A Survey of the Grasslands of the Northeast Ridge (Guadalupe Hills) as Habitat for the Mission Blue Butterfly *(Icaricia icarioides missionensis)* and the Callippe Silverspot *(Speyeria callippe callippe)*

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Introduction

The Mission Blue butterfly *Icaricia icarioides missionensis* and Callippe Silverspot *Speyeria callippe callippe* are two endangered butterfly species that live on San Bruno Mountain. The Mission Blue was listed by the U.S. Fish and Wildlife Service in 1976 (New 1993), and the Calllippe Silverspot was listed in 1997 (USFWS 2007). Both have a restricted range due mainly to urbanization and their particular ecology. The Mission Blue butterfly lays eggs only on several species of lupines, and has an association with specific ant species for a part of its lifecycle (Cushman and Murphy 1993). The Callippe Silverspot also has a restricted host plant – *Viola pedunculata*. It oviposits in the vicinity of *Viola pedunculata* (Thomas Reed Associates 1982) or on them (Arnold 1981). The host plants for both butterflies are plants of the grasslands – a scarce plant community of the Franciscan peninsula due to urbanization.

The Habitat Conservation Plan of 1983 allowed for take of Mission Blue lands in exchange for land preserved elsewhere and restoration of butterfly habitat. Parts of the Northeast Ridge became the San Bruno Mountain County and State Park. Other parts of it were slated for development and miscellaneous open space.

As part of the Habitat Conservation Plan, mark-release-recapture studies were performed on the Callippe Silverspot and the Mission Blue. The total population of the Silverspot was estimated at 11,000 in 1980 and 9,000 in 1981 (Thomas Reed Associates 1982). Yearly surveys, based on individuals sighted per hour, show its population to to remain steady (Thomas Reed Associates 1983-2002). The population of the Mission Blue was estimated at 18,000 in 1983 (New1993).

Aside from yearly monitoring efforts by Thomas Reed Associates, there has been almost no ecological and scientific research on either butterfly since the passing of the Habitat Conservation Plan. In 1998 and 1999, as part of my master's thesis, I intensively studied the egg and larval ecology of the Mission Blue at eight quadrats on San Bruno Mountain. Two 100 square meter quadrats were at the Northeast Ridge (Guadalupe Hills). My results indicated that eggs were significantly aggregated, all lupine species were well used as host plants, and that a specific native ant - *Prenolepis imparis* - was consistently found tending larvae. Of the four sites I examined: Buckeye and Owl Canyon, Northeast Ridge, South San Francisco, and Radio Ridge, Northeast Ridge was the second favored site for Mission Blue oviposition, averaging a density of $.71 \pm .07$ eggs per plant in the 1998 season. Buckeye and Owl Canyons ranked first.

In March and April of 2007, I returned to the Northeast Ridge to determine the importance of these grasslands as habitat for the Mission Blue butterfly and the Calllipe Silverspot. Specifically, I wanted to answer the following questions: 1) Where are the butterfly host plants located? How many are there? 2) What is the vegetation matrix of these grasslands that supports these endangered butterflies? 3) How many eggs and butterflies does the Northeast Ridge possibly support?

Based on my experience surveying for the Mission Blue butterfly around the Bay Area, and also working as a habitat restorationist for the San Francisco Natural Areas Program from 2000-2004, I discuss the following questions with regard to the long term survival of the Mission Blue and Callippe Silverspot: 1) How will human construction on the lower slopes affect larval host plants and butterfly populations? 2) What is the

viability of current mitigation and restoration efforts? 3) How can we best guard these butterfly populations from extinction?

Methods

I surveyed a section of the Northeast Ridge from Carter Street going west-southwest along Guadalupe Canyon Parkway for approximately 836' (Figure 1). The ridge was divided into ten large quadrats using the trail at the top of the ridge as a centerline, and landmarks such as protruding rock outcrops to demarcate boundaries. On March 14th, I surveyed for the larval host plants of the Callippe Silverspot – *Viola pedunculata*. On March 21st, I surveyed for the host plants of the Mission Blue – predominantly *Lupinus albifrons* and a few *Lupinus variicolor*. Each survey lasted three hours; I walked the grasslands back and forth in approximately 3 meter wide swaths looking for the orange yellow blooms of *Viola pedunculata*, the silver leaves and purple blooms of lupines. From the centerline, I walked approximately 40' down the eastern slope to look for host plants, but did not reach the base of the hill, which is Guadalupe Canyon Parkway. Each plant sighted was counted and recorded. In addition to individual plants, I noted the surrounding plant diversity, and classified the grassland community into distinct matrices based on the different composition of plant species.

