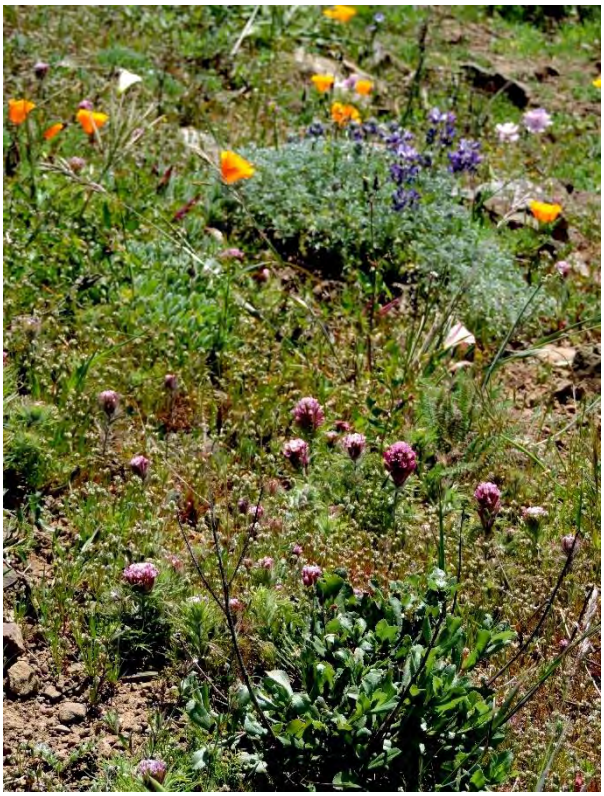
SAN BRUNO MOUNTAIN
HABITAT CONSERVATION PLAN



YEAR 2019-20 ACTIVITIES REPORT FOR FEDERALLY LISTED SPECIES
Endangered Species 10(a)(1)(B) Permit TE215574-6

Prepared By:
Evan Cole
San Mateo County Parks Department
455 County Center, 4th Floor
Redwood City, CA 94063

December 2020

TABLE OF CONTENTS

Table of Contents

GLOSSARY

ANOVA - A statistical procedure called Analysis of Variance. ANOVA is used to test hypotheses about differences between two or more means without increasing the Type I error rate. ANOVA is employed to test whether the mean (or average) for butterfly abundance for a given year or on a given transect is statistically different than another year or transect.

Correlation - Tests for a relationship between two variables.

Endangered - Any species which is in danger of extinction throughout all or a significant portion of its range, other than a species of the class *Insecta* determined by the Secretary to constitute a pest whose protection under the provision of this Act would prevent an overwhelming and overriding risk to man (Federal Endangered Species Act, 1973).

Endangered Species Act - The Federal Endangered Species Act (ESA) of 1973, as amended, 16 U.S.C. Sections 1531-1543. The State of California also has an endangered species act which is referred to as the California Endangered Species Act (CESA).

Invasive Species - Non-native species of plants or animals that out-compete native species in a specific habitat.

Fixed transects - Permanently marked transects that are surveyed year after year. Fixed transects provide a means to compare butterfly observations from year to year at specific locations using standard statistical procedures.

Fixed points - Permanently marked points that are surveyed year after year.

Habitat Conservation Plan (HCP) - The San Bruno Mountain Area Habitat Conservation Plan as adopted by the County Board of Supervisors on September 14, 1982 (Resolution No. 43770).

Habitat Islands – Small areas of native habitat established in restoration sites. Native plantings are installed in relatively small islands where weeds can be more easily controlled. Planting islands generally range in size from 0.1 - 0.25 acres.

Host plant - Particular species of vegetation on which adult butterflies oviposit, and which provides a required food source for survival in the first stages of development after hatching.

Incidental observation - A butterfly observed outside of transects (or point survey area) during travel between survey areas. Transects are belt transect 5-meters wide. Fixed-radius point surveys have a radius of 25-meters.

Management - Treatment afforded portions of San Bruno Mountain to enhance or protect existing habitat or to reclaim habitat invaded by weeds or altered by disturbance.

Monitoring - The task, undertaken by the Plan Operator, of regular observation of biological processes, development and conservation activities on San Bruno Mountain;

the purpose is to assure compliance with the HCP, and to measure the success of its implementation.

Prescribed burn - The controlled application of fire to naturally occurring vegetative fuels, under specified environmental conditions and following appropriate precautionary measures, to achieve specific vegetation management objectives, such as brush and hardwood control, to prepare a site for planting, or reduction of fuel hazards.

Regression - A line of best fit used to define the relationship between two variables.

Section 10a - A section of the Endangered Species Act which authorizes the Secretary of the Interior to permit, under such terms and conditions as he may prescribe, any act otherwise prohibited by Section 9 of the Act. The acts may be permitted for scientific purposes, or to enhance the propagation or survival of the affected species (16 U.S.C. Section 1539).

SUMMARY

This report describes the status of species covered under the San Bruno Mountain Habitat Conservation Plan (SBMHCP) and includes the adult and larval butterfly monitoring results for 2019 and 2020. Vegetation management activities carried out within this timeframe to support habitat improvements to benefit the covered species are also discussed. This report is prepared for submission to the U.S. Fish and Wildlife Service, pursuant to the Endangered Species Act section 10(a)(1)(B) incidental take permit TE215574-6.

Three federally endangered species of butterflies are currently found on San Bruno Mountain and are covered under the SBMHCP: mission blue (*Icaricia icarioides missionensis*, MB), callippe silverspot (*Speyeria callippe callippe*, CS) and San Bruno elfin (*Callophrys mossii bayensis*, SBE) butterflies. One federally threatened species, bay checkerspot (*Euphydryas editha bayensis*, BCB) has recently been reintroduced and is also covered by the SBMHCP. In 2019 MB adult butterflies were counted along thirteen fixed transects. In 2020 San Bruno elfin larvae were counted at eight permanent plots and adult callippe silverspot butterflies were counted along fourteen fixed transects. Of the covered butterfly species found within the SBMHCP area, CS and SBE butterflies are monitored in even years while MB butterflies are monitored in odd years. This has been done to accommodate the challenging weather conditions during adult butterfly flight seasons. Both CS and MB require temperatures to be warm, usually over 65-degrees Fahrenheit and winds less than 10-miles per hour. An additional constraint is the overlap of MB adult monitoring and SBE larvae monitoring. Simply stated, seasonal overlap, staff time requirements, and financial constraints has led to this alternating year approach for endangered butterfly monitoring within the SBMHCP area. The monitoring and reporting for BCB occurs on a separate cycle, and the reports on the reintroduction efforts and monitoring are provided separately to the USFWS; however, the Executive Summaries of the 2019 and 2020 reports for this species are provided with this report as well.
SBE butterfly larvae were monitored and counted between May 12, 2020 and June 02, 2020. Eight permanent plots have been utilized to count species abundance within known habitat for the past 20 years (with surveys completed every two years since 2003). Fixed-radius plots are deployed around a permanent center stake and all larvae observed on broadleaf stonecrop are counted. This year a season total of 1,191 larvae were counted. All permanent plots were surveyed three times this season.

All adult MB and CS butterflies observed along the fixed transects were counted in 2019 and 2020, respectively. The fixed transects are walked by observers at a slow, set pace and all observations for adult butterflies are recorded. Data collected during these surveys includes date, duration for completion of the transect, weather conditions, location along transect of CS adults, behavior, sex, and observed nectaring plant species. This information is reviewed to ensure standardization of the data for statistical analysis. The standards that should be met include minimum weather threshold, ≥65° and < 10 mph winds (5 mph for MB), and that transect observations are only counted if they are at least 1-week apart. A sightings per hour value is calculated for each transect as well as for the year. This index is not a population estimate, but rather a coarse density measurement that can be used in statistical comparison from year to year.

All MB transects were surveyed two to five times between April 8, 2019 and May 23, 2019. A total of 157 MB were observed and counted during the course of all transect surveys.

No MB were observed on transect 1-5 or 8. No modifications were made to MB transects in 2019, though scrub encroachment into transects affecting the passable length was observed.

All CS transects were surveyed five times between May 28, 2020 and July 10, 2020. A total of 686 CS were observed and counted during the course of transect surveys. No CS were observed on T-1 or T-6.

Vegetation management activities in 2019 and 2020 had the purpose of protecting occupied grasslands from ongoing scrub encroachment and invasion of target weed species. Areas were prioritized using guidance from the Assessment of the Past 30 Years of Habitat Management and Covered Species Monitoring Efforts Associated with the San Bruno Mountain Habitat Conservation Plan (Assessment) by Creekside Science completed in February 2015. Using guidance from the Assessment, scrub removal and associated high priority invasive species (e.g., fennel) were targeted in occupied high quality MB and CS habitat in 2019 and 2020.

Ecological Concerns, Inc. and Go Native, Inc. worked in various treatment locations of the SBMHCP area, and targeted scrub and invasive species. In that time they treated a combination of native and non-native scrub, fennel, broom, mustard, thistle, and other weed species in more than 472 acres of the highest priority occupied MB and CS butterfly grassland habitat. Scrub control targets young scrub species for full removal in the grasslands designated as “Essential” habitat by the Assessment.

Volunteer efforts continue in conjunction with San Bruno Mountain Watch (SBMW) and the San Mateo County Parks Department Stewardship Corps program in butterfly habitat areas and areas that support other unique plants or habitats. Volunteer efforts were halted and reduced in scope for 2020 due to the pandemic. SBMW volunteer efforts for the butterfly species focused primarily in Owl and Buckeye Canyon management unit with additional sites in Hillside/ Juncus and South Ridge management units. SBMW lead both weeding and planting events. Host and nectar plants were installed in areas where recent scrub removal efforts occurred.

Statistical analysis is planned for all butterfly data in 2020. Anyone interested in accessing data related to SBMHCP listed butterflies should contact the Parks Department’s Natural Resource Manager. Hannah Ormshaw is currently serving in this role and can be reached at (650) 599-1377 or hormshaw@smcgov.org.

I. INTRODUCTION

In 2019 and 2020, a variety of habitat management work and three butterfly species were monitored to satisfy the requirements of the U.S. Fish and Wildlife Service (USFWS) Incidental Take Permit (TE215574-6) for the San Bruno Mountain Habitat Conservation Plan (SBMHCP). Protected butterfly monitoring for the federally protected mission blue (*Icaricia icarioides missionensis*, MB), callippe silverspot (*Speyeria callippe callippe*, CS) and San Bruno elfin (*Callophrys mossii bayensis*, SBE) butterflies occurred. The complementary habitat management activities to support grassland dependent butterfly species included scrub and invasive species control work, habitat restoration, and coordination with volunteer groups for site specific projects. Lastly, Parks Department staff coordinate with Plan signatories, coordinate technical and natural resource committees, and provide planning assistance to individuals, organizations and agencies related to development within the SBMHCP area and conserved habitat.

The SBMHCP and Endangered Species Act Section 10(a) permit was adopted in November 1982. The 30-year permit was renewed in March 2013. Annual monitoring and reporting of federally-listed species is conducted as part of SBMHCP implementation, and this report is presented to the U.S. Fish and Wildlife Service for review.

A. Covered Species Population Status

Under the SBMHCP the primary emphasis of the biological monitoring program is to evaluate the population status of the endangered butterflies occurring within the San Bruno Mountain area. In 2019 and 2020, fixed transects were used to assess the status of the MB and CS butterflies, respectively, and in 2020 fixed radius plots were used to monitor SBE butterfly larvae on San Bruno Mountain.

The monitoring protocol for CS and MB produce an adult observation index that can be used in a similar way as population estimates to look for population trends. The index generated from transect counts relies on the assumptions that the count is proportional to the population size and that the proportion is constant (Haddad et al. 2008). The current sightings per hour (S/H) index is modeled after the Pollard-Yates index (Pollard and Yates 1993). Pollard-Yates indices do not produce estimates of sampling variation and are believed to perform well regardless of sampling intensity (Haddad et al. 2008). These indices have been shown to correlate with mark-and-recapture estimates. Estimates related to detection probability and survival rates for MB and CS rely on the 1981 Biological Study that supported the development of the SBMHCP. The ability of monitors to observe the species is critical to meet one of the index assumptions, so monitoring is constrained by favorable weather conditions.

The current adult CS and MB monitoring approach is a density measurement. The current methodology aims at collecting peak density as an index of population size (Weiss et al. 2015). This serves as a proximate tool to determine general trends related to these butterfly populations. In 2000, long fixed transects were established to standardize this density measurement and to improve the statistical comparisons between years and among transects. Fixed transects are supposed to be surveyed 4-6 times a flight season when weather conditions meet minimum requirements for temperature and wind speeds.

The reason for at least four to six survey rounds is to ensure that the peak flight season is reflected in the monitoring observations. The monitoring approach for San Bruno Elfin consists of larvae counts performed at 8 fixed points over three monitoring cycles historically targeting peak sedum bloom.

In 2015 Creekside Science completed the Assessment of the Past 30 Years of Habitat Management and Covered Species Monitoring Efforts Associated with the San Bruno Mountain Habitat Conservation Plan, hereon referred to as the "Assessment." The report analyzed the last 30-years of butterfly monitoring data (both wandering and fixed transect) to determine the overall trends associated with the listed butterfly species. It included recommendations on butterfly monitoring techniques, including butterfly, habitat, and host plant monitoring.

The Assessment concludes that the MB and CS populations are stable in high quality habitat areas while marginal lower quality areas are at risk of losing their subpopulations. This was concluded after statistical analysis of the available data, including the most recently available fixed transect data. The primary causes of decline in periphery areas was attributed to scrub encroachment and for CS is likely further compounded by thatch accumulation from non-native annual grasses. It is important to remember that butterfly populations are often associated with large population variability due to individual female egg-laying ability and the many factors that influence mortality at immature life stages. Mortality can be driven by annual weather, phenological asynchrony with host plants, predators and parasitoids, and host/nectar plant availability and quality (Weiss et al. 2015; Pollard 1988; Weiss et al 1988; van Swaay et al 2008). The key to sustaining healthy populations in high quality habitat is to increase the abundance and distribution of host and nectar plants on the mountain in close proximity to other essential habitat features for the individual species (Weiss et al. 2015; USFWS 2009; LSA 2004).

Summary of 2019 Mission Blue Status

A total of 157 MB were documented during the monitoring season, observed along seven of the thirteen fixed transects in 2019. This corresponds to an average sightings per hour (S/H) for all transects of 2.1 S/H. The averaged maximum for all transects was calculated to be 5.3 S/H. A total of 50.2 person-hours was spent on transects included in the 2019 analysis, down from 79 person-hours in 2017, producing a higher average S/H in 2019 despite a lower overall count. Though the average S/H in 2019 was lower than in 2017, and still reduced compared to earlier monitoring years since new fixed transects for MB were established in 2007.

To improve our understanding of habitat quality and work on correlations of butterfly occurrences with host plant density, in 2019-20, efforts to complete coarse-scale lupine host plant mapping and quantification of host plant density was continued. Full mapping of all host plant populations was completed during the 2020 growing season, establishing complete coverage of the SBMHCP area.

Summary of 2020 Callippe Silverspot Status

A total of 686 CS were observed along fourteen of the fixed transects in 2020. This corresponds to an average sightings per hour (S/H) for all transects of 11.6 S/H. The

averaged maximum for all transects was calculated to be 30.67 S/H. A total of 44 person-hours was spent on transects included in the 2020 analysis.

A detailed discussion is included in the 2016 annual report regarding the sightings per hour in comparison to previous monitoring years, and how annual variability in climate and monitoring effort should be considered in the big picture for these population metrics. 2016 represents the first year that County Parks took over the monitoring activities for this species. Recommendations from the Assessment are continuing to be incorporated into our management activities in an effort to maintain a robust monitoring dataset, and establish additional indicators for population variability.

To improve our understanding of habitat quality and work on correlations of butterfly occurrences with host plant density, in 2018 efforts to complete coarse-scale viola host plant mapping and quantification of host plant density was conducted. Full mapping of all host plant populations was not completed during the 2018 growing season, but it is planned for these activities to continue in 2021 to establish complete coverage of the SBMHCP area.

Summary of 2020 San Bruno Elfin Status

In 2020 a total of 1,191 SBE larvae were counted at eight permanent survey locations. The number of larvae observed is just over half what was observed in 2018 (2,148 larvae), but still nearly four times more than what was observed in 2016 (320 larvae). This number of larvae observed in 2020 is significantly higher than the numbers seen in other years (except 2018) with three complete rounds of surveys. While the monitoring window in 2020 generally correlated to peak sedum bloom, the larval counts were high prior to the peak bloom, and the larvae observations dropped dramatically by the third survey effort. Since no habitat monitoring is associated with SBE counts, there is no clear explanation of this potential shift in larval abundance as it relates to peak sedum bloom. The methodology used for larval counts in 2020 continued with changes implemented in 2018: (1) other parts of the sedum plant were searched for larval presence, not just the sedum flower heads (stems, leaves, and the insides of rosettes were searched), and (2) larvae that were observed that were likely in the 1st or 2nd instar were recorded as observations, not just those in 3rd or 4th instar stages. However, unlike in 2018, a two-week interval between survey rounds to capture a greater span of time for the life cycle of the larvae was not consistently implemented.

Rare Plant Status

At this time plant monitoring is not included in the current SBMHCP monitoring program or budget due to funding constraints. The executive summary of the 2016 rare plant survey and plant list is included in Appendix A.

II. STATUS OF SPECIES OF CONCERN

A. Mission Blue Butterfly (*Icaricia icarioides missionensis*)

The MB butterfly is the most widespread of the endangered butterfly species on SBM, and its distribution corresponds closely to the distribution of its host plants. The host

plants for the MB butterfly are three perennial lupines: silver lupine (*Lupinus albifrons* var*. collinus*), summer lupine *(L. formosus* var*. formosus)*, and varied lupine (*L. variicolor*). MBs are limited primarily to areas where their host plants and nectar plants are concentrated. MBs use a variety of native and nonnative species for nectaring (especially thistles), which are found throughout the grassland and coastal scrub plant communities. Protection from wind appears to be an important habitat component for MB and often the species is detected on the leeward side of slopes, or within protected road cut areas where host plants are present in suitable densities. MBs have been found to move up to approximately 0.25 miles between habitat patches (Thomas Reid Associates, 1982), though the species is likely to move further when dispersing between habitat areas. It is unlikely that MB are capable of immigrating to, or emigrating from, the SBMHCP area due to the urbanization barriers surrounding the Mountain.

MBs utilize silver lupine and summer lupine as their primary host plants, and utilize varied lupine less frequently on SBM. Silver lupine is the most widespread host plant species on the Mountain, and grows within dry habitats such as south and east-facing native and non-native grasslands, road cuts, rock outcrops, fire breaks, ridgelines, erosion rills, and landslide scars. Summer lupine also grows within disturbed soil conditions and colonizes roadways and landslide scars in more mesic areas, where soils are typically deeper and/or sandier. Varied lupine grows in grasslands and along disturbed roadsides, typically within mesic exposures, and is commonly found within north and west facing grasslands. MBs tend to utilize larger patches of varied lupine, or smaller patches of varied lupine when found in proximity to silver and/or summer lupine.

Typically, MB butterflies begin adult flight in March and are most abundant in April. Observations begin to drop off by late May or early June. The timing and duration of the flight season is influenced by overall seasonal climate as well as microclimate within separate regions of the SBMHCP area. Late spring rains can delay the onset of the flight season, while hot spring conditions can shorten it. MB colonies on the warmer, dryer south-facing slopes of the Mountain begin and end their flight season earlier than colonies on the cooler north-facing slopes.

METHODOLOGY

In the winter of 2006/2007, 13 fixed transects were established on SBM for MB butterflies (Figure 1). In plotting out the new transects, efforts were made to traverse as much MB habitat as possible. Historic habitat as well as restored or planted habitat was included. Where possible, old MB transects were incorporated into the new, longer transects. Transects vary in length from approximately 500 to 2100 meters and are permanently marked in the field. Of the 13 transects, 11 were established with the intention of being regularly monitored. Two transects (transects 2 and 3) were established as transects to be visited less frequently. Transects 2 and 3 were created to study MB usage of these sites, but these sites are not considered of highest importance in terms of measuring MB abundance in the SBMHCP area. Transect 2 is located east of the Pointe Pacific housing development. Transect 3 includes a planting island on the south side of Guadalupe Canyon Pkwy between the Parkway and Colma Creek. The newly established MB transects were monitored for the first time in 2007 and again in 2009, 2011, 2013, 2015, 2017, and 2019.

Due to concern for monitor safety, in 2009 transects 4 and 5 were reconfigured so that monitors were no longer crossing Guadalupe Canyon Parkway. Transect 4 now ends at the south side of Guadalupe Canyon Parkway and transect 5 connects to that portion of the old transect 4 that is on the north side of the Parkway (Figure 1). Thus, the reconfigured transects 4 and 5 have been monitored since 2009.

The purpose of fixed transects is to provide a means with which to compare MB observations from year to year at specific locations. Fixed transect locations were not chosen randomly but were placed in habitat areas with higher butterfly densities and areas that include a variety of slope exposures, nectar plants, and soil conditions (i.e. road cuts, ravines, and natural slopes). Even within high-density habitat locations it is sometimes difficult to observe enough butterflies for statistical comparison. For this reason, fixed transects were located only in areas where there was a good chance of observing MB.

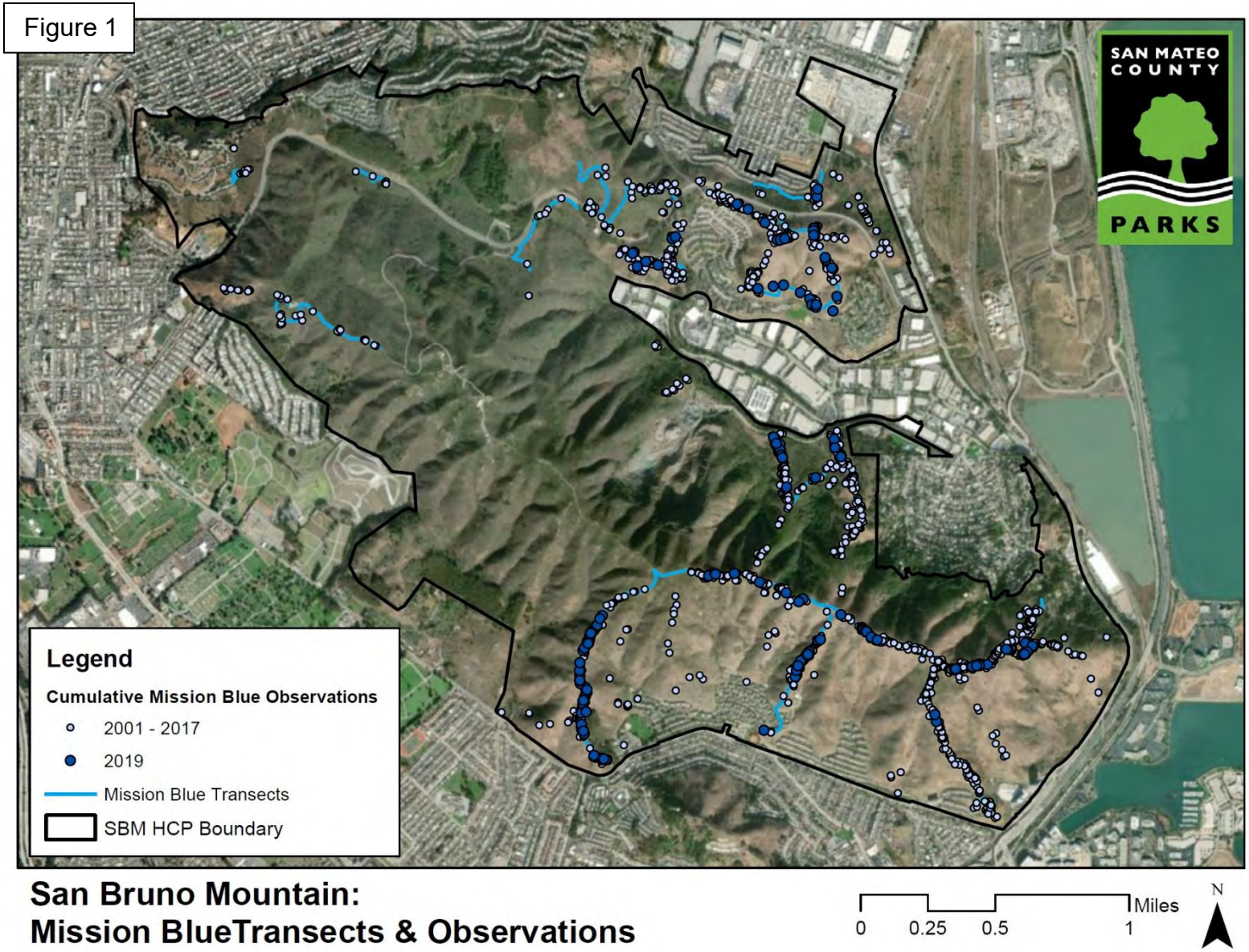
The monitoring program attempts to capture the beginning and end of the flight season and to thoroughly document the observations on a weekly or biweekly basis during that period. It is not cost effective for monitoring teams to monitor the fixed transects prior to species emergence, or to continue monitoring transects after most of the observations have dropped off. As a result, the actual monitoring period does not include the entire flight season for each butterfly species.

Ideally, each transect is monitored approximately 3-5 times over the peak of the flight season. Monitoring occurs only during warm, calm weather (wind speeds less than 10 miles per hour) when MB are most active. Efforts are made to complete an observation cycle (a survey of all 13 transects) within one to two days. All butterflies observed beyond a specific transect or in the transect vicinity during travel between transects are recorded as incidental observations. While the best practice is to leave a 10 day gap of time between monitoring days for each transect, the necessity to monitor under appropriate weather conditions can make this difficult to time. The approach in 2019 for MB was to monitor transects as many times as possible during the period from April 8 through May 23, whenever weather conditions were suitable, regardless of the 10-day timing gap.

The duration spent walking a transect is recorded by the observer and all MB observed along the transect are noted. The location and time of the observation is recorded on a digital map. The number of MB sightings per hour (S/H) is used for analysis. The number of MB observed on a particular transect is divided by the number of minutes to complete the transect survey. For each year, the average and maximum MB sightings per hour for all transects are used to look for upward or downward trends in MB encounter rates among and within transects. The average S/H on a given transect is calculated from the total number of butterflies counted on that transect during all surveys over the total minutes spent on the transect. The maximum value is the highest S/H recorded on a transect in a given year. The maximum S/H is a useful variable for analysis. By looking at only the maximum S/H, the S/H measurements captured at the beginning or end of the flight season that may be of lower value do not skew the data.

Coastal scrub, including poison oak, has encroached on some transects, making complete coverage of these transects difficult if not impossible. Modifications made to these transects are described in the results section where relevant. The original 13 transects in entire length are shown in Figure 1.

Figure 1


SAN MATEO COUNTY
PARKS
Legend
Cumulative Mission Blue Observations
2001 - 2017
2019
Mission Blue Transects
SBM HCP Boundary
San Bruno Mountain:
Mission BlueTransects & Observations
0
0.25
0.5
1
Miles
N

RESULTS

Transect monitoring of MB butterflies occurred between April 8, 2019 and May 23, 2019. A total of 157 MB were counted along all transects. MB were observed on 7 of the 13 transects. The average sightings/hour (S/H) for all transect data combined in 2019 was 2.1. The maximum S/H is what is used to look for trends in abundance, and the average maximum across all transects in 2019 was 5.3 S/H for MB. Each transect was surveyed seven times or more throughout the season, though the 7 to 10 day spacing between surveys was not always adhered to in order to accommodate weather conditions.

Trends observed on each transect are discussed in detail below. Each transect is defined by the Management Unit (MU) that it occurs in and if it is in an Essential, Valuable, or Potential Habitat area for priority scrub management as defined in the Assessment. Priority scrub management habitat areas can be seen in Figure 2 Defining MB in terms of their MU and scrub management area is useful for interpreting butterfly monitoring findings with respect to management actions and recommendations. Sightings per hour for each transect for monitoring years 2007-2019 are summarized in Tables 1 & 2, and illustrated in Figure 3.

T-1, Transect 1 (MU Southwest Slope; some Potential habitat) –
This transect includes a portion of the road cut west of the former ranger's station, part of the summit loop trail, and habitat alongside the paved road (Battery 59 Road) leading to the former ranger's station. In 2019, no MB were observed on this transect.

T-2, Transect 2 (MU Reservoir Hill; Potential Habitat) –
This transect originally looped first through a grassy knoll, then back through scrub to hit a small population of lupine that had been planted by the Point Pacific Homeowners Association. The scrub has become too dense to pass through, therefore the grassy knoll has been the primary focus for the surveys since 2013. In 2019, no MB were observed on this transect.

T-3, Transect 3 (MU April Brook; No Habitat Value) –
The majority of MB habitat on this transect occurs at its eastern end. Only a small number of plants are found at the western end and the route between these areas above the road cut supports coastal scrub. That scrub has become increasingly dense. In 2019, no MB were observed on this transect. This transect was only surveyed twice in 2019, in the fourth and fifth rounds.

T-4, Transect 4 (MU Dairy Wax Myrtle Ravines; some Essential some Potential) –
This transect is located in the Wax Myrtle Ravine and Dairy Ravine area. The transect begins at a planting island in Dairy Ravine, crosses through Wax Myrtle Ravine, following Old Ranch Road trail along Guadalupe canyon parkway. In 2019, no MB were observed on this transect.

T-5, Transect 5 (MU Saddle; some Essential some Potential) –
Much of transect 5 follows an established trail. However, the transect departs from this trail and makes a U-turn through scrub in order to include MB habitat at the top of a

road cut above Guadalupe Canyon Parkway. Coastal scrub on this route has become very thick making passage difficult. In 2013 & 2015, the U-turn was omitted from the transect, and it was assumed that zero MB detections would have occurred while surveying this leg. In 2019, no MB were observed on this transect.

T-6, Transect 6 (MU Dairy Wax Myrtle Ravines; Essential) –
Most of this transect is accessible and supports high quality MB habitat. Only the northern end of the transect has become difficult to traverse with scrub and poison oak. In 2019, a total of 5 MB were observed during the first and third of five visits, equating to a max S/H of 4.09.

T-7, Transect 7 (MU Northeast Ridge; Essential) –
The northwest portion of this transect is within the Toll Brothers development, and since 2011 has been fenced off and then later disturbed by grading. Transect 7 now ends at the Toll Brothers fence. A total of 20 MB were observed along this transect in 2019, during the fourth and fifth of five total visits. Maximum sightings per hour for this transect were 22.0 S/H.

T-8, Transect 8 (MU Carter Martin; Some Valuable) –
When monitored in 2011, the middle of this transect had become difficult to pass due to scrub, including non-native gorse and French broom. In 2013, the transect was monitored in two sections, one on either side of the impenetrable scrub. In 2019, no MB were observed on this transect. Note that two observations on Transect 8 appear on the map on Page 13, though these were unverified and not included in the actual count.

T-9, Transect 9 (MU Northeast Ridge; Essential) –
2017 represents the first year since 2007where the maximum S/H have not declined from the previous year, though the total sightings and S/H were still quite low (1 individual observed, 1.1 max S/H). While grassland habitat along T-9 is fairly intact much of the habitat has sparsely distributed lupines. An exception is at the northern end of this transect where a robust population of lupines are found around the PG&E tower where scrub can be seen starting to expand into grassland habitat just to the west and south of the towers. The southeast corner of T-9 also contains numerous lupines. A total of 10 MB were observed during the fourth and fifth of five surveys. Maximum sightings per hour for this transect were 9.1 S/H.

T-10, Transect 10 (MU Owl Buckeye Canyons, some Essential some Potential) –
T-10 is located at the foot of Owl and Buckeye Canyons within the California Department of Fish and Wildlife lands. This transect traverses open high quality prairie and grassland habitat with diverse nectar sources and scattered lupines along both ridgelines. A total of 9 MB were observed over the second, third, and fourth of five survey rounds. Maximum sightings per hour for this transect were 4.2 S/H.

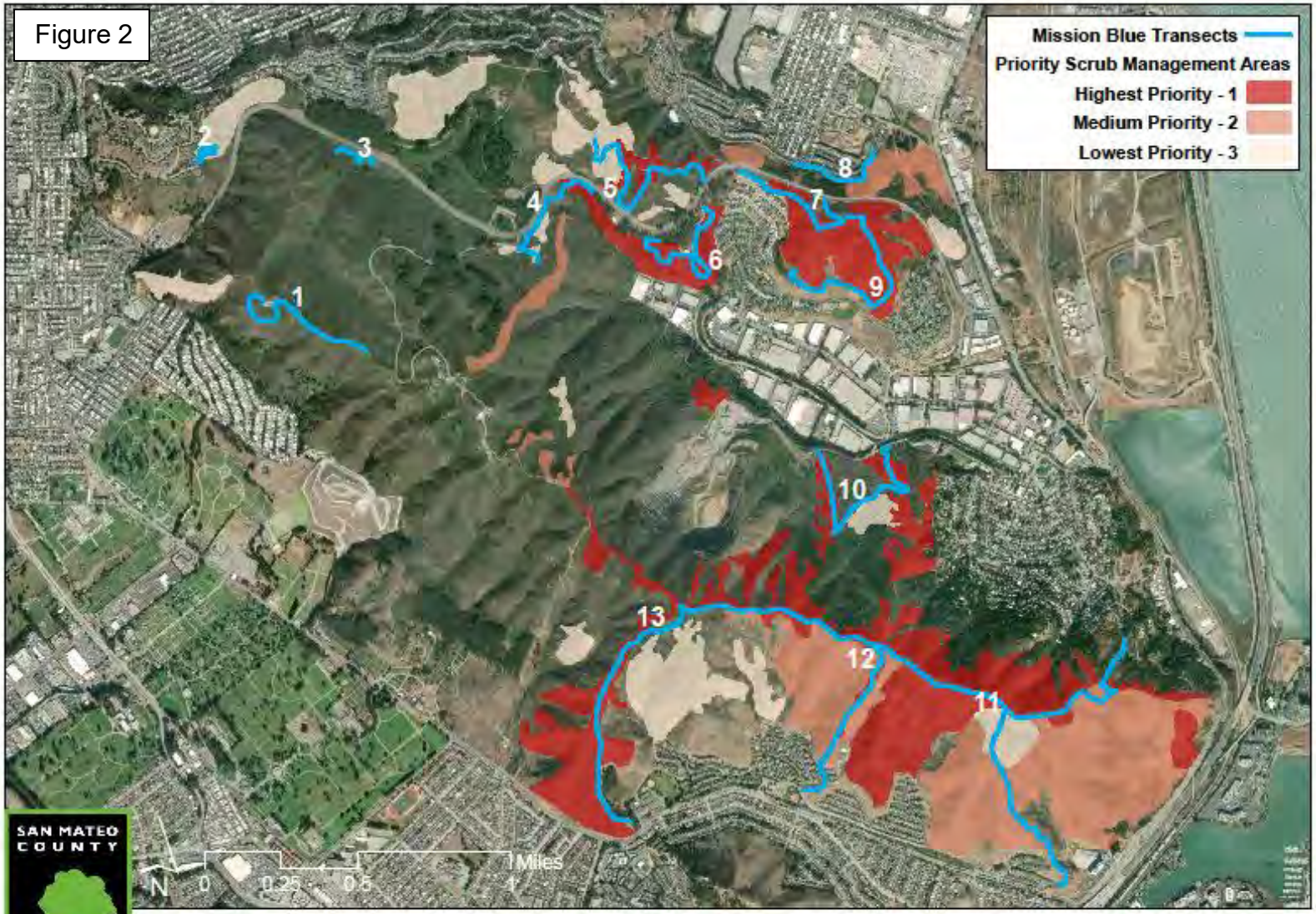
Transect 11 (MU Southeast Ridge; some Essential, some Valuable, some Potential) –
T-11 is located within the Southeast Ridge Management Unit and begins at a previously disturbed slope above Sisters City/Hillside Boulevard that supports lupines. This transect follows the Ridge Trail and includes a portion of the Brisbane Acres Management Unit. T-11 intersects some of the SBM's best lupine habitat with abundant nectar sources. A total of 22 MB were observed on this transect in 2017, down from 47

MB in 2017, with a maximum S/H of 5.2 and an average of 2.6. Most (22) of the observations were recorded during the third round of surveys.

T-12, Transect 12 (MU South Slope; some Essential some Potential) –
T-12 is located within the South Slope and Southeast Ridge Management Units and follows the ridgeline from the Terrabay water tank to the Ridge Trail. Similar to other locations along the South Slope and Southeast Ridge, the habitat here is extensive and continues to support annual grasses, nectar sources, and lupine host plants. 31 MB were observed along T-12 across all survey rounds in 2019 with a maximum S/H of 8.18 and an average of 5.46.

