Project: Mission Blue
Summary Report 2011-2018

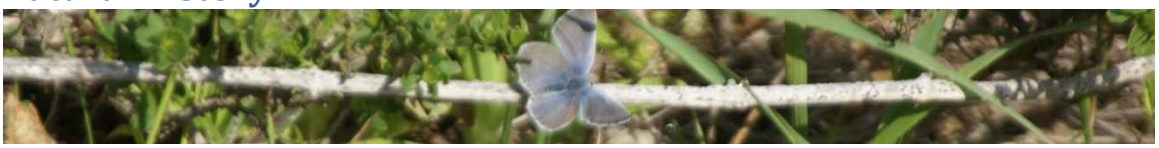
Overview

In May of 2011, the California Garden Clubs Inc. (CGCI) passed a resolution to fund a 5 year project with the Golden Gate National Parks Conservancy to grow lupines in order to preserve Mission blue butterfly (MMB) habitat. This initiative is called Project: Mission Blue. This project works to not only save the endangered Mission blue butterfly by planting its lupine host plant, but also works to meet the secondary goal of fostering an interest in gardening and plant nurseries, and promoting environmental awareness and community engagement.

In 2016 CGCI passed a resolution to continue to fund Project: Mission Blue for 5 more years. This renewed project will continue to plant the lupine host plant, but will expand to also plant Mission blue butterfly nectar plants needed for the health of the adult MBB.

Project: Mission Blue grows and plants the lupine host plant for the Mission blue butterfly and nectar plants at two parks sites within the Golden Gate National Recreation Area called Milagra Ridge and Wolfback Ridge.

Natural History



Milagra Ridge (San Mateo County) and Wolfback Ridge (Marin County) support some of the few remaining populations of the endangered Mission blue butterfly (*Icaricia icarioides missionensis*) in the Golden Gate National Recreation Area.

The Mission blue butterfly is a member of the Lycaenidae butterfly family. It is a butterfly that only lives for one year. The Mission blue butterfly has an adult flight period ranging from mid-March through late May at Milagra Ridge. The adult life span is approximately 6-10 days. During this time, adults will visit several plants for nectar, but are particularly fond of wild buckwheat (*Eriogonum latifolium*), golden aster (*Chrysopsis villosa*), blue dicks (*Brodiaea pulchella*), and Ithuriel's spear (*Brodiaea laxa*). Mission blue butterflies have been documented as being a highly variable subspecies, which is likely a phenotypic intermediate between *Plebejus icarioides pardalis* and *Plebejus icarioides pheres* . It is also

suggested that Mission blue butterflies can acquire varying morphological characteristics due to selective forces in different environments.

Mission blue butterflies use three perennial lupine species as host plants: silver lupine (*Lupinus albifrons var. collinus*), summer lupine (*Lupinus formosus*), and varied lupine (*Lupinus variicolor*), of which *L. albifrons var. collinus* is considered thepreferred host plant. Unlike *L. albifrons var. collinus* and *L. variicolor*, which tend to grow on rocky outcrops among coastal brush grasslands at ridgeline elevations, *L. formosus* is found typically at lower elevations, in less exposed areas, and in continuous grasslands that are more protected in canyons. Of the three lupine species, *L. formosus* is not found at Milagra Ridge though it has been documented on neighboring ridges and valleys. Summer lupine has been introduced to Milagra Ridge as part of the lupine diversification project.

Lupine Host Plants

Silver leaved lupine (*Lupinus albifrons var. collinus)*

- Primary host plant at Milagra Ridge
- Highly used by mission blues

Varied lupine (*Lupinus variicolor)*

- Moderately abundant at Milagra Ridge
- Seldom used by mission blues

Summer Lupine (*Lupinus formosus)*

Primary host plant at Oakwood Valley

Highly used by mission blues

Females usually lay single eggs on the dorsal side of pubescent lupine leaves, but eggs may also be laid on stems, flowers, and seedpods. Eggs hatch within 6-10 days, and the resulting larvae proceed to move

through a series of life stages called *instars*. The first and second instar larvae feed on the mesophyll of the host plant. Approximately three weeks after hatching, the second instar larvae enter into a stage of hibernation called diapause, usually in the dead plant matter at the base of the host plant. Diapause begins at about the same time that the host lupine shifts at its energy from leaf maintenance to flower and seed production. Larvae remain in diapause through winter and emerge to continue feeding in spring into the third and fourth instars. Pupation occurs in the duff at the base of the host plant or at the base of other plants around the host plant.

