Recovery Action Plan For The Mission Blue Butterfly (*Icaricia icarioides missionensis*) At Twin Peaks Natural Area

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**Executive Summary**

The San Francisco Recreation and Park Department (SFRPD) and the United States Fish and Wildlife Service (USFWS) are proposing to implement this Recovery Action Plan for the endangered Mission blue butterfly (*Icaricia icarioides missionensis*) at Twin Peaks Natural Area, San Francisco County. SFRPD’s Natural Areas Program (NAP) has been monitoring the Mission blue butterfly at Twin Peaks for 7 years. Recent monitoring data suggest that the population at Twin Peaks is extremely low. This decline is believed to have been caused largely by massive dieoffs of the main larval host plant, silver lupine (*Lupinus albifrons* var. *collinus*), during the warm and wet El Niño year of 1998. While silver lupine has rebounded on the site, the Mission blue population remains critically low. Without an intervention, this population may be extirpated.

This Recovery Action Plan for the Mission Blue Butterfly at Twin Peaks Natural Area will include the relocation of gravid female Mission blues from San Bruno Mountain to Twin Peaks. Habitat restoration and management activities will accompany this relocation effort. The relocated Mission blue butterflies and habitat will be monitored to evaluate success.

Host plants and nectar sources were mapped in late spring 2008 to assess habitat quality. The host plants consisted of a total of 3575 lupine plants spread throughout the unit, nearly all silver lupine. Also mapped were 97 varied lupine (*Lupinus varicolor*). Both species had evenly distributed size classes, indicating successful recruitment. No summer lupine (*Lupinus formosus*) was found. Nectar species are widespread, although much of the cover is restricted to two species, coast buckwheat (*Eriogonum latifolium*) and the invasive Italian thistle (*Carduus pycnocephalus*). Due to the large numbers and wide distribution of host plants and nectar sources, the habitat in its current state should be able to support Mission blue butterflies. Relocation is recommended in spring 2009.

Habitat enhancement is still recommended, however, in order to buffer the population against stochastic events. Summer lupine (*Lupinus formosus*) should be introduced and additional varied lupine should be experimentally seeded and propagated to create a more resilient Mission blue habitat. Prime Mission blue habitat has been located in the more wind-sheltered areas, and these areas are identified as targets for establishing more robust lupine colonies. Scrub encroachment by plants such as coyote brush (*Baccharis pilularis*) should be managed by mechanical removal, creating outplanting sites for lupine and nectar sources. Native nectar species, including coast buckwheat (*Eriogonum latifolium*), California phacelia (*Phacelia californica*), checker mallow (*Sidalcea malviflora*) and desert parsley (*Lomatium* spp.), should be comparatively seeded and propagated to improve habitat conditions around lupine colonies and to create more robust corridors between host plant colonies. While Italian thistle should not be allowed to create dense monocultures that crowd out host or nectar sources, large scale treatment of this plant is not recommended until native nectar sources are enhanced.
Background

Population Trends and Recovery Plan

Prior to urban development, large relatively contiguous native grasslands existed between the Golden Gate and San Bruno Mountain. These grasslands probably supported large populations of the Mission blue butterfly, which could move relatively easily across the northern end of the San Francisco peninsula. Urbanization has reduced the habitat and distribution of the species such that local extinction of the Mission blue in San Francisco may occur.

The federal government designated the Mission blue butterfly as an endangered species in 1976. A Recovery Plan for the species was prepared in 1984 which detailed the need to protect remaining habitat, repair habitat degraded by urbanization, and control invasion by exotic species. The Recovery Plan identified Twin Peaks as critical to the Mission blue butterfly and states that the species cannot be considered secure until at least one self-sustaining population exists on Twin Peaks. In addition, reintroduction of butterflies from nearby colonies is recommended if recolonization does not occur naturally.

Recent monitoring data collected by SFRPD indicates that the population at Twin Peaks is rapidly declining (see Table 1). In 1997, a survey at Twin Peaks found 10 adult Mission blue butterflies at Twin Peaks (Harris 1997). Sixteen years earlier, Harris (1997) observed over 150 individuals primarily on the southern end of Twin Peaks. Between 2001 and 2007, SFRPD conducted adult, larvae, and egg surveys at Twin Peaks. Only two adults and two larvae were observed during this period. Egg survey numbers varied between 14 and 103 during this period.¹

Table 1. Recent Mission blue butterfly monitoring data, Twin Peaks

<table>
<thead>
<tr>
<th>Year</th>
<th>1997</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
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<td></td>
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<td></td>
<td>2</td>
</tr>
<tr>
<td>total adults</td>
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<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12</td>
<td></td>
</tr>
<tr>
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<td></td>
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<td>3</td>
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</tr>
<tr>
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</tr>
<tr>
<td>Eggs</td>
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<td>84</td>
<td>143</td>
<td>43</td>
<td>22</td>
<td>432</td>
<td></td>
</tr>
</tbody>
</table>

Site Characteristics

Twin Peaks is an approximately 70 acre open space in the geographic center of San Francisco. The land known as Twin Peaks is owned primarily by the City and County of San Francisco and is under the management jurisdiction of several City departments including SFRPD, Fire Department, Water Department, and the Department of Public Works. Approximately half of the acreage is under the jurisdiction of SFRPD and is designated as a Natural Area.

¹ Mission blue butterfly eggs may be difficult to distinguish from other butterfly species, such as the acmon blue; therefore egg survey data may over represent population size.
The Twin Peaks Natural Area is a relatively intact remnant of San Francisco’s indigenous landscape, containing a mix of coastal scrub and grassland habitats. Prior to urban development, large and relatively contiguous native grasslands stretched from the Golden Gate to San Bruno Mountain, and probably contained large populations of Mission blue butterflies. The grasslands at Twin Peaks currently support several colonies of lupine (*Lupinus albifrons* and *L. variicolor*), which are known host plants for the Mission blue butterfly larvae.

Twin Peaks is used as a recreational open space by San Francisco residents and visitors alike. At 922 feet above sea level, Twin Peaks is one of the highest points in San Francisco. The 360 degree panoramic views offered from Twin Peaks make it a regular stop for tourist buses. In addition to the lookout, the site contains approximately 7,000 linear feet of designated trails and approximately 2,300 linear feet of social trails designated for closure (SNRAMP 2006). The trails at Twin Peaks are designed for, and primarily used by, pedestrians; however, some unauthorized mountain bike and motorcycle use does occur.

**Initiation of Recovery**

On October 31, 2007, Lisa Wayne (SFRPD), David Kelly (USFWS), John Hafernik (SFSU), Stuart Weiss (Creekside Center for Earth Observation), Joe Cannon (San Bruno Mountain Conservancy), Christina Crooker (Golden Gate National Parks Conservancy), Susie Bennett (Golden Gate National Parks Conservancy), Liam O’ Brien (Nature in the City), Peter Brastow (Nature in the City) and others met to review and discuss the status of the Mission blue butterfly at Twin Peaks. Lisa Wayne presented monitoring data for the species at Twin Peaks. Liam O’Brien explained his organization’s interest in augmenting the Mission blue population at Twin Peaks. There was general agreement between the agency representatives and scientists at the October 31st meeting that relocation of individuals from San Bruno Mountain was desirable and an important component of the species’ long term recovery. Stuart Weiss and John Hafernik agreed that Twin Peaks likely contains enough habitat to support the butterfly and that relocation of individuals would not have a negative effect on the potential source population at San Bruno Mountain.