T-13, Transect 13 (MU Ridge, Essential) –
T-13 follows the Ridge Trail and then drops down a ridgeline to Hillside Blvd. T-13 is located on the south facing slope of SBM where conditions are the most dry and sunny. While scrub encroachment has been largely ignored on these slopes due to the slower rate of expansion as compared to the more mesic north and east facing slopes this is a concern in 2015. Grassland habitat supporting lupines along T-13 continue to support high MB observations during transect surveys, despite annual variability in total observations on this transect. In 2019, 60 MB were observed on T-13 (compared to 47 MB in 2017), with a maximum S/H of 15.6 and an average of 8.3.

Figure 2



Mission Blue Transects & Scrub Management Areas

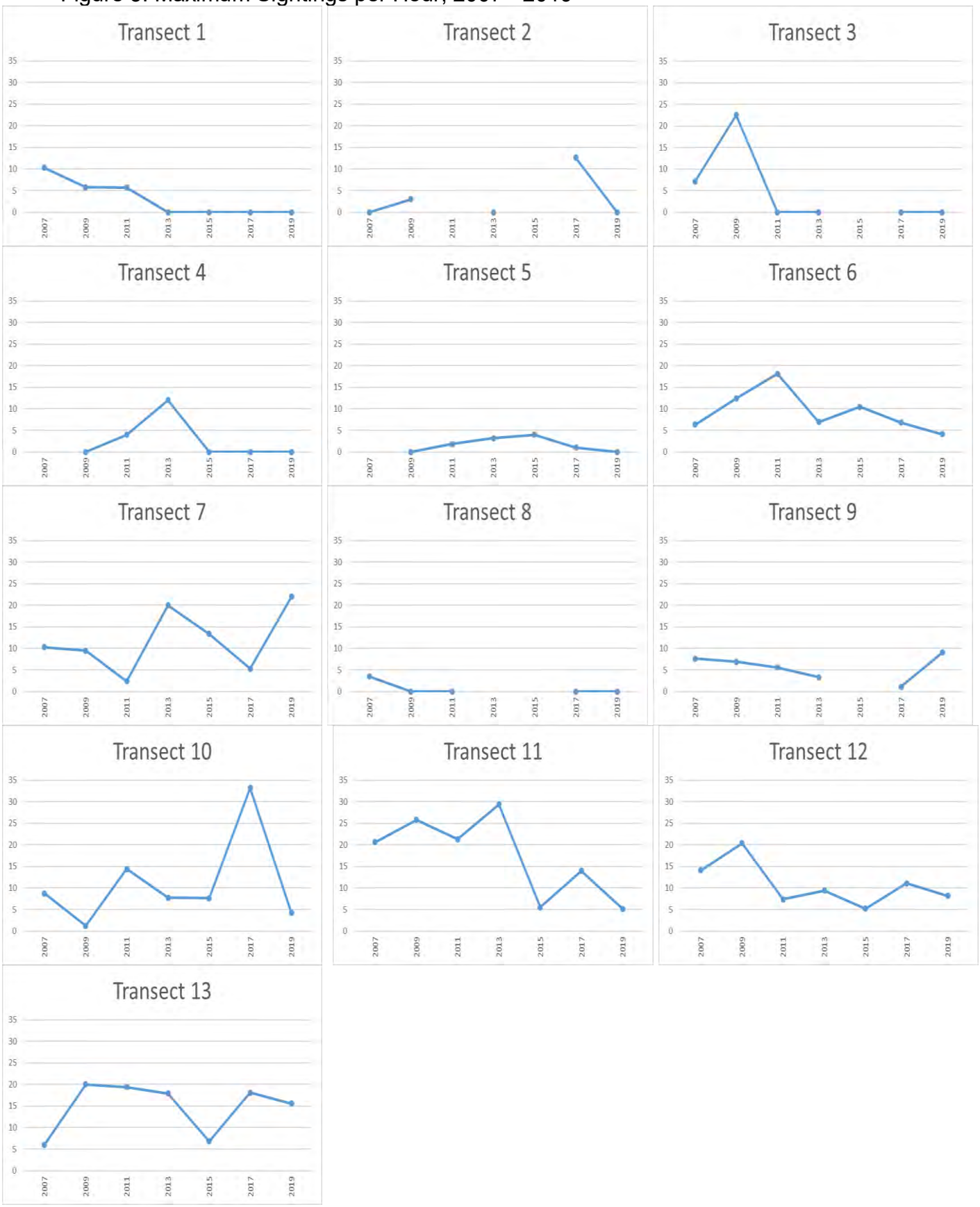
Table 1: Average S/H on each Transect: 2007 – 2019

Average S/H on each Transect from 2007 to 2019							
Year/ Transect	2007	2009	2011	2013	2015	2017	2019
1	2.4	3.57	3.9	0	0	0	0
2	0	3	N/A	0	N/A	3.1	0
3	7.1	22.5	0	0	N/A	0	0
4	N/A	0	2.7	4.86	0	0	0
5	N/A	0	1.7	1.32	0.98	0.1	0
6	2.8	9.68	15.3	4.02	4.94	2.6	1.22
7	3.9	6.18	0.8	13.04	12	1.2	5
8	0.6	0	0	N/A	N/A	0	0
9	4.6	4.5	2.7	1.31	0.49	0.1	2.17
10	4	1.15	7.6	5.27	5.63	5.9	2.18
11	11.3	15.04	15.2	10.73	3.32	3.3	2.61
12	6.5	14.21	5.1	6.32	1.53	3.7	5.46
13	2.2	13.33	11.1	12.52	4.11	4.1	8.34

Table 2: Maximum S/H on each Transect: 2007 – 2019

Maximum S/H on each Transect from 2007 to 2019							
Year/ Transect	2007	2009	2011	2013	2015	2017	2019
1	10.3	5.8	5.7	0	0	0	0
2	0	3	N/A	0	N/A	12.6	0
3	7.1	22.5	0	0	N/A	0	0
4	N/A	0	4	12	0	0	0
5	N/A	0	1.8	3.16	4.0	1.0	0
6	6.3	12.4	18.1	6.92	10.43	6.8	4.1
7	10.3	9.5	2.4	20	13.33	5.3	22
8	3.5	0	0	N/A	N/A	0	0
9	7.6	6.9	5.6	3.33	N/A	1.1	9.06
10	8.7	1.2	14.4	7.74	7.64	33.2	4.21
11	20.6	25.8	21.3	29.41	5.54	14	5.18
12	14.1	20.4	7.4	9.38	5.22	11.1	8.18
13	6	20	19.4	17.89	6.82	18.1	15.56

Figure 3: Maximum Sightings per Hour, 2007 - 2019



DISCUSSION

In 2019, MB observations were down from 2017 counts, and largely reduced from previous years. While in 2017, 221 MB were observed on 9 of 13 transects, in 2019 there were 157 MB observed on 7 of 13 transects. In several of the transects where observations were still recorded in 2019, the maximum and average S/H have dropped from earlier monitoring years. There are a number of potential contributing factors that could explain these decreases. In attempts to correct for previous monitoring years, which the monitoring efforts did not meet the minimum recommended 3 annual surveys, were missing important details in the data sheets, and had low overall person-hours contributing to the efforts, the monitoring approach in 2017 (and continued, to a lesser extent, in 2019) was to complete as many surveys as possible during the flight period when weather conditions were favorable, regardless of the interval between surveys (recommended 10-day intervals between survey rounds). While the level of effort, number of person hours, and attention to detail in recording observations was greatly increased for 2017 and 2019, there were still many surveys where no MB where observed for the entire duration of a transect survey. In calculating the average and maximum sightings per hour for the transects, these occurrences with 0 observations for the duration of the surveys brought down the averages overall. As a result, while the total numbers of MB observed in 2017 (221) and 2019 (157) were much greater than the total observed in 2015 (62), the average sightings per hour in 2017 (1.9) and 2019 (2.14), were lower compared to 2015 (3.2). Further, in both 2017 and 2019, there were a number of occurrences where survey conditions were not optimal in respect to temperature or wind.

In 2019, the greatest average number of MB recorded per hour was, in order, on transects 13, 12, and 7, and the greatest maximum number of MB recorded per hour was, in order, on transects 7, 13, and 9. Transects 11 and 12 contain prime hilltopping habitat along the Ridge Trail and Southeast Ridge with thin soils. Transects 7 and 9 also contain hilltopping habitat along the Northeast Ridge. Lupines are well-distributed across much of these grassland habitats.

Transects that performed the worst in 2019 include 1-5 and 8 with no observations of MB adults recorded. All of these transects have had few to no other MB observations in recent and/or previous years but Transects 2 and 5 dropped to zero in 2019. Scrub encroachment and lack of adequate hilltopping habitat continue to hamper MB populations in these areas, and a cooling effect from fog and a wind-tunneling effect along Guadalupe Canyon Parkway may be suppressing detections along these transects.

CONCLUSIONS

MBs are found in relatively low densities (as is typical for most *Lycanidae* species), but are widely distributed on San Bruno Mountain. The distribution of MBs observation in 2019 on San Bruno Mountain is similar to that of 2017; however, the total number of MBs observed is lower while the average S/H is higher. North to south this species continues to be found in a wide variety of microclimates and slope exposures within SBMHCP area, although in significantly varying densities. The total observed number and calculated sightings/hour of MB in 2019 was low in comparison to previous years; however, this does

not necessarily signal a downward trend in MB abundance as year to year variation has been observed on San Bruno Mountain since 1981 when studies of this species began.

The western portion of SBM has not seen any reliable observations of MB in 2013, 2015, 2017, or 2019, aside from 7 MB sightings on T-2 in the Reservoir Hill area in 2017. This could be due to the combination that high quality habitat is found in smaller habitat patches and unabated scrub encroachment into grassland areas. Weather variability on SBM plays a role in monitoring and it can be difficult to schedule butterfly monitoring visits during ideal monitoring conditions, warm and calm weather days.

A mitigation project undertaken by PG&E, initiated in 2018, focused on grassland restoration efforts on the west peak of SBM, on the south-west facing slope. This location is less than 0.5 miles from T-1 as well as T-2, where observations of MB were made in 2017 but not in 2019. Though this distance is greater than the typical 0.25 mile dispersal distance for MB, there is additional restoration potential to establish a dispersal corridor with habitat islands connecting these two areas and allowing for greater movement of MB throughout this area.

As documented over the past 30 years of butterfly monitoring on SBM, the Southeast Ridge and South Slope continue to provide the largest contiguous patches of high quality habitat for MB butterflies. MBs are widely distributed on San Bruno Mountain, but it is primarily on the South Slope and Southeast Ridge that MB are consistently found in high densities. The South Slope contains large areas of contiguous grassland, and is located on south-facing aspects of San Bruno Mountain as is therefore drier and warmer. Historically coastal scrub succession has been less of a threat than on the south facing slopes, but with little natural disturbance (fire) and absence of grazing these areas are beginning to see more scrub encroachment into grassland areas. The planned San Bruno Mountain Conservation Grazing Pilot Program, which will target areas on the Northeast Ridge and Southeast Slope, may help halt or reverse scrub encroachment and bolster host and nectar plant abundance and distribution in these areas.

The Assessment conducted by Creekside Science provides clear guidance concerning grassland evaluation in light of scrub encroachment. Grassland quality, specifically with respect to host and nectar plant distribution and abundance, are important considerations for healthy MB populations. While the HMP and the SBMHCP documents both identified scrub encroachment as threats to MB neither document provided clear guidance concerning how to define grassland quality or levels of scrub encroached grasslands with quantifiable definitions and actionable thresholds. The lack of a clear definition and SMART (specific, measurable, achievable, results-focused, and time-bound) goals and objectives coupled with limited resources had delayed meaningful management activities targeting this threat until recently.

RECOMMENDATIONS

Based on the Assessment's statistical analysis it appears that SBE are secure in high quality coastal scrub habitat and tracking abundance may not be worth the time and effort. The Assessment recommends establishing presence surveys at all historic sites using larval presence surveys at appropriate times of the year (April through early June) on a

3-4 year interval. Including a short timed search (10 person-minutes) once larvae are found. This would allow for a coarse density class to be reported as supplementary information. This may be considered for the 2022 monitoring season. A reduced frequency of SBE monitoring would enable additional host plant monitoring for MB and CS, due to the greater availability of staff time and funding to support these monitoring activities, if not dedicated to the same degree of intensive SBE surveys. This could also facilitate the Assessment's recommendation of a hybrid monitoring approach (adult observations and habitat monitoring) that would better inform management activities. Since the SBE habitat was not impacted by authorized development under the SBMHCP it may be reasonable to reduce efforts here based the overall stability of this population.

SCRUB ENCROACHMENT

Scrub encroachment is a serious threat to the quality of grasslands and prairie habitats that support MB butterfly populations scattered throughout SBMHCP area. Scrub has been identified as a threat to covered species throughout the SBMHCP and in all documents that provide habitat and vegetation management suggestions. Scrub within the SBMHCP area consists of both native and exotic species. Habitat management activities now balance native scrub control, along with continued containment of noxious exotic plants (gorse, fennel, broom, eucalyptus), and continued treatment of invasive plant species that have the potential to impact covered species habitat.

1. Scrub encroachment should continue to be the primary focus for budget expenditures related to habitat management. Using the Assessment, areas designated as "essential" should continue to be prioritized for treatment. This work includes continued exotic control in these areas. Areas undergoing scrub removal may also require additional restoration work including host and nectar plantings. Restoration plantings will help increase density and distribution of host and nectar plants in essential habitat.

MB MONITORING

2. Consider adding weather & vegetation data into statistical models: temperature, rainfall, solar radiation, and host plant data can be incorporated into statistical analysis, modeling, and hypothesis testing. Standardize methodology for all monitoring.

3. Initiate flight season documentation; may improve monitoring deployment, level of effort, and limit the potential to miss the peak flight season. Monitoring for butterfly flight season may need to begin up to a month ahead of historically documented flight seasons in light of changing climate conditions. Consider, monitoring both key nectar plant phenology as well as host plant phenology to improve survey initiation and timing.

4. Continue to initiate surveys only when the base temperature of 64.4 degrees Fahrenheit is met; logistically this can be the most challenging aspect of butterfly monitoring, day-to-day and hour-to-hour, as temperatures oscillate on the mountain. Collecting more than five weeks of monitoring data may be necessary to absorb the variability associated with cool, cloudy, or windy conditions that

have hampered shorter monitoring seasons.

MB HOST AND NECTAR PLANT MONITORING

MB host and nectar plant monitoring had not been a priority in recent years; however, coarse scale vegetation mapping of lupine host plant populations throughout grassland habitats on San Bruno Mountain was completed in 2020. MB host plants and nectar plants are a critical part of the MB lifecycle and intimately tied to the health of the population.

5. Continue to implement host plant monitoring at regular intervals, perhaps every five-years.

6. Monitoring of MB host plants and potentially associated nectar plant densities within host plant patches to help clarify habitat management activities including scrub management. Define high, medium, and low density host plant populations. MB habitat.

7. Over the next several years and as funding allows, host plant monitoring should become part of the SBMHCP monitoring program and clear definitions of habitat quality should be created.

B. Callippe Silverspot Butterfly (*Speyeria callippe callippe*)

The CS distribution is similar to that of the MB, however CS is less frequently observed on the west side of the Mountain. Habitat for CS includes grasslands supporting its host plant, *Viola pedunculata*. Viola is predominately found within mesic to dry open grasslands on both north and south-facing slopes. Viola can also be found on disturbed road cuts, and along the boundaries between grassland and scrub under partial shade of taller plants. CS use a variety of native and non-native species for nectaring (especially thistles) that are found throughout the grassland and coastal scrub plant communities.

Ridgelines and hilltops within grassland habitats are an important habitat component for this butterfly species, as CS utilize these features for mate selection. The species has been shown to move up to approximately 0.75 mile between habitat patches (Thomas Reid Associates, 1982), but likely can move further in multiple movements.

The flight season for adult CS is typically from mid-May to mid-July. Due to their larger size and stronger flying ability than MBs, CS are not as sensitive to strong winds. Often this species is detected along ridgelines and hilltops in high densities, sometimes during windy conditions (>10 mph average). Transect monitoring of CS was conducted between May 28 and July 10 of 2020. Survey methodology, results, discussion, and recommendations are included in this report.

METHODOLOGY

Surveys are conducted on fixed transects to provide a means with which to compare CS observations from year to year at specific locations. Fixed transect locations were not

chosen randomly but were placed in habitat areas with higher butterfly densities and in areas that include a variety of slope exposures, nectar plants, and soil conditions (i.e. road cuts, ravines, and natural slopes). Even within high-density habitat locations, it is sometimes difficult to observe enough butterflies for statistical comparison; for this reason 14 fixed transects have been located only in areas where there is a good chance of observing CS under desirable weather conditions. Transects vary in length from approximately 500 to 2100 meters and are permanently marked in the field (Figure 4). A total of 14 fixed transects were monitored in 2020.

Twelve of the 13 transects have been surveyed for CS since 2000. Transect 13, east of the terminus of Carter Street and on the north side of Guadalupe Canyon Parkway, was added in 2005. This location was chosen in order to learn more about potential CS presence and movement in grasslands north of Guadalupe Canyon Parkway. Transect 14, within the Hillside-Juncus management unit, was established in the winter of 2018. This location was chosen due to the healthy populations of *Viola pedunculata*, diverse nectar sources, and open grassland habitat. This location had not, to this point, been surveyed for CS use.

Ideally, each transect is monitored approximately three to five times during the peak of the flight season, with monitoring at any individual transect spaced approximately 10 days apart, weather permitting. Monitoring occurs only during warm, calm weather (wind speeds less than 10 miles per hour) when CS are most active. All butterflies observed beyond a transect or in the transect vicinity during travel between transects are recorded as incidental observations. Transects are considered belt transects and are three meters wide.

The duration spent walking each transect is recorded by the observer and all CS observed along within the belt transect are noted. The location and time of the observation is recorded on a digital map, as well as sex, condition, behavior, and nectaring plant information. The number of CS sightings per hour (S/H) is used for analysis. The number of CS observed on a particular transect is divided by the number of minutes to complete the transect survey. For each year the average and maximum CS sightings per hour for all transects are used to look for upward or downward trends in CS encounter rates among and within transects. The maximum value is the highest S/H recorded on a transect in a given year. The maximum S/H found on a transect in a given year is a useful variable for analysis. By looking at only the maximum S/H it can be assumed that the sightings per hour captured at the beginning or end of the peak flight season, which may be lower, do not skew the data.

Figure 4

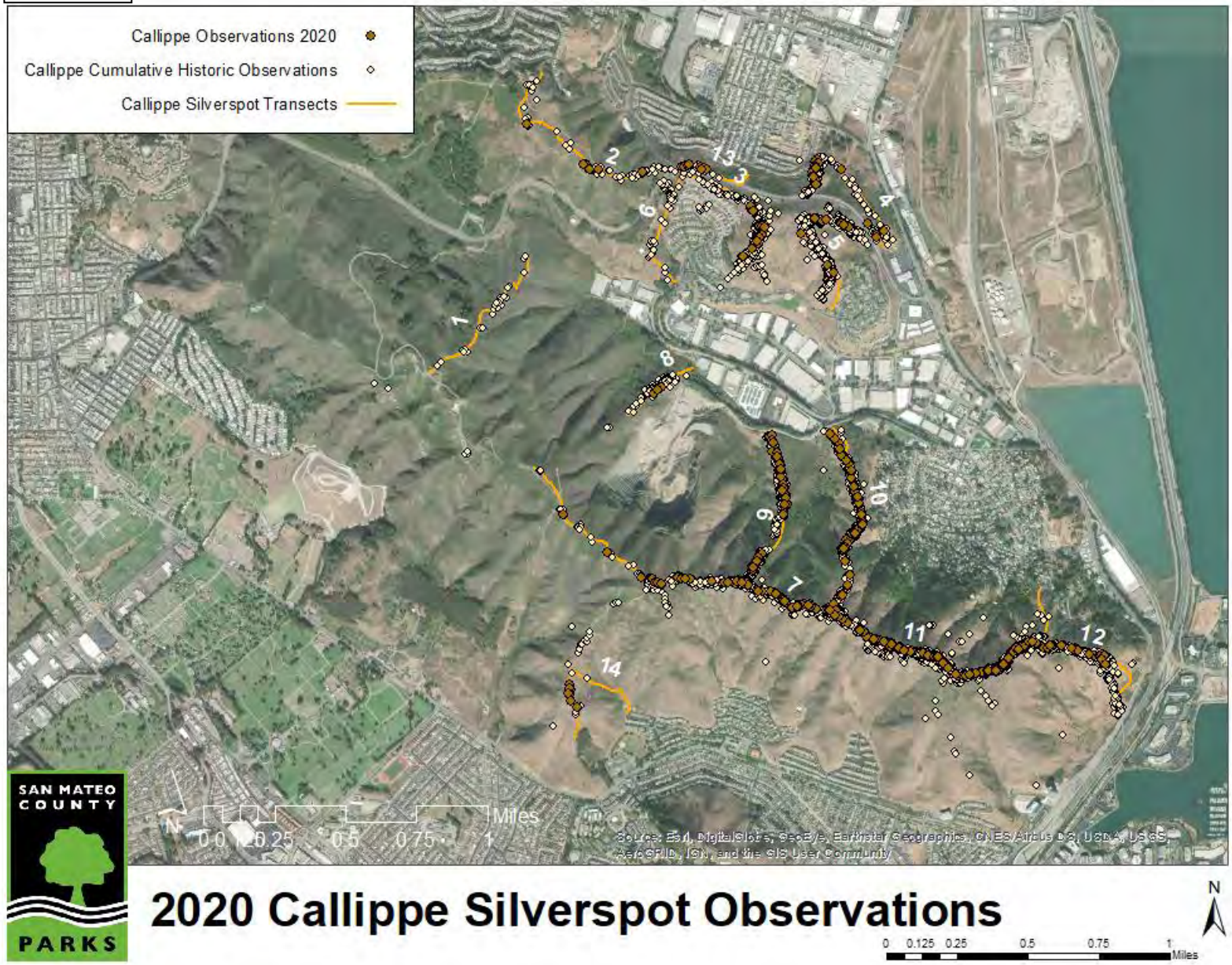
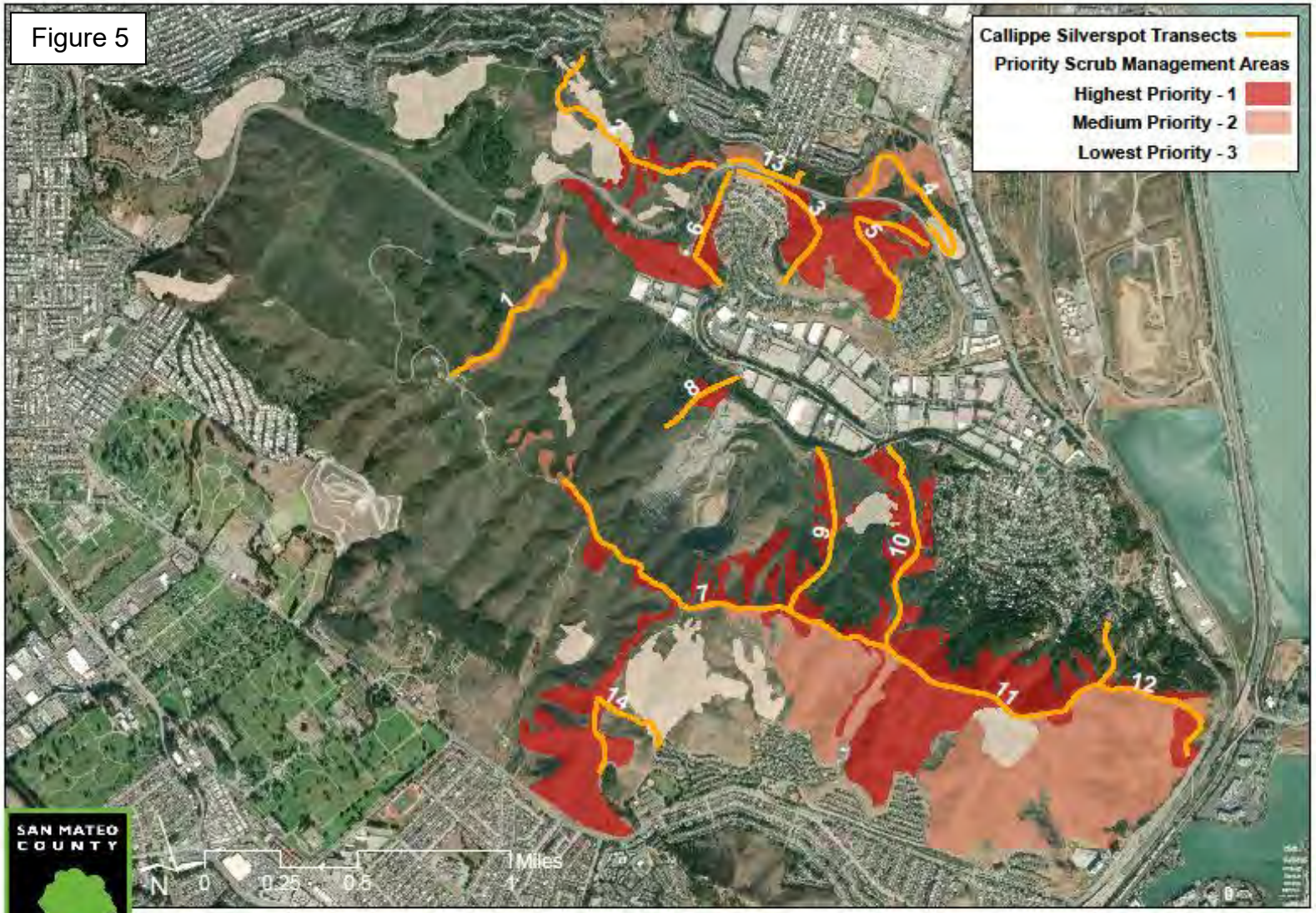

Callippe Observations 2020
Callippe Cumulative Historic Observations
Callippe Silverspot Transects
1
2
3
4
5
6
7
8
9
10
11
12
13
14
SAN MATEO COUNTY
PARKS
N
0 0.125 0.25 0.5 0.75 1 Miles
Source: Esri, MapmyIndia, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
2020 Callippe Silverspot Observations
N
0 0.125 0.25 0.5 0.75 1 Miles

Figure 5



CallippeTransects & Scrub Management Areas

RESULTS

Transect surveys of CS butterflies occurred between May 28, 2020 and July 10, 2020. A total of 686 CS were counted along all transects. CS were observed on 11 of the 14 transects. The average S/H for all transect data combined in 2020 was 11.6. The maximum S/H is what is used to look for trends in abundance, and for 2020 the average maximum was 30.67 S/H for CS. Each transect was surveyed five times throughout the season, spaced at least one week apart. Trends observed on each transect are discussed in detail below. Each transect is defined by the Management Unit (MU) that it occurs in and if it is in an Essential, Valuable, or Potential Habitat area for priority scrub management as defined in the Assessment. Defining CS in terms of their MU and scrub management area is useful for interpreting butterfly monitoring findings with respect to management actions and recommendations.

T-1, Transect 1 (aka Dairy Ravine; MU Dairy and Wax Myrtle Ravines; Valuable) –
Since 2000 T-1 has consistently had a low S/H due to the limited Viola habitat along this transect. In 2020, no CS were seen on Transect 1, nor were any CS observed there from 2012 through 2018. The most recent year CS were observed on Transect 1 was in 2010, when a single CS was observed during all of the three surveys. Transect 1 supports primarily coastal scrub and adjacent areas of grassland habitat supporting viola have become increasingly limited. Although no major visible changes were recorded by monitors it is possible that cumulatively small changes in viola patch size or other habitat conditions shifted over time, an example is thatch density in grassland areas.

T-2, Transect 2 (MU Saddle; some Potential some Valuable) –
There were 8 CS observed over the five completed surveys dates in 2020. This is in contrast to the 2016 observations, where there were no CS recorded on this transect, though in 2018 there were a total of 3 individuals observed.

T-3, Transect 3 (MU Northeast Ridge; Essential) –
This transect is located on the Northeast Ridge and includes Callippe Hill and a portion of land comprising the Toll Brothers Development (Figure 4). The maximum S/H on Transect 3 was 19.4 in 2018, which was considerably lower than that recorded in 2014 (73.3), but an increase from 2016 (11.7). In 2020, the maximum S/H on Transect 3 dropped again to 12.0. Scrub encroachment along the ridge top leading to Arnold Slope and on Arnold Slope continues; this area is under private ownership.

T-4, Transect 4 (MU Carter Martin; some Potential some Valuable) –
T-4 is located on the north side of Guadalupe Canyon Parkway across from the Northeast Ridge and/or Callippe Hill (Figure 4). The average (8.7) and maximum (28) S/H calculated reversed a declining trend in observations on this transect since 2012.

T-5, Transect 5 (MU Northeast Ridge; Essential) –
T-5 is located on the eastern side of the Northeast Ridge. 16 CS were observed during surveys in 2020, with a max S/H of 12, a stark contrast to 2018 where no CS were observed. Little visual change in habitat quantity or quality has been documented in past annual reports, and despite some fennel and broom invasion on the lower slopes, this transect is still through predominantly open grassland. Parks staff have noted that dense

thatch under non-native annual grasses appears to be present in many areas along this transect.

T-6, Transect 6 (MU Dairy and Wax Myrtle Ravines; Essential) –
T-6 intersects sparse viola habitat, and consequently few CS are recorded here during most monitoring years. In 2018 and 2020, there were no CS observed on transect 6, while in 2016 there was a single CS observation on one of the survey dates, and in 2014 no CS were observed. Modifications to this transect may be necessary since it was shortened due to the northern portion of the transect becoming more dense with scrub species including coyote brush (*Baccharis pilularis*), poison oak (*Toxicodendron diversilobum*), and Scotch broom (*Cytisusscoparius*). Meanwhile, Italian thistle (*Carduus pycnocephalus*) has proliferated along the east-west portion of this transect. Portions of this transect were a focus for habitat management in 2018, with broom and scrub removal activities taking place in the fall of 2018. Further scrub removal and retreatment along the slope to the west of the transect (south of Guadalupe Canyon Parkway) occurred in 2019 and 2020.

T-7, Transect 7 (Ridge Trail, not associated with specific MU; Essential) –
T-7 is located along the Ridge Trail (Figure 4). In 2020 CS were encountered at a rate in line with the trend seen in past years with an average and maximum S/H of 20.7 and 31, respectively. The Ridge Trail remains a hotspot for CS among the transects, particularly east of the scrub/grassland interface that bisects Transect 7. Two observations were even recorded within the western scrubland section.

T-8, Transect 8 (MU Devil's Arroyo; Essential) –
This transect is located west of the Quarry (Figure 4) and access is made through the Quarry property. The scrub and particularly poison oak along this transect has increased significantly over the years and the upper portion of the transect is no longer passable. There were 7 CS observed on this transect in 2020, with a max S/H of 36, denoting the short time required to complete this abbreviated transect. 10 CS were observed on this transect in 2018, and none in 2016. This transect was a focus for habitat management activities in 2018-2020, addressing scrub encroachment and the overgrowth of Portuguese broom in this high quality grassland.

T-9, Transect 9 (MU Owl and Buckeye Canyons; Essential) –
This transect follows a ridgeline between Owl and Buckeye Canyons down from the Ridge Trail (Figure 4). Despite a fire in 2008, viola and nectar plants have regenerated along this transect based on incidental observations. The 2020 average and maximum calculated S/H were greater than both 2016 and 2018 sightings, with an average and maximum S/H of 26.4 and 87.8, respectively. Similar to the trends seen along other transects in 2020, CS numbers dropped off dramatically along this transect over the course of the five surveys, with none observed in the fourth or fifth surveys.

T-10, Transect 10 (MU Owl and Buckeye Canyons; Essential) –
This transect is located east of Buckeye Canyon and follows an existing gravel, PG&E road (Figure 4). The maximum and average S/H on this transect in 2020 were 75 and 26.6, respectively, continuing a rising trend since 2016. The 2016 maximum S/H was the lowest recorded over the 12 sample years since 2000. CS were also very abundant on this transect in 2012 and 2014.

T-11, Transect 11 (Ridge Trail, not associated with specific MU; Essential) –
T-11 follows the eastern portion of the Southeast Ridge (Figure 4). In the past this has been a high performing transect as it follows hilltopping habitat with a variety of nectar plants and adjacent grasslands supporting viola. 2020 showed a continued increase in observations since 2016, with an average S/H of 41.5 and a maximum S/H of 86.7. For 2016, there was a marked decline in observations, with an average and maximum S/H of 6.3 and 18.8, respectively, which was significantly lower than 2014 with an average and maximum S/H of 111.5 and 182.1 (the highest encounter rate ever documented on this transect or on any transect since fixed transect surveys began in 2000). Transect 11 was the highest performing transect in terms of sightings per hour in both 2018 and 2020.

T-12, Transect 12 (MU Southeast Ridge; Valuable and Essential) -
T-12 follows the Southeast Ridge east and down to the mountain's base near Bayshore Boulevard (Figure 4). This transect also includes part of a subridge north toward the Brisbane Acres. In 2012 a small grass fire burned the steep slope along the southern part of the transect up to where the transect meets up with the Ridge Trail. There has also been significant scrub overgrowth along the portion of the transect that extends downslope into Brisbane acres, making the last 150 meters impassable. The maximum S/H recorded in 2020 was 18.7, representing a modest increase from the low numbers in 2016 and 2018. Almost all of the CS observations on Transect 12 were along the Ridge Trail; the grassland portion that descends from the Ridge Trail down the Southeast Slope shows significant thatch buildup.

T-13, Transect 13 (MU Carter Martin; Essential) –
T-13 was established in 2005 to collect data on butterfly presence as it is across from the section of the Northeast Ridge that was at that time planned for development and recently completed development. Very few butterflies have been recorded on Transect 13 in the past. During the first year this transect was surveyed (2005), an average S/H of 5.2 and a maximum of 15.0 was recorded. Then in 2006, 2008 and 2010 no CS were seen. In 2012 a single CS was recorded here, then in 2014 a total of 13 CS were seen on this transect. In 2016, however, sightings were lower than 2014 but higher than 2012 with 3 CS observations for a max S/H of 5.7. For 2018, there was only one CS observed during one of the surveys. Average S/H was 0.9, and maximum S/H was 4.6. In 2020, there were 17 CS observed during the surveys; average S/H was 9.4, and maximum S/H was 24.5.

T-14, Transect 14 (MU Hillside Juncus; Essential) –
T-14 was established in 2018 to collect data on butterfly presence in the Hillside Juncus management unit that had not yet been surveyed for CS, despite the presence of suitable habitat components. For the 2018 survey period, there were 9 CS observed, equating to an average S/H of 3.1 and a maximum S/H of 10.3. In 2020, there were 7 CS observed, equating to an average S/H of 2.7 and a maximum S/H of 8.0.

Overall, many transects showed an increase in CS observations in 2020 when compared to counts and calculated sightings per hour in 2018.