During the third and fourth instars, ants such as *Prenolepis imparis* and *Formica lasioides* tend to larvae. The ants are attracted by a sugary secretion produced by late-instar larvae. In return, larvae are protected from various parasitoids including a species of Tachinid fly and a Braconid wasp. Eggs are also parasitized by three species of Hymenoptera. Rodents prey upon larvae and pupae, and many pupae . Trampling of host plants, larvae, and pupae is also a threat to survivorship.

Despite the aforementioned factors, monitoring suggests that the most significant threat to the Mission blue butterfly has been outbreaks of a fungal pathogen (*Colletotrichum lupini*) that causes disease and dieback in *L. albifrons* host plants. In 1998, the fungal pathogen negatively affected up to 70% of *L. albifrons* individuals park-wide, followed by precipitous declines in overall Mission blue abundance in 1999 and 2000. While many of the lupine populations recovered after the fungal outbreak, the butterfly populations did not. The impact of the pathogen on butterfly populations is still being investigated, as is shown in some of the analyses used in this report. In 2010, Milagra Ridge experienced another fungal pathogen outbreak affecting *L. albifrons,* which was followed by a second decline in Mission blue sightings.

By increasing the abundance and diversity of lupines in Mission blue butterfly habitat we can decrease the impact of fungal pathogen outbreaks, increase the butterfly population size, and increase the overall resiliency of the Mission blue butterfly.

Lupine Planting 2011-2018

Planting is done with the help of volunteers, and each lupine that is planted in the park is protected from herbivory from deer, rabbits, and rodents by being covered with a mesh cage. This mesh cage is removed once the lupine is big enough to survive without this protection. The lupine is caged for between 1-3 years.

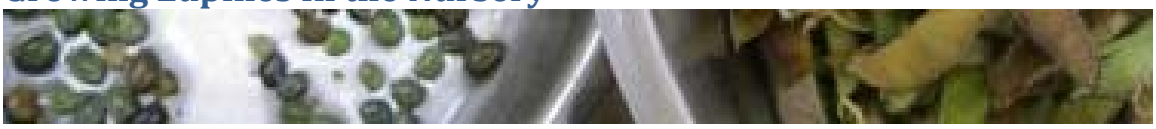
The plants are watered every other week with the help of volunteers until the plant naturally goes dormant during the summer months.

Lupine plants that have grown to maturity are uncaged and monitored for signs that they are hosting the Mission blue butterfly caterpillars. We have successfully found signs of caterpillars on newly planted lupines. This confirms that the lupines we have planted are being used by the Mission blue butterfly.

Lupines Planted in the National Park by Year		
Year	Milagra Ridge	Wolfback Ridge
2011	136	25
2012	248	171
2013	1,342	125
2014	668	226
2015	661	97
2016	1,000	225
2017	820	120
TOTAL	**4,137**	**989**

This picture was taken at Wolfback Ridge and shows how the newly planted lupines are caged from herbivory by deer, rabbits, and rodents

Growing Lupines in the Nursery



The lupine host plants do not grow easily in the nursery. They have long tap roots that do not like being in pots. They are also susceptible to fungal problems. The seeds of lupines have a hard shell that must have abrasion to allow the seed to germinate. These lupines have never been commercially grown, so there is no information on the best way to grow these lupines. Many hours were spent on finding the best way to grow these lupines.