In spring 2008, the SFPRD and USFWS provided funding for the project, and contracted with the Creekside Center for Earth Observation to provide scientific support for the project and development of this Recovery Action Plan.

The Mission blue butterfly is not protected under California law, therefore the California Department of Fish and Game is not involved in this project.

**Species Description**

**Life History**

First described by Hovanitz in 1937, the Mission blue butterfly (*Plebejus icarioides missionensis*) is a small, nickel-sized member of the Lycaenidae family, or "gossamer-winged" butterflies. The males are silvery blue and the females are slate grey to brown, with some blue
towards the middle of the upper fore and hindwings. Contingent on the rainfall in spring, adults fly from mid-March to early June, with peak emergence in late May. The imago (adult phase) live eight to ten days (USFWS 1984). Females lay eggs on leaves, buds and seed pods on three types of lupine including silver lupine (*Lupinus albifrons var. collinus*), summer lupine (*L. formosus*) and varied lupine (*L. variicolor*) (Thelander and Crabtree 1994). Early flying butterflies tend to use silver lupine, while late-season flyers use summer lupine. Varied lupine is less commonly used (TRA 2008a).

The eggs are round, bright, and white, typically laid singly on the upper surface of the lupine leaflet. Eggs hatch within 6 to 10 days and the first and second instar larvae feed on the leaf tissues. Approximately 3 weeks after the eggs hatch, the larvae enter an obligate diapause usually in the litter at the base of the plant. Larvae emerge and continue feeding the following spring. Ants (*Formica lasioides* and *Prenolepis imparis*) tend the third and fourth instar larvae, protecting them from predators and parasites in exchange for sugary secretions the ants feed on. Both of these ant species and 7 other native ant species are known from Twin Peaks. Also found at Twin Peaks are nonnative Argentine ants (Clark et al. MS submitted). Argentine ants are known for outcompeting native ant populations, but also for tending butterfly larvae such as Acmmon blues and Palos Verdes blues (Shors, personal communication 2009, The Urban Wildlands Group 2007). These ants are found in Mission blue habitat on San Bruno Mountain, and have been observed investigating post-diapause larvae in the Marin Headlands in 1996 (Bennett 2008a, TRA 2008b). It is unknown whether Argentine ants have a negative impact on the butterflies and their ant symbionts, or whether they can have a positive effect by tending larvae. Further study into this issue may be warranted, but does not seem critical at this point.

### Nectar Sources

Adult Mission blue butterflies use many different nectar sources, including coast buckwheat (*Eriogonum latifolium*), California phacelia (*Phacelia californica*), checkerbloom (*Sidalcea malviflora*), yarrow (*Achillea millefolium*), blue-eyed grass (*Sisyrinchium bellum*), blue dicks (*Dichelostemma capitatum*), Ithuriels’s spear (*Triteleia laxa*), coyote mint (*Monardella villosa*), golden aster (*Heterotheca sessiliflora bolanderi*), California horkelia (*Horkelia californica*), narrow-leaved mule ears (*Wyethia angustifolia*), and brownie thistle (*Cirsium quercetorum*). They are also known to use nonnative forbs such as Italian thistle (*Carduus pycnocephalus*), milk thistle (*Silybum marianum*), and rough cat’s ear (*Hypocharis radicata*) (Arnold 1983, Bennett 2008b, TRA 2008b). Desert parsley (*Lomatium spp.*) is also recognized as a general nectar source. All of these nectar sources, with the exception of golden aster and milk thistle, are known from Twin Peaks.

Mission blue butterflies tend to fly low to the ground in search of potential mates, oviposition sites, and nectar sources. Trees, scrub, annual grasses, and tall forbs can create navigational challenges to Mission blues. Presence of adult Mission blue butterflies is correlated not only with host plant presence, but also with bare ground. A site dominated by host plant and nectar source vegetation and high cover of bare ground allows Mission blues to quickly and efficiently find mates and host plants during their short flight season (Bennett 2008b, Lucas 1998).
Distribution

The Mission blue now occurs only in northern San Mateo County (San Bruno Mountain, Sweeney Ridge, and a small colony on Milagra Ridge), San Francisco County (Twin Peaks), and Marin County (small pockets along the Southern Headlands, Fort Baker, and along the eastern edges of the Golden Gate National Recreation Area [GGNRA]). The Twin Peaks Mission blue locale has special significance as the "type locality," the site where specimens used to describe the subspecies were collected. The pardalis blue (Plebejus icarioides pardalis), which ranges throughout much of the San Francisco Bay region south along the Coast Range to San Luis Obispo County, is represented by populations occurring north and south of the range of the Mission blue colonies (Orsak 1982). The Mission blue butterfly has always been only known from small colonies within San Francisco. Collections records show individuals from Glen Park, Glen Park Canyon, Mount Davidson, Corona Heights, and Gilman Beach (Reinhard undated), all locations where the Mission blue has been extirpated.

The recent presence of Mission blue butterfly at Twin Peaks indicates that the southern and eastern portions of the open space offer the best habitat, with plentiful lupine and wind shelter. Most of the individuals found at Twin Peaks over the last 17 years were observed in the shallow soiled grassland and scrub mosaic communities within and around the park’s southern hairpin turn, informally known as Mission Flats. The last sighting of an adult Mission blue at Twin Peaks (2004) was on the park’s eastern side below the north peak, in the area informally known as Gardenside. This shallow soiled grassland is well protected from the prevailing winds.

Proposed Recovery Actions

Without any recovery actions, the Mission blue butterfly will likely become extirpated at Twin Peaks in the next year or two. SFRPD and USFWS are proposing several actions to conserve the Mission blue butterfly at Twin Peaks in San Francisco. Specifically, SFRPD and USFWS propose to relocate individuals from populations at nearby San Bruno Mountain, initiate a captive rearing program, implement specific habitat enhancement activities, and monitor reintroduction success.

Relocation Alternatives

A number of scenarios were considered for relocation, and it was decided that initial attempts will use wild caught female butterflies from existing populations. Eggs, larvae, and pupae are difficult to find, collect, and relocate compared with adults. If a captive rearing program is initiated, then other life stages will be considered.

The criteria for numbers and sites to collect from are:

1) Sufficient numbers of gravid females are released to maximize chances of establishment
2) The numbers collected do not have an adverse effect on the source populations.