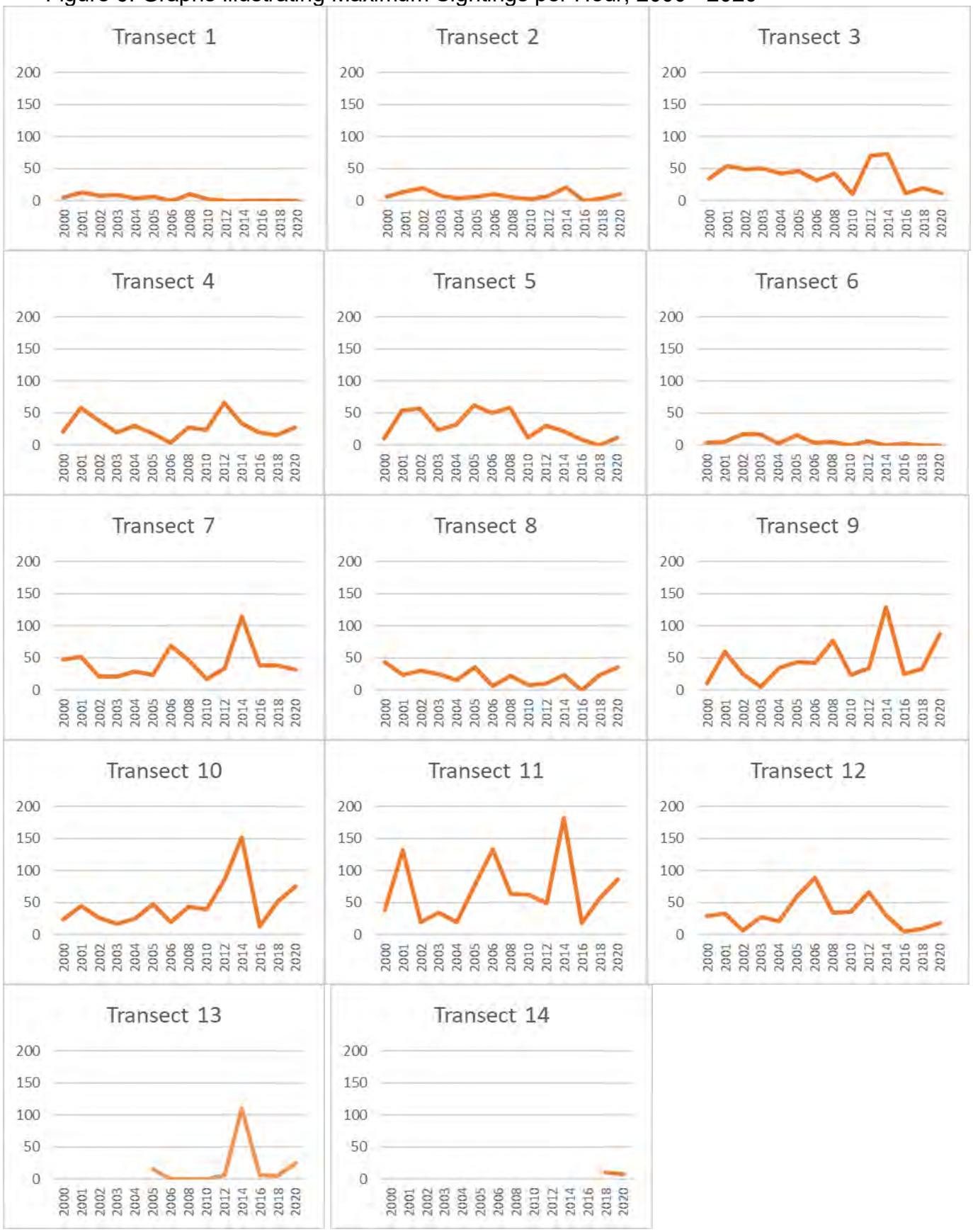
Table 3: Average S/H on each Transect from 2000 to 2020

Year/ Transect	2000	2001	2002	2003	2004	2005	2006	2008	2010	2012	2014	2016	2018	**2020**
1	2.3	4.2	2.5	1.4	1.2	1.6	0	4.4	2	0	0	0	0	**0**
2	3.2	5	10.2	3.2	1.7	2.4	3	0.5	1	1.8	13.4	0	0.9	**2.4**
3	16.5	21.4	31.1	32.1	23.4	23.1	12.1	14.5	3.6	23.3	57	8.9	6.9	**4.8**
4	12.3	26.1	16.1	7.7	11.5	5.5	3.5	11.2	13.6	32.7	24.7	7.4	5.	**8.7**
5	5.2	28.7	23.9	10	16.7	26.2	14.7	16.9	7.7	17.8	15.3	3.3	0	**3.5**
6	1.1	1.4	9.1	6.9	0.8	4.2	1.4	2.2	0	1.3	0	0.37	0	**0**
7	20.4	25.1	9.8	10.9	13	16.6	25.4	30.5	20.2	18.1	72.5	18.8	16.8	**20.7**
8	18.6	10.5	17.2	7.6	5.9	11.4	4.8	12.5	3.3	5	12	0	9	**8.7**
9	5.2	24.5	16.2	1.6	5.5	19	13.7	55.6	14.6	22.5	61.5	13.4	16.3	**26.4**
10	11.5	37.9	13.7	5.7	6.2	21	15.1	23	28.6	68.1	71.9	8.7	20.4	**26.6**
11	25.4	79	14.4	18.4	8.2	37.6	37.4	35.6	38.6	23.7	111.5	6.3	29.6	**41.5**
12	14.2	20.1	2	6.8	11.4	18.9	34.2	17.2	23.9	26.7	15.4	2.1	2	**7**
13	N/A	N/A	N/A	N/A	N/A	5.2	0	0	0	3.3	30	2.4	0.9	**9.4**
14	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.1	**2.7**

Table 4: Maximum S/H on each Transect from 2000 to 2020

Year/ Transect	2000	2001	2002	2003	2004	2005	2006	2008	2010	2012	2014	2016	2018	**2020**
1	4.6	12.4	7.2	8.6	2.9	6	0	10	2	0	0	0	0	**0**
2	6	13.5	19.4	7.2	3	5.5	9.6	5	1.8	7.5	20.9	0	3.2	**9.7**
3	34.2	54.3	48.5	50.3	42.2	45.6	31.1	42.5	10.6	70	73.3	11.7	19.4	**12**
4	20.5	58.5	38.7	20	30	18.3	2.9	27.7	23.6	65.7	34	18.9	15.8	**28**
5	10.3	53.6	56.5	24	31.7	62.5	50.4	57.6	11.1	30	21.8	9.4	0	**12**
6	3.3	4.2	16.8	16.6	2.2	16	4.1	4.3	0	5.5	0	1.5	0	**0**
7	47.1	51.3	20.5	20.8	28.9	24	69.5	45.8	17.1	34	113.6	38.7	38	**31**
8	43.6	23.6	30	25	15	35	5.5	21.8	7.5	10	24	0	24	**36**
9	9.6	60	25.2	4.7	33.6	43.5	42.4	77.4	24	34	128.6	25.3	33	**87.8**
10	23	45	25.7	17.4	24.3	47.6	19.4	42.9	39.3	86	152	12.3	51.3	**75**
11	38.4	131. 1	20	34	18.9	77.1	132. 9	63.2	62.3	49	182.1	18.8	56.6	**86.7**
12	28.3	33.2	6	27.4	20.9	60	88.4	34.1	35.3	66.7	30	4.5	8.3	**18.7**
13	N/A	N/A	N/A	N/A	N/A	15	0	0	0	6.7	110	5.7	4.6	**24.5**
14	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10.3	**8**

Figure 6: Graphs Illustrating Maximum Sightings per Hour, 2000 - 2020



DISCUSSION

Overall, many of the transects exhibited an increase in CS observations in 2020 compared to 2018, with 686 individuals observed, and an average S/H of 11.6, compared to 387 CS observed in 2018, with an average S/H of 7.9. The 2020 observations were more than in 2014, which, with 594 CS observed, was previously the monitoring year with the highest observations overall, since monitoring began in 2000. However, the average S/H in 2014 was still far higher at 48.6 S/H, as there were only three surveys per transect, more centered within the peak flight season. In 2020, the greatest maximum number of CS recorded per hour was on transects 9, 11, 10, 8, and 7, respectively. Transects 7 and 11 contain prime hilltopping habitat along the Southeast Ridge with thin soils and the observation locations for these and all transects can be seen in Figure 4. Transect 10 climbs the ridge to the east of Owl Canyon, while Transect 9 climbs the ridge to the west of Owl Canyon and both intersect with Transect 7 at their terminus on the top of the mountain's main ridge that runs east/ west. Transect 8 featured a relatively high maximum S/H (36.0) despite a relatively low total observations (7), as the transect is mostly unnavigable and was completed, on average, in less than 10 minutes.

Transects that performed the worst in 2020 include 1 and 6 with no observations of CS adults recorded. While Transect 5 had no observations in 2018 – the first time since 2000 – there were 12 CS observed in 2020. Annual reports have not reported on significant scrub encroachment along Transect 5, though high accumulations of thatch from the overgrowth of non-native annual grasses has been reported, and could be hindering the viola populations in this area. Transect 6 has had a number of years with few or no sightings, including 2010, 2014, and 2018. According to past annual reports T-6 historically intersects only limited viola populations. Transect 1 has had no observations since 2010.

Within a single transect, CS abundance varies from year to year as can be seen in the transect line graphs in Figure 6. Data variability from year to year is attributable to a number of factors, van Swaay et al.(2008) indicated that variation can come from weather, time of day, observer experience, changes in vegetation height, and succession (Pollard et al 1986; Harker & Shreeve 2008; and Pellet 2008). It is unlikely that observers in a given area can detect all butterfly adults present in the study area during their visit (van Swaay et al. 2008; Dennis et al. 2006; and Kery & Plattner 2007). CS monitoring in 2020 was performed by Parks Department staff, who have taken over the monitoring activities as of 2016 (having previously been conducted by Thomas Reid Associates). While cool temperatures and high winds hindered monitoring efforts in 2018, with monitors having short windows of time where all weather conditions met the necessary thresholds for monitoring as outlined in the methodology, most transects in 2020 were completed during optimal weather conditions. According to the monitoring protocol all transects should be surveyed within 2-3 days and the monitoring rounds should be spaced approximately a week apart from each other (TRA 2008), which was possible due to new staff capacity and flexibility, and optimal weather conditions. See Tables 9 and 10 in Appendix B for raw data from monitoring efforts, which outlines the weather conditions for each survey.

The level of field monitoring effort in 2020 amounted to 44.06 hours on all transects over five rounds of surveys, on par with the level of effort in 2018 (42 hours on all transects

over the five rounds of surveys) and 2016 (31 hours over four survey rounds – close to 8 hours per survey round for both monitoring years). In contrast, the 2014 CS surveys had just over 12-hours spent on transects total, and yet had the highest recorded counts overall. Abiotic conditions can influence a butterfly population such as rain and solar radiation and the timing of these events (Pollard 1988). This topic has been suggested in previous annual reports specifically questioning how CS populations may vary due to abiotic factors such as weather.

The growth of grassland plants (both grasses and forbs) varies not only by total rainfall amount but seasonality of rainfall including temperature during a growing season (George et al. 2001). Table 5 lists the annual rainfall totals for each rain-year since 2014 (when highest counts to date had been recorded)

Table 5: Rain Year precipitation totals, San Francisco International Airport, 2013-2020

Rain-year	Precipitation total
2013 - 2014	12.54
2014 - 2015	18.19
2015 - 2016	23.26
2016 - 2017	32.24
2017 - 2018	17.53
2018 - 2019	25.72
2019 - 2020	11.69

Our data imply that the drought conditions from 2012 through 2015 did not negatively affect CS butterflies. Rather CS were encountered overall at a greater rate than has been recorded in any other year since fixed transect monitoring began in 2000. As a species whose life span is completed within a year, year to year variation in population size is normal and expected. Results as found this year indicate only that environmental conditions in 2014 favored CS emergence and breeding. The species continues to be seen over most of the area surveyed.

It is assumed that butterflies use a variety of microhabitats from year to year, and these areas of use can shift. This change in use patterns can be influenced by host plant expansion or contraction, nectar plant sources, competing vegetation height and composition, and succession. In 2009 the USFWS issued and approved a Callippe Silverspot Butterfly (Speyeria callippe callippe) 5-year Review: Summary and Evaluation. This review document identifies five essential features believed to be required for CS: grasslands with proper topography in the San Francisco Bay area, sufficient larval host plants, adequate nectar sources, within the area influenced by coastal fog, and hilltops for mating congregations (USFWS 2009). CS behavior and usage of these habitat features plays a role in the ability of monitors to observe adults along transects during surveys. It is important to note that the inherent relationships related to CS abundance and host plant density, proximity to adult nectar plants and their temporal distribution, hilltop features for mating, and the assembly of these features and their associated adjacency within the grassland landscape is still poorly understood. It is possible that the fixed transects no longer adequately traverse through or intersect areas that support all five essential features associated with CS functional habitat.

It is assumed that higher-yielding transects intersect the greatest amount of hilltop and

Viola habitat, including, 3, 7, 9, 10, and 11. As mentioned earlier, transects 9, 11, 10, 8, and 7 exhibited the greatest maximum CS observations in 2020. These five transects accounted for 556 out of the 686 total observations along transects (81% of annual total observations). These transects follow ridgeline habitat generally associated with lower non-native annual grass height. The ridgetops have thin, moisture limited soils and are more insulated from nitrogen deposition. The 1981 Phase II Biological Study does recognize that Viola unlike the lupine species does not appear to have a clear environmental requirement (e.g. rocky outcrops) yet it does tend to occur in dense stands scattered in low density grasslands (TRA 1981). It is interesting to note that even on cool days traditional "hot spots" for CS still yielded observations.

The 2020 data supports the concept that, in our core grassland areas, CS populations are fairly stable and continue to support butterflies. However, year-to-year variability appears to be high and additional statistical analysis is likely necessary to detect potential population trends based on the density index. The key to improving stewardship of this species will be to tie management activities to host plant patches to size, quality, and distribution – efforts for which are underway.

CONCLUSION

While the overall adult CS butterfly observations were greater in 2020 than in any other year since monitoring began in 2000, these numbers are likely not outside the range of variability for the overall population contained within the San Bruno Mountain Habitat Conservation plan area, as exhibited by the high annual variability graphed in Figure 6. It is advisable to initiate a statistical analysis of all the currently available data to better understand the trends associated with the overall population and the subpopulations found throughout the hill that make up the SBMHCP area. An analysis of individual transects and year to year variation based on the last fourteen rounds of data collection may improve management priorities based on statistically significant findings related to adult observation trends. As such, Creekside Science is working on an updated statistical analysis including the most recent monitoring years, which is expected to be completed in 2021.

Until statistical analysis is performed to properly assess the population trends, this data suggests that the SBMHCP is successfully maintaining a steady CS population in the core habitat areas. It appears that year to year variation in marginal habitat is increasing and likely reflects decline in those subpopulations. The differences between the 2014, 2016, 2018, and 2020 CS sightings per hour index could be attributed to abiotic factors such as weather and likely its interaction with non-native annual grass and thatch production; however, this is likely a cumulative issue that compounds over time. Continued scrub encroachment, identified in the original documents of the SBMHCP and in the more recent 2015 Assessment, is also considered a threat and increases the marginalization and loss of habitat for both CS and MB. It is important to note that increased soil moisture associated with average or wet years also favors woody species establishment in grasslands with deeper soils. However, a decline in the ability of the grasslands to support large populations of Viola host plants due to inter-annual shifts in the success of non-native annual grasses should also be seriously considered as a possible threat. Increased grass and thatch production reduces the space available for

host plant population expansion/ recruitment and possibly provides additional cover to rodent populations which target host plants for food resources. This is currently being seen in areas such as Hillside/Juncus grasslands and is impacting lupine populations.

The 2006 Annual Report suggested that additional statistical research should be focused on weather variables, such as rainfall (TRA 2006). The benefit of exploring various biotic and abiotic factors and their potential interactions is the ability to tie them to a specific management action that can directly address that interaction's environmental outcome on the land. As an example, if non-native grass and thatch production is negatively associated with the density of CS host plants, a specific and targeted management action can be developed (e.g., cattle grazing). According to the 1980 Biological Study, "During the grazing years, the populations of CS and the MB co-existed with grazing, and may have actually been enhanced by it since grazing helped to preserve the grassland against invasion by brush" (TRA 1980; pg. VII-10). Grazing is a manual control for non-native annual grass production and is used to favor a small statured host plant, *Plantago erecta*, for bay checkerspot butterflies on Coyote Ridge in the San Jose area. The benefits to host plant patch size as a function of cattle grazing may likely be positively correlated with the BCB population at that location. Until direct or indirect habitat or host plant patch size and distribution monitoring occurs we may not be able to demonstrate a statistical relationship between management actions and increases or decreases in CS populations.

With the majority of the SBMHCP budget dedicated to management, it may be a good time to review and implement a butterfly habitat monitoring approach along with adult butterfly monitoring. The goal of designing a hybrid approach is to be able to quantify that management activities are improving host plant patch size, quality, and distribution. According to Weiss et al. (2015) inclusion of a host plant mapping and monitoring protocol provides a direct link to management activities. A reduction in marginal, valuable, and essential habitat is likely to make CS less resilient to climate change in the future, unless Viola populations expand considerably with increased periods of droughts. With this in mind, in 2015 the management approach shifted from a wide-ranging invasive species control and containment strategy to a focus on scrub removal and containment focus. This was aimed at stabilizing the amount of grassland available for MB and CS butterflies. However, the quality of the remaining grassland should also be considered. As of 2020, host plant monitoring and mapping activities for both lupine and viola have been undertaken, and specific habitat components have been monitored. The goal will be to analyze this host plant data with CS or MB data to provide a more robust way to determine if specific management activities are improving habitat. CS population responses could result in increases in CS density observed along transects with active management or a decrease in the year-to-year variability along transects.

At this time, it is difficult to make a full assessment of the overall population trend for CS; although the 2020 observations showed an overall increase in adult butterfly observations from previous years, interannual variability is still significant and monitoring effort has improved in recent years. The 1981 Biological Study cautions the use of two consecutive years of monitoring data to determine a potential population decline (TRA 1981). TRA's annual report from 2014 attributed abiotic weather conditions (i.e., drought) as likely beneficial for CS observations that year. It is possible that viola host plants were favored and occurred at a higher density due to less non-native annual grass competition in 2014. Native forbs are generally believed to be favored in California

grasslands in times of drought. If this is the case perhaps increased frequency of drought periods may favor viola expansion in the future. Until the relationships between CS host plant and essential habitat components are better understood, it is difficult to determine the best management approach to improve habitat quality. The hope is that our current efforts to collect data on host plants and habitat components will help inform this as we continue monitoring for the SBMHCP. The 2020 observation data appears to be within the range of variability observed throughout the life of the SBMHCP. Additional statistical analysis should be conducted with the most recent data years to determine if any population trends can be identified.

RECOMMENDATIONS

CS MONITORING

1. Consider adding weather & vegetation data into statistical models: temperature, rainfall, solar radiation, and host plant data can be incorporated into statistical analysis, modeling, and hypothesis testing.

2. Initiate flight season documentation; may improve monitoring deployment, level of effort, and limit the potential to miss the peak flight season. Monitoring for butterfly flight season may need to begin up to a month ahead of historically documented flight seasons in light of changing climate conditions. Consider, monitoring both key nectar plant phenology as well as host plant phenology to improve survey initiation and timing.

3. Continue to initiate surveys only when the base temperature of 64.4 degrees Fahrenheit is met; logistically this can be the most challenging aspect of butterfly monitoring, day-to-day and hour-to-hour, as temperatures oscillate on the mountain. Collecting more than five weeks of monitoring data may be necessary to absorb the variability associated with cool, cloudy, or windy conditions that have hampered shorter monitoring seasons.

CS HOST AND NECTAR PLANT MONITORING

4. In 2017 and 2018, lupine and viola host plant mapping activities were initiated, and it is recommended that periodic host plant and habitat feature monitoring continues.

5. Consider mapping essential habitat features in areas that have repeatedly high observations of CS. This may refine our understanding of high, medium, and low quality CS habitat on San Bruno Mountain.

SCRUB ENCROACHMENT AND GRASSLAND MANAGEMENT

6. Continue efforts to arrest scrub succession and expansion in essential, valuable, and in some cases potential habitat, as defined by the Assessment.

7. Pilot grazing, weed whipping, or scything plots for *Viola pedunculata*.

C. San Bruno Elfin (*Callophrys mossii bayensis*)

SBE are closely associated with their host plant, Pacific stonecrop (*Sedum spathulifolium*), which grows within higher elevation grasslands on northeast to northwest facing slopes. SBE butterflies occur where there are high densities of Sedum and in areas that are protected from strong winds. Arnold has documented this species movements to be at least 0.15 mile between habitat patches, however it is likely adults can move much further over the course of multiple flights (1983). The adult flight season for SBE typically occurs between early March and mid-April. Third and Fourth instar SBE larvae are present and easily identifiable on the Sedum plant parts and flower heads typically for 2-3 weeks in May and/or June, and monitoring activities in 2018 indicated the First and Second instar larvae could be observed as early as mid-April.

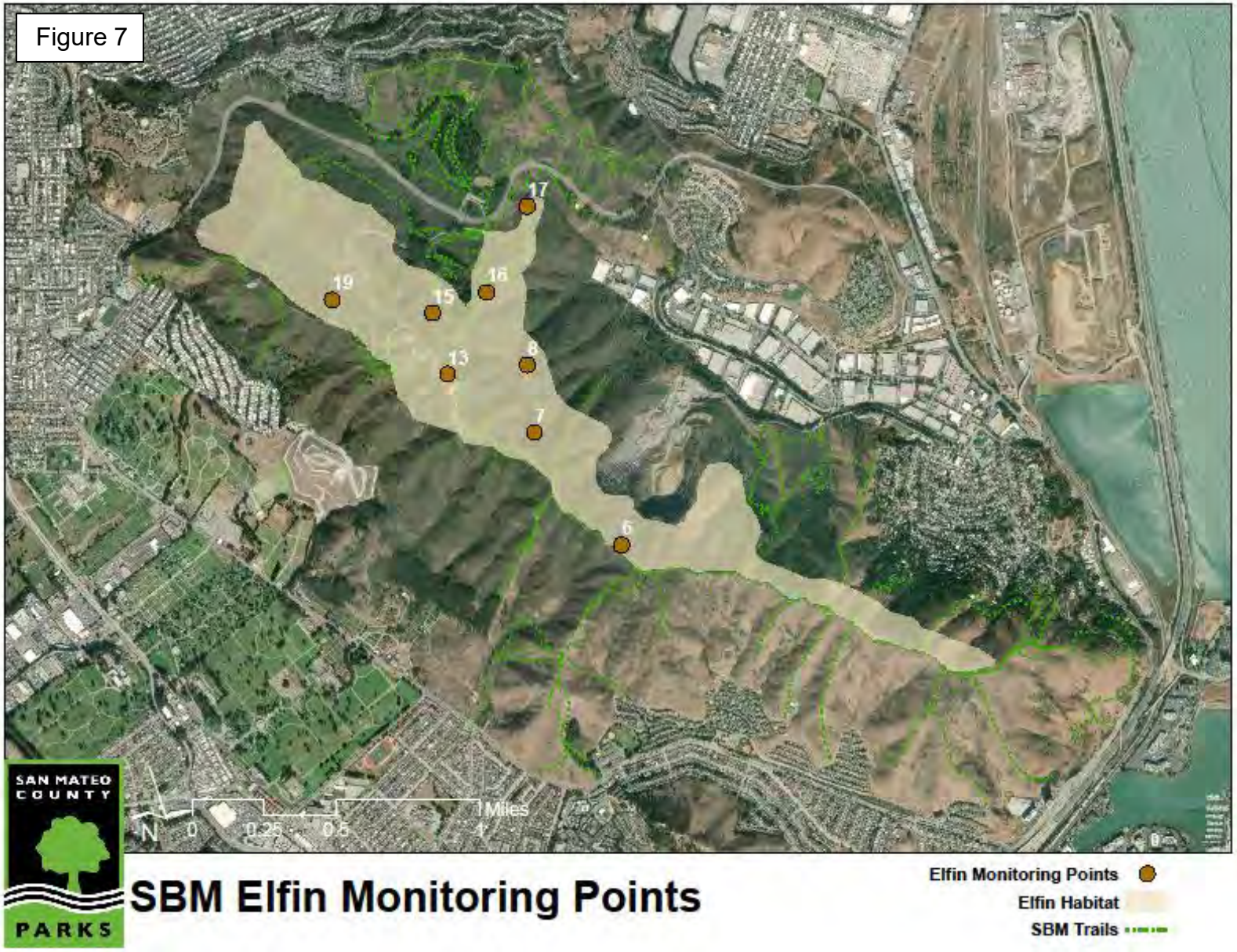
SBE larvae are preferable to survey over adults as they are conspicuous, less sensitive to weather, and their movement is closely tied to Sedum. Eight fixed permanent points for monitoring SBE larvae were established in 1998 and these were monitored every year from 1999 to 2003 (Figure 7). No SBE monitoring of larvae was conducted in 2004 or 2005. Monitoring was resumed in 2006 and set on a biennial schedule. SBE larvae were monitored in 2006, 2008, 2010, 2014, 2016, 2018, and 2020. In 2012, monitoring was not conducted in order to allocate funds to presence/absences surveys for CS and MB. We now have twelve years of larval monitoring data based on these fixed data points.

All of the existing SBE butterfly habitat on San Bruno Mountain has been protected as open space within San Bruno Mountain State and County Park since 1975. Development that was approved through the SBMHCP did not affect this species, and therefore monitoring and management for this species and its habitat was not a requirement of the SBMHCP permit. However, this species' habitat partly overlaps with that of the MB and CS, and is composed of some of the most pristine coastal prairie and coastal scrub habitat on the Mountain. Continued monitoring and management of SBE should continue at some level due to the biological value of this species and its habitat.

METHODOLOGY

Larvae counts are performed at 8 fixed points over three monitoring cycles historically targeting peak sedum bloom. Counts are conducted when larvae have been observed at least one survey point in the days prior to the start of monitoring. Locations of the fixed points have a permanent center point stake so that surveys occur in the same location year-to-year. A 25-meter radius circular plot is marked in the field surrounding the center-point stake with tall wire stakes or flagging tape. All sedum are marked in each quadrat of the 25-meter plot (NE, SE, NW, and SW) with a pin flag. Then monitors systematically search every sedum for larvae. No time limit is placed on the survey effort due to the high variation in sedum density at each point. As much time was taken as needed at each point to allow for inspection of all sedum plants within the 25-meter radius. Locations of the 8 SBE monitoring points are presented in Figure 7.

Figure 7


17
16
19
15
13
8
7
6
SAN MATEO COUNTY
PARKS
N
0
0.25
0.5
1 Miles
SBM Elfin Monitoring Points
Elfin Monitoring Points
Elfin Habitat
SBM Trails

RESULTS

Three larvae survey rounds were performed in 2020: May 12th-13th; May 20th-21st, and June 1st-2nd. The timing for these surveys varied slightly from previous years, in part due to scheduling constraints and a delayed start resulting from a county-wide shelter-in-place order intended to slow the spread of COVID-19. Prior to 2018, each survey round would be conducted in immediate succession from the previous round. The decision was made for 2018 to include a 2-week time gap in between monitoring rounds, to ensure that the beginning and end of the larval activity period was captured in the survey window. This decisions was based on the fact that peak larval activity seemed to occur during the first monitoring round in 2016, with considerable declines in larvae counted in the two following rounds. Additionally, research on the life cycle of the SBE indicated that SBE can be in the larval stage for 34 days, on average. By spacing out the survey rounds to span a greater time period when larvae were active, the opportunity to capture early and late cohorts of larvae was increased. In 2020, surveys did not begin until two weeks after they had begun in 2018. The first and second survey rounds were separated by one week, and the second and third were separated by one week and a half. The timing of the first round of surveys in 2020 was based on the identification of 1st and 2nd instar larvae present on Sedum at the fixed plots; while later than in 2018, the start date was more typical in terms of sedum bloom development and survey timing of previous years. During the second survey, most sedum was in peak bloom, while in the third round of surveys sedum bloom was past peak in many plots. Larvae observations dropped off dramatically in the third survey round.

A total of 700 larvae were counted at all eight monitoring points during the first round of surveys, from May 12th to 13th. For the second monitoring period (May 20th to 21st), 478 larvae were counted at all eight survey points, and 13 were counted during the third monitoring period (June 1st to 2nd) (Table 7). In 2020 a total of 1,191 SBE larvae were counted. The last several years of monitoring are in Table 6 below

Table 6. Annual SBE Counts 1999-2020

Total SBE Larvae Counted at all 8 Fixed Monitoring Points, 1999 - 2020	
Year	Total Larvae Counted
1999	140
2000	115
2001	253
2002	291
2003	281
2006	373
2008	77
2010	364
2014	145
2016	320
2018	2,148
2020	1,191

Table 7 SBE Larvae Counts at 8 Fixed Plots for 2020

SBE Larvae Counts for 2020 Monitoring Period						
Fixed Point	Date	**Larvae Count**	Management Unit	Temp (˚F)	Wind Speed (mph)	Flower Development Stage
Monitoring Round 1 (May 12th to 13th)						
6	May 13	**127**	Devil's Arroyo	62-65	1-3	2
7	May 12	**156**	Devil's Arroyo	58-60	5-10	2
8	May 12	**230**	Devil's Arroyo	58-60	5-10	2
13	May 13	**80**	Devil's Arroyo	60-62	1-3	2
15	May 12	**48**	Dairy & Wax Myrtle	58-60	5-10	1
16	May 12	**38**	Dairy & Wax Myrtle	58-60	5-10	1
17	May 12	**12**	Dairy & Wax Myrtle	58-60	5-10	1
19	May 13	**9**	April Brook	60-62	1-3	2
Larvae Subtotal		**700**				
Monitoring Round 2 (May 20th to 21st)						
6	May 21	**42**	Devil's Arroyo	62-65	1-3	3
7	May 20	**122**	Devil's Arroyo	65-68	8-13	3
8	May 20	**194**	Devil's Arroyo	60-64	3-5	3
13	May 20	**44**	Devil's Arroyo	68-70	2-5	3
15	May 20	**37**	Dairy & Wax Myrtle	68-70	2-5	3
16	May 20	**31**	Dairy & Wax Myrtle	65-68	0-2	3
17	May 20	**4**	Dairy & Wax Myrtle	60-63	0-2	3
19	May 21	**4**	April Brook	68-70	3-5	3
Larvae Subtotal		**478**				
Monitoring Round 3 (June 1st to 2nd)						
6	June 1	**0**	Devil's Arroyo	65-68	1-3	5
7	June 1	**5**	Devil's Arroyo	62-67	5-10	5
8	June 1	**4**	Devil's Arroyo	57-62	5-10	5
13	June 1	**0**	Devil's Arroyo	68-70	1-3	5
15	June 2	**1**	Dairy & Wax Myrtle	78-83	0-2	5
16	June 2	**2**	Dairy & Wax Myrtle	78-83	0-2	5
17	June 2	**0**	Dairy & Wax Myrtle	73-78	0-2	5
19	June 2	**1**	April Brook	72-75	1-3	5
Larvae Subtotal		**13**				
2020 Total Count		**1191**				

Due to the change in monitoring protocol from previous years (with the exception of 2018), larvae that were estimated to be in the 1st or 2nd instar development stage, based on the observed size, color, and marking differences, were recorded as observed larvae. In previous years, monitoring protocol had only specified to record 3rd or 4th instar larvae. All recorded larvae observations were grouped in a size class in order to record the estimated stage of development for each larvae observed. The size classes are as follow: group 1 - less than 2mm; group 2 – 2 to 4mm; group 3 – 4mm or greater. It is estimated, based on description of instar characteristics in literature, that size class group 1 would represent

1st instar larvae, size class group 2 would represent 2nd instar larvae, and size class group 3 would represent both 3rd and 4th instar larvae. Each larvae observation was tallied in a grouping according to observer estimation of size. Table 8 below breaks down the percentage of larvae observations that fall into each size class for each monitoring round, as well as a total for all observations for the entire monitoring season.

Table 8 Size of observed larvae as a proportion of total observations for 2020 monitoring season

Size of observed larvae as a proportion of total observations for 2020 monitoring season			
	Percent of observations per size class and monitoring round		
	Size Class 1 (less than 2mm)	Size Class 2 (2mm to 4mm)	Size Class 3 (4mm or greater)
Monitoring Round 1 (05/12 to 05/13)	32.1%	45.6%	22.3%
Monitoring Round 2 (05/20 to 05/21)	20.9%	36.8%	42.3%
Monitoring Round 3 (06/01 to 06/02)	0.0%	0.0%	100.0%
% of Total Observations	27.3%	41.6%	31.2%

DISCUSSION

Based on the flower stages observed, the period roughly between the first and second monitoring periods correlated with the peak of the sedum bloom. Peak sedum bloom occurs when most plants observed were in flower. The highest number of larvae observations occurred in the first monitoring period, followed by an increasingly precipitous decline in observations for each successive monitoring period. The total number of observations for the entire 2020 monitoring season (1,191 total) was just over half (55.4%) of the total in 2018 (2,148 total), which itself was nearly 7 times what was observed in 2016 (320 total).

Within a season, the abundance of larvae at a point is assumed to resemble a bell-shaped curve. It has been thought that peak larvae abundance occurs at some time midway between visibility of the first and last larvae feeding on the sedum flower heads. Upon review of the results from 2014-2020, it may be that larvae are emerging earlier than previous monitoring years. It is unclear why this may be occurring. In 2018, the surveys were implemented ahead of peak sedum bloom due to larvae presence, a high proportion of larvae recorded as being in the early stage of development (1st instar), and many larvae observed feeding on sedum leaves. In 2020, surveys were implemented later in the season when larvae were already widely abundant, and above-average temperatures may have accelerated the bloom season or otherwise influenced larvae development, resulting in a steeply declining curve rather than a bell-curve.

Data presented in Table 8 supports this, showing that the 1st monitoring round in mid-May had the highest proportion of 2nd instar larvae, while the 2nd monitoring round already tilted towards a majority 3rd and 4th instars. By the 3rd monitoring round, when larvae counts had already diminished to zero for several plots, all observations were classified in Size Class 3 (i.e., 3rd and 4th instars). The survey window was offset from the seasonal peak, constructing a skewed representation of the larval development cycle, and suggesting that the overall abundance of SBE in 2020 may have been closer to or even greater than in 2018.

Based on these very high counts in comparison to previous monitoring years, along with the consistent number of larvae observed at the fixed points over the last several years, scrub succession does not appear to be a significant threat to SBE persistence. However, scrub expansion into coastal terrace prairie has occurred in the Dairy Wax Myrtle Ravine management unit over the last several years. This current data set may be used for comparisons of population abundance among points and between years. Since no major changes in habitat have been noted in the incidental observations over the years it is possible that incremental shifts in habitat quality have escaped notice. It would be helpful to determine if any specific data points currently monitored have experience a decline in larvae counts so that habitat conditions can be evaluated and considered for future management.

Similar to MB and CS butterfly monitoring, no habitat monitoring occurs to inform the analysis of the SBE data. Sedum grows on rocky outcrops, competition from weeds does not appear to pose a significant threat due to the harsh conditions of the habitat. However, in some plots it appears that scrub is possibly expanding into the areas that support the low-growing Sedum. Shifts in abundance at different locations could indicate host plant population expansion or contraction and/or nectar plant population changes. If host plant populations are declining it will likely cause a signal in larvae numbers in areas with diminishing adult populations.

CONCLUSIONS

SBE butterfly populations appear to be stable at the eight permanent monitoring points. It is advisable to initiate statistical analysis for the ten years of data since the Assessment did not include data from 2014 or 2016. After analysis of point data from year-to-year additional larvae monitoring adjustments could be considered. The statistical analysis can inform the stability of this population of endangered butterflies. SBE monitoring is also discussed in the Assessment. Based on the Assessment and the 2018 and 2020 data, SBE appear to be secure in high quality coastal scrub habitat and evaluation of the monitoring interval should be considered.

The Assessment recommends that presence surveys be established at all 21 historic points. The surveys would be conducted at appropriate times of the year and, given the most recent data, larvae observations may need to begin in late April and continue throughout May and possibly into June. The Assessment recommends consideration of a shift in SBE larvae monitoring from the point-counts to short timed searches, 10 person-minutes (Weiss et al. 2015). This methodology could improve efficiency and create coarse density classes. Ahead of a switch in monitoring methodology a statistical analysis

should be conducted on the current data. If in fact the SBE are secure in their current habitat, it may be suitable to consider monitoring on a 3-4 year interval. The change in frequency would continue to provide long term abundance monitoring for the species, but allow for staff time and resources to be allocated to other monitoring activities more readily.

The above recommendation to change the monitoring strategy should be considered in light of long-term data needs. This should be a discussion with area experts and statisticians to ensure that the data collected can inform future management actions if deemed necessary. Changing a monitoring scheme should only occur if it has the potential to improve habitat and/or species management of SBE. Once a clear understanding of how the changes can direct improved SBE habitat management they should be considered by the TAC. Decreased frequency of SBE monitoring would be a benefit to MB and CS monitoring needs. Additional host plant monitoring could take place if SBE monitoring was not necessary every other year.

Most areas supporting Sedum are within protected areas, and there is currently no take of SBE or their habitat authorized under the SBMHCP.

RECOMMENDATIONS

SBE MONITORING

1. Initiate statistical analysis of all SBE monitoring data at the eight fixed points. It would be helpful to determine if any specific data points currently monitored have experience a decline in larvae counts so that additional consideration of habitat conditions can be explored for future management.

2. Consider a longer monitoring interval for SBE larvae counts. Continue with the methodology implemented in 2018 with at least 3 survey rounds at all 8-fixed points, spaced approximately one week apart once larvae are initially detected. Each set of counts should be completed with two-week intervals to improve the ability to capture the full larval life cycle.

3. Changes to the current monitoring strategy should be discussed with the USFWS and experts and statisticians. If agreeable and the new methodology could improve efficiency and management of the species it would be wise to adopt it. The value of long-term data sets for evaluation of populations cannot be understated and additional analyses of the current SBE data will be important before changes in monitoring methodology should be considered.