Results

I counted a total of 369 *Viola pedunculata* plants, 1132 *Lupinus albifrons* plants, and 6 *Lupinus variicolor* plants (Tables 1 and 2). Many *Violas* were found scattered along the upper parts of the ridge. The greatest concentration of *Violas* (over 130 plants) was found in a patch on the west slope about sixty feet upslope of the Blue gum *Eucalyptus globulus* trees, next to large sections of oats *Avena, Hordeum,* Brome *Bromus*, and Italian thistle *Carduus pycnocephalus*. Its associates within this viola patch were *Ranunculus californica*, *Iris longipetala*, *Sidalcea malvaeflora*, *Chlorogalum pomeridianum*, and *Festuca rubra*.

The Northeast Ridge was densely populated with lupines. The great majority of silver lupines *Lupinus albifrons* were found near the compacted trail along the top of the ridge, around rock outcrops, and on the eastern slope of the Guadalupe Canyon Parkway roadcut.

The Northeast Ridge grasslands could roughly be classified into five distinct matrices that mesh and overlap in species composition with one another (Table 3). The plants describe the differing soil types, water tables, and historical human influences. Over the years, the east side road cut of Guadalupe Canyon Parkway has been colonized by a diverse array of native plants from the existing seed bank and neighboring areas; these range from lupines to mosses. The west slope going down towards the Eucalyptus trees is different. It hosts a greater variety of European plants commonly associated with cattle and grazing such as annual grasses, thistle, and *Erodium*. Around particular soils and rocky outcrops, native plants such as Blue Dicks *Dichelostemma capitatum* and soaproot *Chlorogalum* thrive. Occassionally, under the shade of Eucalyptus trees, lupines and coyote mint *Monardella villosa* survive.

Table 1: Number of *Viola pedunculata*

Quadrat	# *Viola pedunculata*
I	12
II	28
III	46
IV	16
V	11
VI	105
VII	98
VIII	34
IX	13
X	6
Total	369

Table 2: Number of *Lupinus albifrons* and *Lupinus variicolor*

Quadrat	# *Lupinus albifrons*	# *Lupinus variicolor*
I	62	0
II	28	2
III	181	0
IV	328	4
V	346	0
VI	96	0
VII	13	0
VIII	26	0
IX	21	0
X	31	0
Total	1132	6

Table 3:

Description of location; greater/lesser plants

1) Compacted trail, top of the ridge:
Lupinus albifrons, *Lomatium* species., *Chlorogalum pomeridianum* / *Sidalcea malvaeflora*, *Eschscholzia californica*, *Plantago lanceolata*, *Marah fabaceus*

2) Guadalupe Canyon roadcut, east facing:
Eriogonum latifolium, *Lupinus albifrons*, *Chlorogalum pomeridianum*, *Lomatium* species, *Viola pedunculata*, *Heteromeles arbutifolia*/ *Briza maxima*, *Claytonia perfoliata*, *Sidalcea malvaeflora*, *Baccharis pilularis*, *Gallium aparine*, *Ranunculus californica*, *Achillea millefolium*, *Toxicodendron diversilobum*

3) West slope scrub and rocky outcrops:
Baccharis pilularis, *Monardella villosa*, *Dichelostemma capitatum*, *Marah fabaceus*, *Hirschfeldia incana*/ *Viola pedunculata*, *Rumex acetosella*, *Lathyrus* species.

4) West slope annual grasslands:
Avena sativa, *Hordeum* species, *Lolium* species, *Bromus* species, *Carduus pycnocephalus*, *Foeniculum vulgare*, *Chlorogalum pomeridianum*, *Marah fabaceus*/ *Raphanus sativa*, *Erodium cicutarium*

5) West slope *Viola* patch:
Viola pedunculata, *Ranunculus californica*, *Chlorogalum pomeridianum*, *Iris longipetala*, *Festuca rubra*, *Vulpia* species.

Discussion

Population of butterflies at the Northeast Ridge

Based on my data from the Northeast Ridge (Wang 2004), I used the egg counts to determine the population of the Mission Blue butterflies on this section of the Northeast Ridge. In 1998, I counted 450 eggs on 72 *Lupinus albifrons* host plants. Given this data, 1132 lupine plants at the Northeast Ridge would host 7075 eggs over the course of the season. Due to lack of research, and the cryptic nature of eggs and larvae, there exists no survivorship table for the Mission Blue Butterfly in nature. This is to say, we do not know how many of these 7075 eggs will survive to adulthood year to year.