Butterfly reintroductions do not necessarily succeed on the first try. Schultz et al. (2008) compiled information of butterfly introduction attempts and found the following:
• British tend to release adults at reintroduction sites, versus American releases of adults, pupae and/or larvae.
• For British attempts, at least 10.8 release attempts per species (Oates and Warren, 1990).
• 29 reintroduction successes/226 attempts for 11 of 25 species reviewed by Schultz et al. (2008).
• In above attempts, an average of 292 individuals per reintroduction was used, and attempts lasted an average of 15 years.
• Species with successful reintroductions were introduced 11.1 times; unsuccessful reintroductions were introduced 3.5 times (Oates and Warren, 1990).
• Introductions failed due to poor planning, limited stock, insufficient knowledge of species’ biology, and poor introduction site quality.
• Schultz et al. stresses:
  - Increase systematic recordings of effort details including number of founders, source populations sizes, and number of individuals released in effort
  - Enhance monitoring and experimental design
  - Incorporate ecological modeling
  - Improve species-specific understanding

With this background in mind, contingency plans for adaptive management must be made if the initial attempt fails.

Large, self-sustaining populations exist at San Bruno Mountain and are a potential source of individuals for reintroducing the butterfly to Twin Peaks. Removal of several dozens of individuals from the center of the San Bruno populations will have little impact if the populations remain at present levels (see below, Impact on Source Populations). It is possible, however, that relocation of the butterfly could result in the unintended death of, or injury to, individuals, but proper protocols minimize this risk.

Another possible source for a small number of butterflies is Skyline College. Victoria Harris (TRA Environmental Sciences, pers. comm.) has observed 30-40 Mission blue butterflies in a few hours at the site 7 years ago. This suggests a robust local population extending over several acres of cut slope behind the college, from which some small fraction of the relocated butterflies could be collected. The current status of this population and institutional issues will be investigated for potential future relocation efforts.

**Relocation**

The advantages of using adult butterflies are they are easiest to collect, handle and transport, release into the habitat is straightforward and releases can be timed to minimize the effects of inclement weather (Weiss 2002). Butterflies would be collected during the peak season for *L. albifrons* feeding populations, so that phenological synchrony with that particular host plant is established. A qualified biologist approved by USFWS would perform the relocation.
**USFWS Collection Guidelines**

The USFWS has created the following guidelines for collection and relocation of adult butterflies from San Bruno Mountain to Twin Peaks in spring 2009. The following procedures are listed in order to minimize the effects of the first year of the proposed reintroduction program on the source population at San Bruno Mountain:

1. For the 2009 flight season, capture, captivity, transport, and release shall be limited to no more than twenty-two (22) adult female mission blue butterflies from San Bruno Mountain to Twin Peaks; under no circumstances shall male mission blue butterflies be held in captivity or transported to Twin Peaks.

2. Capture of adult female mission blue butterflies shall be conducted on or after April 15, 2009, and may continue until the end of their 2009 season on San Bruno Mountain.

3. Capture of adult female mission blue butterflies shall be limited to Transects 12 and 13, as described on page 5 and figure 2 in *San Bruno Mountain Habitat Conservation Plan Year 2007 Activities Report for Species Status Species Endangered Species Permit PRT-2-9818*, dated February 2008, that was prepared by Thomas Reid and Associates.

4. Permission from the appropriate landowners to capture adult female mission blue butterflies shall be obtained in writing and high quality photocopies of the original letters or permits shall be supplied to the Service prior to implementing field work on San Bruno Mountain.

5. There shall be at least three (3) or more calendar days between consecutive capture days.

6. No individuals may be captured if three (3) or less adult female mission blue butterflies are observed along Transects 12 and 13 on the day of proposed collection. If four (4) or more adult female mission blue butterflies are observed on Transects 12 and 13 on the day of proposed collection, 25% of them may be captured, held in captivity, transported to Twin Peaks and released on that same date.

7. Adult female mission butterflies may only be transported and released on Twin Peaks. No other relocation site is authorized under this biological opinion.

8. Adult female butterflies shall be held in vented Styrofoam containers supplied with host plant during the transfer from San Bruno Mountain to Twin Peaks Natural Area. The details of the transfer cages used in the transfer of the Palos Verdes blue by Moorpark College will serve as guidance for the cages used for this trans-location.

9. Written reports shall be provided to the Service at the end of each field day indicating the number of adult male and female mission blue butterflies were observed on Transects 12 and 13, the number captured, held in captivity, transported to Twin Peaks and released; the number of butterflies injured or killed; the names and address of the personnel involved with the field work; and any other appropriate information. Reports may be sent to the Service via electronic mail.

10. A written report shall be supplied to the Service within ten (10) business days of the last field
day on San Bruno Mountain, indicating the number of adult male and female mission blue butterflies were observed on Transects 12 and 13, the number captured, held in captivity, transported to Twin Peaks and released; the number of animals released and their behavior after release; the precise locations of capture and release marked on maps at the appropriate scale, the number of animals injured or killed; whether the translocation program is considered successful and why; names and address of the personnel involved with the field work; and any other appropriate information.

Butterflies would be released in the highest quality known habitat areas on Twin Peaks, centered on Mission Flats and Mission Ridge. Females will be caged on selected *L. albifrons* for their first day to encourage local egg deposition. Jessica Shors has used cages for her experimental work on Acmon blues, and has generously offered to provide existing cages and the design for additional units. Cages will not be left unattended, and will be removed at the end of the first day after butterflies have roosted for the night. These lupine plants will provide known locations for examining the efficiency of searches for eggs and prediapause feeding damage.

While the gravid Mission blue females by themselves could repopulate Twin Peaks, the likelihood of success could be increased by including male butterflies. One of the truisms of butterfly biology is that the presence of other butterflies of the same species indicates quality habitat to the butterflies themselves, so increasing the density of adult butterflies increases the chances of lower emigration rates and higher local egg deposition (Schultz 1998). Mission blue females can also mate multiple times, so genetic diversity may also be enhanced by the presence of males. If a female-only introduction is not successful, the possibility of including males should be considered in future attempts.

**Impact on Source Populations**

Scouting surveys on San Bruno Mountain and professional experience with the butterfly indicate that the collection numbers are achievable over several days by a team of biologists. A 5% removal rate is considered a safe limit by USFWS (Dave Kelly, pers. comm.), so a source population with 440 female butterflies is necessary for removal of 22 individual females. In 1981 the total Mission blue population on San Bruno Mountain was estimated by mark-recapture at 18,000 individuals, spread across the whole mountain (TRA 1982). There has been no long-term downward trend detected (TRA 2007 personal communication). Assuming a conservative 2:1 male: female ratio, 12,000 males and 6000 females may be present in an average year, a considerable margin of safety above the 440 population limit.

The number of butterflies suggested for collection from San Bruno Mountain is well below the threshold that would negatively impact this source population.

**Success Criteria**

Success has both short-term and long-term aspects. The following categories of success criteria are discussed below: relocation success, short-term establishment success, and self-sustaining population success.
Given limited resources, intensive monitoring of adult numbers over the long-term is not feasible. Several concentrated field days with staff and volunteers will be arranged for training and monitoring egg counts and larval feeding damage, which can be done under inclement weather. Attempts will be made to observe adult butterflies when weather is appropriate as staff and volunteer time/schedules permit. The monitoring section below goes into more detail on methods.