MANAGEMENT IMPLICATIONS

At this time there are no specific management activities recommended for SBE habitat.

D. Bay Checkerspot Butterfly (*Euphydryas editha bayensis*)

A small population of the Bay checkerspot butterfly (BCB) was present near the summit of San Bruno Mountain up until the mid-1980s, but for decades had been determined to be extirpated from the mountain. To reestablish the Bay checkerspot butterfly (*Euphydryas editha bayensis*) (BCB) on San Bruno Mountain (SBM), translocations from Coyote Ridge in south San Jose (Santa Clara County) began in 2017 with funding from the Disney Butterfly Conservation Initiative. In March 2017, 3,630 postdiapause larvae were collected from Coyote Ridge and released at SBM along the main ridge. In early February 2018, postdiapause larvae were observed, confirming that BCB larvae released in 2017 had successfully reproduced. After this trial period, the project continued in 2018 with funding from the Central Valley Project Conservation Program. An additional 5,000 larvae were translocated in mid-February 2018 in areas east and west of the original release area. Adults were observed along the entire length of the release areas in 2018. There was a notable concentration of adults at the western release area, where a small hilltop provided a focus for aggregation. Adult butterfly encounter rates (butterflies/hour) were higher at SBM than at the Coyote Ridge reference site and the Edgewood reintroduction site. Prediapause larvae from freely ovipositing females were documented on the nonnative perennial host *Plantago lanceolata*, and in late April third instar larvae were observed on still lush hostplants. As expected, *P. lanceolata* remained green and edible through and beyond the prediapause larval period. Native annual *Plantago erecta* stands, where present, remained green and edible into late May, with *Castilleja* spp. remaining edible into early June. These observations of comparatively high adult encounter rates and host plant availability into the larval diapause stage indicate there is a high likelihood of success for BCB establishment on SBM.

In February 2019, 91 postdiapause larvae were observed in 17 survey plots across the 2017 and 2018 release areas. Initial calculations indicate a minimum larval population of 2,100 larvae in just the survey plots. Extending the estimate to the entire release area gives an estimate of 3,900 larvae. In February and March 2019, an additional 5,000 larvae were translocated into stands of *P. lanceolata* and *P. erecta* further to the east and west of the 2018 release areas. In 2019 adults were observed in all three release locations and along the entire extent of the monitoring transects.

A total of 5,000 larvae were translocated from Coyote Ridge to SBM in 2020. 3,668 larvae were collected on February 17, 2020 and that afternoon they were released on *Plantago lanceolata* at Buckeye Canyon. 1332 larvae were collected on February 18, 2020, and released the same day in Owl Canyon. While the Northeast Ridge has dense stands of *P. lanceolata* and local hilltops for aggregation, as of late 2019 the area has not yet been dedicated to San Mateo County Parks and will be targeted for releases in 2021.

A detailed report written by Creekside Science in October 2020, summarizing these activities, was prepared and submitted to USFWS and can be referenced for additional information on these translocation efforts. See Appendix C for the Semi-Annual Report for April 1, 2020 - September 30, 2020 on BCB reintroductions at San Bruno Mountain.

E. San Francisco Garter Snake (*Thamnophis sirtalis tetrataenia*)

The San Francisco garter snake (SFGS) was identified in the SBMHCP (1982) as having potential habitat on San Bruno Mountain. No SFGS were observed on the Mountain by field crew while conducting biological activities and overseeing development activities in 2019 or 2020. There have been no confirmed observations of SFGS on San Bruno Mountain in over 30 years of the SBMHCP monitoring program. Based on the lack of significant ponds and other aquatic habitats, this species is unlikely to be present.

F. California Red-legged Frog (*Rana draytonii*)

The California red-legged frog (CRLF) shares similar aquatic habitat with SFGS. Though it was not identified as a sensitive species at the time of the SBMHCP, CRLF has since been listed as a Federally Threatened species. No CRLF were observed on San Bruno Mountain by field crews while conducting biological activities and overseeing development activities in 2019 or 2020. There have been no confirmed observations of CRLF on San Bruno Mountain in over 30 years of the SBMHCP monitoring program. Based on the lack of significant ponds and other aquatic habitats on San Bruno Mountain, it is unlikely this species is present.

G. Plants of Concern

The rare plant survey completed in 2016 (see Appendix A) continues to be a guiding document for our knowledge of rare plant populations within the SBMHCP area, and allows better management decisions and appropriate avoidance an minimization measure to be in place to prevent impacts to known populations. In 2017 and 1028, additional populations of *Silene verecunda verecunda* and *Helianthella castanea* were identified. A restoration plan for *Lessingia germanorum* was proposed and approved in 2020 and is funded through a grant from the USFWS. These restoration activities are underway, in involve seed collection and propagation of lessingia, and experimental plots for reseeding and reintroduction with dune habitat.

III. VEGETATION AND HABITAT MANAGEMENT

A. Introduction

1. Site History

San Bruno Mountain State and County Park has been the site of many landscape and landowner changes since European settlement. Prior to European's inhabiting the land, the Ohlone (Costanoan) peoples are known to be the first to establish settlements on what we call San Bruno Mountain today. Evidence of the Ohlone's presence on San Bruno Mountain can be found throughout the mountain in the form of shell mounds (San Bruno Mountain Watch, 2020). During the period of Spanish settlement (roughly 1769-1884), the land was largely displaced from the Ohlone peoples, but remained largely

undeveloped, as it was being used for farming. When California became a state and the land was purchased, the majority of the area was devoted to grazing. That was until the 1970s when the majority of the park was purchased by the County of San Mateo. In 1982, the San Bruno Mountain Habitat Conservation Plan (SBMHCP) was enacted and created federally-listed species protections, but also allowed for development within certain non-County owned lands. The increased development surrounding San Bruno Mountain in the subsequent decades, and the diminished occurrence of natural disturbance regimes, saw a vast change in the mountain's native vegetation cover. Further, the affects of climate change and increased human presence in and around the mountain has had negative impacts on many sensitive wildlife habitats.

2. Vegetation Management

With European settlement came European species. Along with livestock and other farm animals, Europeans, both purposefully and accidentally, brought European plant species, the most notable and destructive being the annual grass species. These annual grasses thrived at San Bruno Mountain and throughout California, displacing many California native grassland wildflowers and grasses. The introduction of many motorways adjacent to San Bruno proliferated the European annual grass production leading to increased nitrogen input into the soils creating massive stands of grass which produce too much shade and thatch for California adapted species. Further, many native California grassland species are not adapted to high nutrient soils exacerbating the European invasive plant takeover. Once houses were built in and around San Bruno Mountain and people started planting non-indigenous ornamentals in their yards, a new wave of invasive species became present and destructive. Many people started planting *Eucalyptus globulus* (blue gum eucalyptus), *Pinus radiata* (Monterey pine), and *Cupresses macrocarpa (*Monterey cypress) for wind protection and as a natural delineation of property boundaries. Unfortunately, these species as well as many garden ornamentals spread onto the mountain changing the landscape rapidly. The impact of the quarry at San Bruno Mountain was not just limited to the landform disturbance. Vehicles driving into, throughout, and across other locations in California and beyond likely spread invasive species on the periphery of the quarry which then spread outward into the mountain. Evidence of this is shown by the bright yellow display in late spring months when *Cytisus striatus (*Portuguese broom) is in flower.

The spread of invasive species from these initial introductions has exponentially increased due to lack of coordinated management efforts for some time. After the SBMHCP was put into effect in 1982, vegetation management on San Bruno Mountain became structured with the focus being on protecting existing occupied habitat of federally-protected species. Further, efforts to identify specific causes for decline in federally-protected species were amplified leading to efforts to control the succession of grassland to scrub.

Beginning July 1, 2015 scrub removal became one of the highest priorities for habitat management in the SBMHCP area. This focus has been continued in 2019 and 2020 and remains a priority. The 2015 30-Year Assessment identified scrub as the biggest threat to occupied high quality habitat within the SBMHCP area and was also identified as a threat in the final SBMHCP (1982). Due to constraints related to controlled burns or the

infrastructure cost associated with conservation grazing strategies, manual and chemical control of scrub species, both native and invasive, have been deployed.

B. Methods

1. Location

Vegetation management in 2019-2020 was done in the majority management units throughout the SBMHCP area. The SBMHCP area ranges from the city limits of Daly City, Colma, South San Francisco, and Brisbane (Figure 8). Locations for habitat restoration work are selected by staff from SMCPs Natural Resource Management division using several different criteria. Factors include but are not limited to the following:

- Invasive plant species threats to present or potentially present locally rare or state and/or federally-listed flora or fauna species
- Are considered high habitat value for any of the listed flora and fauna, and have high native plant diversity that is important to conserve
- Areas where invasive plant infestations have a high likelihood of spreading
- Areas where there are known plant species that are on the California Department of Food and Agriculture Noxious weed list, given a California Invasive Plant Council rating, or are listed as priority species on the San Mateo County Weed Management Area group.
- Areas where invasive species or encroaching natives (i.e. coastal scrub species) are threatening high value vegetation communities (i.e. grasslands)
- Areas where effort has been put into for restoration in the past and ongoing effort is needed to ensure habitat health.
- Areas deemed by the *2015 Assessment of Past 30 Years of the San Bruno Mountain HCP* to be priority grassland management areas

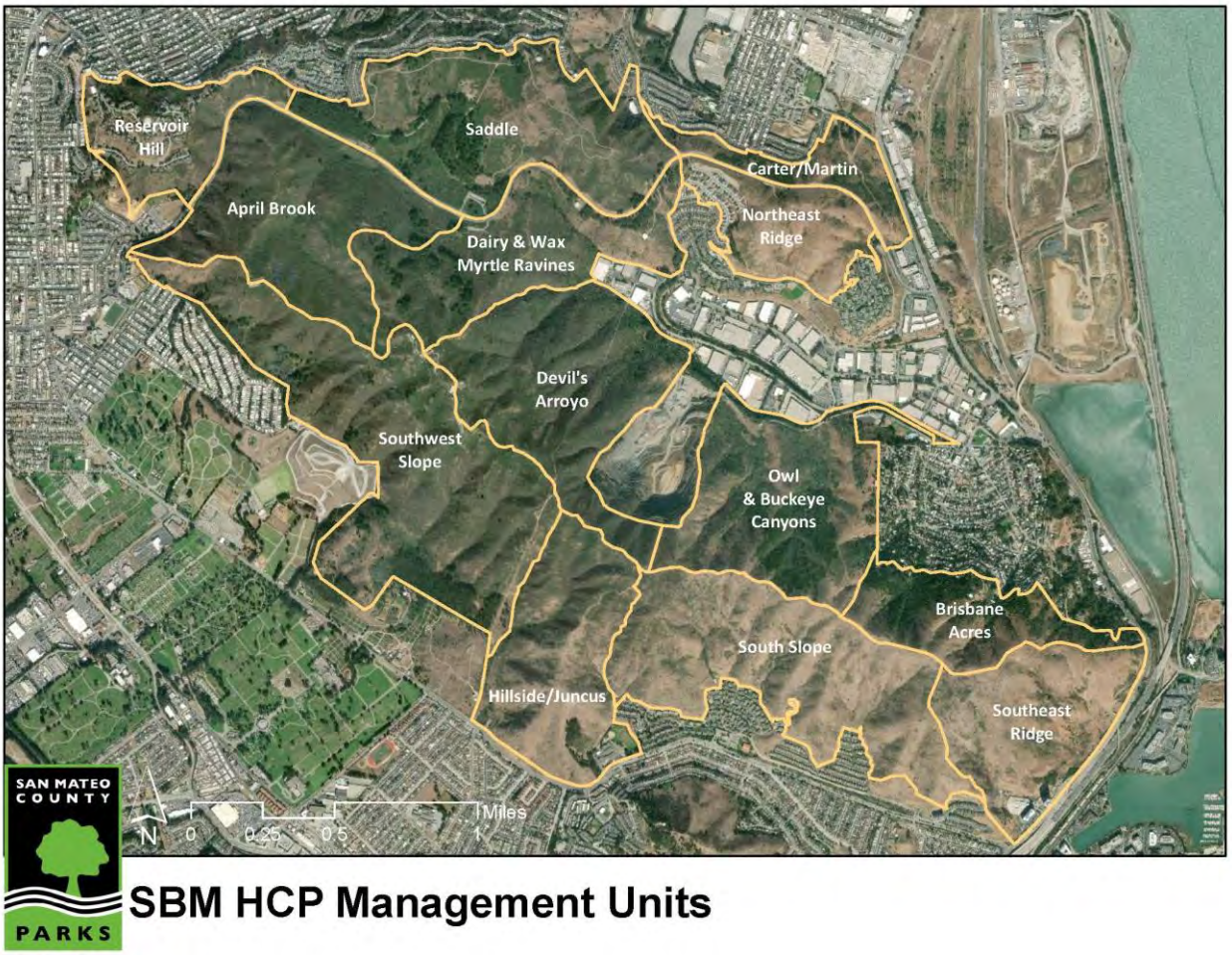


Figure 8: San Mateo County, CA. 2020. Map displaying the San Bruno Mountain Habitat Conservation boundary (green) and the corresponding Management Units.

There are thirteen official management units (MU) contained within the SBMHCP, as depicted in Figure 8. Not all MUs were prioritized for vegetation management activities as some units do not support occupied habitat for the covered butterfly species.

2. Vegetation Management Groups

In 2019 and 2020, Ecological Concerns Incorporated (ECI), Go Native Incorporated (GNI), and San Mateo County Parks (SMCP) staff and interns implemented vegetation management within the SBMHCP area. Funds for ECI and GNI are all from the SBMHCP trust fund or funds provided by developers for vegetation work needed to improve dedicated lands as part of their mitigation requirements. Invasive plant control has been augmented by volunteer groups, local homeowner's associations, and private landowners throughout the life of the SBMHCP. Current groups involved are: California Native Plant Society (CNPS) volunteers, San Bruno Mountain Watch (SBMW), City of Brisbane, Toll Brothers Inc., and TerraBay Master HOA. In addition to invasive species control, both SBMW and SMCP coordinated volunteer events within the SBMHCP to plant native species. Further, in 2018 Creekside Science Center for Earth Observation (Creekside Science) initiated a lupine direct seeding experiment within the SBMHCP to establish the

most successful methods for establishing host plants for the Mission blue butterfly (MBB). They have continued this experiment in new areas and with more seed in 2019 and 2020.

3. Vegetation Management Techniques

Three primary methods are employed for invasive species control, these include handwork, mechanical, and selective herbicide applications.

a. *Handwork*

Seedlings and saplings are pulled from the crown upward to reduce soil disturbance. This approach is most effective with plants that have shallow root systems. Hand tools used to remove the whole plant and root systems for this method include Pulaski or axe mattock, dandelion weeder, hori hori knives, pruning saw and loppers. If the soil is disturbed when the target is removed, then it is tamped down with a foot or the tool after weed removal. Species targeted for this method include fennel, broom (all species), eucalyptus, coyote brush, and Armenian blackberry.

b. *Mechanical*

A brush cutter is often used for either mowing or cutting weeds. A weed whip head mows soft forbs and grasses, where a metal triple blade on the same stock is used to cut through plants with woody stem tissue and tall seed stalks. The triple blade is used to gain access the root crown and is often followed by an herbicide application if the species is known to sprout. Two treatments based on size include 1) cut stump treatment at the base of larger (> 2 in DBH) stumps removed by chainsaws and 2) foliar application to secondary growth on smaller plants (<2 in DBH). Species include coyote brush, fennel, cotoneaster, broom (all species), eucalyptus, and acacia.

In addition to brush cutters, SMCP staff have utilized the use of masticators and dozers to treat patches of thick *Ulex europaeus* (gorse). This approach is also being considered for use by CalFire in certain areas of the SBMHCP near homes as fire fuel reduction efforts. SMCP operators use dozers to crush already burned standing woody vegetation to smaller more manageable pieces so that later CalFire can use brush rakes and create burn piles. SMCP operators use masticators to cut through dense stands of woody vegetation. The operators will repeatedly go over the masticated area to achieve the proper chip depth and size so that an average depth of chips is around 3-5 inches. This creates a layer of chips that will suppress the seed bank

c. *Herbicides*

Some weedy species are treated with an herbicide solution using foliar, basal bark and cut stump methods. The three herbicides applied are Garlon 4 Ultra® (Triclopyr ester), Roundup ProMax® (glyphosate), and Roundup Custom Aquatic and Terrestrial® (glyphosate). These herbicides are used due to their high effectiveness, low toxicity rating, and short half-life in the soil. Garlon 4 Ultra® herbicide is the preferred chemical for broadleaf weeds and has little effect on monocots (grasses). Round Up Custom Aquatic and Terrestrial® is an aquatic herbicide applied to plants adjacent to creeks or in areas subject to seasonal runoff. Roundup ProMax® is a non-selective herbicide with a surfactant added to the formulation and is used to treat grasses as Garlon 4 Ultra® is not very effective on monocots. Roundup ProMax® is also used to foliar spray gorse due it's

known high effectiveness for this species. The herbicide application type and method depend upon the species and location. Three application treatments (foliar, cut-stump, and thin-line) are used within SBMHCP area. Foliar treatment is when the whole of the plant's canopy and leaf area are targeted using backpack sprayers and cone/jet tips. The spray tips are designed to adjust and allow target specific applications. Cut-stump treatments are when the trunk is cut 1-2 inches above soil surface and treated with a twenty-five percent mixed solution with Round Up Custom Aquatic and Terrestrial® and vegetable oil. Thinline treatments are considered a low volume application and is used primarily on trees and shrubs less than six inches in diameter. A thin stream of undiluted or highly concentrated herbicide is applied in a horizontal line around each stem. All application techniques are focused on the target species, and drift to adjacent plants is avoided by using the appropriate equipment and applying during appropriate weather conditions.

All San Mateo County integrated pest management policies, and relevant pest control recommendations for the prescribed herbicides are adhered to for all applications.

d. *Approach*

Sites targeted for work are generally visited approximately twice annually and in some cases more. Activities completed by each contractor or group is input into a digital mapping application (ArcGIS Collector/ArcGIS Online/Calflora Weed Manager). The data recorded reflect treatment management units, treatment method, work effort, weather data, and specific work sites denoted on the map for each day. The benefit of using this data collection methodology allows for annual treatments and activities to be automatically integrated into a digital record that can be tracked overtime and as feature class layers in a GIS database. This provides a consistent record of all activities past and present and a visual representation of where activities occur over time.

4. Data analysis

We analyzed all spatial data using ESRI's ArcGIS Pro or ArcMap applications. Other data analysis was done in Microsoft Excel spreadsheets. All data we collected in the field using ArcGIS Collector or Calflora Weed Manager was transferred to spreadsheets.

C. Results

The vegetation management data we analyzed for this report is comprised of work performed from January 2, 2019 through November 5, 2020. Some work performed from October – December 2020 is not included in this report as the data was not made available in time for publishing. The data from work performed from this period and a summary will be provided on the 2021-2022 report.

1. Personnel

Vegetation management contractors treated most of the acreage within the SBMHCP in the 2019-2020 period, treating over 472 acres or about 97% of land (Figure 9). SMCP staff, interns, and volunteers treated over 13 acres with over 12 acres being the

management of gorse in the Saddle and North Saddle management units. However, this data does not consider the management done by volunteers organized by SBMW. SMCP and SBMW are now coordinating together to collect data on vegetation management using Calflora's Weed Manager and in the future will have collaborative data in one collective database.

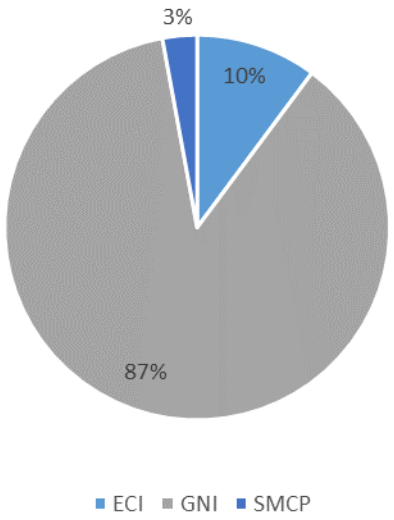


Figure 9. Percentage of acreage treated by Ecological Concerns Incorporated (ECI), Go Native Incorporated (GNI), and San Mateo County Parks (SMCP) within the SBMHCP from 2019-2020.

2. Treatment Distribution

SMCP staff and contractors managed vegetation in 19 of the 24 management units from 2019-2020 (Figure 10).

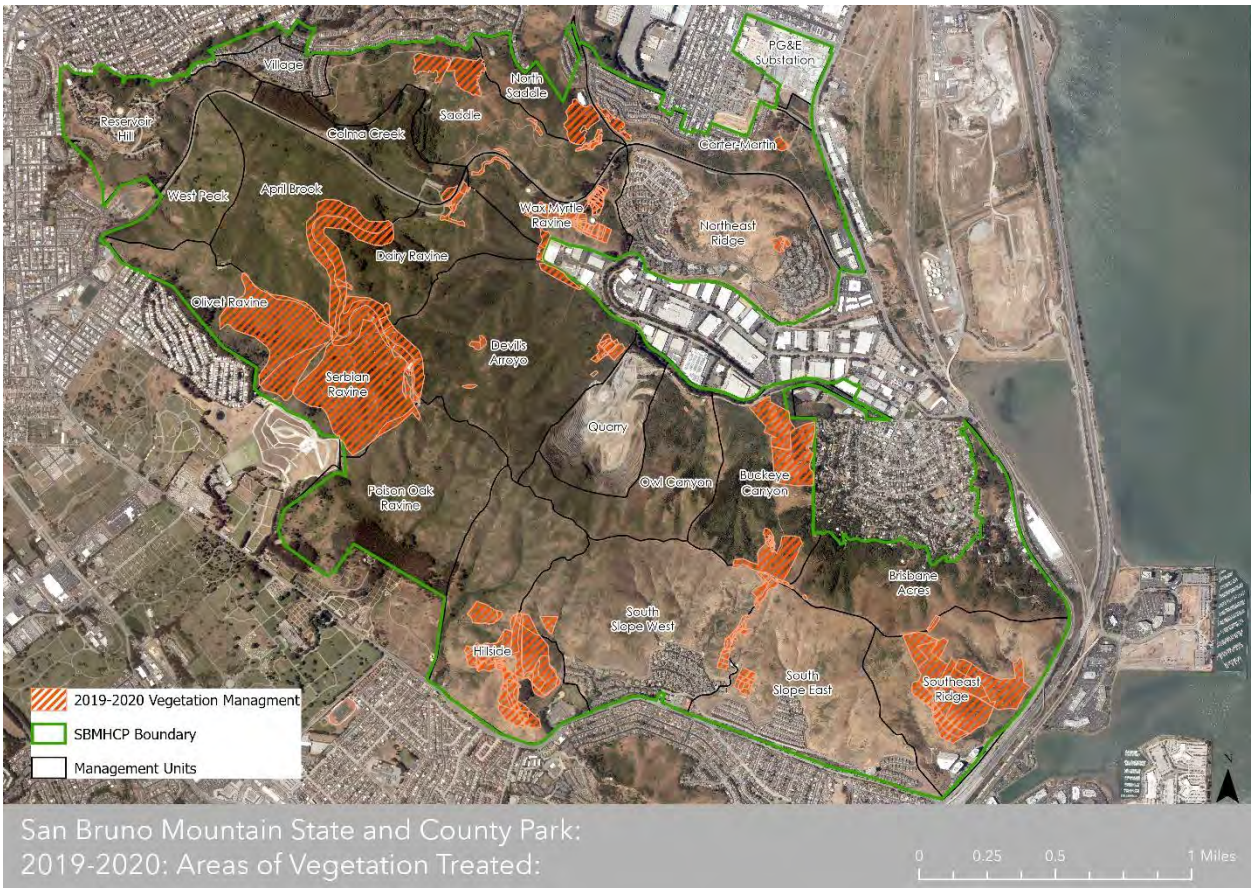


Figure 10. San Mateo County, Ca. Areas where vegetation was managed at San Bruno Mountain from 2019-2020.

Total acreages of treatments do not represent actual on the ground manipulation of vegetation. Rather the vegetation managed in these areas show the total area vegetation was searched and encompasses areas where treatments were done. For example, treatments done in the Serbian Ravine, Poison Oak Ravine, and Olivet Ravine were to control *Cortaderia jubata* (jubatagrass) infestations. The percent cover of these infestations was very sparse; however, contractors are instructed to record the area where they have swept for the species which helps us to know what area has been deemed clear of jubatagrass. Contractors and SMCP also conduct vegetation management within small areas and often do so over multiple occasions to achieve a desired result. This is to ensure that the butterfly habitats are restored properly and with the proper amount of sensitivity.

3. Methods of Treatment

SMCP contractors, staff, and volunteers used manual methods whenever it was possible to reduce the amount of disturbance to area. However, most of the area that was managed in the SBMHCP area in 2019 - 2020 was managed using herbicide (Figure 11). However, the area managed with herbicide is much larger than what was actually applied on the ground, as chemical treatments used are quite sparse as compared to the entire area that is treated. Comparatively, our mechanical treatments conducted represent a

more precise area measurement of what vegetation was mechanized. Manual methods are somewhere in between, as manual removals are both conducted in very dense invasive plant infestations and in large less dense areas.

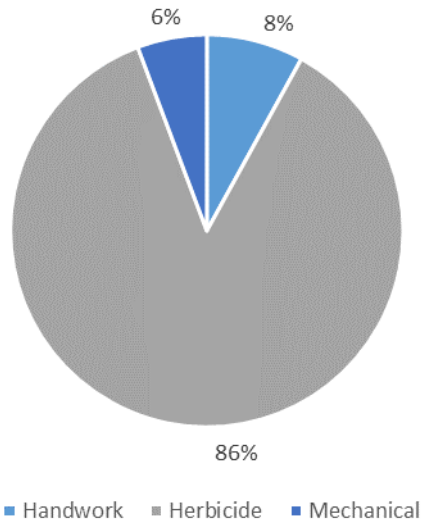


Figure 11. Percentage of acreage treated by control method within the SBMHCP from 2019-2020.

Volunteers and SMCP staff did not use chemical control methods in 2019 and 2020. Volunteers will never be permitted to use chemicals, but SMCP staff will use chemical control methods whenever it is necessary to protect sensitive ecosystems. In 2019 and 2020, SMCP staff did not feel equipped to perform herbicide treatments in protected butterfly habitat and instead hired contractors to do the work instead. The contractors that SMCP has hired are well experienced to perform highly calibrated and ecologically safe herbicide applications. The contractors used the spot spraying method to control forbs and small bushes over a large landscape for very fine controlled treatments. The contractors also utilized cut stump treatments on dense shrubs and some encroaching blue gum eucalyptus to clear grasslands.

Another effective control technique utilized by our vegetation management contractors is the use of brush cutters or chainsaws. In 2019-2020 contractors used these tools to treat weeds such as *Foeniculum vulgare* (Fennel), Monterey pines, and Monterey cypresses. However, often contractors would utilize both brush cutters and chainsaws with herbicide spot treatments to effectively control plants that would re-sprout after being cut. SMCP staff utilized our Caterpillar 299 masticator to mow over 7 acres of almost 100% gorse cover in the Saddle and North Saddle. The SMCP operator then precisely ran the masticator over the limbs and trunks of the gorse to create a 3-6-inch layer of wood chips to suppress the seed bank and below ground roots of the gorse. SMCP staff also utilized our dozer which we used to crush over 5 acres of burned standing gorse skeletons. The gorse was burned during a fire in February 2020 which was contained by CalFire. This patch of gorse is going to be managed by either piling and burning the brush or by just piling and leaving the gorse to decompose on site. By piling and removing the crushed biomass out of the way of the treatment, applicators will have a better view of newly growing weeds to target.

4. Species Treated

SMCP targeted several invasive plant species for control or containment during the 2019-2020 period. The list of species that are considered priority weed species and given the capacity and resources at our disposal it is not feasible to control them all. As such, SMCP identifies specific high priority targets and areas that are in specific need of preservation or restoration. There are 12 main species that SMCP targeted (Figure 12). However, many other species were also treated, but at a much smaller scale.

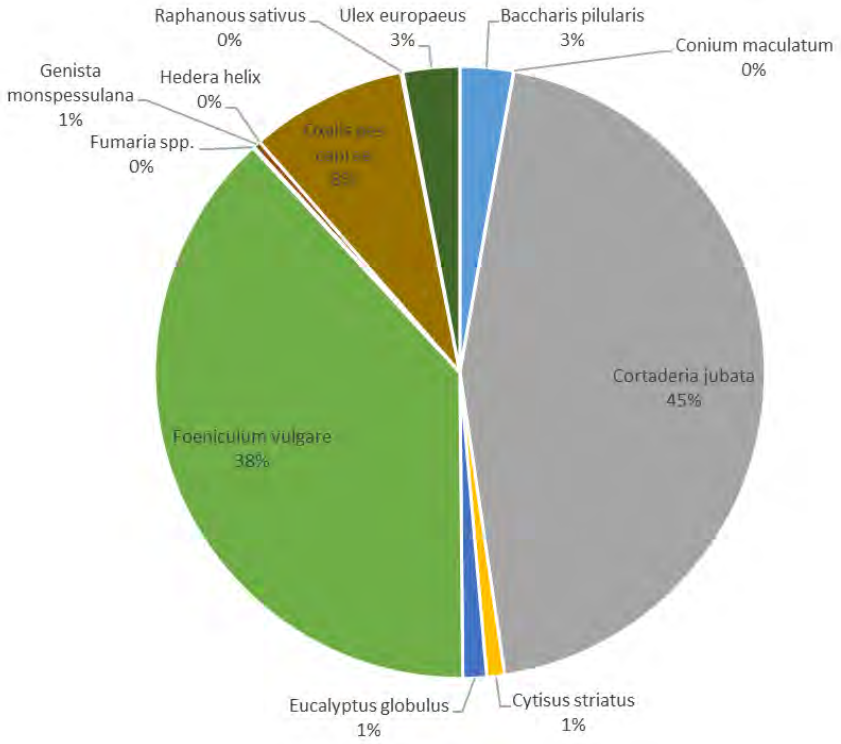


Figure 12. Percentage of acreage treated by plant species within the SBMHCP from 2019-2020.

The treatments of *Cortaderia jubata* (jubata grass) and *Foeniculum vulgare* (fennel) appear much higher proportionately, as the acreage to cover for scattered individuals for this species is much larger (see section *B. Treatment Distribution* for more details). Species such as *Baccharis pilularis* (coyote brush) and *Ulex europaeus* (gorse), are very concentrated in terms of total acreage treated, as these species tended to be present in high density in relation to the treatment area.

D. Discussion

1. Habitat Enhancement

San Bruno Mountain's federally-listed butterfly species continue to be at risk due to invasive plant species, and native scrub encroachment. SMCP continues to prioritize

areas of high-quality habitat to preserve considering butterfly life stage and invasive species effects to the habitat. We also aim to restore butterfly habitats with declining numbers or that are under threat of invasive species. San Mateo County Parks work for 2019-2020 show continued effort to devote resources and people power to assess and combat invasive species and integrating the knowledge of the butterfly population data and habitat quality. Typically, areas where large scale restoration is needed to preserve habitat quality heavily covered by scrub back to grassland are beyond our capabilities unless we have special funding outside of the annual SBMHCP trust fund allocations. Consequently, efforts to conduct a landscape-scale habitat restoration project are underway with the current planning for a Pilot Cattle Grazing Program. This project will aim to introduce cattle to certain areas of San Bruno Mountain, with the goal to reduce grass height and thatch build-up thus promoting host and nectar plant expansion. This project would deliver much needed large-scale restoration to the grasslands and help reduce the amount of thatch buildup that decades of unmanaged European annual grass growth has produced. Projects such as this are paramount for the long-term health of the butterflies and provide the data necessary to properly assess the success of the site-specific pilot program rather than having to extrapolate findings from other California based projects.

SMCP has continued to focus habitat restoration work on large woody invasive plants which is one of the main threats to the butterfly species occupying grassland habitats and their host plants. However, the rate at which the scrub is establishing in grasslands is more than what hand crews can treat, especially with access to certain areas being difficult. The introduction of cattle will also help combat this issue. By bringing in large grazers, SMCP hopes that grazed areas will have decreased sprouting scrub individuals, halting ongoing encroachment of the scrub into the grasslands.

a. *McKesson Parcels*

The work in the McKesson Parcels located in the Wax Myrtle Ravine and the Devil's Arroyo MUs have been successful in improving habitat for covered butterfly species. In the Wax Myrtle Ravine, work has centered around treating fennel and native scrub species out grasslands. Work has also been conducted on the outskirts of the eucalyptus grove to control encroaching saplings. Work has also been done in the grove to treat small diameter trees (less than 8 in DBH) and broom species to reduce fire ladder fuels in the grove. Work at the Devil's Arroyo site has focused on reducing Portuguese broom and coastal scrub species from the grassland areas where Callippe butterflies are still present. Work in both areas has been ongoing in both 2019 and 2020, with the majority of the work being done in the winter and spring months to best time treatments to when target species are actively growing. All work in the McKesson parcels has been done by ECI.

b. *TerraBay Parcels*

The work in TerraBay Parcels 1 and 2 has been primarily focused on reducing the fennel that has inundated many of the grassland areas on the southern slope of the mountain. TerraBay Parcels 1 and 2 are located in the South Slope MU. TerraBay Parcels 1 and 2 are both situated in scrub and grassland and the transition between the two areas. The goal for these sites is to treat the fennel prior to it going to seed, but at the same time

prioritizing areas of high-quality host plants and of high plant species richness. Work was conducted in these parcels in May-June of 2020 by ECI.

c. *Preservation Parcel*

The work in preservation parcel area has been focused on treating highly dense fennel patches on the Southeast Ridge MU. Preservation Parcel is situated on the southern side of the Southeast Ridge upslope of the Genesis high-rise building off Airport Boulevard. The work has been very successful in controlling the fennel infestations leading to much healthier grassland areas. The work in 2019 and 2020 was done by GNI.

2. Butterfly Host Plant Establishment

The ability to repopulate host plants is also crucial to the restoration and continued augmentation of the butterfly's habitat. Finding ways to establish host plants in large numbers and doing so with the most diverse genetic material gives the butterfly species a higher likelihood of population expansion. The success of the lupine direct seeding and amplification projects across the Bay Area provides a hope that even with the potential for fungal pathogen outbreaks, there could still be a way to provide host plants to declining populations. The proven ability to propagate and plant sedum is also a great sign that you can establish these hearty succulents in areas of present or historically present San Bruno elfin butterfly populations. The next challenge for SMCP is to establish nursery grown Viola at San Bruno Mountain. This has proved difficult in the past. However, thanks to our valued partners at San Bruno Mountain Watch and the Mission Blue Nursery, we are aiming to try again with a new approach. Instead of container planting which was traditionally attempted, we have set our sights on attempting a direct seeding experiment at San Bruno Mountain using site specific seed grown in Brisbane at Mission Blue Nursery. The goal is to collect seed in 2021 for propagation and amplification at the nursery, and reseed areas in subsequent seasons.

3. Bay Checkerspot Reintroduction

The continued success of the Bay Checkerspot Reintroduction Project led by Creekside Science is very promising for sustainable populations persisting at San Bruno Mountain. Having utilized the invasive English plantain as an alternate host plant, the translocation of larvae to San Bruno Mountain has been a great success thus far. With the larvae completing their life cycle, and thus reproducing, the possibility of expansion of the species wherever habitat is available is possible. SMCP has been in close contact with Creekside Science to adequately manage their habitat from invasion while also maintain buffers and timing treatments to the butterfly's phenology. This close collaboration between Creekside Science and SMCP is crucial to the recovery of the species at San Bruno Mountain.

4. Natural Disasters

Two large fires occurred during the 2019-2020 period. The first being a scrub, oak, and grassland fire on the east facing slopes in the Brisbane Acres management unit near the ridgetop. This fire was approximately 8.5 acres in size and burned a highly biodiverse grassland area with some mustard, radish, and oxalis patches. In March 2020, radish covered many areas near the ridge trail and where European grass thatch buildup was high. Contractors were deployed soon after to control the species, but the regulation put forth following COVID-19 outbreak did cause the work to be cut short. The cause of this fire is still unknown. The second fire occurred in February 2020 and was about 5.3 acres in size. This fire burned almost a complete outline of a dense gorse stand in the Saddle management unit. The fire caused much of the gorse to be left standing while leaving a few native shrubs crumbling to the ground. With gorse being an effective coppice sprouter and fire events causing amplified stimulation of the seed bank, the opportunity to control this population following the fire has been of high importance. Soon after the fire in the early spring, stump sprouting was already occurring, and gorse seed was beginning to germinate. As mentioned in section *C. Methods of Treatment*, this gorse patch was crushed with a dozer so that the material could be piled to allow for retreatment of the area to follow. It was deemed that the area would not be successfully masticated and mulched due to the low biomass that was remaining after the fire. As such, follow up treatments in this area are planned for early 2021 during the growing season. The cause of this fire is also still unknown.