When collected and reared in the lab, Downey and Fuller (1961) reported that all fifty of his Twin Peaks Mission Blue eggs hatched and survived to the diapause stage, but few or none lived thereafter. Arnold (1983) reported a 35% egg parasitism rate, and a large

proportion of specimens dying due to parasitism, dessication, or disease during the larval and diapause stages. It is not clear the total number of butterflies he attempted to rear. These deaths were attributed to parasitoids as well as to lab conditions. Taking the data of these two researchers into account, I assumed an overall range of 60-80% mortality rate from egg to adult stages in nature. This section of the Northeast Ridge would therefore yield from 1415-2830 adult individuals: about 8-16% of all adults on San Bruno Mountain if Thomas Reed Associates' 1983 estimate of 18,000 adults is accurate. A significant number of Mission Blue butterflies are here. Given a count of 369 *Viola pedunculata* plants, there is no similar research available to determine the size of the Callippe Silverspot population that lives at the Northeast Ridge.

Effect of urbanization on butterfly habitat

Urbanization is and has been the primary cause of extinction and endangerment for a number of butterfly species in the Bay Area (Connor et al 2002). Prominent examples of extinction include the Xerces Blue Butterfly and the Pheres Blue, which disappeared as the western sand dunes of San Francisco were developed and their host plants razed. The importance of grasslands on San Bruno Mountain lies in its seed bank as a repository of plant genomes, and the specific areas grasslands inhabit due to geography, climate, exposure, and water movement. Human construction activities such as grading and soil movement start an avalanche of catastrophic damage and the destruction of soil, plant, fungal, and insect symbioses.

As the lower parts of hills are graded, the slope gradually falls and settles down to find its repose. In spite of erosion control efforts such as straw rolls, hydroseeding, and retaining walls, existing soils are washed and carved away in the process of construction. The exposed and loose soils are colonized either by the local wild plants adapted to such conditions, human introduced plantings, or by weedy invasive plants if they are nearby. When the soil is dug to the level of the bedrock, and the existing soil dumped down the hill or trucked away, the ancient seed bank is entirely lost. In other cases where the development is above the native grasslands, the grading and paving alter the movement of water and soils; adding run-offs of pesticides, fertilizers and chemicals. These 'disturbed' sites are colonized by plants which hitchhike along with human activities such as French broom *Genista monspessulana*, *Cotoneaster*, *Oxalis*, fennel *Foeniculum vulgare*, and radish *Raphanus sativa*.

Ant species, which Mission Blue larvae are dependent upon for part of their lifecycle, are also site specific and dwellers of the intact system. At San Bruno Mountain, over twenty-seven native ant species have been documented (Ward 1997). There is a diverse ant fauna that differs from the western to the eastern parts of the mountain. On the west side where fog and onshore winds are prevalent, I documented ants such as *Formica argentea*, *Formica subpolita, Leptothorax nevadensis*, and *Aphenogaster occidentalis*. These ants do not tend the Mission Blue larvae; the lack of oviposition activity there reflects the combination of factors that determine the suitability of butterfly habitat.

On the warmer, lower, eastern side of San Bruno Mountain I found *Prenolepis imparis*, *Crematogaster coarctata*, and *Messor andrei*. The native ant *Prenolepis imparis* was consistently found at the Northeast Ridge tending larvae. They are known to nest 15-20 feet in the ground, and are active in the winter months of February and March

when butterfly larvae are feeding and getting ready to enter into their chrysalis. Without the ants' protection and care, it is likely that a much smaller percentage of larvae would survive into adulthood. This is part of the reason why the Northeast Ridge of San Bruno Mountain is so important to the survival of the Mission Blue.

A number of examples from San Bruno Mountain to Pacifica serve to illustrate the gradual fragmentation of endangered butterfly habitat, and the cumulative effects that nearby human dwellings have on these places. The west facing lower slopes of the Northeast Ridge have already been much built upon. Beginning in 1997 I started to survey the area as part of my thesis; Figures 2 and 3 show the disappearance of prime grasslands and lupine – viola rich butterfly territories.