The following criteria for relocation success are proposed:
1) Sufficient butterflies are encountered in source populations and captured for release.
2) Butterflies are relocated with minimal impact on individuals.
3) Eggs from caged females are deposited on lupine plants.
4) Free-flying adult butterflies observed in release areas after cage removal.
5) Successive releases, up to 22 females total.
6) Eggs are observed on additional lupine plants.
7) Feeding damage is observed on lupines.
8) Enough data under known distribution and abundance are gathered to create confidence that the monitoring techniques are sufficient to determine distribution and some relative measure of local abundance.

For the second season, short-term establishment success criteria include:
1) Observation of both female and male butterflies on multiple days during the flight season (weather permitting) in and near release areas.
2) Observation of eggs on multiple lupines in and near release areas.
3) Observation of prediapause feeding damage on multiple lupines.

Beyond the second season, the following criteria are proposed:
1) Observation of both female and male butterflies on multiple days during the field season in and near release areas.
2) Multiple observations of butterflies outside of release areas, indicating that the population is spreading.
3) Continued observations of eggs in release areas.
4) Observations of eggs outside the release area, indicating population spread.
5) Prediapause feeding damage observation is optional at this point.

If the Twin Peaks population does not take within 3 years of the initial single relocation attempt, plans will be developed to repeat the introduction. The use of captive-reared individuals to supplement any wild caught butterflies will be considered.

For the habitat, the following success criteria are proposed for long-term:
1) Continued high density of *L. albifrons*, within existing populations, using 2008 as a benchmark.
2) Increased distribution of *L. albifrons* into new areas adjacent to existing populations.
3) Increased density of *L. variicolor* within Mission Flats and Mission Ridge, eventually into the hundreds of plants.
4) Increased distribution of *L. variicolor* into new areas interspersed with *L. albifrons*.
5) Establishment of robust populations of *L. formosus* (>100 plants), in appropriate areas.
6) Increased distribution and abundance of major native nectar sources.
7) Control of key invasive species.
8) Management of annual grass buildup in selected areas.

Captive Rearing
Captive breeding and rearing is an additional method that will be investigated and implemented, if feasible, in the future to serve both as a source for augmentation and for public outreach. Planned partners for the future captive breeding and rearing effort are Moorpark College, which is currently conducting captive rearing of three federally listed butterfly species, and the San Francisco Zoo. The USFWS will be leading the effort to initiate and oversee the captive breeding program.

If the Twin Peaks population maintains success criteria based on relocation alone, these captive reared butterflies may be released at another of the existing populations in San Mateo or Marin County. The recovery project at Twin Peaks will proceed even if captive rearing does not.

Habitat Enhancement
Long term success of the Mission blue butterfly depends in large part on the quality of habitat at Twin Peaks. A significant portion of the peak appears to remain in its pre-European state, with native bunchgrasses and forbs prevalent in much of the grasslands. Urban development has isolated this habitat, which is further decreased in size and fragmented by the invasion of annual grasses and other nonnatives, as well as encroachment of native scrub. In order for Mission blues to persist, the grassland community must be restored, enhanced, and maintained. Key to this effort will be managing the abundance and distribution of lupine host plants and nectar sources, the encroachment of invasive annual grasses, and succession (i.e., the replacement of grassland with scrub).

The size and distribution of lupine were measured as a way to evaluate recruitment of the Mission blue host plants. These efforts are detailed in the following section. After the restoration actions are implemented, the survey will be repeated to evaluate the effects on grassland composition and lupine colonies.

Decreasing annual grass cover is one way to enhance the Mission blue habitat at Twin Peaks. Mowing annual grasses after flowering and before seed set has been shown to reduce competition and increase native cover. This timing is critical to reduce invasive grass recruitment while minimizing negative impacts on native annual forbs. Mowing would be performed by SFRPD staff with training in natural resource management. String cutters will be used to pinpoint patches to be mowed. Dense grass patches will be targeted, and host and nectar plants will be avoided as much as possible. To reduce possible impacts to pupae or adults during the mowing season, mowing will be done with a six-inch buffer from the ground to avoid individuals pupating at the base of vegetation, and on sunny days to allow adults to fly away. Mowing would be accompanied by thatch removal. Thatch within one foot of lupine plants will not be disturbed, in order to protect pupae or diapausing larvae. Lupines also will be planted or seeds broadcast into appropriate habitats.
Lupine colonies can be vulnerable to encroachment by native coastal scrub, which includes quick-growing coyote brush. The succession of coastal scrub into the grasslands may require select removal of shrubs, in order to maintain grasslands for the Mission blue. Scrub removal would be accomplished by NAP using hand labor, goat grazing or a combination of the two techniques. Initial efforts would be done on a small scale using hand labor. Goat grazing would be limited to areas with no or very low cover of lupine to avoid potential negative impacts on host plants.

Native coastal scrub is a desirable element at Twin Peaks. This vegetation type only becomes a threat to butterfly habitat when it reaches a high density and overtakes important butterfly host and nectar plant habitat within the grasslands (TRA 2008b). Management should focus on reducing density in key locations, not on eradicating coastal scrub.

**Habitat Mapping and Analysis**

Habitat mapping focused on location and sizes of Mission blue host plants and nectar sources. Twin Peaks was divided into nine management areas based on topography, roads, and discrete lupine colonies. Within these management areas, wind shelter, sun exposure, and connectivity were analyzed in GIS.

The most resilient Mission blue habitat will have robust colonies of all three lupine species, spread throughout the park. Areas that are sheltered from the wind will be most important, and thus should have sufficient lupine. Lupine centers should be connected by a wide variety of nectar sources.

**Host Plants**

Mission blue females lay eggs on three species of lupine: silver lupine (*Lupinus albifrons* var. *collinus*), varied lupine (*L. variicolor*), and summer lupine (*L. formosus*). Early flying butterflies tend to use silver lupine, while late-season flyers use summer lupine. Varied lupine is less commonly used. Large varied lupine individuals or patches, or plants near silver or summer lupine colonies, seem to be most attractive to Mission blues (TRA 2008a).

Silver lupine can be susceptible to fungal infection, especially in warm, wet El Nino years. Dieback was noted at several lupine colonies on San Bruno Mountain and at Mission blue colonies in the Golden Gate National Recreation Area during the winter of 1998. This extremely wet year brought over 30 inches of rainfall to San Bruno Mountain in the months of January and February, and over 11 inches in the months of March, April, and May (TRA 1999). Field samples from plants affected in the Golden Gate National Recreation Area did not yield conclusive identification, but the dieoffs appear to be the result of widespread damping off root rot fungi, which is often fatal to young plants. Many native plants are not adapted to warm wet conditions and are vulnerable to fungal attacks as the soil warms up (Young 2006).