The effect of the COVID-19 outbreak in 2020 has had an impact on the ability to conduct vegetation management on the mountain. In the early stages of the virus, while San Mateo County had the shelter-in-place order, vegetation management contractors were pulled from the field. Further, volunteer projects were cancelled. Staff were only able to conduct wildlife monitoring and were unable to conduct the vegetation management work that often occurs during the crucial spring period. Restrictions did loosen as time went on and come May, vegetation management contractors could conduct work. Volunteers were granted permission to conduct small scale socially distanced programs throughout SMCP network. However, volunteer projects did not resume on the mountain until December of 2020.

E. RECOMMENDATIONS

1. Habitat Enhancement Prioritization

Scrub encroachment should continue to be a primary focus for budget expenditures related to habitat management. Using the Assessment, areas designated as “essential” should be prioritized for treatment as a starting point. Scrub encroachment should continue to be prioritized until grassland habitat increases to the minimum threshold of 1200 grassland acres. Grassland acres should be evaluated at a regular interval to ensure the minimum threshold is retained.

A more detailed analysis of the long-term butterfly monitoring data is currently underway and may become an important tool for prioritization of habitat enhancement work. With this forthcoming analysis, it become possible to identify segments of the larger fixed

monitoring transects where declines in the species observations have been sustained for several years. This allows or a finer resolution look at specific areas of occupied habitat where the species occupancy is in decline. With this knowledge we can prioritize areas for scrub removal, invasive species control, and host plant seeding or planting efforts to attempt to reverse the declining trend before the habitat in these locations is entirely lost.

2. Host and Nectar Plant Monitoring

For the past 4 years, host plant mapping and monitoring across San Bruno Mountain has been implemented, and efforts should continue to fill any gaps in the dataset, or to conduct repeated visits to previously mapped areas to verify extent. In particular, there are additional areas where *Viola pedunculata* has not been mapped in recent years, which should be prioritized in the coming bloom periods.

Efforts to measure and monitor the response of host and nectar plants to habitat enhancement techniques should be undertaken. It is understood that scrub encroachment and non-native annual grasses suppress host and nectar plant populations, but effectiveness of various habitat enhancement techniques in promoting and expanding host and nectar plant populations is not explicitly measured. Implementing monitoring plots and/or transects with the intent of measuring host and nectar plant density and cover in response to specific vegetation management treatments should be implemented. For instance – in an area where scrub removal has occurred, relevee transects could be established to measure percent cover and density of host and nectar plants. An experiment of grassland mowing and host plant expansion can be implemented, where plots are established and mowed seasonally, and there are measurements of host plant density to assess the effects of non-native grass and thatch reduction on host plant growth. These two actions – scrub removal and annual grass reduction – are assumed to provide habitat benefits, but the collection and interpretation of specific measurement on the habitat response can aid in our implementation of future habitat enhancement efforts. This level of monitoring and analysis will also tie in well with the pilot cattle grazing program, which will have explicit measuring and monitoring goals to determine the success of cattle grazing for improving butterfly habitat. By also measuring and monitoring habitat responses to other management techniques, we can compare the differences in efficacy and achieving the desired results.

IV. COVERED SPECIES AND VEGETATION MANAGEMENT PARTICIPANTS

Annual report prepared by San Mateo County Parks Natural Resource Specialist, Evan Cole, with contributions by Natural Resource Manager Hannah Ormshaw and Natural Resource Specialist Sean Correa, and use of previous Activities reports from past habitat managers, Autumn Meisel and Patrick Kobernus. Monitoring in 2019 and 2020 was implemented by Hannah Ormshaw, Evan Cole, Sean Correa, Olivia Kurz, Johanna Harrison, and contractors from Coast Ridge Ecology.

Habitat Management Activities were implemented by: Ecological Concerns Inc. and Go Native Inc.

REFERENCES

Arnold, 1983. Ecological studies of six endangered butterflies (Lepidoptera, Lycaenidae): island biography, patch dynamics, and design of habitat preserves. Univ. of Calif. Publications in Entomology. 99:1-161.

San Bruno Mountain History. San Bruno Mountain Watch. www.mountainwatch.org

Thomas Reid Associates, 1982. Endangered Species Survey San Bruno Mountain. Biological Study 1980-1981. Prepared for San Mateo County.

TRA Environmental Sciences, 1983-2014. SBMHCP Annual Activities Reports. Prepared for the County of San Mateo.

Weiss, S.B., Naumovich L. and C. Niederer. 2015. Assessment of the past 30 years of habitat management and covered species monitoring associated with the San Bruno Mountain habitat conservation plan. Prepared for the San Mateo County Parks Department.

Appendix A:

2015 Rare, Threatened, and Endangered Plant Survey

2015 Rare, Threatened, and Endangered Plant Survey
San Bruno Mountain

A REPORT FOR SAN MATEO COUNTY PARKS DEPARTMENT

CREEKSIDE SCIENCE

2015 Rare, Threatened, and Endangered Plant Survey: San Bruno Mountain

Report for San Mateo County Parks Department

Report Authors: Lech Naumovich, Christal Niederer of Creekside Science, 27 Bishop Lane, Menlo Park, CA 94025

Report Date: August 19, 2016

Preferred Citation: Naumovich, L. and C. Niederer. 2016. 2015 Rare, Threatened, and Endangered Plant Survey: San Bruno Mountain. Report for the San Mateo County Parks Department. Creekside Science. Menlo Park, CA

Cover photo: San Francisco spineflower located on the San Bruno Mountain in 2015, in the Colma Dunes area. Above photo: Extensive San Bruno Mountain manzanita stand located on Manzanita Dike. All photos provided by L. Naumovich unless otherwise noted.

CREEKSIDE SCIENCE

Executive Summary

From February thru November 2015, targeted botanical surveys were conducted for 20 unique taxa within the San Bruno Mountain (SBM) Habitat Conservation Plan (HCP) area. These unique taxa are also known as "Rare, Threatened, and Endangered" (RTE) plants that have been afforded regulatory protection from either the US Fish and Wildlife Service or the California Department of Fish and Wildlife. Fifteen (15) of the 20 RTE taxa were observed in 2015. Each taxon located was documented with photographs, GPS location, and the completion of a California Natural Diversity Database (CNDDB) form for each separate occurrence of these plants. Four (4) of the RTE plants were designated as "locally abundant," indicating that they were found in numerous locations and habitat types on SBM. Eleven (11) plants were designated as restricted, indicating that their presence on the mountain was closely linked to specific climate, substrate, or confluence of other conditions. Five (5) taxa were not located in 2015 surveys and we believe at least two taxa (white-rayed pentachaeta and San Francisco owl's clover) are extirpated from SBM because habitat where they once existed is now gone. The remaining three taxa that were not located (bent-flowered fiddleneck, Choris's popcorn flower, and San Francisco campion) may persist outside of our survey areas, or may occur in very low densities and were not detected in our surveys. In 2016, a notable population of San Francisco campion was relocated by volunteers. Since we are in the midst of a historic 4-year drought, it is likely that certain annual plants are not germinating as they do in a year with average precipitation.

Plant population data were updated for all the occurrences. Plant/population vigor is also presented as a measure of conservation success. Notably, at least three taxa have well documented taxonomic inconsistencies and can be difficult to identify: San Bruno Mountain manzanita (intergrading with Montara mountain manzanita), San Francisco Gumplant (which has been lumped into a parent genus in the most recent taxonomic treatment), and San Francisco campion (which has been studied with other campion only to determine that the taxa in the San Francisco area would benefit from further study).

Despite taxonomic difficulties and historically dry weather, we believe this report will help land managers, citizens and non-profit groups take meaningful steps to help preserve the RTE flora of San Bruno Mountain. To this end, this report provides preliminary recommendations for stewardship actions and ranks each RTE element in terms of its priority for receiving stewardship. We believe a distinct subset of the RTE plants can benefit greatly from well-timed and executed stewardship projects. Our intent in providing this information is that it may encourage a thoughtful, informed discussion about conserving extant populations of RTEs and even introductions of new or extirpated populations where appropriate.

Table ES-1: Results of 2015 RTE plant surveys on San Bruno Mountain

Scientific Name	Common name	**Rarity Status** (CRPR = California Rare Plant Rank list 1B plants are rare, threatened or endangered in CA and elsewhere, list 3 plants require more information, list 4 plants are of limited distribution)	**Taxon found** (X = not found, A = locally abundant, R = restricted)	**Stewardship Priority** (3 is high, 2 is medium, 1 is low, 0 is no action recommended)
Amsinckia lunaris	Bent-flowered Fiddleneck	CNPS 1B.2	X	1
Arabis blepharophylla	Coast Rock Cress	CRPR 4.3	A	2
Arctostaphylos imbricata	San Bruno Mountain Manzanita	CE/CRPR 1B.1	R	3
Arctostaphylos montaraensis	Montara Manzanita	CRPR 1B.2	R	3
Arctostaphylos pacifica	Pacific Manzanita	CE/CRPR 1B.2	R	3
Arctostaphylos uva-ursi forma *coactilis*	Bearberry Manzanita	None	R	3
Arctostaphylos uva-ursi forma *leobreweri*	Bearberry Manzanita	CBR (considered for status but rejected)	R	3
Arctostaphylos uva-ursi forma *suborbiculata*	Bearberry Manzanita	CBR (considered for status but rejected)	R	3
Chorizanthe cuspidata	San Francisco Spine-Flower	CRPR 1B.2	R	3
Collinsia multicolor	San Francisco Collinsia	CRPR 1B.2	R	3
Erysimum franciscanum var. *franciscanum*	San Francisco Wallflower	CRPR 4.2	A	2
Grindelia hirsutula var. *maritima*	San Francisco Gum Plant	CRPR 3.2	A	0
Helianthella castanea	Diablo helianthella	CRPR 1B.2	R	2
Iris longipetala	Coast Iris	CRPR 4.2	A	1
Lessingia germanorum	San Francisco Lessingia	FE/CE/CRPR 1B.1	R	3
Pentachaeta bellidiflora	White-Rayed Pentachaeta	FE/CE/CRPR 1B.1	X	2
Plagiobothrys chorisianus var. *chorisianus*	Choris's Popcorn Flower	CRPR 1B.2	X	1
Silene verecunda ssp. *verecunda*	San Francisco Campion	CRPR 1B.2	R (located in 2016)	3
Tanacetum bipinnatum	Dune Tansy	CBR	R	2
Triphysaria floribunda	San Francisco Owl's Clover	CRPR 1B.2	X	1

See http://www.cnps.org/cnps/rareplants/ranking.php for more information on rare plant ranks.

Acknowledgements

A number of people were instructive in creating this report. Volunteers of the San Bruno Mountain community, San Mateo County Parks staff, local non-profit groups, and regional experts offered volumes of information and insight. Their support was essential. We want to especially thank a few people who have been intimately involved in our work including: Doug Allshouse (and his wife who kindly shared their home for meetings), David Nelson, David Schooley, Aaron Sims, California Department of Fish and Wildlife staff, Mike Vasey, Jake Sigg, Mike Forbert, Joe Cannon, Scott Simono, Aaron Schusteff, Mark Sustarich, Margo Bors, Thomas Stoughton, the San Bruno Mountain HCP Technical Advisory Committee, the California Academy of Sciences herbarium staff, and our project manager at the County: Ramona Arechiga.

We apologize for any omissions, they are unintentional.

This study was funded by County of San Mateo Measure A funds.



Introduction

Ecological Setting

San Bruno Mountain (SBM) State and County Park is an ecological landmark of regional significance that protects a majority of the remaining, undeveloped San Bruno Mountains. Formally, all that remains undeveloped of the San Bruno Mountains is the main southeast to northwest ridge of San Bruno Mountain and its slopes, the Guadalupe Hills (Callippe Hill) and Colma Canyon and its surrounding slopes. For this report, SBM refers to the larger San Bruno Mountains. The survey area stands as a virtual ~2,500 acre island of habitat in the midst of the urban South San Francisco area metropolis. SBM is both an island and a critical bridge between the vast expanses of habitat north of the Golden Gate and the contiguous expanses of the Santa Cruz Mountain Range. The vegetation on SBM has been studied since the late 1800s and its elevation relief and heterogeneity allow for the mountain, with its many nooks and crannies, to serve as a refuge for unique flora and fauna.

San Bruno Mountain is an tectonostratigraphic terrane where one tectonic plate breaks off and is sutured onto a second. The mountain's ridge line runs in an east-west configuration, with slopes ranging from zero to vertical, and elevations ranging from 250 to 1,314 feet. The bulk of the mountain is composed of late Cretaceous (~100 million years old) dark greenish-grey graywacke of the Franciscan formation (McClintock et al. 1990). This graywacke is a type of poorly sorted sandstone that consists of angular rock fragments, detrital chert and feldspar (Ibid.). Serpentinite is restricted to small lenses on Serbian ridge and is not a prominent geologic feature of the Mountain. A notable sand dune and sandy soils occur near the head of Colma canyon on the western end of SBM. McClintock notes that since “SBM is composed almost entirely of one rock type, there is little variation in the type of soil… the varying factor is the soil depth” (Ibid.).

Vegetation on San Bruno Mountain is a dynamic mix of several prominent communities, most notably coastal prairie grassland and northern coastal scrub that are in a continuous battle for real estate. Non-native annual grassland, needlegrass grassland, blue blossom chaparral, central coast riparian scrub, and eucalyptus forest are also dominant vegetation types on the island. A number of other unique vegetation types dot the landscape (e.g. central dune scrub, fresh water marsh, gorse scrubland, manzanita scrubland, and seasonal wetlands) to further add to the diversity of the area.

The parks' principal biotic resources include 20 species of rare, threatened and endangered (RTE) plant life, as well as host and nectar plants of endangered butterflies. The endangered or threatened butterflies (San Bruno elfin, Mission blue, and Callippe silverspot) are found in only a few other places in the world. Another species considered for listing, the San Francisco tree lupine moth (*Grapholita edwardsiana*), was known to inhabit the area, but urban development destroyed this population. Conserved habitat on SBM is managed under the nation’s first Habitat Conservation Plan established in 1982.

Many community groups are interested and invested in this park. In fact, it was the work of several community groups and an interested public that helped conserve this unique mountain. The work in this report, as well as much of its foundation, was based on the research and dedication of volunteers.

San Bruno Mountain has undergone dramatic ecological changes since the HCP was first approved over 30 years ago. The island has become more isolated by increased development, climate is changing, many invasive species populations have been limited and locally eradicated, and a major vegetation shift on the mountain is occurring from grasslands to coastal scrub (Weiss et al. 2015). Very limited resources have been directed toward understanding how these changes affect the RTE plants. This 2015 survey aims to address this issue.

Scope of Work

This report updates the current state of knowledge around rare, threatened and endangered (RTE) plants that occur, or once occurred on San Bruno Mountain. This study aims to comprehensively visit all known rare plant occurrences on the Mountain and document the findings. In addition, a task of this survey was to actively search areas of likely habitat for new occurrences of RTEs. The findings will directly inform the Parks Department's natural resource management program in order to implement improved management and stewardship strategies.

Completed Tasks:

- Survey known and historic rare, threatened, and endangered (RTE) plant species (Table 1) on SBM using all available means, best available science, and local SBM experts
- Capture population demographics (population size, status, health, threats etc.) and habitat information (Manual of California Vegetation's Alliances) for each located species using the accepted CA Department of Fish and Wildlife protocols
- Create spatially accurate maps of all RTE species in one GIS project
- Provide management recommendations for the continued conservation of RTEs on SBM

Table 1: Taxa for which targeted surveys were conducted

Scientific Name	**Common name**	**Rarity Status** (CRPR = California Rare Plant Rank list 1B plants are rare, threatened or endangered in CA and elsewhere, list 3 plants require more information, list 4 plants are of limited distribution)
Amsinckia lunaris	Bent-flowered Fiddleneck	CNPS 1B.2
Arabis blepharophylla	Coast Rock Cress	CRPR 4.3
Arctostaphylos imbricata	San Bruno Mountain Manzanita	CE/CRPR 1B.1
Arctostaphylos montaraensis	Montara Manzanita	CRPR 1B.2
Arctostaphylos pacifica	Pacific Manzanita	CE/CRPR 1B.2
Arctostaphylos uva-ursi forma *coactilis*	Bearberry Manzanita	None
Arctostaphylos uva-ursi forma *leobreweri*	Bearberry Manzanita	CBR (considered for status but rejected)
Arctostaphylos uva-ursi forma *suborbiculata*	Bearberry Manzanita	CBR (considered for status but rejected)
Chorizanthe cuspidata	San Francisco Spine-Flower	CRPR 1B.2
Collinsia multicolor	San Francisco Collinsia	CRPR 1B.2

Erysimum franciscanum var. *franciscanum*	San Francisco Wallflower	CRPR 4.2
Grindelia hirsutula var. *maritima*	San Francisco Gum Plant	CRPR 3.2 (taxonomically difficult)
Helianthella castanea	Diablo helianthella	CRPR 1B.2
Iris longipetala	Coast Iris	CRPR 4.2
Lessingia germanorum	San Francisco Lessingia	FE/CE/CRPR 1B.1
Pentachaeta bellidiflora	White-Rayed Pentachaeta	FE/CE/CRPR 1B.1
Plagiobothrys chorisianus var. *chorisianus*	Choris's Popcorn Flower	CRPR 1B.2
Silene verecunda ssp. *verecunda*	San Francisco Campion	CRPR 1B.2
Tanacetum camphoratum	Dune Tansy	CBR
Triphysaria floribunda	San Francisco Owl's Clover	CRPR 1B.2

See http://www.cnps.org/cnps/rareplants/ranking.php for more information on rare plant ranks.

Our work on San Bruno Mountain relies heavily on place names. We were generously provided the following map (unpublished) from David Nelson which highlights many of the most recognized place names (Figure 1). The locations listed on this map will be referenced throughout this report.

Appendix B:

Mission Blue, Callippe Silverspot, and San Bruno Elfin Butterfly Monitoring Raw Data

OBJECTID	BUTTERFLY	TRANSECT	Round	TIME_	COUNT_	TOTAL	CONDITION	SEX	BEHAVIOUR	NECTAR_PLANT	NOTES
1	Mission Blue	13	1	11:21	1		Fresh	Female	Resting		04/08 Round 1 START
2	Mission Blue	13	1	11:26	1		Fresh	Female	Searching		
3	Mission Blue	13	1	11:27	1		Fresh	Male	Resting		
4	Mission Blue	13	1	11:29	2			Male	Travelling		
5	Mission Blue	13	1	11:38	1		Fresh	Male	Resting		
6	Mission Blue	13	1	11:39	1		Fresh	Male	Travelling		
7	Mission Blue	13	1	11:41	1		Fresh	Unknown	Searching		
8	Mission Blue	13	1	11:42	1	9	Fresh	Female	Resting		
9	Mission Blue	12	1	12:53	1		Unknown	Unknown	Travelling		
10	Mission Blue	12	1	12:55	1				Travelling		
11	Mission Blue	12	1	12:59	1		Fresh	Male	Travelling		
12	Mission Blue	12	1	1:16	1	4	Fresh	Male	Travelling		
13	Mission Blue	11	1		1	1					Incidental
17	Mission Blue	6	1	10:38	1		Unknown	Unknown	Travelling		Fast moving - unverified if MB or other species.
18	Mission Blue	6	1	10:57	1		Fresh	Female	Nectaring	other	
19	Mission Blue	6	1	11:00	1	3	Unknown	Unknown	Travelling		Fast moving - out of sight before 100% verification of species
20	Other	8	1	10:56	1						Small blue butterfly, flying by, could not confirm species.
21	Other	8	1	10:59	3	4					Small blue butterflies, flying by/ over shrubs, could not confirm species, may overlap w nearby pt.
22	Other	2	1	12:09	3						Small blue butterflies, flying by, could not confirm species.
23	Other	2	1	12:25	1	4					Small blue butterfly, flying by, could not confirm species. 04/10 Round 1 END
24	Mission Blue	13	2	11:16	1		Fresh	Unknown	Searching		04/17 - Round 2 START
25	Mission Blue	13	2	11:19	1		Fresh	Female	Resting		Sunning
26	Mission Blue	13	2	11:23	1		Fresh	Female	Ovipositing		On the flyer head of lual
27	Mission Blue	13	2	11:31	1		Worn	Female	Resting		On lual
28	Mission Blue	13	2	11:35	1		Worn	Male	Resting		Sunning
29	Mission Blue	13	2	11:38	1		Worn	Female	Nectaring	other	Invasive clover app
30	Mission Blue	13	2	11:44	2		Unknown	Unknown	Chasing		One was searching then proceeded to chase
31	Mission Blue	13	2	11:47	1		Unknown	Unknown	Travelling		
32	Mission Blue	13	2	11:53	1		Fresh	Unknown	Resting		On lual
33	Mission Blue	13	2	11:55	1		Fresh	Unknown	Chasing		Found other mb
34	Mission Blue	13	2	11:56	1		Unknown	Unknown	Travelling		
35	Mission Blue	13	2	11:57	2		Fresh	Female	Resting		Unknown sex and condition for the other mob
36	Mission Blue	13	2	11:59	1		Unknown	Unknown	Searching		
37	Mission Blue	13	2	12:00	1		Unknown	Unknown	Searching		From lual to lual
38	Mission Blue	13	2	12:01	1		Unknown	Unknown	Resting		On lual then flushed it
39	Mission Blue	13	2	12:03	2		Unknown	Unknown	Searching		Second traveling unknown sex and condition
40	Mission Blue	13	2	12:05	1		Unknown	Unknown	Travelling		
41	Mission Blue	13	2	12:24	1	21	Unknown	Unknown	Travelling		
42	Mission Blue	10	2	14:17	1		Unknown	Unknown	Resting		Flushed
43	Mission Blue	10	2	14:19	1	2	Fresh	Unknown	Resting		On lual
44	Mission Blue	12	2	11:39	1		Fresh	Male	Resting		
45	Mission Blue	12	2	11:41	1		Unknown		Travelling		
46	Mission Blue	12	2	11:46	1			Male	Searching		
47	Mission Blue	12	2	11:47	1		Fresh	Female	Resting		
48	Mission Blue	12	2	11:48	1			Male	Travelling		
49	Mission Blue	12	2	11:48	1			Male	Travelling		
50	Mission Blue	12	2	11:52	1			Female	Travelling		
51	Mission Blue	12	2	11:53	1			Male	Travelling		
52	Mission Blue	12	2	12:06	1	9			Travelling		
53	Mission Blue	11	2	1:20	1	1	Fresh	Male	Resting		On lupine
62	Mission Blue	13	3	10:56	1		Fresh	Unknown	Resting		
63	Mission Blue	13	3	11:07	1						
64	Mission Blue	13	3	11:11	1		Unknown	Female			
65	Mission Blue	13	3	11:17	3		Unknown				
66	Mission Blue	13	3	11:26	1		Unknown	Male	Travelling		
67	Mission Blue	13	3	11:32	1		Fresh	Male	Travelling		
68	Mission Blue	13	3	11:35	1			Female			
69	Mission Blue	13	3	11:38	2		Fresh	Male	Chasing		
70	Mission Blue	13	3	11:40				Male			
71	Mission Blue	13	3	11:41	2		Unknown	Unknown	Travelling		
72	Mission Blue	13	3	11:43	1						
73	Mission Blue	13	3	11:44	1		Fresh				
74	Mission Blue	13	3	12:17	1		Unknown		Searching		
75	Mission Blue	13	3	12:19	1			Male			
76	Mission Blue	13	3	12:24	1	18					
77	Mission Blue	12	3	13:37	1		Fresh	Male	Resting		
78	Mission Blue	12	3	14:17	1						
79	Mission Blue	12	3	14:21	1						
80	Mission Blue	12	3	14:22	2				Chasing		
81	Mission Blue	12	3	14:25	1	6		Male			
82	Mission Blue	10	3	15:50	1						
83	Mission Blue	10	3	15:56	1						
84	Mission Blue	10	3	15:57	1						
85	Mission Blue	10	3	16:05	1	4		Unknown			Being blown by wind. Iâ€™m seeing lots of silvery blues as well
87	Mission Blue	6	3	12:45	2	2	Unknown	Unknown	Travelling		
89	Mission Blue	11	3	11:14	1		Fresh	Male	Resting		On L. formosus..... not in bloom
90	Mission Blue	11	3	11:20	2		Fresh	Male	Chasing		Both males
91	Mission Blue	11	3	11:40	1		Fresh	Male	Searching		
92	Mission Blue	11	3	11:42	1		Worn	Female	Nectaring	other	Phacelia californica
93	Mission Blue	11	3	11:55	2		Fresh	Male	Searching		Both males, searching l. Variicolor
94	Mission Blue	11	3	12:00	1		Unknown	Unknown	Travelling		
95	Mission Blue	11	3	12:15	1		Fresh	Female	Resting		
96	Mission Blue	11	3	12:22	1		Fresh	Male	Searching		l. Formosus
106	Mission Blue	11	3	12:30	1						
107	Mission Blue	11	3	12:31	1	12					
108	Mission Blue	12	4	12:01	1		Worn	Female	Resting		Lual
109	Mission Blue	12	4	12:04	1			Male	Searching		
110	Mission Blue	12	4	12:27	1			Male	Searching		
111	Mission Blue	12	4	12:28	2		Fresh	Male	Resting		
112	Mission Blue	12	4	12:28	1		Unknown	Male	Travelling		
113	Mission Blue	12	4	12:29	2				Resting		1 female 1 unknown
114	Mission Blue	12	4	12:30	1	9	Fresh	Female	Resting		On briza

115	Mission Blue	11	4	13:02	1		Unknown	Unknown	Travelling		
116	Mission Blue	11	4	13:04	2		Fresh	Male	Resting		One resting on LuFo
117	Mission Blue	11	4	13:11	1		Worn	Female	Resting	other	
118	Mission Blue	11	4	13:17	1	5	Fresh		Resting		
119	Mission Blue	7	4	12:02	1		Fresh	Male	Resting		Basking on path - flushed when walking
120	Mission Blue	7	4	12:03	1				Searching		
121	Mission Blue	7	4	12:03	4						Basking 2 male 2 female
122	Mission Blue	7	4	12:07	1			Male			
123	Mission Blue	7	4	12:07	2		Fresh	Male	Resting		
124	Mission Blue	7	4	12:08	2		Fresh	Female	Resting		
125	Mission Blue	7	4	12:10	1		Fresh	Male			
126	Mission Blue	7	4	12:15	1				Travelling		Fast
127	Mission Blue	7	4	12:21	1			Male	Resting		
128	Mission Blue	7	4	12:24	1	15	Fresh	Female	Resting		On Lual
129	Mission Blue	9	4	11:49	1		Fresh	Male	Resting		Flushed when walking
130	Mission Blue	9	4	12:02	1		Fresh	Female	Resting		On plantago
131	Mission Blue	9	4	12:03	1		Fresh	Male	Resting		
132	Mission Blue	9	4	12:06	1		Fresh	Male	Resting		
133	Mission Blue	9	4	12:07	1		Fresh	Female	Resting		
134	Mission Blue	9	4	12:12	1			Male			
135	Mission Blue	9	4	12:13	1		Worn	Female			
136	Mission Blue	9	4	12:14	1	8	Fresh	Female			
137	Mission Blue	13	4	11:40	1						
138	Mission Blue	13	4	11:47	1				Searching		
139	Mission Blue	13	4	11:59	1		Fresh	Male	Nectaring		
140	Mission Blue	13	4	12:04	1		Unknown		Travelling		
141	Mission Blue	13	4	12:05	1			Male			
142	Mission Blue	13	4	12:20	1			Female			See photo. Sheâ€™s beautiful
143	Mission Blue	13	4	1:08	1	7	Fresh	Male			
144	Mission Blue	10	4	2:49	1			Male			
145	Mission Blue	10	4	3:29	1			Female			
146	Mission Blue	10	4	3:32	1	3		Male			
148	Mission Blue	13	5	11:51	1		Worn	Male			Round 5 Start
149	Mission Blue	13	5	11:52	1						
150	Mission Blue	13	5	11:57	2						
151	Mission Blue	13	5	11:58	1	5					
152	Mission Blue	12	5	11:58	2						
153	Mission Blue	12	5	11:58	1	3					
154	Mission Blue	11	5	12:57	1						
155	Mission Blue	11	5	12:59	1						
156	Mission Blue	11	5	1:12	1	3					
157	Mission Blue	7	5	11:37	1						
158	Mission Blue	7	5	11:39	2						
159	Mission Blue	7	5	11:42	2	5					
160	Mission Blue	9	5	1:05	1						
161	Mission Blue	9	5	1:07	1	2					Round 5 End

FID	Shape *	BUTTERFLY	TRANSECT	DATE	TIME_	COUNT_	CONDITION	SEX	BEHAVIOUR	NECTAR_PLA	NOTES
120	Point	Callippe Silverspot	2	29-May	11:36	1	Worn		Searching		Breezy, took a few minutes to chase down and confirm
121	Point	Callippe Silverspot	2	29-May		1					Callippe looking bfly flew past quickly in breeze. Went off transect to find but couldn't
270	Point	Callippe Silverspot	2	9-Jun	9:31	1					
271	Point	Callippe Silverspot	2	9-Jun	9:40	1					
272	Point	Callippe Silverspot	2	9-Jun	9:42	1					
276	Point	Callippe Silverspot	2	9-Jun	10:25	1	Fresh	Female	Resting		
277	Point	Callippe Silverspot	2	9-Jun		2	Unknown	Unknown	Searching		
89	Point	Callippe Silverspot	3	29-May	10:25	1	Unknown	Unknown	Searching		
90	Point	Callippe Silverspot	3	29-May	10:30	3	Unknown	Unknown	Chasing		
91	Point	Callippe Silverspot	3	29-May	10:40	1	Fresh	Unknown	Nectaring	other	Nectarine on Eriogonum
92	Point	Callippe Silverspot	3	29-May	10:40	1	Unknown	Unknown	Searching		
93	Point	Callippe Silverspot	3	29-May	10:45	1	Unknown	Unknown	Resting		
94	Point	Callippe Silverspot	3	29-May	10:47	1	Unknown	Unknown	Searching		
95	Point	Callippe Silverspot	3	29-May	10:50	2	Unknown	Unknown	Chasing		
96	Point	Callippe Silverspot	3	29-May	10:51	1	Unknown	Unknown	Chasing		
97	Point	Callippe Silverspot	3	29-May	10:55	1	Unknown	Unknown	Searching		
98	Point	Callippe Silverspot	3	29-May	10:57	1	Fresh	Unknown	Resting		
99	Point	Callippe Silverspot	3	29-May	11:00	1	Unknown	Unknown	Travelling		
100	Point	Callippe Silverspot	3	29-May	11:05	1	Unknown	Unknown	Travelling		
243	Point	Callippe Silverspot	3	8-Jun	9:44	1	Unknown	Unknown	Travelling		
244	Point	Callippe Silverspot	3	8-Jun	9:47	1	Unknown	Unknown	Resting		
245	Point	Callippe Silverspot	3	8-Jun	9:47	2	Unknown	Unknown	Mating		Mating pair on coyote brush
246	Point	Callippe Silverspot	3	8-Jun	9:49	1	Unknown	Unknown	Resting		
247	Point	Callippe Silverspot	3	8-Jun	9:52	1	Unknown	Unknown	Nectaring	radish	
248	Point	Callippe Silverspot	3	8-Jun	9:53	3	Unknown	Unknown			
108	Point	Callippe Silverspot	4	29-May	13:27	1	Unknown	Unknown	Travelling		
109	Point	Callippe Silverspot	4	29-May	13:34	1	Unknown	Unknown	Searching		
110	Point	Callippe Silverspot	4	29-May	13:36	5	Unknown	Unknown	Searching		
111	Point	Callippe Silverspot	4	29-May	13:37	3	Unknown	Unknown	Searching		
112	Point	Callippe Silverspot	4	29-May	13:38	2	Unknown	Unknown	Searching		
113	Point	Callippe Silverspot	4	29-May	13:40	1	Unknown	Unknown	Nectaring	radish	
114	Point	Callippe Silverspot	4	29-May	13:42	1	Unknown	Unknown	Searching		
115	Point	Callippe Silverspot	4	29-May	13:43	6	Unknown	Unknown	Searching		
116	Point	Callippe Silverspot	4	29-May	13:44	1	Unknown	Unknown	Searching		
253	Point	Callippe Silverspot	4	8-Jun	11:19	1			Nectaring	toyon	
254	Point	Callippe Silverspot	4	8-Jun	11:22	1			Searching		
255	Point	Callippe Silverspot	4	8-Jun	11:23	2			Chasing		
256	Point	Callippe Silverspot	4	8-Jun	11:24	1					
257	Point	Callippe Silverspot	4	8-Jun	11:28	1			Travelling		
258	Point	Callippe Silverspot	4	8-Jun	11:48	1	Worn		Searching		
259	Point	Callippe Silverspot	4	8-Jun	11:51	2			Searching		Wind avg 11 mph - still seeing CS
260	Point	Callippe Silverspot	4	8-Jun	11:52	1	Worn		Resting		
261	Point	Callippe Silverspot	4	8-Jun	11:55	1	Unknown		Travelling		
101	Point	Callippe Silverspot	5	29-May	11:54	2	Unknown	Unknown	Searching		
102	Point	Callippe Silverspot	5	29-May	12:10	1	Unknown	Unknown	Searching		Seen on coffeeberry below transmission tower
103	Point	Callippe Silverspot	5	29-May	12:20	1	Unknown	Unknown	Searching		
104	Point	Callippe Silverspot	5	29-May	12:25	3	Unknown	Unknown	Nectaring	thistle	
105	Point	Callippe Silverspot	5	29-May	12:27	2	Unknown	Unknown	Searching		
106	Point	Callippe Silverspot	5	29-May	12:30	2	Unknown	Unknown	Searching		
107	Point	Callippe Silverspot	5	29-May	12:33	1	Unknown	Unknown	Travelling		
249	Point	Callippe Silverspot	5	8-Jun	10:40	1	Unknown		Searching		
250	Point	Callippe Silverspot	5	8-Jun	11:01	1			Nectaring	toyon	
251	Point	Callippe Silverspot	5	8-Jun	11:02	1			Travelling		
252	Point	Callippe Silverspot	5	8-Jun	11:03	1			Searching		
69	Point	Callippe Silverspot	7	28-May	1132	4	Unknown	Unknown	Searching		
70	Point	Callippe Silverspot	7	28-May	1133	2	Unknown	Unknown	Searching		
71	Point	Callippe Silverspot	7	28-May	1135	6	Unknown	Unknown	Searching		
72	Point	Callippe Silverspot	7	28-May	1136	4	Unknown	Unknown			
73	Point	Callippe Silverspot	7	28-May	1140	3	Unknown	Unknown	Searching		
74	Point	Callippe Silverspot	7	28-May	1142	1	Unknown	Unknown	Searching		
75	Point	Callippe Silverspot	7	28-May	1144	1	Unknown	Unknown	Resting		
76	Point	Callippe Silverspot	7	28-May	1147	1	Unknown	Unknown	Chasing		
77	Point	Callippe Silverspot	7	28-May	1153	2		Unknown			1 resting in worn condition, the other searching in unknown condition
78	Point	Callippe Silverspot	7	28-May	1155	1	Unknown	Unknown	Searching		
79	Point	Callippe Silverspot	7	28-May	1200	1	Fresh	Unknown	Nectaring	radish	
80	Point	Callippe Silverspot	7	28-May	1201	2	Unknown	Unknown	Searching		
81	Point	Callippe Silverspot	7	28-May	1203	2	Unknown	Unknown	Searching		
82	Point	Callippe Silverspot	7	28-May	1204	3	Unknown	Unknown	Searching		
83	Point	Callippe Silverspot	7	28-May	1208	8	Unknown	Unknown	Searching		
84	Point	Callippe Silverspot	7	28-May	1210	1	Unknown	Unknown	Searching		
85	Point	Callippe Silverspot	7	28-May	1213	2	Unknown	Unknown	Chasing		
174	Point	Callippe Silverspot	7	8-Jun	1033	1			Resting		
175	Point	Callippe Silverspot	7	8-Jun	1036	4					
176	Point	Callippe Silverspot	7	8-Jun	1039	2	Fresh		Chasing		
177	Point	Callippe Silverspot	7	8-Jun	1044	4			Chasing		
178	Point	Callippe Silverspot	7	8-Jun	1052	3					
179	Point	Callippe Silverspot	7	8-Jun	1053	2					
180	Point	Callippe Silverspot	7	8-Jun	1055	2					
181	Point	Callippe Silverspot	7	8-Jun	1057	1					
182	Point	Callippe Silverspot	7	8-Jun	1102	5			Chasing		
282	Point	Callippe Silverspot	7	18-Jun	9:56	1	Worn		Chasing		Chasing with anise swallowtail
283	Point	Callippe Silverspot	7	18-Jun	10:04	1	Unknown		Resting		Resting on BAPI
287	Point	Callippe Silverspot	7	18-Jun		2			Chasing		

