, E.H. 1981. Thermal influences on oviposition in the montane butterfly, *Euphydryas gillettii*. Oecologia 50: 342-346.

Personal Communications

Arnold, R. A. 2009. Entomological Consulting Services, Ltd. Pleasant Hill, California.

Pratt, G. 2007. Electronic mail correspondence to David Kelly, November 01, 2007. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, California.

Solvesky, B.G. 2009. United States Fish and Wildlife Service. Sacramento Fish and Wildlife Office. Sacramento, California.

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW

San Bruno Elfin butterfly (*Callophrys mossii bayensis*)

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

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
__X__ No change is needed

Review Conducted By: Sacramento Fish and Wildlife Office staff

FIELD OFFICE APPROVAL:

Field Supervisor, Fish and Wildlife Service

Approve _____ Date 2·16·10

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW

Mission blue butterfly (*Icaricia icarioides missionensis*)

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

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
__X__ No change is needed

Review Conducted By: Sacramento Fish and Wildlife Office staff

FIELD OFFICE APPROVAL:

Field Supervisor, Fish and Wildlife Service

Approve _____ Date 2-16-10