Mission blue populations in the Marin Headlands and San Bruno Mountain were noted to have declined following silver lupine dieoffs (TRA 2004, Lew Stringer, GGNRA pers. comm.). On Twin Peaks, the adult observations (Table 1) declined from 10 adults in 1997, to one male observed in 2002 and another in 2004. This silver lupine dieoff is believed to be a key cause of the Mission blue butterfly decline at Twin Peaks.
Lupines on Twin Peaks were mapped on a fine scale in early May 2008, with a total of 3575 individuals located (Maps 1 and 2). The vast majority of lupines were silver lupine, although some varied lupines were found. No summer lupine plants were found on Twin Peaks (Table 2). The Mission Flats area had the most extant lupine.

Table 2. Total lupine individuals by species, organized from areas with most to fewest individual plants.

<table>
<thead>
<tr>
<th>Area</th>
<th>Total <em>Lupinus albifrons</em></th>
<th>Total <em>Lupinus varicolor</em></th>
<th>Total Lupine (any species)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mission Flats</td>
<td>1229</td>
<td>2</td>
<td>1231</td>
</tr>
<tr>
<td>Mission Ridge</td>
<td>781</td>
<td>26</td>
<td>807</td>
</tr>
<tr>
<td>West Slope</td>
<td>318</td>
<td>27</td>
<td>345</td>
</tr>
<tr>
<td>Northwest Slope</td>
<td>292</td>
<td>27</td>
<td>319</td>
</tr>
<tr>
<td>Mission Bowl</td>
<td>292</td>
<td>0</td>
<td>292</td>
</tr>
<tr>
<td>Gardenside</td>
<td>270</td>
<td>0</td>
<td>270</td>
</tr>
<tr>
<td>South Peak</td>
<td>214</td>
<td>12</td>
<td>226</td>
</tr>
<tr>
<td>North Peak</td>
<td>81</td>
<td>1</td>
<td>82</td>
</tr>
<tr>
<td>East Slope</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>3478</strong></td>
<td><strong>97</strong></td>
<td><strong>3575</strong></td>
</tr>
</tbody>
</table>
Map 1. Locations of silver lupine plants.
Map 2. Locations of varied lupine plants.

Twin Peaks *Lupinus variicolor* Data
Lupine by Size Class

Lupine plants were categorized by size as a proxy for age class. Three size classes were used: plants with diameters less than 6 inches, from 6-12 inches, and greater than 12 inches. There was an even distribution of lupines by size class across both species, indicating that the lupines are naturally recruiting and successfully living to maturity (Tables 3 and 4). This even distribution is an excellent sign for the butterflies that depend on it.

Table 3. Size distribution of silver lupine.

<table>
<thead>
<tr>
<th>Area</th>
<th>Lupinus albifrons &lt; 6&quot;</th>
<th>Lupinus albifrons 6-12&quot;</th>
<th>Lupinus albifrons &gt;12&quot;</th>
<th>Total Lupinus albifrons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mission Flats</td>
<td>385</td>
<td>367</td>
<td>477</td>
<td>1229</td>
</tr>
<tr>
<td>Mission Ridge</td>
<td>358</td>
<td>194</td>
<td>229</td>
<td>781</td>
</tr>
<tr>
<td>West Slope</td>
<td>135</td>
<td>89</td>
<td>94</td>
<td>318</td>
</tr>
<tr>
<td>Northwest Slope</td>
<td>200</td>
<td>43</td>
<td>49</td>
<td>292</td>
</tr>
<tr>
<td>Mission Bowl</td>
<td>59</td>
<td>78</td>
<td>155</td>
<td>292</td>
</tr>
<tr>
<td>Gardenside</td>
<td>91</td>
<td>67</td>
<td>112</td>
<td>270</td>
</tr>
<tr>
<td>South Peak</td>
<td>81</td>
<td>82</td>
<td>51</td>
<td>214</td>
</tr>
<tr>
<td>North Peak</td>
<td>27</td>
<td>13</td>
<td>41</td>
<td>81</td>
</tr>
<tr>
<td>East Slope</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>1336</strong></td>
<td><strong>933</strong></td>
<td><strong>1209</strong></td>
<td><strong>3478</strong></td>
</tr>
</tbody>
</table>

Table 4. Size distribution of varied lupine.

<table>
<thead>
<tr>
<th>Area</th>
<th>Lupinus varicolor &lt; 6&quot;</th>
<th>Lupinus varicolor 6-12&quot;</th>
<th>Lupinus varicolor &gt;12&quot;</th>
<th>Total Lupinus varicolor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mission Flats</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Mission Ridge</td>
<td>12</td>
<td>6</td>
<td>8</td>
<td>26</td>
</tr>
<tr>
<td>West Slope</td>
<td>4</td>
<td>11</td>
<td>12</td>
<td>27</td>
</tr>
<tr>
<td>Northwest Slope</td>
<td>12</td>
<td>7</td>
<td>8</td>
<td>27</td>
</tr>
<tr>
<td>Mission Bowl</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Gardenside</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>South Peak</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>North Peak</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>East Slope</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>30</strong></td>
<td><strong>30</strong></td>
<td><strong>37</strong></td>
<td><strong>97</strong></td>
</tr>
</tbody>
</table>

Mission Flats

Mission Flats is seen as a critical habitat area because it was one of the last places adult Mission blues were sighted and it has the highest density of lupine on Twin Peaks. Mapping here was carried out on a smaller scale, within a grid of mostly 10x10m squares. This grid can be used as a baseline to monitor habitat enhancement activities. All but two of the plants were silver lupine (Map 3).
Map 3.

**Twin Peaks**

1231 Total Lupine Plants in Mission Flats

Nectar Sources

Adult Mission blue butterflies use a variety of nectar sources. The major sources were mapped, especially those located in high density lupine areas that tend to bloom during flight season. Coast buckwheat (*Eriogonum latifolium*) is the most widespread nectar source mapped on Twin Peaks (Map 4). The invasive Italian thistle (*Carduus pycnocephalus*) is the next most common nectar source (Map 5). California phacelia (*Phacelia californica*) was fairly abundant, while checker mallow (*Sidalcea malviflora*) and desert parsley (*Lomatium spp.*) were more limited (Maps 6-8). The maps indicate colonies of nectar sources by species. If resources allow, more comprehensive nectar maps may be created.
Twin Peaks Nectar
Carduus pycnocephalus
Twin Peaks Nectar
Phacelia californica
Map 8.

Twin Peaks Nectar
Lomatium spp.
Mission Flats

Individual nectar species were mapped in the Mission Flats grid, using class sizes based on number of plants. These maps are presented in Maps 9-13. All nectar sources found on Twin Peaks were present in Mission Flats.

Map 9.

*Twin Peaks*

*Carduus pycnocephalus* Plants in Mission Flats
Map 10.

Twin Peaks
_Eriogonum latifolium_ Plants in Mission Flats

Map 11.

Twin Peaks
_Phacelia californica_ Plants in Mission Flats
**Wind Shelter**

Mission blues are not particularly strong fliers, and the open grasslands and scrub of Twin Peaks are commonly exposed to strong ocean winds. Strong winds hinder adult flight, and therefore the ability to find mates, nectar, and oviposition sites. The total reproductive output of butterflies that lay eggs singly is often in direct proportion to the amount of flight time. Less exposed areas will provide a better chance of population success.