288	Point	Callippe Silverspot	7	18-Jun	10:12	1						
289	Point	Callippe Silverspot	7	18-Jun	10:13	1			Chasing			
290	Point	Callippe Silverspot	7	18-Jun	10:13	1	Worn		Chasing			
291	Point	Callippe Silverspot	7	18-Jun	10:14	1						
292	Point	Callippe Silverspot	7	18-Jun	10:17	3			Searching			
293	Point	Callippe Silverspot	7	18-Jun	10:18	1	Worn		Searching			
294	Point	Callippe Silverspot	7	18-Jun	10:19	2			Travelling			
295	Point	Callippe Silverspot	7	18-Jun	10:27	1			Searching			
296	Point	Callippe Silverspot	7	18-Jun	1029		Worn	Unknown	Nectaring	other	Scabiosa	
297	Point	Callippe Silverspot	7	18-Jun	1031	1			Chasing			
298	Point	Callippe Silverspot	7	18-Jun	1035	1			Travelling			
299	Point	Callippe Silverspot	7	18-Jun	1035	1			Travelling			
300	Point	Callippe Silverspot	7	18-Jun	1035	1	Unknown	Unknown	Searching			
301	Point	Callippe Silverspot	7	18-Jun	1037	1			Chasing			
302	Point	Callippe Silverspot	7	18-Jun	1038	2			Chasing			
303	Point	Callippe Silverspot	7	18-Jun	1039	1			Resting			
304	Point	Callippe Silverspot	7	18-Jun	1040	2	Unknown	Unknown	Searching			
305	Point	Callippe Silverspot	7	18-Jun	1040	1			Resting		BAPI	
306	Point	Callippe Silverspot	7	18-Jun	10:45	5			Chasing		Group of 5 chasing with anise swallowtails	
347	Point	Callippe Silverspot	7	30-Jun	1032	1	Unknown	Unknown	Travelling			
348	Point	Callippe Silverspot	7	30-Jun	1034	3	Unknown	Unknown	Chasing			
349	Point	Callippe Silverspot	7	30-Jun	1038	1	Worn	Unknown	Resting			
350	Point	Callippe Silverspot	7	30-Jun	1039	1	Unknown	Unknown	Searching			
352	Point	Callippe Silverspot	7	30-Jun	1043	1	Unknown	Unknown	Travelling			
353	Point	Callippe Silverspot	7	30-Jun	1047	2	Unknown	Unknown	Searching			
355	Point	Callippe Silverspot	7	10-Jul	1050	1	Worn	Unknown	Resting			
356	Point	Callippe Silverspot	7	10-Jul	1052	1	Worn	Unknown	Resting			
357	Point	Callippe Silverspot	7	10-Jul	1106	1	Unknown	Unknown	Searching			
359	Point	Callippe Silverspot	7	10-Jul	1040	3	Unknown	Unknown	Chasing			
361	Point	Callippe Silverspot	7	10-Jul	1108	1	Unknown	Unknown	Chasing		Chasing / being chased by anise swallowtail on rocky hilltop	
159	Point	Callippe Silverspot	8	28-May	1:17	5						
160	Point	Callippe Silverspot	8	28-May	1:20	1			Searching			
273	Point	Callippe Silverspot	8	9-Jun	11:08	1			Travelling			
50	Point	Callippe Silverspot	9	28-May	1000	1	Unknown	Unknown	Searching			
51	Point	Callippe Silverspot	9	28-May	1003	1	Unknown	Unknown	Searching			
52	Point	Callippe Silverspot	9	28-May	1004	1	Unknown	Unknown	Searching			
53	Point	Callippe Silverspot	9	28-May	1005	4	Unknown	Unknown	Searching			
54	Point	Callippe Silverspot	9	28-May	1010	2	Unknown	Unknown	Searching			
55	Point	Callippe Silverspot	9	28-May	1012	2	Unknown	Unknown	Resting			
56	Point	Callippe Silverspot	9	28-May	1015	1	Worn	Unknown	Searching			
57	Point	Callippe Silverspot	9	28-May	1016	3	Unknown				1 M and 1 F mating; 1 Unknown	
58	Point	Callippe Silverspot	9	28-May	1018	1	Unknown	Unknown	Nectaring	other	Nectarine on clarkia / farewell to spring	
59	Point	Callippe Silverspot	9	28-May	1020	2	Unknown	Unknown	Searching			
60	Point	Callippe Silverspot	9	28-May	1022	5	Unknown				1 M and 1 F mating; 3 unknown	
61	Point	Callippe Silverspot	9	28-May	1025	6	Unknown	Unknown			Searching and chasing	
62	Point	Callippe Silverspot	9	28-May	1030	4	Unknown	Unknown	Searching			
63	Point	Callippe Silverspot	9	28-May	1033	7	Unknown	Unknown			Searching and chasing	
64	Point	Callippe Silverspot	9	28-May	1037	4	Unknown	Unknown	Searching			
65	Point	Callippe Silverspot	9	28-May	1040	2	Unknown	Unknown	Searching			
66	Point	Callippe Silverspot	9	28-May	1055	2	Unknown	Unknown	Searching			
67	Point	Callippe Silverspot	9	28-May	1058	1	Unknown	Unknown	Searching			
68	Point	Callippe Silverspot	9	28-May	1100	3	Unknown	Unknown	Searching			
143	Point	Callippe Silverspot	9	28-May	10:02		Unknown	Unknown	Searching			
144	Point	Callippe Silverspot	9	28-May	9:59	2	Unknown	Unknown	Searching			
145	Point	Callippe Silverspot	9	28-May	1007	4	Unknown	Unknown	Chasing			
146	Point	Callippe Silverspot	9	28-May	1010	2	Unknown	Unknown	Searching			
147	Point	Callippe Silverspot	9	28-May	1013	3	Unknown	Unknown	Chasing			
148	Point	Callippe Silverspot	9	28-May	1015	1	Unknown	Unknown	Searching			
149	Point	Callippe Silverspot	9	28-May	1019	3	Unknown	Unknown	Chasing		2 chasing 1 searching	
150	Point	Callippe Silverspot	9	28-May	1022	1	Unknown	Unknown	Searching			
151	Point	Callippe Silverspot	9	28-May	1023	1	Unknown	Unknown	Searching			
152	Point	Callippe Silverspot	9	28-May	1029	5	Unknown	Unknown	Searching		searching and chasing	
153	Point	Callippe Silverspot	9	28-May	1031	5	Unknown	Unknown			searching and chasing	
154	Point	Callippe Silverspot	9	28-May	1036	10	Unknown	Unknown	Chasing			
155	Point	Callippe Silverspot	9	28-May	1054	1	Worn	Male	Resting			
156	Point	Callippe Silverspot	9	28-May	1055	1	Unknown	Unknown	Travelling			
157	Point	Callippe Silverspot	9	28-May	1058	2	Unknown	Unknown	Searching			
158	Point	Callippe Silverspot	9	28-May	1103	7	Unknown	Unknown			chasing, mating, searching	
161	Point	Callippe Silverspot	9	8-Jun	925	1						
162	Point	Callippe Silverspot	9	8-Jun	926	2						
163	Point	Callippe Silverspot	9	8-Jun	929	2						
164	Point	Callippe Silverspot	9	8-Jun	931	1						
165	Point	Callippe Silverspot	9	8-Jun	935	2						
166	Point	Callippe Silverspot	9	8-Jun	939	1						
167	Point	Callippe Silverspot	9	8-Jun	940	1						
168	Point	Callippe Silverspot	9	8-Jun	941	1						
169	Point	Callippe Silverspot	9	8-Jun	954	1						
170	Point	Callippe Silverspot	9	8-Jun	957	1						
171	Point	Callippe Silverspot	9	8-Jun	959	1						
172	Point	Callippe Silverspot	9	8-Jun	1005	3	Fresh		Mating		1 m and 1 f mating. 1 other m attempted to steal f	
173	Point	Callippe Silverspot	9	8-Jun	1004	1						
278	Point	Callippe Silverspot	9	18-Jun	937	1	Unknown	Female	Searching			
279	Point	Callippe Silverspot	9	18-Jun	940	1	Unknown	Unknown	Searching			
280	Point	Callippe Silverspot	9	18-Jun	945	1	Unknown	Unknown	Travelling			

281	Point	Callippe Silverspot	9	18-Jun	949	2	Unknown	Unknown	Nectaring	toyon	
284	Point	Callippe Silverspot	9	18-Jun	1005	1	Unknown	Unknown	Searching		
285	Point	Callippe Silverspot	9	18-Jun	1007	4	Unknown	Unknown			2 mating (1M + 1F), 1 resting, 1 searching
286	Point	Callippe Silverspot	9	18-Jun	1011	2	Unknown	Unknown	Chasing		
339	Point	Callippe Silverspot	9	30-Jun	1010	1	Worn	Unknown	Searching		
122	Point	Callippe Silverspot	10	28-May	1225	5					
123	Point	Callippe Silverspot	10	28-May	1142	1	Fresh	Unknown	Nectaring	radish	
124	Point	Callippe Silverspot	10	28-May	1139	10	Unknown	Unknown			chasing, searching
125	Point	Callippe Silverspot	10	28-May	1200	2			Mating		
126	Point	Callippe Silverspot	10	28-May	1202	3					
127	Point	Callippe Silverspot	10	28-May	1205	2					
128	Point	Callippe Silverspot	10	28-May	1206	4					
129	Point	Callippe Silverspot	10	28-May	1208	11					
130	Point	Callippe Silverspot	10	28-May	1209	3					
131	Point	Callippe Silverspot	10	28-May	1209	4					
132	Point	Callippe Silverspot	10	28-May	1210	3					
133	Point	Callippe Silverspot	10	28-May	1212	2			Nectaring	ithuriel' spear	
134	Point	Callippe Silverspot	10	28-May	1214	2					
135	Point	Callippe Silverspot	10	28-May	1215	4					
136	Point	Callippe Silverspot	10	28-May	1220	5					
137	Point	Callippe Silverspot	10	28-May	1221	4					
138	Point	Callippe Silverspot	10	28-May	1229	1			Resting		
139	Point	Callippe Silverspot	10	28-May	1233	4					
140	Point	Callippe Silverspot	10	28-May	1237	6					
141	Point	Callippe Silverspot	10	28-May	1239	1			Searching		
142	Point	Callippe Silverspot	10	28-May	1241	3					
183	Point	Callippe Silverspot	10	8-Jun	920	1	Unknown	Unknown	Searching		
184	Point	Callippe Silverspot	10	8-Jun	924	1	Unknown	Unknown	Resting		
185	Point	Callippe Silverspot	10	8-Jun	928	1	Unknown	Unknown	Searching		
186	Point	Callippe Silverspot	10	8-Jun	935	2	Unknown	Unknown	Nectaring	other	Scabiosa
187	Point	Callippe Silverspot	10	8-Jun	938	2	Unknown	Unknown	Chasing		
188	Point	Callippe Silverspot	10	8-Jun	940	2	Unknown	Unknown			1 searching, 1 nectaring on scabiosa
189	Point	Callippe Silverspot	10	8-Jun	944	3		Unknown			1 traveling, 1 searching, 1 worn resting
190	Point	Callippe Silverspot	10	8-Jun	946	2	Unknown	Unknown	Chasing		
191	Point	Callippe Silverspot	10	8-Jun	948	2	Unknown	Unknown	Searching		
192	Point	Callippe Silverspot	10	8-Jun		2	Unknown	Unknown	Searching		
193	Point	Callippe Silverspot	10	8-Jun	950	1	Unknown	Unknown	Searching		
194	Point	Callippe Silverspot	10	8-Jun	951	4	Unknown	Unknown			3 chasing, 1 searching
195	Point	Callippe Silverspot	10	8-Jun	953	2	Unknown	Unknown	Chasing		
196	Point	Callippe Silverspot	10	8-Jun	955	4	Unknown	Unknown			3 searching, 1 nectaring on scabiosa
197	Point	Callippe Silverspot	10	8-Jun	958	1	Unknown	Unknown	Resting		
198	Point	Callippe Silverspot	10	8-Jun	1000	1	Unknown	Unknown	Nectaring	other	Scabiosa
199	Point	Callippe Silverspot	10	8-Jun	1009	3	Unknown	Unknown	Nectaring	other	Scabiosa
307	Point	Callippe Silverspot	10	18-Jun	1045	1	Unknown	Unknown	Travelling		
308	Point	Callippe Silverspot	10	18-Jun	1047	1	Worn	Unknown	Nectaring	other	Scabiosa
309	Point	Callippe Silverspot	10	18-Jun	1048	2	Worn		Mating		
310	Point	Callippe Silverspot	10	18-Jun	1055	1	Unknown	Unknown	Searching		
311	Point	Callippe Silverspot	10	18-Jun	1056	1	Unknown	Unknown	Searching		
312	Point	Callippe Silverspot	10	18-Jun	1100	3	Unknown	Unknown			1 nectaring toyon, 1 nectaring scabiosa, 1 resting
313	Point	Callippe Silverspot	10	18-Jun	1105	1	Unknown	Unknown	Searching		
314	Point	Callippe Silverspot	10	18-Jun	1107	1	Unknown	Unknown	Resting		
315	Point	Callippe Silverspot	10	18-Jun	1118	1	Unknown	Unknown	Searching		
316	Point	Callippe Silverspot	10	18-Jun	1120	1	Unknown	Unknown	Searching		
317	Point	Callippe Silverspot	10	18-Jun	1122	1	Unknown	Unknown	Searching		
318	Point	Callippe Silverspot	10	18-Jun	1124	1	Unknown	Unknown	Searching		
319	Point	Callippe Silverspot	10	18-Jun	1126	1	Unknown	Unknown	Travelling		
335	Point	Callippe Silverspot	10	30-Jun	9:34	1	Unknown	Unknown	Travelling		
336	Point	Callippe Silverspot	10	30-Jun	9:36	1	Worn		Travelling		
337	Point	Callippe Silverspot	10	30-Jun	9:43	1	Worn		Nectaring	other	Scabiosa
338	Point	Callippe Silverspot	10	30-Jun	9:57	1			Travelling		
358	Point	Callippe Silverspot	10	10-Jul	9:55	1	Worn		Searching		
0	Point	Callippe Silverspot	11	28-May	1133	1	Fresh	Unknown	Nectaring		
1	Point	Callippe Silverspot	11	28-May	1134	1	Fresh	Unknown	Nectaring		
2	Point	Callippe Silverspot	11	28-May	1135	1	Fresh	Female	Travelling		
3	Point	Callippe Silverspot	11	28-May	1137	1	Fresh				
4	Point	Callippe Silverspot	11	28-May	1138	1	Fresh		Searching		
5	Point	Callippe Silverspot	11	28-May	1139	2	Fresh	Female	Chasing		
6	Point	Callippe Silverspot	11	28-May	1140	1			Nectaring		
7	Point	Callippe Silverspot	11	28-May	1141	1	Worn		Searching		
8	Point	Callippe Silverspot	11	28-May	1142	1			Travelling		
9	Point	Callippe Silverspot	11	28-May	1143	1	Fresh		Travelling		
10	Point	Callippe Silverspot	11	28-May	1147	2	Fresh		Chasing		1m 1 f
11	Point	Callippe Silverspot	11	28-May	1150	2			Chasing		
12	Point	Callippe Silverspot	11	28-May	1150	1			Chasing		
13	Point	Callippe Silverspot	11	28-May	1151	2			Travelling		
14	Point	Callippe Silverspot	11	28-May	1153	2	Unknown		Chasing		
15	Point	Callippe Silverspot	11	28-May	1155	1	Fresh	Female	Searching		
16	Point	Callippe Silverspot	11	28-May	1156	1	Unknown	Unknown	Searching		
17	Point	Callippe Silverspot	11	28-May	1156	3			Searching		
18	Point	Callippe Silverspot	11	28-May	1157	2	Fresh				1m 1 f
19	Point	Callippe Silverspot	11	28-May	1158	3					
20	Point	Callippe Silverspot	11	28-May	1159	4			Chasing		
21	Point	Callippe Silverspot	11	28-May	1202	3	Unknown		Chasing		
22	Point	Callippe Silverspot	11	28-May	1202	1	Fresh		Travelling		

23	Point	Callippe Silverspot	11	28-May	1202	1	Unknown		Chasing			
24	Point	Callippe Silverspot	11	28-May	1202	1			Searching			
25	Point	Callippe Silverspot	11	28-May	1203	1			Searching			
26	Point	Callippe Silverspot	11	28-May	1204	1			Nectaring	other		
27	Point	Callippe Silverspot	11	28-May	1205	1	Fresh		Resting			
28	Point	Callippe Silverspot	11	28-May	1201	1	Worn		Searching			
29	Point	Callippe Silverspot	11	28-May	1206	1	Fresh		Nectaring			
30	Point	Callippe Silverspot	11	28-May	1207	1	Worn		Searching			
31	Point	Callippe Silverspot	11	28-May	1208	1	Worn	Female	Searching			
32	Point	Callippe Silverspot	11	28-May	1208	1	Worn		Travelling			
33	Point	Callippe Silverspot	11	28-May	1209	1	Worn		Searching			
34	Point	Callippe Silverspot	11	28-May	1209	1	Unknown		Searching			
35	Point	Callippe Silverspot	11	28-May	1209	4						2m 2f
36	Point	Callippe Silverspot	11	28-May	1211	5			Searching			
37	Point	Callippe Silverspot	11	28-May	1212	2	Unknown		Searching			
38	Point	Callippe Silverspot	11	28-May	1213	1	Unknown		Searching			
39	Point	Callippe Silverspot	11	28-May	1213	1			Searching			
40	Point	Callippe Silverspot	11	28-May	1215	2	Fresh		Nectaring	thistle		
200	Point	Callippe Silverspot	11	8-Jun	1035	3	Unknown	Unknown	Searching			
201	Point	Callippe Silverspot	11	8-Jun	1038	2	Fresh	Unknown	Chasing			Chasing and being chased by anise swallowtail
202	Point	Callippe Silverspot	11	8-Jun	1040	1	Fresh	Female	Resting			
203	Point	Callippe Silverspot	11	8-Jun	1040	1	Unknown	Unknown	Searching			
204	Point	Callippe Silverspot	11	8-Jun	1044	2	Unknown	Unknown	Chasing			
205	Point	Callippe Silverspot	11	8-Jun	1046	2	Unknown	Unknown	Searching			
206	Point	Callippe Silverspot	11	8-Jun	1048	3	Unknown	Unknown	Chasing			
207	Point	Callippe Silverspot	11	8-Jun	1049	1	Unknown	Unknown	Nectaring	other		Scabiosa
208	Point	Callippe Silverspot	11	8-Jun	1052	2	Unknown	Unknown	Nectaring			Scabiosa
209	Point	Callippe Silverspot	11	8-Jun	1053	2	Unknown	Unknown				1 searching, 1 nectaring on scabiosa
210	Point	Callippe Silverspot	11	8-Jun	1054	1	Unknown	Unknown	Searching			
211	Point	Callippe Silverspot	11	8-Jun	1058	2	Unknown	Unknown	Chasing			
212	Point	Callippe Silverspot	11	8-Jun	1102	3	Unknown	Unknown	Chasing			
213	Point	Callippe Silverspot	11	8-Jun	1104	2	Unknown	Unknown	Chasing			
214	Point	Callippe Silverspot	11	8-Jun	1105	4	Unknown	Unknown	Chasing			
215	Point	Callippe Silverspot	11	8-Jun	1107	3	Unknown	Unknown	Chasing			
216	Point	Callippe Silverspot	11	8-Jun	1109	2	Unknown	Unknown	Searching			
217	Point	Callippe Silverspot	11	8-Jun	1111	2	Unknown	Unknown	Searching			
218	Point	Callippe Silverspot	11	8-Jun	1113	2	Unknown	Unknown	Searching			
219	Point	Callippe Silverspot	11	8-Jun	1115	1	Unknown	Unknown	Searching			
220	Point	Callippe Silverspot	11	8-Jun	1118	3	Unknown	Unknown	Searching			
221	Point	Callippe Silverspot	11	8-Jun	1120	2	Unknown	Unknown	Searching			
222	Point	Callippe Silverspot	11	8-Jun	1123	2	Unknown	Unknown	Chasing			
223	Point	Callippe Silverspot	11	8-Jun	1124	2	Unknown	Unknown	Searching			
224	Point	Callippe Silverspot	11	8-Jun	1128	1	Unknown	Unknown	Searching			
225	Point	Callippe Silverspot	11	8-Jun	1130	1	Worn	Unknown	Nectaring	toyon		
226	Point	Callippe Silverspot	11	8-Jun	1136	2	Unknown	Unknown	Searching			
227	Point	Callippe Silverspot	11	8-Jun	1138	1	Unknown	Unknown	Searching			
228	Point	Callippe Silverspot	11	8-Jun	1140	1	Unknown	Unknown	Searching			
229	Point	Callippe Silverspot	11	8-Jun	1142	1	Unknown	Unknown	Searching			
321	Point	Callippe Silverspot	11	18-Jun	1046	1			Searching			
322	Point	Callippe Silverspot	11	18-Jun	1049	2			Chasing			
323	Point	Callippe Silverspot	11	18-Jun	1058	2						
324	Point	Callippe Silverspot	11	18-Jun	1105	6			Mating			
325	Point	Callippe Silverspot	11	18-Jun	1106	4						
326	Point	Callippe Silverspot	11	18-Jun	1107	2			Chasing			
327	Point	Callippe Silverspot	11	18-Jun	1108	2			Nectaring			scabiosa
328	Point	Callippe Silverspot	11	18-Jun	1109	1			Nectaring			scabiosa
329	Point	Callippe Silverspot	11	18-Jun	1110	1			Searching			
330	Point	Callippe Silverspot	11	18-Jun	1111	1			Nectaring			scabiosa
331	Point	Callippe Silverspot	11	18-Jun	1112	5						
332	Point	Callippe Silverspot	11	18-Jun	1114	3						
333	Point	Callippe Silverspot	11	18-Jun	1116	1			Chasing			
334	Point	Callippe Silverspot	11	18-Jun	1117	1			Resting			
340	Point	Callippe Silverspot	11	30-Jun	10:16	1	Unknown		Travelling			
341	Point	Callippe Silverspot	11	30-Jun	10:21	1	Unknown	Unknown	Searching			
342	Point	Callippe Silverspot	11	30-Jun	10:22	1			Chasing			Chasing anise
343	Point	Callippe Silverspot	11	30-Jun	10:26	1	Worn		Resting			
344	Point	Callippe Silverspot	11	30-Jun	10:28	2	Worn		Travelling			
345	Point	Callippe Silverspot	11	30-Jun	10:29	2						
346	Point	Callippe Silverspot	11	30-Jun	10:29	1	Worn		Resting			
351	Point	Callippe Silverspot	11	30-Jun	10:42	1	Worn		Travelling			
354	Point	Callippe Silverspot	11	30-Jun	10:49	1	Worn		Nectaring	other		Scabiosa
360	Point	Callippe Silverspot	11	10-Jul	11:07	1	Worn		Nectaring			Scabiosa
41	Point	Callippe Silverspot	12	28-May	1225	1	Fresh	Female	Searching			
42	Point	Callippe Silverspot	12	28-May	1225	1			Searching			
43	Point	Callippe Silverspot	12	28-May	1226	1			Searching			
44	Point	Callippe Silverspot	12	28-May	1227	3	Unknown		Searching			
45	Point	Callippe Silverspot	12	28-May	1228	1	Worn		Searching			
46	Point	Callippe Silverspot	12	28-May	1229	1	Worn					
47	Point	Callippe Silverspot	12	28-May	1230	1			Travelling			
48	Point	Callippe Silverspot	12	28-May	1237	1	Worn		Travelling			
49	Point	Callippe Silverspot	12	28-May	1238	1	Fresh		Searching			
230	Point	Callippe Silverspot	12	8-Jun	1206	2	Unknown	Unknown	Searching			
231	Point	Callippe Silverspot	12	8-Jun	1209	1	Unknown	Unknown	Searching			
232	Point	Callippe Silverspot	12	8-Jun	1211	1	Unknown	Unknown	Searching			

233	Point	Callippe Silverspot	12	8-Jun	1214	1	Unknown	Unknown	Travelling			
234	Point	Callippe Silverspot	12	8-Jun	1218	1	Unknown	Unknown	Travelling			
235	Point	Callippe Silverspot	12	8-Jun	1219	1	Unknown	Unknown	Nectaring	toyon		
236	Point	Callippe Silverspot	12	8-Jun	1222	1	Unknown	Unknown	Travelling			
237	Point	Callippe Silverspot	12	8-Jun	1224	1	Unknown	Unknown	Travelling			
238	Point	Callippe Silverspot	12	8-Jun	1225	1	Fresh	Female	Nectaring	toyon		
239	Point	Callippe Silverspot	12	8-Jun	1226	1	Unknown	Unknown	Searching			
240	Point	Callippe Silverspot	12	8-Jun	1228	1	Unknown	Unknown	Searching			
241	Point	Callippe Silverspot	12	8-Jun	1229	1	Unknown	Unknown	Searching			
242	Point	Callippe Silverspot	12	8-Jun	1231	1	Unknown	Unknown	Searching			
320	Point	Callippe Silverspot	12	18-Jun	1009	1			Searching			
117	Point	Callippe Silverspot	13	29-May	10:07	1	Unknown	Unknown	Travelling			
118	Point	Callippe Silverspot	13	29-May	10:11	2			Chasing		1m 1f	
119	Point	Callippe Silverspot	13	29-May	10:13	1						
262	Point	Callippe Silverspot	13	9-Jun	9:22	3			Travelling			
263	Point	Callippe Silverspot	13	9-Jun	9:23	3			Chasing		Pearly everlasting nectar	
264	Point	Callippe Silverspot	13	9-Jun	9:24	2			Nectaring		Gumplant nectarine	
265	Point	Callippe Silverspot	13	9-Jun	9:28	1	Fresh		Searching			
274	Point	Callippe Silverspot	13	17-Jun	9:26	1	Fresh	Unknown	Searching			
275	Point	Callippe Silverspot	13	17-Jun	9:30	3	Unknown	Unknown			2 mating (1M + 1F), 1 searching	
86	Point	Callippe Silverspot	14	29-May	11:03	1						
87	Point	Callippe Silverspot	14	29-May	11:05	1			Chasing			
88	Point	Callippe Silverspot	14	29-May	11:07	1			Chasing			
266	Point	Callippe Silverspot	14	9-Jun	10:32	1			Nectaring	other	Hummingbird sage	
267	Point	Callippe Silverspot	14	9-Jun	10:31	1			Travelling			
268	Point	Callippe Silverspot	14	9-Jun	10:33	1	Unknown		Searching			
269	Point	Callippe Silverspot	14	9-Jun	10:28	1			Nectaring	other	Gumplant	

		Observer											
		Evan											
		Quadrant											
Plot	Date	NE			NW			SE			SW		
		Size Class			Size Class			Size Class			Size Class		
		Small	Medium	Large	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large
6	13-May												
	21-May												
	1-Jun												
7	12-May												
	20-May												
	1-Jun							0	0	0	0	0	0
8	12-May												
	20-May												
	1-Jun	0	0	3									
13	13-May							13	6	0			
	20-May							2	3	3			
	1-Jun												
15	12-May				11	9	0						
	20-May				2	0	5						
	2-Jun												
16	12-May										5	6	1
	20-May				9	9	5						
	2-Jun												
17	12-May	0	0	0									
	20-May				0	0	1				0	0	0
	2-Jun												
19	13-May										0	0	0
	21-May												
	2-Jun												

Observer													
Hannah													
Quadrant													
NE			NW			SE			SW			NE	
Size Class			Size Class			Size Class			Size Class			Size Class	
Small	Medium	Large	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large	Small	Medium
			0	8	3								
0	0	0										0	0
1	6	1	4	17	4	3	9	2	4	16	12	11	8
0	0	3	1	14	22							4	4
5	22	9	1	3	3	9	41	31	2	15	9	11	7
						5	6	1	11	24	4		
						0	3	0	3	13	11		
												0	0
0	9	6	0	5	6				0	0	0		
0	0	0	0	0	1				0	0	0		
			0	3	5								
			0	1	2								
						0	1	1					
												0	0
			0	0	1								

Observer													
Johanna													
Quadrant													
	NW			SE			SW			NE			
	Size Class			Size Class			Size Class			Size Class			
Large	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large	Small
							8	8	6				
0	0	0	0	0	0	0	0	0	0				
6	10	7	0	10	7	0	9	7	2				
3	0			7	16	6	4	10	2	2	8	5	0
4	2	1	0	14	17	5	8	6	2				
	3	3	4	16	14	24	30	25	31				
0	0	0	0	0	0	0	0	0	0				
										0	0	0	
0	0	0	0	0	0	0	0	0	0				

Observer													
Olivia													
Quadrant													
NW		SE			SW			NE			NW		
Size Class		Size Class			Size Class			Size Class			Size Class		
Medium	Large	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large
								15	10	5	21	12	9
					2	5	2						
1	0								2	8			
								0	0	5			
					1	1	1						
									6	33			
								0	0	1			
		4	3	1	1	1							
		3	2	1									
								1	0	0	11	9	0
		1	1	1	0	1	0						
								2	4	3	1	3	1
								0	0	0	0	0	2
								0	0	0	1	4	7
		1	2	4									
		3	1	0									

erver						
an						
drant						
SE			SW			
Size Class			Size Class			
Small	Medium	Large	Small	Medium	Large	**TOTAL**
2	0	0	7	19	27	127
						42
						0
						156
						122
						5
						230
	1	4				194
						4
						80
						44
						0
3	4	0	0	0	0	48
						37
						1
5	6	1	0	0	0	38
						31
						2
0	0	0	0	0	0	12
						4
0	0	0	0	0	0	0
						9
						4
						1
						1191

Appendix C:

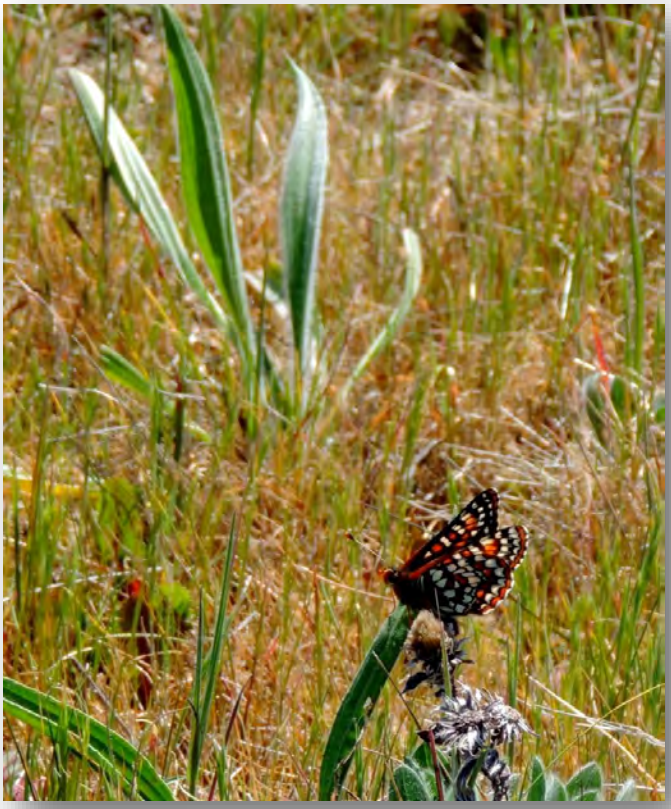
Bay Checkerspot 2019-20 Reintroduction Semi-Annual Report

Central Valley Project Conservation Program

and Central Valley Project Improvement Act Habitat Restoration Program

R17AP00018

Reintroduction of the Bay Checkerspot Butterfly to San Bruno Mountain



Semi-Annual Report for April 1, 2020-September 30, 2020
October 2020

Stuart B. Weiss Ph.D., Kirra Swenerton
Christal Niederer
Creekside Center for Earth Observation
PO Box 1553
Los Gatos, CA 95031

CREEKSIDE SCIENCE
www.creeksidescience.com

Contents

Executive Summary

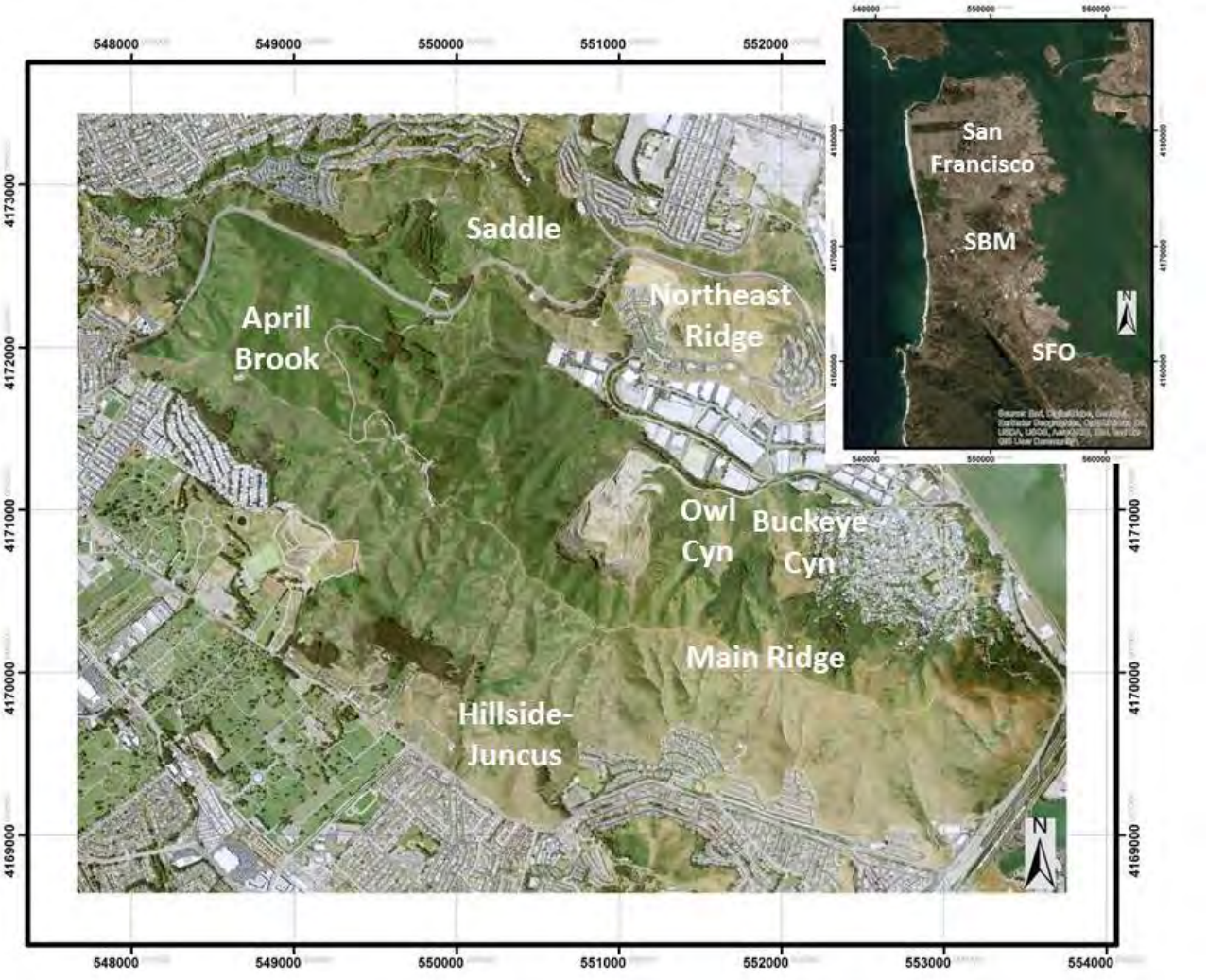
This project aims to re-establish the Bay checkerspot butterfly (*Euphydryas editha bayensis*) (BCB) on San Bruno Mountain (SBM). A major goal is for the butterfly to switch its larval hostplant from the native annual *Plantago erecta* to the non-native perennial *Plantago lanceolata*. Annual translocations of postdiapause larvae from Coyote Ridge in south San Jose (Santa Clara County) began in 2017, funded by the Disney Butterfly Conservation Initiative. Each year since then, adult butterflies and postdiapause larvae were detected in all of the release areas. By 2019 after three years of translocations with a total of 13,360 larvae, the presence of adult butterflies and native born postdiapause larvae indicated that the population was establishing. Eggs and prediapause larvae were found on *P. lanceolata,* demonstrating oviposition and larval survival on the new hostplant. In addition, postdiapause larvae were found in stands of *P. erecta* on the northern slopes of Upper Buckeye and Owl Canyons. In 2019, it was estimated that ~4,000 postdiapause larvae occupied the 2017 and 2018 release areas. In 2020, no new larvae were translocated along the Main Ridge; eight postdiapause larvae and 45 adults were observed along the entire ~2.5 km length of transects in the release areas.