At first we tried gathering lupine seeds when they were young, before the hard seed coat was finished developing. This prevented the nurseries from having to give abrasion to each seed (to allow water to get into the germ of the seed). It was difficult to gather seeds this way because timing had to be precise. If the seeds were too young or old, they would not germinate. Also, young seeds had to be planted immediately in the nurseries because of the lack of a seed coat. Often these planted seeds would grow into lupines, but then would be forced to wait a long time in the nursery to be planted in the park. We plant all native plants in the winter, California's rainy season, to use the naturally occurring rain to water the lupines. While waiting to be planted, the tap roots of the lupines would reach the bottom of the pot and the lupine leaves would begin to immediately die back.

We then discovered that if we collected fully developed lupine seeds and then soaked them in diluted coffee water, the acid from the coffee would break down the seed coats and greatly increase our germination rate. It was much easier to collect fully mature seeds in the park. By collecting fully developed seeds, it increased the duration of time during the summer that we could collect seeds from lupines. Fully mature seeds also stored well in the nursery, so we could hold off on germinating the seeds until just the right time. When we judged it was the right time to germinate the seeds, we would activate germination by soaking the seeds in the diluted coffee water, and then plant the seeds. By timing the germination of the seeds, we can make sure that the lupines spend only the minimum amount of time in the pots, and the roots will not be impacted by reaching the bottom of the pot.

Top Right: Is a picture of demonstrating different ripeness of seeds
Bottom Right: Seeds being taken out of lupine pods
Left: Lupine seeds laid out to germinate

Science

Many experiments have been conducted over the years to increase our understanding of growing lupines. We regularly monitor survivorship of the lupines planted in the field. We have compared this data with soil tests to try and better understand what kind of soil the lupines like to grow in. We have also compared slope and aspect maps of the land to better understand the growing conditions of lupines.

Another experiment we did was to see if adding soil amendment to the ground where we plant lupines will increase their survivorship. We have found that a water—absorbing polymer added to the soil to hold moisture in the soil slightly increased the survivorship of the lupines. Adding a nutrient—free soil amendment to the planting area also increased survivorship of the lupines.

Community Engagement

Project: Mission Blue would not be possible without the many volunteers that help collect lupine seeds, grow, plant, and water lupines. By engaging volunteers in this project, we can teach them about environmental stewardship and conservation. We have partnered with Oceana High School next to our Milagra Ridge park site. Through this partnership we can teach nursery techniques, communicate the importance of conservation, and inspire the next generation of gardeners.

We have also hosted special celebration event days themed around the Mission blue butterfly and hosted special park walks to educate the community on the endangered butterfly, the plants and animals in the grassland, and the great work that we are doing to restore these natural places.

Working with volunteers has also allowed us to maximize the impact of the donations provided by CGCI.

Phase 2

In 2016 we began another phase of Project: Mission Blue. While continuing to grow and plant lupines, we have also started to grow nectar plants for the adult Mission Blue butterfly. In 2017 we planted 703 nectar plants that included coast buckwheat (*Eriogonum latifolium)*, California phacelia (*Phacelia californica)*, checkerbloom (*Sidalcea malviflora)* , and yarrow (*Achillea millefolium)*. These nectar plants are much easier to grow, and we have had high planting survivorship rates.

The increase in lupines at our park site called Milagra Ridge has given us the opportunity to apply and receive a permit from the Department of Fish and Wildlife to move Mission blue butterflies from an existing healthy butterfly population at San Bruno Mountain County Park to the newly created lupine patches at Milagra Ridge. For the past two years we have introduced Mission blue butterflies to new and existing lupine patches and are successfully monitoring the establishment of these new populations of butterflies.

Conclusion

The National Park and the Golden Gate National Parks Conservancy want to thank the California Garden Clubs, Inc. for their sustained support of Project: Mission Blue. It is through a prolonged effort that we

are able to make such a great impact on the survival of the endangered Mission blue butterfly and engage the surrounding communities in environmental education and stewardship.

Appendix 1: Pictures of the nectar plants of Mission blue butterflies that are being planted in Phase 2 of the project.

Coast Buckwheat (*Eriogonum latifolium)*

California phacelia (*Phacelia californica)*

Checkerbloom (*Sidalcea malviflora)*

Yarrow (*Achillea millefolium)*