A wind exposure index was developed as follows:

\[
\text{Wind Exposure Index} = \text{elevation of the point} - \text{mean elevation in 90° wedge, 100 m out immediately west of point.}
\]

A positive value means the site is above the terrain to the west, with high exposure to prevailing westerly winds. A negative value means the site is more sheltered from that direction (Map 14).

The map clearly shows the differences in wind exposure from the western to eastern slopes. Wind exposure by management unit shows a predictable progression for the east slope to west slope units (Figure 1). Gardenside is the most sheltered. Mission Ridge, Mission Flats, and Mission Bowl are intermediate, and the West and Northwest Slopes are most exposed. Within each management unit, there is a spread (represented by the standard deviation bars) that indicates local variability.

**Figure 1.**

![Wind Exposure per Management Area](image)
Map 14.

Twin Peaks Wind Exposure Index

Meters above adjacent 100 m western wedge
-42.3 -23.2
-23.1 -19.2
-19.1 -15.2
-15.1 -11.2
-11.1 -7.2
-7.1 -3.2
-3.1 -0.8
0.9 -4.8
4.9 -8.8
8.9 -12.8
12.9 -16.7
16.8 -48.6
Lupines are distributed across the wind gradient (Figure 2), suggesting lupines are not wind limited. The major peak at -5 to 0 is Mission Flats. The large West Slope lupine aggregation is at the high end of the scale at 20-25.

Figure 2.

![Wind Exposure of *Lupinus albilfons*](image)

Varied lupine is also found across the wind exposure gradient, but the majority of plants are in the more wind exposed areas (Figure 3).

Figure 3.

![Wind Exposure of *Lupinus variicolor*](image)
Sun Exposure

The butterflies need warm areas to bask and generate enough energy to fly. Flight seasons begin and end sooner on warm, south-facing slopes as compared with cooler north-facing slopes (TRA 2008a). It is likely that a variety of insolation regimes contributes to population resiliency because of the spread in phenology.

Twin Peaks has a range of equinox insolation from 10-16 MJ/m$^2$, with south-facing slopes having higher insolation than north-facing slopes, with east and west and flat intermediate (Map 15). Silver lupines do not occupy the whole range of insolation (only from 12 to 14.5 MJ/m$^2$ (Figure 4) although this range comprises the vast majority of area on Twin Peaks.
Map 15.

Twin Peaks Equinox Clear Sky Insolation

MJ/m²
March 21

- 10.2 - 10.5
- 10.6 - 11
- 11.1 - 11.5
- 11.6 - 12
- 12.1 - 12.5
- 12.6 - 13
- 13.1 - 13.5
- 13.6 - 14
- 14.1 - 14.5
- 14.6 - 15
- 15.1 - 15.5
- 15.6 - 16
Lupinus formosus is found disproportionately on cooler eastern and northern slopes on San Bruno Mountain, so identifying such slopes on Twin Peaks can guide the introduction of L. formosus.

**Recommendations**

Mission blue habitat at Twin Peaks is currently considered to be sufficient to support introduced butterflies. Specific management activities should be taken, however, to increase the chance of their long-term viability. These include augmenting host plant and nectar source populations, managing scrub succession, and controlling invasive plants.

**Propagate Summer and Varied Lupine**

Any Mission blue larvae at Twin Peaks would be relying heavily on silver lupine. While this species is widespread and robust on Twin Peaks, it is potentially vulnerable to fungal infections in El Nino years. Increasing the number and distribution of summer and varied lupine is a high priority in order to create habitat resilience and potentially lengthen Mission blue flight season, a key factor in reproductive success.

Although in low numbers, varied lupine is known from throughout Twin Peaks. The first priority should be planting it in the high quality habitat areas of Mission Flats, Mission Ridge, and Gardenside. Mission Bowl is the second priority area.

Summer lupine is not currently found on Twin Peaks, and its introduction should also be a priority. This plant may have more specialized habitat requirements than the other two lupine species. On San Bruno Mountain, it grows within disturbed soil conditions, and colonizes
roadways and landslide scars that are more mesic, with deeper and/or sandier soils (TRA 2008b). At Twin Peaks, it will probably do best on the cooler east-facing slopes of Mission Ridge, East Slope, and Gardenside. It should also be reintroduced experimentally to Mission Flats, to determine if it can survive outside the coolest environments.

The success of direct seeding versus propagation of nursery plants should be investigated. Experimental seeding on Mission Flats should be combined with removal of about 20 to 30 large coyote brush plants. The resulting bare area should be experimentally seeded with the three lupine species. While propagation of silver lupine is seen as unnecessary at this point, it should be determined how well this species responds to direct seeding. While nearby National Park Service sites have shown very low survivorship of seeded lupines (Gennet 1999), it is possible this site may have more success. A simple experiment will determine whether seeding is worthwhile.

Silver and varied lupine propagation and outplanting have been initiated, and as of February 2009, no problems with fungal pathogens or herbivory have been noted.

Summer and varied lupine should be monitored not only for survivorship, but to ensure they don’t outcompete the existing widespread silver lupine colonies.

Nectar Sources
While native nectar sources are widespread, their numbers should be increased in the wind-sheltered, lupine rich areas of Mission Flats, Mission Bowl, Mission Ridge, and Gardenside. Areas to be seeded or planted should be cleared of scrub or invasive grasses as needed. The survivorship of seeded versus outplanted propagules should be compared. A diversity of the native nectar species found on Twin Peaks should be used in this effort.

Connectivity
Twin Peaks is small, so connecting habitat patches with corridors is important to maximize usable habitat area. Connectivity creates resilience by allowing metapopulation dynamics to occur, with individual butterflies moving in or out of habitat areas based on yearly weather patterns or changes affecting host and nectar source availability. Establishing multiple nectar sources between core lupine colonies will enhance connectivity.

Nectar sources appear to be concentrated along the spine and the western side of the park. There are currently no nectar sources mapped on the East or Northwest Slopes. The secondary goal of improving connectivity should focus on the East Slope because it is wind sheltered and connects the lupine-rich Gardenside and Mission Ridge areas. Likewise, the eastern wind-sheltered portions of North and South Peaks should also be enhanced with native nectar sources. The Northwest Slope remains a lower priority due to wind exposure, even though it does have a large lupine colony.

Clearing nonnative vegetation or scrub to increase bare ground facilitates Mission blue flight and navigation, thus increasing connectivity.
Native versus Nonnative Nectar Sources
The invasive Italian thistle (Carduus pycnocephalus) is currently serving as a widespread nectar source on Twin Peaks. This invasive species, while a nectar source, does have the potential to compete with native host plants and nectar sources, decrease bare ground, and hamper butterfly navigation around host and nectar sources. While native nectar sources are also widespread, and SFRPD vegetation management policy includes treating invasive plants, intensive treatments to remove the Italian thistle are not recommended until native nectar sources are enhanced. This is stated with the caveat that the species should be watched to make sure it doesn’t form dense monocultures. Italian thistle should not be purposely propagated to increase nectar availability.