In February 2020, 5,000 larvae were translocated from Coyote Ridge to dense stands of *Plantago lanceolata* on the lower slopes of Owl and Buckeye Canyons. Adult butterflies were observed in these release areas in March and April 2020. The phenology of the native hostplants *P. erecta* and *Castilleja densiflora* and *C. exserta* provided opportunities for prediapause survival where those species were still present in Upper Buckeye and Owl Canyons. The long-lasting availability of green *P. lanceolata* provided potential food well into summer in all of the release areas.

2021 is the final year of CVPCP funding for translocations. The Northeast Ridge (NER) has numerous dense stands of *P. lanceolata* and a series of local hilltops for adult aggregation and is the first choice for releases. The NER, however, has not yet been dedicated to San Mateo County Parks so it may not be possible to release larvae there in 2021unless special arrangements are made before transfer of ownership (which is pending). As a backup, areas in Hillside-Juncus and the Saddle are being considered, depending on results of fall 2020 surveys of the distribution and abundance of *P. lanceolata* in those areas.

Introduction

San Bruno Mountain (Map 1) is home to three species of butterflies listed as endangered by the U.S. Fish and Wildlife Service (USFWS): the Mission blue butterfly (*Icaricia icarioides missionensis*), the San Bruno elfin butterfly (*Callophrys mossii bayensis*), and the callippe silverspot butterfly (*Speyeria callippe callippe*). Their habitat is protected in perpetuity as a part of the SBM Habitat Conservation Plan (HCP). Portions of SBM were identified as critical habitat for the BCB in the HCP based on known occurrences of this butterfly. Unfortunately, in the mid-1980s, the BCB was extirpated from SBM (TRA Environmental Sciences 1986, 2008). USFWS commissioned a feasibility study for a BCB reintroduction at SBM (Niederer et al. 2015). Habitat surveys in spring 2014-2015 mapped many small patches of the BCB native annual host plant *Plantago erecta*, not enough to support a viable BCB population. Also observed were near ubiquitous stands of the nonnative perennial *Plantago lanceolata*, which could likely provide enough habitat to sustain a population of BCB. The last postdiapause larvae (1983) were feeding on *P. lanceolata* (Weiss pers. obs.), therefore some host-switching was already occurring before the extirpation of the BCB from SBM. *P. lanceolata* was believed to be less common on the mountain at that time. *Euphydryas editha* ssp. *taylori* populations in Oregon and Washington (Severns and Grosboll 2011) and an *E. editha* population in the Sierra Nevada (Schneider's Meadow) have adopted *P. lanceolata* as a hostplant (Ehrlich and Hanski 2004). *P. lanceolata* was successfully used in several laboratory experiments with BCB at the Stanford Department of Biological Sciences in 1985 (Weiss pers. observation.). *P. lanceolata* is a robust biennial/perennial species that remains green many weeks and even months longer than the native *P. erecta*. Given that BCB adult females will oviposit on *P. lanceolata*, and that prediapause and postdiapause larvae survive on it (experimentally confirmed), potential BCB habitat occurs across much of the grassland on SBM. Nectar is plentiful during the flight season. The mountain is large and topographically/climatically diverse, similar to Coyote Ridge where a healthy, thriving population of BCB persists. *Euphydryas editha* is an adaptable species. Reintroducing the BCB to SBM with the expectation they will switch to a nonnative hostplant is a conservation experiment that raises many interesting ecological and policy issues in a rapidly changing environment. This project could show we are able to reintroduce extirpated species without the technical difficulties and expense of restoring all historical conditions.



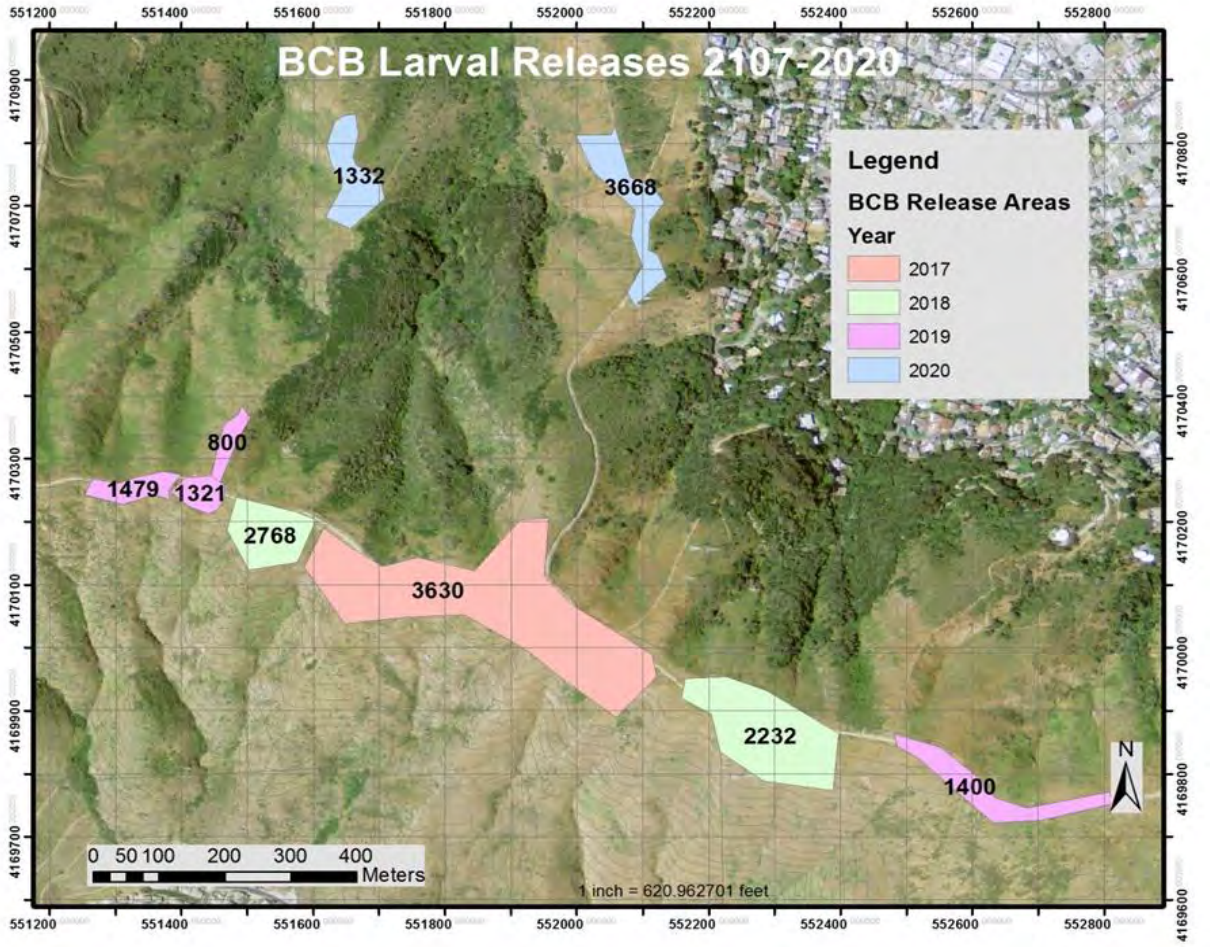
Map 1. Locator map for San Bruno Mountain (SBM) and place names within SBM

Summary of Previous Reintroduction Work

The first year of translocation took place in 2017 under a related project funded by the Disney Butterfly Conservation Initiative. In March 2017, 3,630 postdiapause larvae were collected from Coyote Ridge and released at SBM along the Main Ridge in (Map 2). A total of 47 adults were observed along the transect system in March and April. Three postdiapause larvae descended from these 2017 adults were observed on February 8, 2018, before 2018 translocations.

Funding from CVPCP started in fall 2017. In winter 2018, 5,000 larvae were translocated from Coyote Ridge into areas west and east of the 2017 release area (Map 2). A total of 109 adult butterflies were observed along the entire length of the release areas. A notably dense concentration of adults was observed at a small hilltop “hotspot” at the west end of the 2018

release area. Prediapause larvae in webs were observed on *P. lanceolata* at this location, indicating free oviposition on *P. lanceolata*.



Map 2. Larval release areas 2017-2020, with number released in each Release years differentiated by colors. Grid interval = 100 meters

Prior to translocation in 2019, a total of 24 larvae were observed in the 2017 release areas, and an additional 67 larvae observed in the 2018 release areas, including a dense concentration on the small hilltop hotspot noted above. The larval population was estimated at ~4,000. In February 2019, 5,000 larvae were translocated from Coyote Ridge into areas further east and west of the previous release areas. A total of 185 adults were observed along the transect system in March and April 2019.

In February 2020, only eight postdiapause larvae were found along the Main Ridge. That month 5,000 larvae were translocated from Coyote Ridge into Owl and Buckeye Canyons. A total of 45

adults were observed along the main ridge and 53 in Owl-Buckeye Canyons in March and April 2020 (Table 1).

Year	Postdiapause Larvae Observed Main Ridge (MR)	Larvae released	Adults observed Main Ridge (MR)	Adults Observed Owl-Buckeye (OB)
2017	n/a	3,630 (MR)	47	n/a
2018	3	5,000 (MR)	109	n/a
2019	91	5,000 (MR)	185	n/a
2020	8	5,000 (OB)	45	53

Table 1. Release numbers and BCB observations 2017-2020. Postdiapause larvae observed are those just in the sampling plots in previous year release areas. Adults observed are those along the entire transect system. No incidental observations are included.

Project Objectives

1. Re-establish an initial population of at least 600 postdiapause BCB larvae or 300 adults on SBM in two of the four monitoring years.
2. Document BCB oviposition on the plant *Plantago lanceolata.*
3. Document BCB larval use of *Plantago lanceolata.*

2020 Progress

For the first objective, we report postdiapause larvae encountered in sampling plots, and adult numbers encountered on transects for 2018, 2019, and 2020. The details are in the various sections below.

In assessing whether objectives are met, it is important to keep in mind that the numbers of larvae and adults directly observed are a small fraction of those actually present. Also, newly released larvae should not count toward the objectives, obviously. Separating out resident reproduction from newly introduced larvae/adults requires some assumptions and calculations that are detailed in subsequent sections. We do make considerable progress on developing a relationship between larval release numbers and subsequent adult observations on transects,

since we now have 7 spatially discrete release areas over 4 years. But the actual conversion factors for adults observed on transects to those present are not yet firmly established.

In 2018, we counted 3 larvae in the 2017 release area, all of which were in one plot at the top of Buckeye Canyon. This translates into an estimated 157 larvae in the entire release area. A total of 109 adults were observed on transects, 34 within the 2017 release area. These included observations were well away from the one site where the larvae were found. In 2018, we established a breeding population from the release in 2017. No objectives for 2018 were stated for the Disney Butterfly Conservation Initiative grant.

In 2019 we counted 91 larvae in 17 search plots, which estimated ~4000 larvae total across the 2017 and 2018 release areas. A total of 185 adults were observed on transects. Given the large number of larvae estimated, and a typical mortality rate of 50% between larval and adult stages, we can be confident that more than 600 adults were present. Both objectives were met.

In 2020, we counted eight postdiapause larvae across the 2017-2019 release areas, indicating that a population has established. The eight larvae translate ~330 larvae across 11 ha of habitat. This estimate is less than the objective of 600 larvae.

A total of 45 adults were observed over the course of the 2020 flight season along the Main Ridge, which is similar to the 47 adults observed in 2017 after 3,630 larvae were released. Given that no larvae were released on the Main Ridge, this number represents native-born butterflies and is far in excess of the number that could be produced by 330 larvae. It appears that our larval estimation technique developed in sparse serpentine grassland may not be well suited to denser grassland and clumped perennial *P. lanceolata*, and vastly underestimates larval densities. This is discussed in more detail below, and when the numbers are extrapolated according to a realtionship between larval release numbers and adults observed, the objectives of 600 larvae and 300 adults have been met along the Main Ridge in 2019 and 2020.

Also in 2020, 5,000 larvae were released into empty habitat in Owl-Buckeye. 53 adults were observed aong transects in this area.

The second two objectives, documentation of BCB oviposition and documentation of BCB larval use of *Plantago lanceolata* were met in 2018 and 2019 (Table 2).

	2018	2019	2020	2021
Objective 1. 600 postdiapause BCB larvae or 300 adults in two of four years	40 larvae, 110 adults observed. Objective not met	~4000 larvae, 185 adults observed. Objective met	~350 larvae, 98 adults observed, including ~45 in non-release area, implying low thousands of larvae. See Larval Release Numbers and Local Adult Observations Objective met	n/a
Objective 2. Document BCB oviposition on the plant *Plantago lanceolata*	Completed	Completed	n/a	n/a
Objective 3. Document BCB larval use of *Plantago lanceolata.*	Completed	Completed	n/a	n/a

Table 2. Progress of project objectives

To date, all project milestones are on track for completion (Table 3). The 2018, 2019, and 2020 translocations are complete at full quota, and all three monitoring seasons are complete. Below is a summary of the progress and ongoing work required to meet each project milestone. More detailed data analysis and discussion follows.

Milestones	**Progress for 2020**	**Final Completion Date**
1. Obtain permits and conduct project planning with regulators and landowners	February 2020, complete	Ongoing until December 2020
2. Conduct postdiapause BCB larval and adult collection and transfers	February 2020, Y3 complete	Ongoing through Y4
3. Conduct postdiapause BCB larval monitoring at SBM.	February 2020, Y3 complete	Ongoing through Y4

4. Set up and update adult butterfly and plant phenology monitoring courses as SBM and Coyote Ridge.	March 2018, complete	March 2018, complete
5. Monitor adult butterflies at SBM	March-April 2020, Y3 complete	Ongoing through Y4
6. Monitor host plant phenology at SBM	March-June 2020, Y3 complete	Ongoing through Y4
7. Collect adult butterfly and plant phenology data at Coyote Ridge	March-June 2020, Y3 complete	Ongoing through Y4
8. Conduct data analysis	October 2020, Y3 complete	Ongoing through Y4
9. Write annual reports	October 2020, Y3 complete	Ongoing through Y4

Table 3. Scope of work and milestones

Summary of Progress and Milestones

1. Obtain permits and conduct project planning with regulators and landowners.

Progress: All permits and permissions are in place with USFWS, San Mateo County Parks, and Santa Clara Valley Open Space Authority for work taking place during 2020.

Ongoing Work: Future coordination and permit updates will be required through the completion of this project. Discussions of 2021 release sites in progress.

2. Conduct postdiapause BCB larval and adult collection and transfers.

Progress: In February 2018, 5,000 postdiapause larvae were collected on Coyote Ridge and moved to SBM. Larvae were placed to the west and east of the 2017 release areas on the Main Ridge (Map 2). All larvae were collected and released the same day without injury and were observed basking or feeding after release. Based on high adult encounter rates on SBM, no adults were translocated in 2018. In February and March 2019, another 5,000 postdiapause larvae were collected on Coyote Ridge and moved to SBM. Again, all larvae were collected and released the same day without injury and were observed basking or feeding after release. Based on high adult encounter rates on SBM, no adults were translocated in 2019. In 2020, 5,000 postdiapause larvae were collected on Coyote Ridge and released in lower Owl and Buckeye Canyons. No adults were translocated in 2020.

Ongoing Work: Future larval transfers will take place annually at appropriate sites. The larval transfers may be supplemented with up to 60 adults in subsequent years, as needed as determined by Creekside Science. Additional release sites are being evaluated at SBM.

3. Conduct postdiapause BCB larval monitoring at SBM.

Progress: Three last-instar postdiapause BCB larvae were documented on February 8, 2018 demonstrating that some adults transferred in 2017 successfully reproduced on SBM. Seventeen postdiapause larvae monitoring plots, stratified by topoclimate, were established and monitored in early March 2019. 91 larvae were found in 17 plots, indicating 2,100 larvae in the plots themselves (4.33 ha). Extrapolation to a 7.86 ha area encompassing all of the plots and adjacent areas gave a population estimate of 3941 (95% CI 1737 - 6144). Larval monitoring plots have been added as translocations have expanded. A total of eight postdiapause larvae were found in 27 monitoring plots in 2020, which yielded an estimate of 330 larvae. But, as described below, this appears to underestimate the population because of the lower detectability of larvae in dense grassland.

Ongoing Work: Postdiapause larvae monitoring plots, stratified by topoclimate, will be checked and estimates conducted over subsequent years. Plots will be added in new release areas in Owl-Buckeye as needed. More work will be done to understand the detectability of larvae in 2021.

4. Set up adult butterfly and plant phenology monitoring courses at SBM and Coyote Ridge.

Progress: By 2019, 51 adult monitoring transects and 20 plant phenology plots have been set up and marked at SBM to be compared with those established at the reference sites at the Kirby Canyon Butterfly Reserve on Coyote Ridge.

In 2020, an additional 27 transect segments were established in Owl and Buckeye Canyons to cover the new release areas.

Ongoing Work: Course markers will be maintained and repaired as needed.

5. Monitor adult butterflies at SBM.

Progress: Adult transects were walked 13 times during the 2018 season, from before the first butterflies were observed to past the flight season. A total of 110 adults were observed between March 6 and April 22, 2018 along 1250 m of the ridgeline.

At the Western release site, prediapause larvae were found in webs on *P. lanceolata* away from confined oviposition sites, indicating oviposition by free-flying females. Larvae were observed through the third instar.

During the 2019 season, transects were walked five times between March 29 and May 2, 2019. A total of 185 adult butterflies were observed along 2250 m of the ridgeline and the four wandering transects.

On May 1, 2019, both first and second instar pre-diapause larvae were found in webs on *P. lanceolata* at the 2018 western release site hotspot, indicating that adult females opted to oviposit on these plants of their own accord.

During the 2020 season, transects were walked seven times between March 3 and April 23. A total of 45 butterflies were observed on the Main Ridge, and 53 butterflies observed in the Owl-Buckeye release areas.

Ongoing Work: Adult transects will continue to be monitored and compared interannually against the Coyote Ridge reference site. If populations spread, the transect system will be expanded to cover new areas.

6. Monitor host plant phenology at SBM.

Progress: Log scale estimates of the native annual host plants (*Plantago erecta, Castilleja exserta,* and *C. densiflora*) and some nectar sources were recorded on two transects (one at the top of Buckeye Canyon, and one at the west end of the adult transects) with ten 1 m^2 quadrats each. Plant phenology monitoring began on March 3, 2020 and continued over ten monitoring dates through May 21, 2020. Both *Plantago erecta* and *Castilleja* spp. remained green and edible into mid-May 2020, three weeks after the last adult was observed flying. As *P. lanceolata* is a perennial host plant, it remains available as a BCB food source year-round.

Ongoing Work: Host plant phenology monitoring will continue each year and the timing of the flight season relative to host plant growth and senescence will be analyzed. Phenology data will be compared with flight season data to estimate whether prediapause

larvae could have survived on the native hostplants long enough to reach diapause, and confirmed by the presence of postdiapause larvae in the *P. erecta* areas in 2021.

7. Collect adult butterfly and plant phenology data at Coyote Ridge.

Progress: Adult butterfly and plant phenology were monitored weekly from March-June 2020.

Ongoing Work: Adult butterfly and plant phenology monitoring at the Coyote Ridge reference site will continue over subsequent years and these data will be used to determine if populations track similarly and to trigger adaptations to release site selection or changes in habitat management at SBM.

8. Conduct data analysis.

Progress: Data analysis for 2020 is complete, and is included in this report. Some additional analyses were developed such as the relationship between larval release numbers and adult observations.

Ongoing Work: Data analysis will begin after all data collection from each field season is complete. Analyses include: distribution and abundance of larval and adult BCB, and their phenology; phenology of host and nectar sources and comparisons with the reference site at Kirby Canyon Butterfly Reserve on Coyote Ridge; and interpretation of population responses at introduction sites, quality of habitat, and effects of weather and topography.

Weather

Because BCB are sensitive to weather fluctuations, daily weather records (precipitation, T_{max} and T_{min}) for nearby San Francisco Airport (SFO) were compiled from Weather Underground (2020) for Oct. 2019-May 2020, Oct. 2018-May 2019, and Oct. 2017-May 2018 (Figures 1-3). Total precipitation in 2019-2020 was 352 mm, 2018-2019 was 553 mm, and 2017-2018 was 325 mm, compared with a long-term average of 500 mm. The growing season started with the late onset of rainfall (31 mm) at the end of November, including the heaviest daily rainfall of 25 mm. February and early March brought no rainfall for 6 weeks, and warm temperatures with many days of T_{max} >20^{o}C. March had 9 rainy days totaling 35 mm that replenished soil moisture, and April had 3 rainy

days totaling 36 mm that maintained soil moisture. Temperatures rapidly warmed after mid-April. The last light rainfall (5 mm over 3 days) occurred in mid-May.

2019 had brought many more rainy days and slightly above average precipitation (Figure 2), while 2018 was a drought year, albeit with a relatively wet March (Figure 3). Because *P. lanceolata* is perennial, we suspect that the SBM population is less sensitive to temperature and precipitation than serpentine grassland populations feeding on annual *P. erecta*.

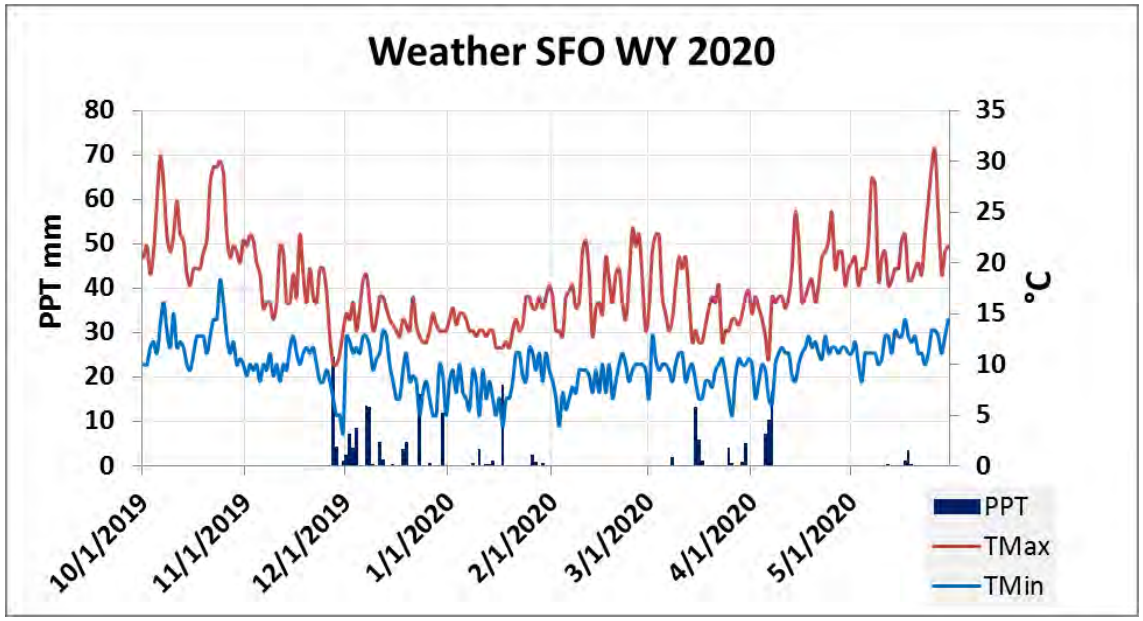


Figure 1. WY 2020 Weather at San Francisco Airport. WY = Water Year, Oct. 1-Sep. 30

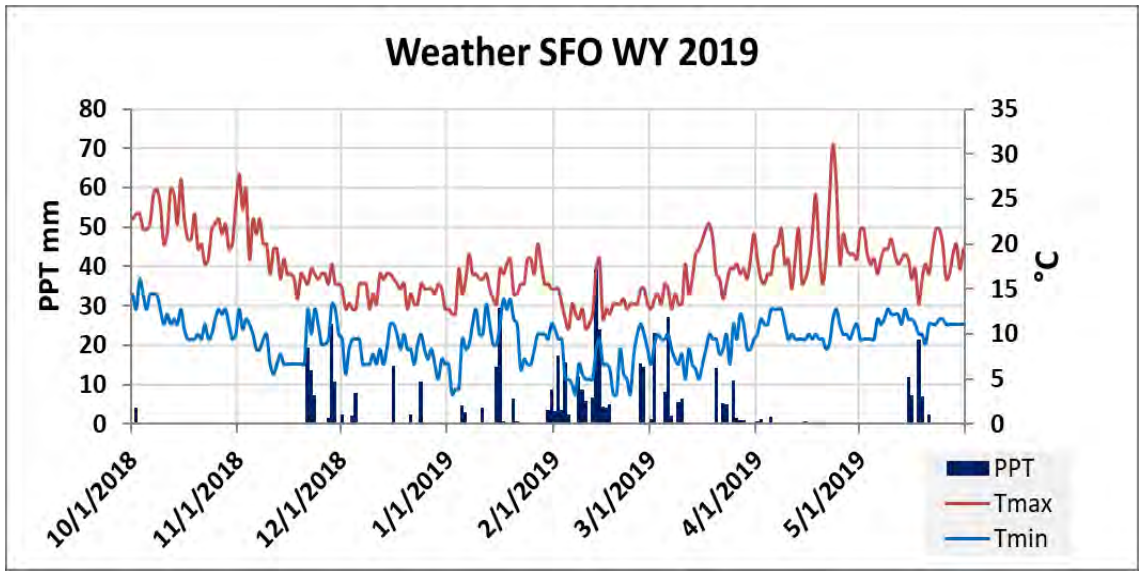


Figure 2. WY 2019 Weather at San Francisco Airport.

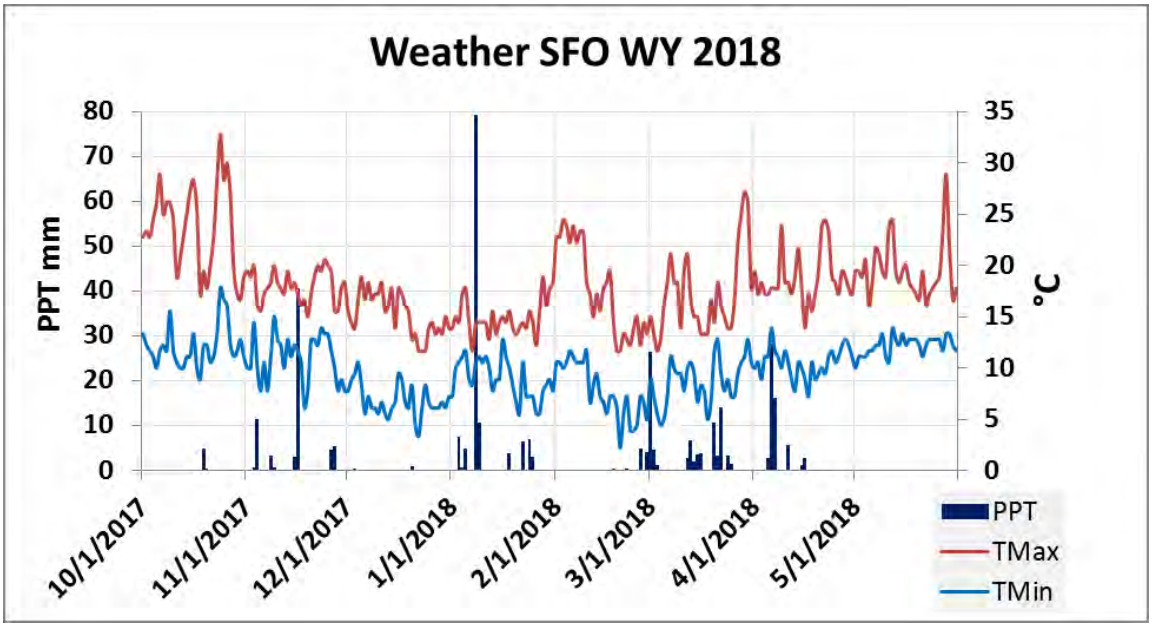


Figure 3. WY 2018 Weather at San Francisco Airport.

Coyote Ridge Source Population

Larval numbers in on Coyote Ridge are shown in Table 4. Total Coyote Ridge larval numbers decreased from 890,000 in 2019 to 695,000 in 2020. But the Kirby Canyon Butterfly Reserve showed a sharp increase from 16,000 ±10,000 to 108,000 ±53,000. Other parts of the ridge showed a mix of increases and decreases. Larvae were collected from Coyote Ridge Open Space Preserve and areas north. The 5000 larvae collected comprise less than 1% of the total Coyote Ridge population.

	Kirby Canyon	Coyote Ridge*
2011	94,000 ± 32,000	530,000
2012	132,000 ± 38,000	470,000
2013	250,000 ± 47,000	1,250,000
2014	92,000 ± 35,000	780,000
2015	190,000 ± 70,000	2,100,000
2016	45,000 ± 16,000	380,000
2017	12,000 ± 4,300	380,000
2018	5,500 ± 4,000	220,000
2019	16,000 ± 10,000	890,000
2020	108,000 ± 53,000	695,000

*Confidence intervals across Coyote Ridge have not been calculated.

Table 4. Kirby Canyon is 250 acres within the larger ~7000 acres of Coyote Ridge. The Kirby numbers are shown with 95% confidence intervals.

Postdiapause Larval Surveys

In February 2020, 8 postdiapause larvae were counted in 27 plots within the 2017- 2019 release areas (Map 3). Larvae were found in five plots. On the map, the posted number is larvae/10 person minutes, the standard method elsewhere in the BCB range. 22 plots had zero larvae. The highest count was 3 larvae/10 minutes in Upper Buckeye Canyon, where *P. erecta* is the primary hostplant.

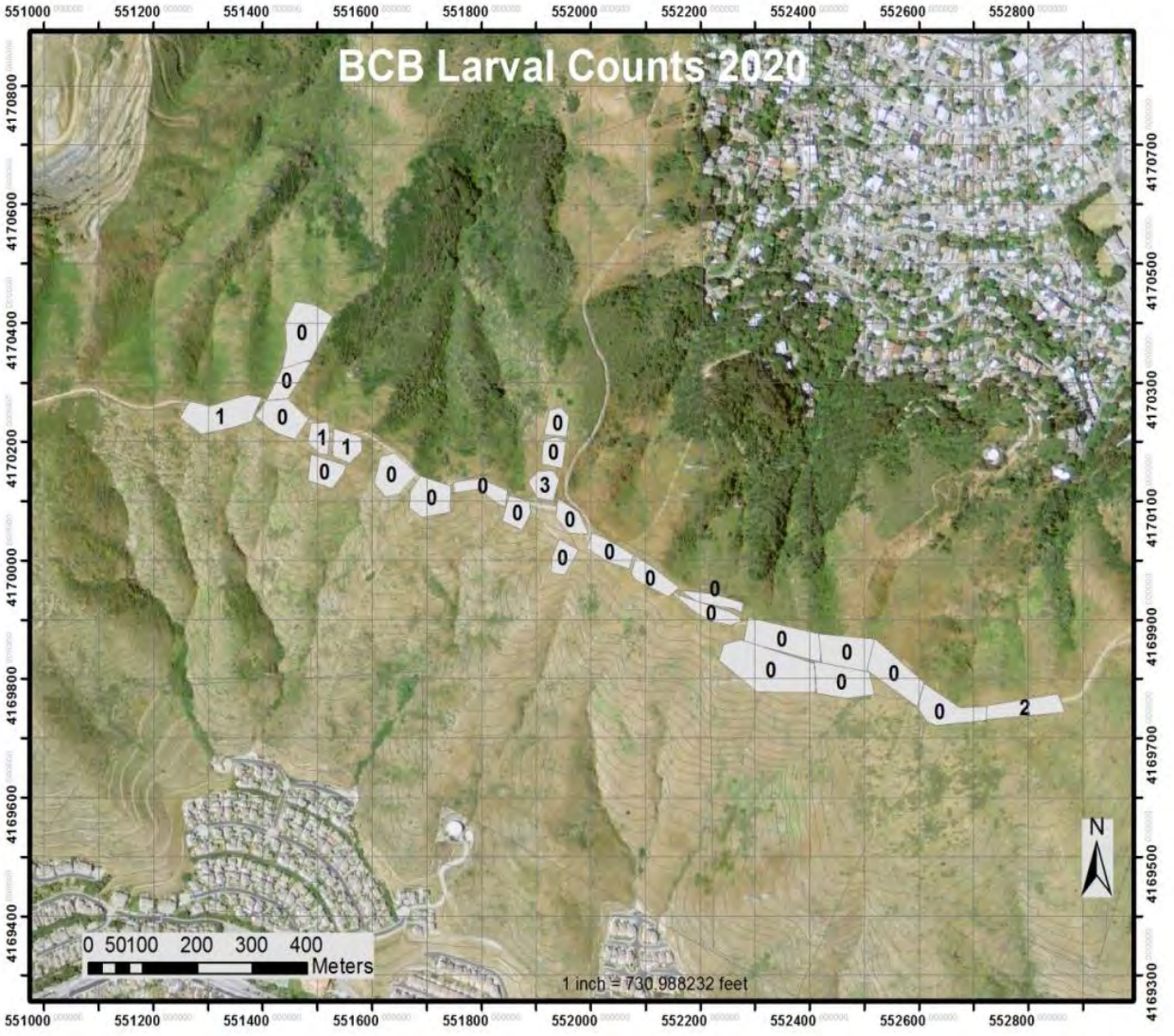
Larval counts are converted to larval density by an empirical formula:

$$\text{Larvae/ha} = 10{,}000 * e^{(-4.33+0.88*\ln(\text{count}))}$$

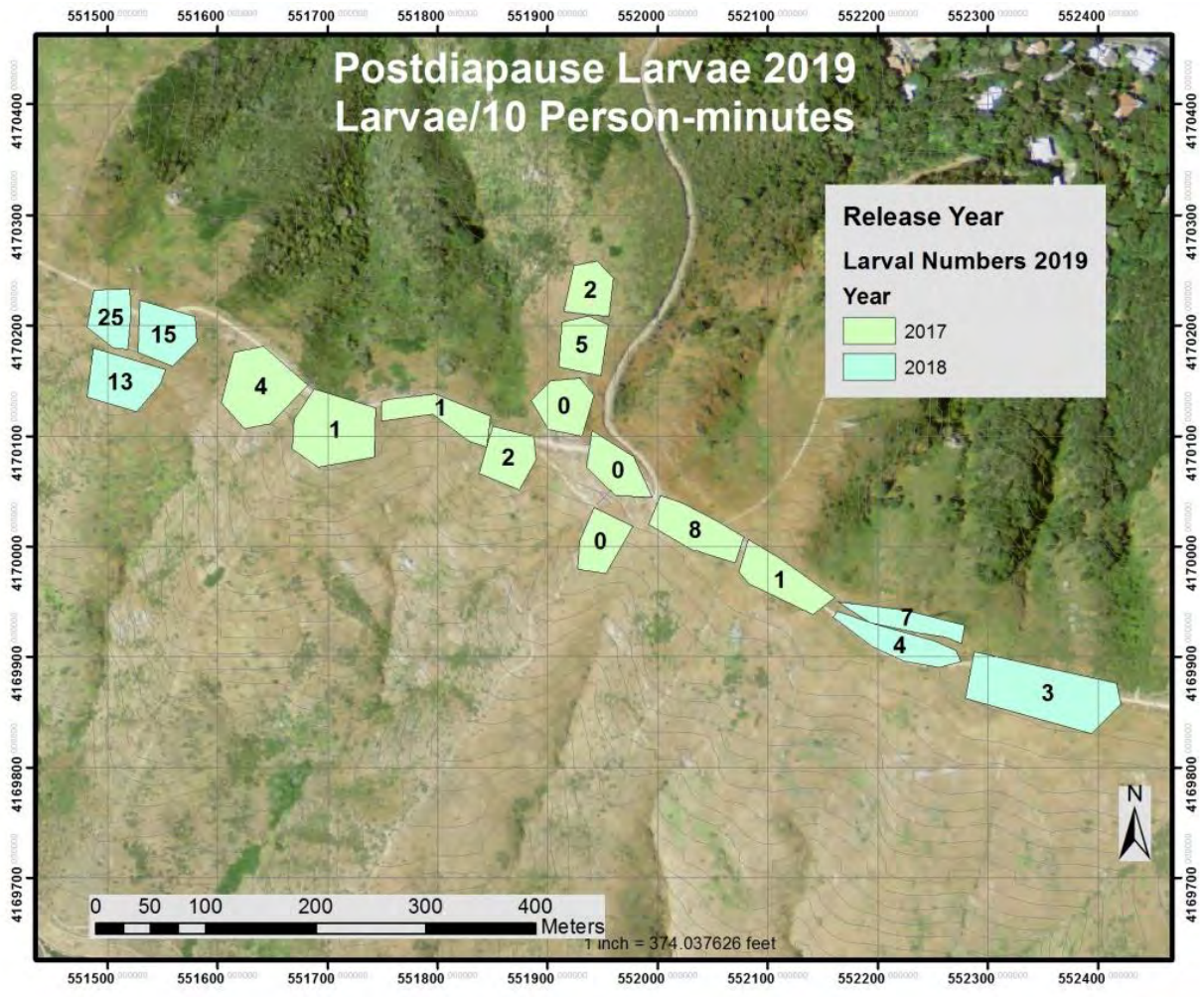
1 larva/10 person-minutes corresponds to 133 larvae/ha, and 3 larvae = 346 larvae/ha

The number of larvae within each sample site was calculated using the area of the sample. Plots varied in size from 0.17 to 0.61 ha. Summing up this calculation across the sample sites, there were 259 larvae total within just the sample sites, which cover 9.67 ha. An overall population estimate used an area 11.01 ha in 2020. The weighted mean density was 30 larvae/ha, and the total was estimated at 330 larvae (95% CI 170- 610). Confidence intervals were set by fitting a Poisson

distribution in JMP 15.1 (SAS Institute). In 2019, 91 larvae were observed in 17 plots (Map 4), leading to a population estimate of 3,941 larvae (95% CI 1737- 6144) over 7.86 ha (Table 5).