Atop the South San Francisco grasslands near Highway 101 were two quadrats I had studied in 1998 and 1999. Since then, there has been steady construction at the base of the mountain (Figures 4 & 5). The lower parts of the mountain are important in that they serve to buttress the mountain from erosion and they retain the native seed bank. In this capacity, it is a zone of protection against invasive weeds. At this particular site, the lower flat parts were a small creek drainage that was a tree frog *Hyla regilla* breeding ground. It was also a congregation spot for a variety of butterflies due to its protection from the wind and availability of surface moisture.

When built, human dwellings and their surroundings continue to degrade habitat further. I have surveyed for the Mission Blue butterfly at Mariner's Pointe in Pacifica for the past three years from 2004-2006 (Figure 6 and 7). Here, homes were built around and above Mission Blue habitat. Three plots of silver lupines were fenced in, and signs posted warning of sensitive butterfly habitat. With homes came landscaping, irrigation, pesticides, fertilizers, water run off, snails, and other human activities. During the period from 2004-2006, one of the plots has been almost completed decimated by snails *Helix aspersa* and landscaping practices. The number of lupines has plummeted from over 90 plants to less than 13. Another plot with over 10 lupines in 2004 has succumbed to a combination of snails, run-off, and weeds, and no longer has any lupines left.

Mitigation and restoration

The process of destruction, mitigation, and restoration does not address the site specific ecology of butterfly species, and the complexity of these grassland systems. It is entirely without scientific merit. The survival of these butterflies is not as simple as the farming of host plants, or the mass rearing of larvae (Matoon et al 1971). To replicate the system would require its associated group of organisms to *all* be present. To the best of my knowledge, no *new* Mission Blue nor Callippe Silverspot areas have been established by humans in the past twenty five years since the Habitat Conservation Plan.

When lupines are growing in the wild, nature selects for the fittest individuals. That is to say, germination is intermittent, variable, and staggered in time. Seeds may sit in the soil waiting for the most opportune and ecologically moment to grow. Lupine roots may reach deep into the soil, 20 feet down. Vegetative leafy growth is in step with available soil nutrients; the un-germinated lupine seeds remain in the seed bank. These lupines grow exactly where they are most appropriate, along compacted trails and around rocky outcrops. They are *ecologically fit*.

In the nursery, a different scenario is played out. Human selection tends towards uniformity and fast growth. Planted lupine seed coats are scarified by sand paper and or hot water and grown in trays of 100 plants. They are grown in potting mix, sometimes with fertilizers, and become a favorite food for nursery slugs and snails due in part to their nitrogen rich leaves. The lupines are planted out in the fall and winter months with potting soil intact. The existing lupine population are sometimes augmented by planting lupines next to them (Milagra Ridge, Mariner's Pointe, Fort Baker). These human bred lupines grow quickly due to their added soil nutrients. In growth form and long term survival, they are not natural nor *fit*. They sometimes suffer from introduced soil pathogens (GGNRA 1998). For the Callippe Silverspot, I am unaware of any native plant restoration project that has successfully propagated and out planted *Viola pedunculata*.

Granted, the field of restoration is young, there is still much to learn from the growing of native plants and the communities they come from. However, first and foremost is the conservation of existing butterfly habitats, and the understanding of symbioses that connect webs of relationships. Much basic research about the ecology of these butterflies still needs to be done (USFWS 2007) before we can swap habitats, as was the assumption of the Habitat Conservation Plan.

Establishment of a Butterfly Land Trust

Given the rarity of grassland habitats that host the combination of lupines, *Viola pedunculata*, Mission Blues, Callippe Silverspots, and the ant *Prenolepis imparis*, among others, it is essential to protect whatever remains of these areas wherever they occur. The best bet is the establishment of a trust to preserve the San Bruno Mountains as a contiguous whole, thus minimizing human development, and preserving this unique ecosystem.

Summary

The grassland systems of the Northeast Ridge are host to a significant proportion of the population of the Mission Blue butterfly as well as the Callippe Silverspot. Continued development of the Northeast Ridge will cause immediate impact to larval host plants and adults, and cause long-term damage as habitats become more fragmented, land is eroded, and weeds invade. Such activities will bring these two endangered butterflies one huge step closer to extinction. With current technology and knowledge, restoration and re-creation of butterfly grassland habitat is impossible – time and evolution has led to the diversity and ecology of these sites. *In situ* conservation must be the first priority for the survival of these two butterflies. If the Mission Blue and the Callippe Silverspot are to continue to live on San Bruno Mountain and survive in the Bay Area, I recommend the preservation of the remaining grasslands of the Northeast Ridge, and San Bruno Mountain as a whole.

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