Vegetation Management Strategy
Discrete patches of coyote brush occurring within primary lupine centers will be selectively thinned during the fall months. Resulting openings will be planted and seeded with lupines and nectar plants in the late fall and early winter. In late winter, encroaching sourgrass and veldt grass will be spot treated with herbicide, and other invasive weeds will be mechanically removed. In the spring, before mature butterflies emerge, annual grasses will be mowed with mechanical string trimmers to within one foot of existing lupines. This process of incremental scrub removal, planting and seeding, invasive control and habitat expansion will be repeated annually. Scrub removal, mowing, invasive weed removal and planting will not occur within one foot of any lupine plant during the Mission blue overwintering period.

Once the existing habitat has been enhanced and expanded, a similar process will be employed to remove scrub and create nectar corridors between primary lupine centers. Long-term maintenance and invasive species management will continue indefinitely.

Long-term Management and Monitoring
The SFRPD will continue to manage Twin Peaks for its habitat and recreational values (SFRPD 2006). A number of ongoing maintenance activities are required to preserve and enhance the Mission blue butterfly habitat and the biological diversity at Twin Peaks and allow for recreational access to the area. Among these activities are invasive plant control, planting, erosion control, trash and debris removal, and trail maintenance.

Habitat Restoration and Management
Restoration would be achieved through planting, seeding, and other appropriate techniques. All propagules would be collected from on site or within the Twin Peaks region of San Francisco and would be propagated in the Natural Areas Program nursery in Golden Gate Park, to the maximum extent practicable. Site preparation for planting may include weed removal, scraping soil, digging holes 6-12” deep and mulching with on site materials or weed free rice straw as needed.

Integral to the restoration of the Mission blue’s habitat is the control of invasive non-native plant species. Control would be prioritized based on species extent, invasiveness, rate of spread and level of threat to Mission blue habitat. Several invasive plant species threaten the native plant communities, including the Mission blue habitat, at Twin Peaks. These include sourgrass (Oxalis
pes-caprae), Veldt grass (*Ehrharta erecta*), bur clover (*Medicago polymorpha*), French broom (*Genista monspessulana*), English plantain (*Plantago lanceolata*), European annual grasses and others. For non-native invasive species that function as nectar sources for the Mission blue butterfly, such as Italian thistle (*Carduus pycnocephalus*), a phased approach to removal would be followed. Intensive treatments to remove the Italian thistle will not be performed until native nectar sources are enhanced. Some limited removal of Italian thistle may occur in order to prevent dense monocultures from forming.

Various methods of control may be employed which include but are not limited to, manual, mechanical and chemical treatments that would be applied consistent with SFRPD Integrated Pest Management Program. Manual control—which includes hand pulling, cutting and grubbing—is the most commonly used method for controlling invasive plants and an activity commonly performed by volunteers. Hand pulling involves pulling the entire plant from the ground using hands or a tool such as a weed wrench. Cutting may include cutting stems using loppers, hand shears or handsaws. Grubbing uses hand tools to dig out plants. This technique is commonly used to dig out plants that cannot be easily hand pulled. It entails more ground disturbance than other manual methods and chemical methods.

Mechanical weed removal methods include flaming, mowing, and brushcutting. Flaming involves the application of heat to seedlings with a propane torch. Flaming is conducted in the late winter and early spring in order to most effectively treat seedlings. Brushcutting and mowing is used to control large patches of vegetation and is most typically used as a method of reducing biomass or for eliminating inflorescences from mature plants before they set seed.

Chemical control of invasive plants is limited to spot application or stump treatment of plant specific herbicides. Herbicides are used only when other treatments are not practicable. All herbicides used by SFRPD must be approved by the Department of the Environment’s Integrated Pest Management Program. Integrated Pest Management encourages the use of the least toxic effective method be employed for all pest management problems. At Twin Peaks, plant specific herbicides would be used to control species such as sourgrass that cannot be effectively controlled with hand and mechanical means. Any herbicide treatment should be employed with an effort toward minimizing impacts to nontarget species. Appropriate techniques may include using imazapyr/Habitat™ (which has minimal reaction to members of the pea family, such as lupines), using low-volume, low-pressure nozzles, drizzle technique, or wick applications to reduce drift or overspray (Heath 2007).

**Trash and Debris Removal**

In order to create a pleasing environment for park users, trash and debris that mar the aesthetic value of the landscape would be removed. Placed fill and debris (non-native rock/sand/gravel, asphalt, cement, etc.) may be removed throughout Mission blue habitat if deemed necessary to preserve or enhance the aesthetic and ecological integrity of the site. Illegal dumping is an ongoing problem, especially in habitat areas adjacent to roadways. Removal would most likely be performed by hand; however, some heavy equipment use may be required.
Recreational Trail Use and Maintenance

To protect the Mission blue and its habitat from trampling, it is important to focus recreational hiking/walking use on designated trails and maintain those trails. SFRPD would conduct regular maintenance on the existing trail network including trimming trailside vegetation, replacement of trail base materials and localized soil disturbance associated with repair of erosional features, installation or repair of water bars or steps, replacement of retaining features, etc. Maintenance activities would also include monitoring and repair of trailside amenities including signs, fencing, benches, etc.

As recreational use patterns change and new ones emerge, it may be necessary to minimize impacts to Mission blue habitat associated with human use. For example, heavy off-trail bicycle use may pose a threat to Mission blue habitat. In order to protect the habitat, fencing may be required in some locations. Also, trails may be re-routed away from Mission blue habitat.

It is not feasible to fence off every trail or every area with potential Mission blue habitat on Twin Peaks. As long as large numbers of individual lupines are not being lost to trampling, occasional off-trail use will be considered an acceptable disturbance.

The SFRPD will continue to maintain designated trails at Twin Peaks in order to allow for recreational access. Trail maintenance and rehabilitation activities typically include benching, trail outsloping, installing water bars, installing drain dips and replacing and installing steps.

Site Amenities and Safety Improvements

Possible site improvements may include but are not limited to sign installation (wayfinding, interpretive, regulatory), installation or replacement of guard rails, benches and limited fencing for safety or to protect sensitive habitat.

Trail Maintenance and Construction Best Management Practices

Social Trail Closure.
Non-designated trails would be decommissioned by using fencing, signage, mechanical scarification and placing of brush. Scarification would occur only to a depth necessary to restore soil conditions consistent with adjacent uncompacted sites using hand tools and to a maximum width of 4 feet. Revegetation would also occur, as appropriate to rehabilitate the area. To the extent possible, host and nectar plants would be avoided during all decommissioning activities.

Improve/Maintain Trails.
Trail maintenance would include trail benching, installation or replacement of timber steps, installation of trail edging, excavation of soils deposited on steps, installation of trailside erosion materials (e.g., coir rolls, straw wattles, sterile rice straw, jute mesh, etc.) and pruning of trail side vegetation. Mission blue nectar and host plants will be avoided wherever possible.

New Trails and Amenities.
New trails would be constructed so that they are outsloped from 2 to 5% to allow water to drain from the surface naturally. Trails would be developed to a maximum width of 8 feet. Where trail
alignments exceed 8 to 12%, construction of timber steps and associated timber trail edging would be considered. The purpose of new trail construction would be to re-route recreational uses away from Mission blue habitat.

Installation of site benches, fences, signage and other amenities associated with new trails may cause localized ground disturbance. To the extent practicable, individual host plants and nectar plants will be avoided during construction of trails and amenities.

Trail closure, maintenance and construction would not occur during overwintering periods unless absolutely necessary. If trail maintenance must occur during overwintering periods, a one foot no disturbance zone will be created around lupine plants.

**Monitoring**

SFRPD will continue to monitor Mission blue eggs and larvae each spring. Adults will be monitored for at least the first few years.

_Eggs._ Total number of eggs, host plant, and management area will be recorded from a minimum of 30 host plants randomly selected from each of the management areas. Number of eggs, host species, and management area will be recorded. Eggs will be monitored only if and when Mission blue eggs can be definitively identified by staff.

_Larvae._ Feeding damage on host plants by prediapause larvae will be recorded from a minimum of 30 host plants randomly selected from each of the management areas. Number of plants with feeding damage, host species, and management area will be recorded.

_Adults._ A transect system will be installed for timed searches. The exact design and duration of transect walks will be determined from observations immediately following the first and second releases. The first objective of the adult transects is to establish presence within the planning units, or subareas within them. The second is to establish a measure of relative numbers, expressed as butterflies/unit time. It is anticipated that initial numbers of observations will likely be low, and a presence/absence by subarea may be the eventual metric unless numbers are consistently higher.

Monitoring adults presents logistical problems. Mission blues have narrow weather requirements for flight that make scheduling difficult during the already short flight season. Another is that because Twin Peaks is expected to initially support a small population, very low numbers are expected to be encountered on walking transects. Because monitoring the initial success of the release is a high priority, and because monitoring efforts can likely be supplemented with highly skilled volunteer labor in the short term, adults will be monitored for at least the first few years.

A potential disadvantage of permanent transects deals with vegetation dynamics. In a “typical” vegetation patch dynamic, lupine colonies are lost to scrub encroachment, but this loss is generally compensated by new lupine colonies establishing in opened patches created by disturbances such as grazing, fire, or even roadwork. This dynamism has created problems with
monitoring Mission blue adults on permanent transects in the Marin Headlands, as over time lupine has shifted away from some of the transects (Bennett 2008b).

This dynamism is expected to work differently on Twin Peaks. Because the area is relatively small, it will be intensely managed for host plants and nectar sources. Permanent transects will be installed to capture the best habitat of each management area. If prime habitat does seem to be shifting away from the permanent transects over time, however, the transects should be moved to capture the best habitat and therefore to provide the best data with which to estimate true population numbers.

Management Action Timeline

2008

December
✓ Identify areas for experimental seeding/planting in the Mission Flats and Mission Ridge subsites
✓ Identify areas for scrub removal and annual grass mowing around lupine centers and nectar corridors
✓ Identify/prioritize which management areas will be planted, seeded, mown, thinned and monitored over the next 5 years
✓ Plant approximately 80 *Lupinus albifrons*, 24 *Lupinus variicolor*, 50 *Phacelia californica* and 95 *Eriogonum latifolium* into areas of cleared scrub within Mission Flats and Mission Ridge. Mark designated test plots
✓ Flag and experimentally seed *Lupinus variicolor*, *Lupinus albifrons*, *Eriogonum latifolium*, *Sidalcea malviflora*, *Lomatium dasycarpum* and *Phacelia californica* into cleared, scraped scrub perimeters, mark designated monitoring plots.

2009

January
✓ GPS scrub removal areas and *Lupinus variicolor* plantings and seeding plots

February
✓ Identify gravid release sites, consult with Stuart Weiss on planned management actions
  • Spot treatment of invasive *Oxalis pes-caprae* with herbicide

March
• Observe annual grass phenology, mow annual grasses to within one foot of lupines and rake and remove thatch

April
• Collect and release gravid mission blue females from San Bruno Mountain
• Monitor eggs and adult butterflies after release and annually thereafter
• Identify sites for *Lupinus formosus* collection at San Bruno and Bayview Hill (near collapsing headwall)
• Observe nectar plant phenology and plan seed collection

**May**
• Continue collection and release of gravid butterflies
• Monitor eggs and adult butterflies after release and annually thereafter
• Monitor lupine size, distribution and abundance within management areas
• Monitor *Lupinus varicolor* seedling recruitment in direct seeded plots
• Collect seed of nectar plants

**June**
• Collect seed of nectar plants

**July**
• Collect *Lupinus formosus, Lupinus albifrons, Lupinus varicolor* and nectar plant seed
• Begin propagating lupines and nectar plants

**August**
• Selectively remove outlying scrub patches and push back scrub perimeter within primary lupine centers and nectar corridors. Continue scrub thinning at Mission Flats and Mission Ridge and begin thinning at Mission Bowl and Gardenside. Initiate scrub thinning within nectar corridors through East Slope and east facing protected slopes of South and North Peaks.
• Collect seed of lupines and nectar plants

**September**
• Selectively remove scrub from around main lupine centers and nectar corridors

**October**
• Selectively remove scrub from around main lupine centers and nectar corridors
• Direct seed lupines and nectar plants into cleared areas

**November**
• Selectively remove scrub from around main lupine centers and nectar corridors

**December**
• Selectively remove scrub from around main lupine centers and nectar corridors
• Begin planting lupines and nectar plants into scrub removal areas. Focus *Lupinus formosus* reintroduction cooler east and north facing slopes and into areas of deeper soil.

**Additional actions:**
• Decommission trails bisecting habitat
• Develop and post information signage
• Spot herbicide and manual control of mustard, radish, sourgrass, veldt grass, bur clover, French broom, English plantain and limited thistle

**Estimated Cost of Recovery**

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<th>Action</th>
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<td>Survey Lupines and Host Plants and Prepare Recovery Action Plan</td>
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<td>Relocate butterflies</td>
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References


Clarke, K.M., B.L. Fisher, and G. LeBuhn. MS Submitted. The influence of urban park characteristics on ant (Hymenoptera, Formicidae) communities.


Harris, V. 2008. Personal communication with biologist from TRA Environmental Sciences.


Kelly, D. 2008. Personal communication with USFWS biologist.


Young, B. 2006. Unpublished email to student intern and Lewis Stringer, Natural Resource Management Specialist, Golden Gate National Recreation Area, from Betty Young, Director of Nurseries, Golden Gate National Parks Conservancy.
## Appendix

### Ants of SF Parks

Taken from Clarke, K.M., B.L. Fisher, and G. LeBuhn. MS Submitted. The influence of urban park characteristics on ant (Hymenoptera, Formicidae) communities.

### Parks 1-12

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### Park Endemism Score

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*detected but not included in analysis (see methods)

### Parks 12-24

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