Map 3. Number of larvae observed in 10-person minute searches in 2020.



Map 4. Number of larvae observed in 10-person minute searches in 2019. Only the 2018 release sites were counted. See text for description of 2018 survey.

	2020	2019	Units
Sampled Area	9.67	4.33	ha
Total Area	11.01	7.86	ha
Avg Density	30	500	larvae/ha
SE Density	10	130	larvae/ha
N	27	17	plots
Total	330	3941	Larvae
+95%*	170	6144	Larvae
-95%*	610	1737	Larvae

Table 5. Total larvae calculation in 2020 and 2019. *Limits were calculated with a Poisson distribution because of low numbers, hence the asymmetrical confidence limits. The larval survey in 2018 (three larvae in one plot out of ten) could not yield a useful quantitative estimate.

Translocation

A total of 5,000 larvae were translocated from Coyote Ridge to SBM in 2020 (Map 2). 3,668 larvae were collected on February 17, 2020 and that afternoon all were released on *Plantago lanceolata* in Lower Buckeye Canyon. The following day, 1,332 larvae were collected and released on *P. lanceolata* in Lower Owl Canyon. Larvae were released directly on *P. lanceolata*, and started crawling, feeding, and basking until it became too cool for further activity. No larvae were harmed during the translocation. No adults were translocated.

Adult Butterfly Monitoring

When the transect system was established in 2017, it consisted of 35 segments including 33 50-m segments spanning 1650 m along the Main Ridge and Upper Buckeye Ridge plus an additional two wandering transects segments to sample additional areas downslope from the Main Ridge. In 2018, the transect system expanded to 37 segments including 33 50-m segments spanning 1650 m along the Main Ridge and Upper Buckeye Ridge and four wandering transects to sample downslope areas. In 2019, ten segments were added through the 2019 eastern release area, and four additional segments were added down the north side of Upper Owl Ridge for a total of 51 segments, with 47 50-m segments spanning 2350 m transects primarily along the Main Ridge and Upper Buckeye and

Upper Owl Ridges and a few wandering transect spurs on the north and south (Map 5a). Transects are walked at 1.5 minutes/50 m and the total number of butterflies observed within 5 m of the centerline are recorded. Incidental butterfly observations outside of the 5-m zone or outside the timed period are noted. Transects were walked every 6-10 days, weather permitting, and counts from particularly windy, cold days were dropped because of low butterfly activity.

In 2020, the first adult was observed on March 3, and numbers rose to peaks in mid-March (28 butterflies) and in early April (24 butterflies), and the season ended by late-April (Figure 4a). Butterflies/hour (a standardized measure of relative abundance) on the Main Ridge in 2020 was 5.0, comparable to 7.0 in 2017, and substantially less than in 2018 and 2019 (14.8 and 32.8 respectively) (Tables 6-7). But in 2020, all of the butterflies on the Main Ridge were native born (except for perhaps a few dispersing up from Lower Buckeye and Owl over hundreds of meters of scrub); no larvae were translocated, while in 2017 3,630 larvae were released and in 2018 and 2019 5,000 larvae were released in each year (Table 1, Map 2).

The 2020 mean flight date was (March 30/31) was similar to that in 2017 and 2018. Mean flight date was 14 days later in 2019. Flight seasons at both the Ridge and in Owl-Buckeye were longer in 2020 (S.D. > 10) than in previous years. The periods of rain in March and April spread out the season compared with 2017 and 2019.

More detail can be observed by breaking the adult curve down into the separate transect areas (Figure 4b). Buckeye peaked in mid-March, and Owl and the Ridge peaked in early-April. The dip in Owl and Buckeye in late-March can be attributed to marginal weather (temperature 54ºF, wind 6-15 mph) – likely there was a single peak of butterfly abundance but SBM weather makes consistent monitoring of adult butterflies challenging.

Date	Main Ridge	Owl Canyon	Buckeye Canyon	Total
3/3/2020	1	0	0	1
3/12/2020	8	0	4	12
3/20/2020	7	2	19	28
3/26/2020	4	4	3	11
4/3/2020	14	9	1	24
4/13/2020	8	6	5	19
4/22/2020	3	0	0	3
Total	45	21	32	98

Table 6. Adult observations in 2020

Site	Total butterflies	Peak BF/day	BF/ hour	Sample days	Mean Date	S.D Days	Segments	Length (m)
MR 2017	47	16	7.0	6	4-Apr	5.2	35	1750
MR 2018	110	30	14.8	7	1-Apr	9.0	37	2122
MR 2019	185	69	32.8	4	13-Apr	7.4	51	2822
MR 2020	45	14	5.0	7	31-Mar	13.1	51	2822
OB 2020	53	21	11.2	7	30-Mar	10.3	27	1350

Table 7. Flight season summary for 2017-2020. MR = Main Ridge, OB = Owl-Buckeye S.D. = weighted standard deviation

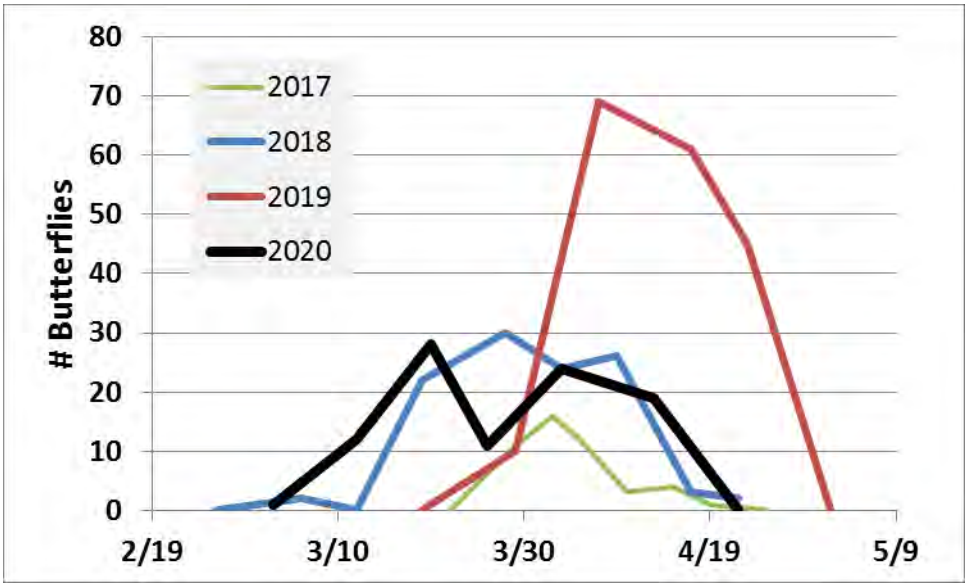


Figure 4a. Flight season phenology and numbers

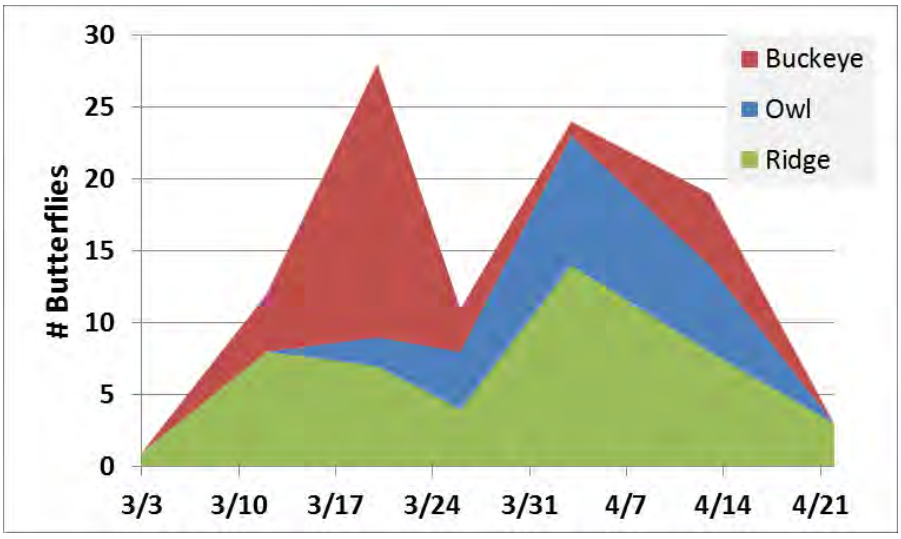


Figure 4b. 2020 flight season on Main Ridge, Owl, and Buckeye, stacked. Totals are the same as in Figure 4a (black line for 2020).

The spatial distribution of adult sightings in 2020 (Map 5a) exhibited several major features:

1. On the Main Ridge, 42 butterflies were observed on 10/57 transect segments, in three clusters. The clusters corresponded to areas where postdiapause larvae were observed earlier in the season (Map 3).

2. The western cluster (24 total butterflies) included the 2018/2019 hilltop "hotspot" (16), and the top of Owl Canyon (5).

3. The middle cluster was at the top of Buckeye Canyon (10 total), with a maximum of five butterflies downslope on the Upper Buckeye lateral transect.

4. The eastern cluster (four total) was at the eastern end of the transect system.

5. Each of the clusters contains a local hilltop, which serves as an aggregation center for BCB that exhibit hilltopping behavior (males and females fly to hilltops to mate).

6. In Buckeye Canyon, 32 butterflies were observed on 8/14 transect segments, all at or above the release area with a maximum of nine per segment.

7. In Owl Canyon, 21 butterflies were observed on 4/13 segments, all within the release area with a maximum of 10 per segment.

Previous years' observations (working backwards) include:

1. In 2019 (Map 5b), 185 butterflies were distributed along the entire 2000 m length of the Main Ridge, in 40/51 transect segments, and 100 m down each of the north-facing Buckeye Ridge and Owl Ridge spur trails.

2. In 2019, the main hotspot outside the 2019 release area was the small hilltop at the 2018 western release area where 54 butterflies were observed. Upper Buckeye was occupied with eight adults observed.

3. In the 2019 release sites, at the Far Western site a total of 23 butterflies were observed in 7/8 segments. In the Far Eastern release site 16 butterflies were observed in 5/8 segments. In the Upper Owl release site 32 butterflies were observed in 3/4 segments.

4. In 2018 (Map 5c), butterflies were spread over 1250 m of the ridgeline. With one exception, butterflies did not spread to the west beyond Owl Canyon (50-100 m outside the release area), nor was the easternmost transect segment occupied. The sedentary nature of BCB was apparent.

5. In 2018, the Western release site had 56 butterflies in four segments. The local hilltop was a good focus for aggregation, and became a "hotspot."

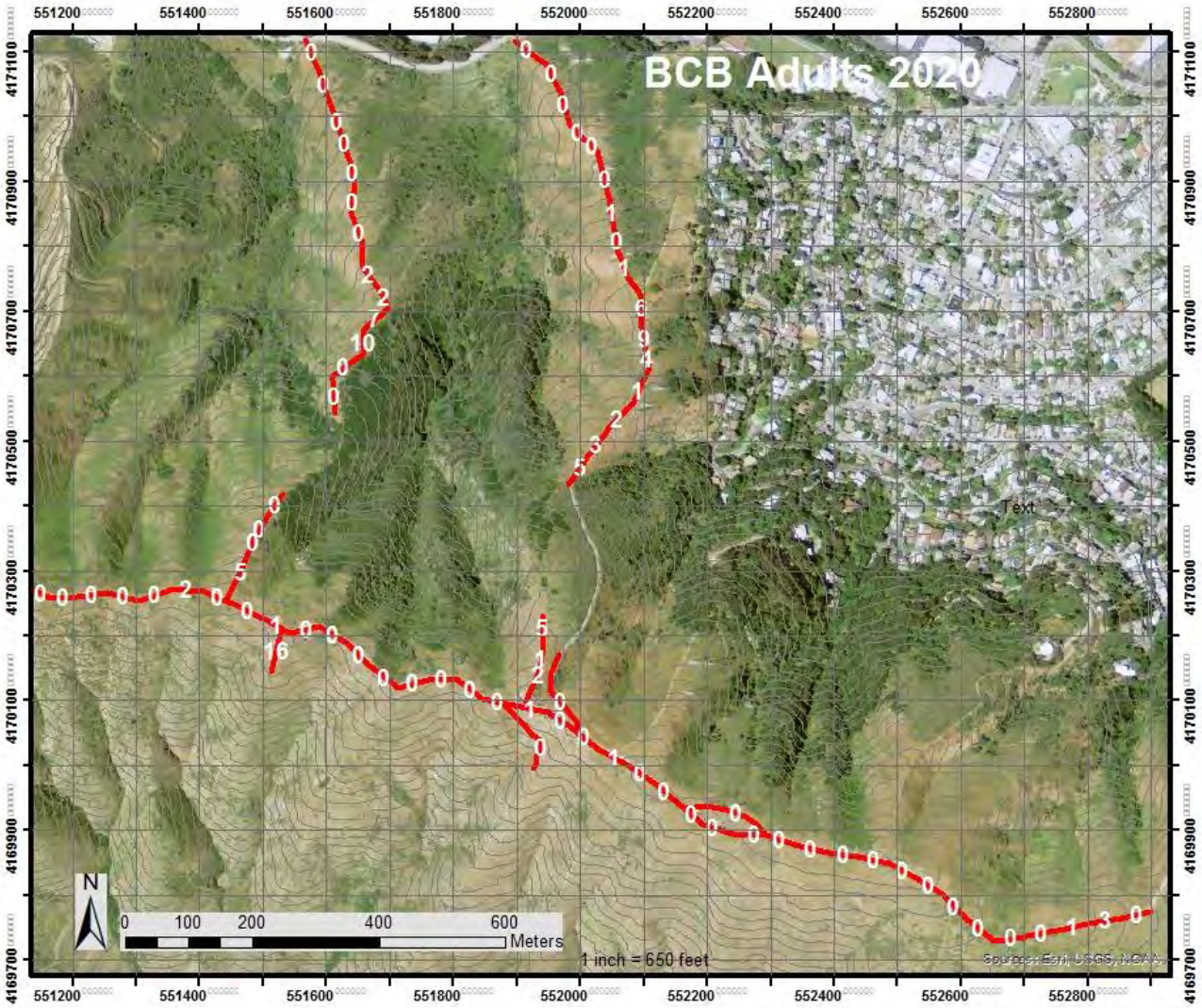
6. In 2018, the Eastern release site had 20 observations in six segments. The local hilltop at the power towers was a good focus for aggregation.

7. In 2018, the Central 2017 release site had 34 adult observations. Upper Buckeye was a hotspot again in 2018, with 20 observations on and near the local hilltop, but butterflies were distributed along the ridgeline within the release area.

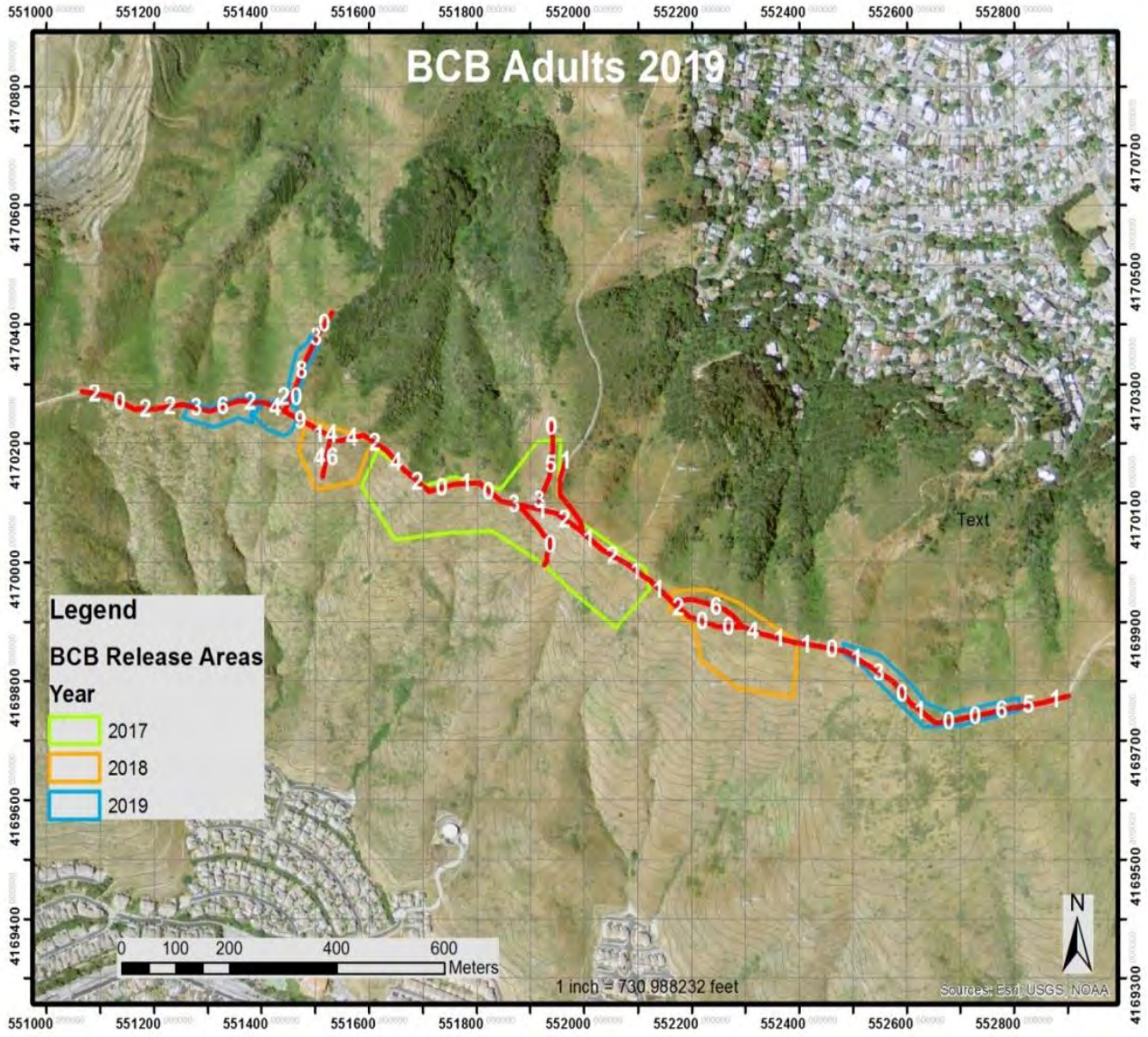
8. In 2017 (Map 5d), adults were concentrated near Upper Buckeye, with a maximum of 8 observed in a single segment. They were distributed across 850 m of the ridgeline. Butterflies spread only 50-100 m beyond the release zone to the east and west.

These results indicate that initial larval releases, not surprisingly, generate many adult observations in the release areas. But expansion of adult distributions outside the release areas appears to be minimal. In the second year, successful reproduction is indicated by both the presence of postdiapause larvae and adult butterflies. The hilltops at Buckeye and Owl Canyons, and the small hilltop east of Owl Canyon are the hotspots for adult distributions.

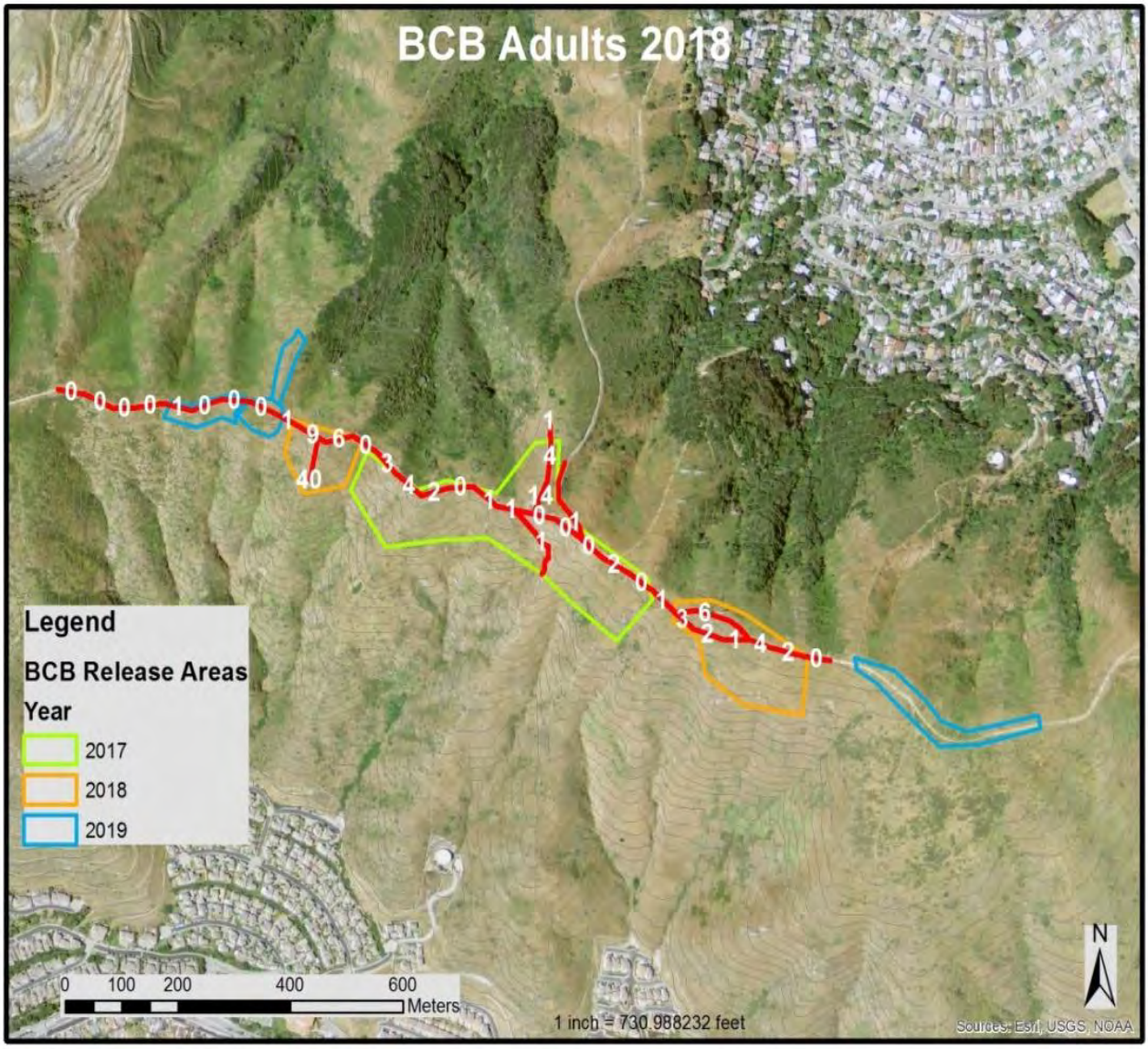
The local hilltop just east of the intersection of the Upper Owl trail and the Main Ridge continued to be a prime hotspot for BCB. The high local density in 2018 and 2019 provided opportunities for detecting prediapause larvae and first and second instar larvae were documented at this site in those years. Adult density there fell in 2020, but it was still a relative hotspot.



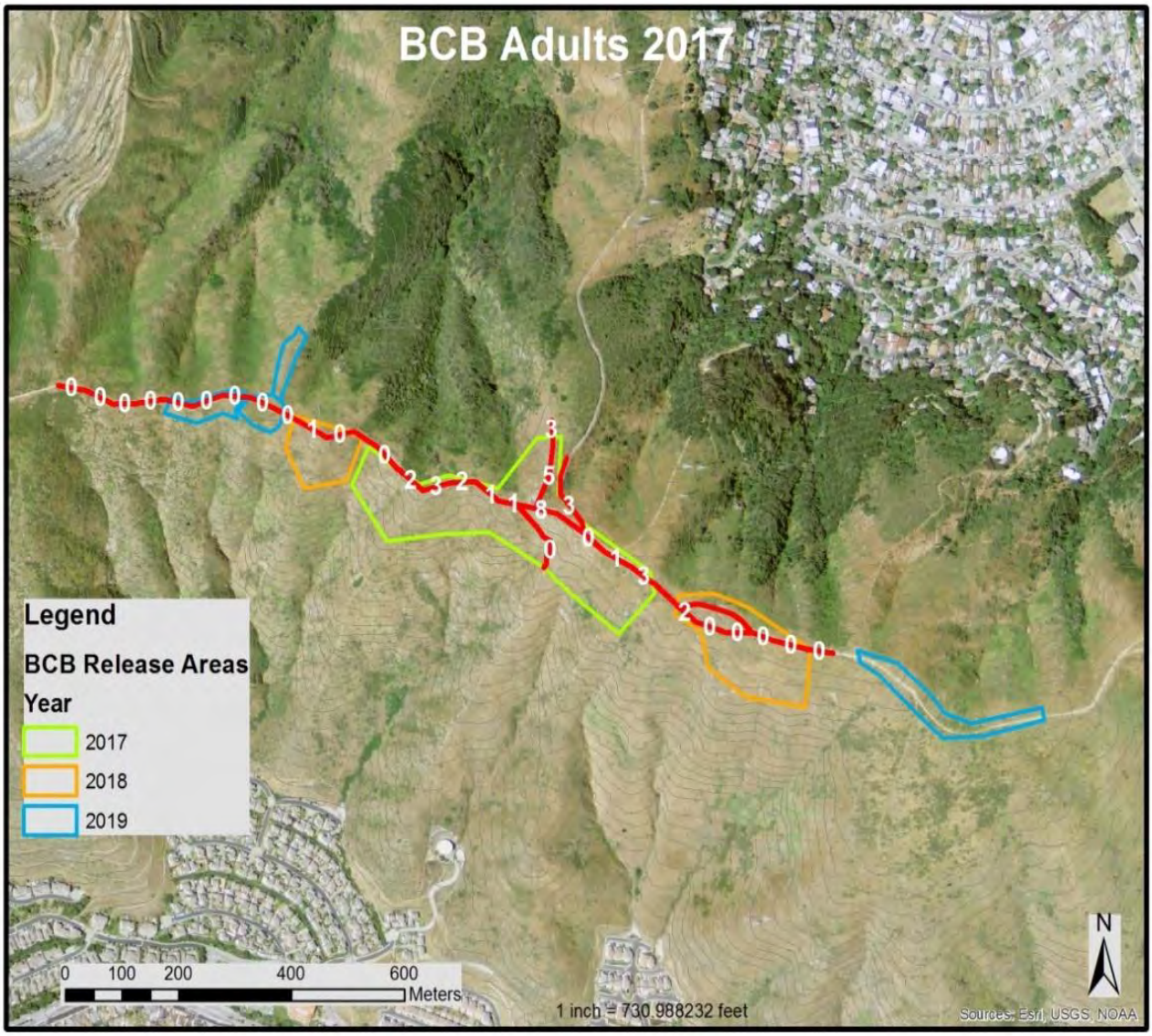
Map 5a. Total number of adults observed on transects, 2020



Map 5b. Total number of adults observed on transects, 2019



Map 5c. Total number of adults observed on transects, 2018



Map 5d. Total number of adults observed on transects 2017

Larval Release Numbers and Local Adult Observations

We now have seven larval release sites with subsequent adult transect observations to develop a quantitative relationship between the number of larvae known present and the number of adults observed. Adult butterflies do not spread widely from the larval release sites (see Maps 5a-d), perhaps 50-100 meters at most, so the vast majority of adults observed in the local transect segments originated within the release areas. Larval release numbers and subsequent local (within 100 m) adult observations show the expected positive correlation (Figure 5). The value of the slope suggests that for every 100 larvae released, the sum of weekly transect counts of adults in the release vicinity should yield ~1.2 observations. This relationship can be reversed (predicting larval numbers from adult observations) to constrain larval numbers.

In 2020, the postdiapause larval sampling technique yielded only eight larvae along the Main Ridge and an estimate of 330 larvae total (Table 5). As calculated, this estimate does not meet the goal of 600 larvae. However, 45 adults were observed across the Main Ridge in 2020, similar to the 47 adults produced by the initial release of 3,630 larvae in 2017. Butterflies per hour were similar as well, 5.0 in 2020 and 7.0 in 2017 (Table 7). This suggests that there were a similar number of larvae along the Main Ridge in 2020 and 2017, well above the 330 estimate from the larval counts or the 600 larval population goals. Dispersal from the 2020 releases in Owl-Buckeye was unlikely to have contributed more than a few adults to the Main Ridge population.

Larval release numbers only account for 50% of the variance in adult observations. The two points most above the regression line include the 2018 release at the small western hilltop hotspot, and the 2019 release at the top of Owl Canyon. At both sites, butterflies concentrated around distinct local hilltops. A more detailed hilltop analysis will be done following the 2021 season.

This discrepancy between estimated larval population and adult numbers suggests that postdiapause larvae are simply more difficult to detect in dense grassland with the clumped perennial *Plantago lanceolata,* compared with the sparse serpentine grassland with dispersed *P. erecta*. Indeed, the majority of the larval observations in every year were in relatively bare areas within the denser grassland (S.B. Weiss personal observation). Our standardized method may not be as robust at this site.

A deeper exploration of this relationship, using population data from Kirby Canyon, Edgewood, and Tulare Hill (where we have both larval population estimates and adult transects over many years), as well as incorporating topographic factors, will be pursued in future reports. For now, it is a good method for an approximate population density estimate that strongly indicates there were more than 600 postdiapause larvae and 300 adults present along the Main Ridge in 2020 (with additional animals in Owl and Buckeye Canyons).

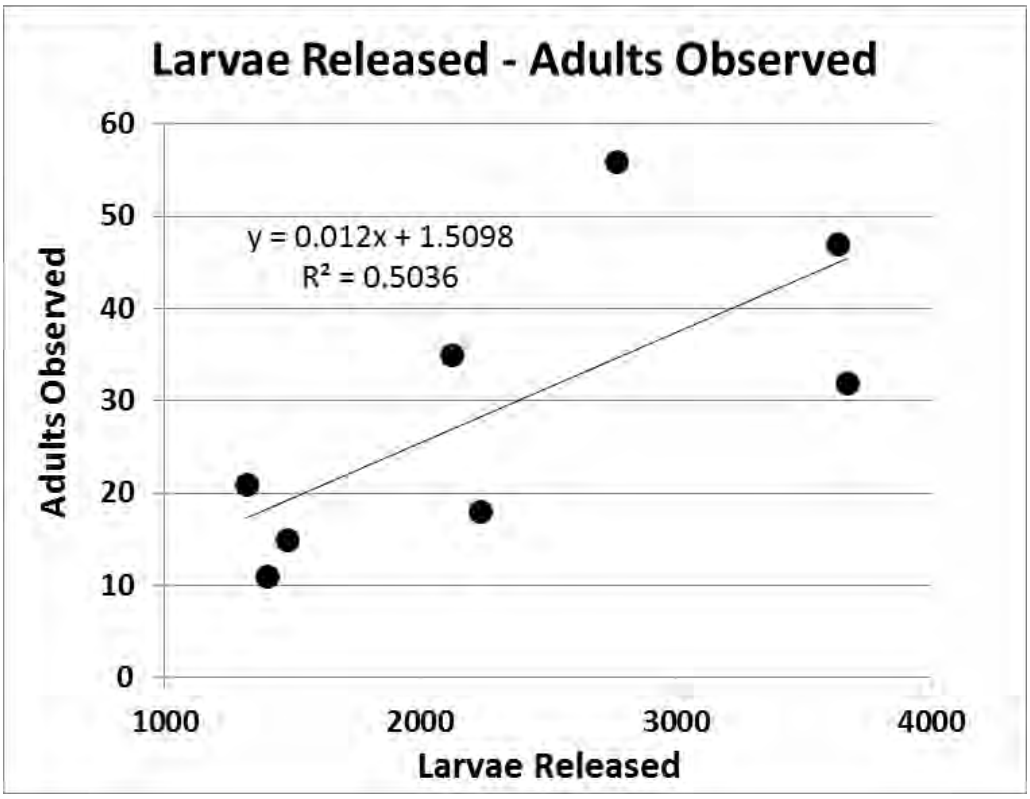


Figure 5. Number of larvae released and local counts of adults on transect system.

Adult Nectaring

Adult butterflies were noted nectaring on many plant species, including the widely distributed *Achillea millefolium* and *Lasthenia californica*. Other abundant nectar sources include *Lomatium* spp., *Sidalcea malvaeflora*, *Phacelia californica,* and *Allium* spp. Nectar does not appear to be a limiting factor for BCB at SBM.

Comparisons of Encounter Rates with Other Sites

The encounter rates (butterflies/hour, Table 8) provide a means to directly compare adult densities among sites. In 2020, the rate at SBM on the Main Ridge (5.0 BF/hr) was 4% of the rate at KC (111.3 BF/hr), and the same as the rate during the lowest year at KC (2018). The rate on the Main Ridge was 25x Edgewood (which is just barely hanging on) (Niederer 2020). The rate at Owl-Buckeye (11.2 BF/hr) was 10% of the rate at KC in 2020, and comparable to the rate in 2017 at KC.

Year	KC	EW	SBM (Main Ridge)	Owl-Buckeye
2011	109.5	3.4	n/a	n/a
2012	104.6	8.8	n/a	n/a
2013	318.5	16.1	n/a	n/a
2014	117.5	16.8	n/a	n/a
2015	206.0	10	n/a	n/a
2016	91.8	1.9	n/a	n/a
2017	13.1	1.6	7.0	n/a
2018	5.0	1.0	12.4	n/a
2019	31.0	0.7	32.8	n/a
2020	111.3	0.2	5.0	11.2

Table 8. Butterflies/hour comparisons among sites and years

Hostplant Phenology

The timing of the flight season relative to host plant growth and senescence is critical for BCB populations. An early start to the flight season and/or late host plant senescence increase the likelihood the new generation of larvae will grow large enough to enter diapause before their host plants dry out. Data on host plant phenology are compared with flight season data to estimate whether most butterflies survived to diapause. But, because of the late phenology of *P. lanceolata* this factor is of lesser importance at SBM except in Upper Buckeye and Upper Owl where *P. erecta* is the primary hostplant available, with *Castilleja* often providing addition prediapause feeding time.

As a general rule, prediapause larval survivorship increases substantially if host plants remain fresh three weeks or more after the midpoint of flight season. The longer the plants stay fresh, the better. In 2020, *P. erecta* remained green into mid-May, six weeks after the mean flight date (March 31) (Figure 6a). Therefore, we would expect that some prediapause larvae would survive in the *P. erecta* stands in Upper Buckeye and Owl Canyons. Previous years are shown in Figures 6b-d. *Castilleja* density was low relative to other years, and senescence was early. *Castilleja* had senesced by mid-May (Figure 7) similar to *P. erecta*, unlike in previous years when *Castilleja* remained green a week or more after *Plantago* senesced.

The temporal relationship between SBM and KC was variable over the four years (Figure 6). Comparing the 90% senescence dates across all years (Table 9), *P. erecta* senescence on SBM was later than KC by 4-19 days, except in 2020 when they were the same. In general, the cool coastal climate at SBM, especially fog, delays *P. erecta* senescence compared with the warm temperatures at KC in the inland South Bay. But in 2020, there was a late flush of *Plantago erecta* at KC when rain returned after a six-week dry period in Jan-Feb 2020, which delayed senescence there.

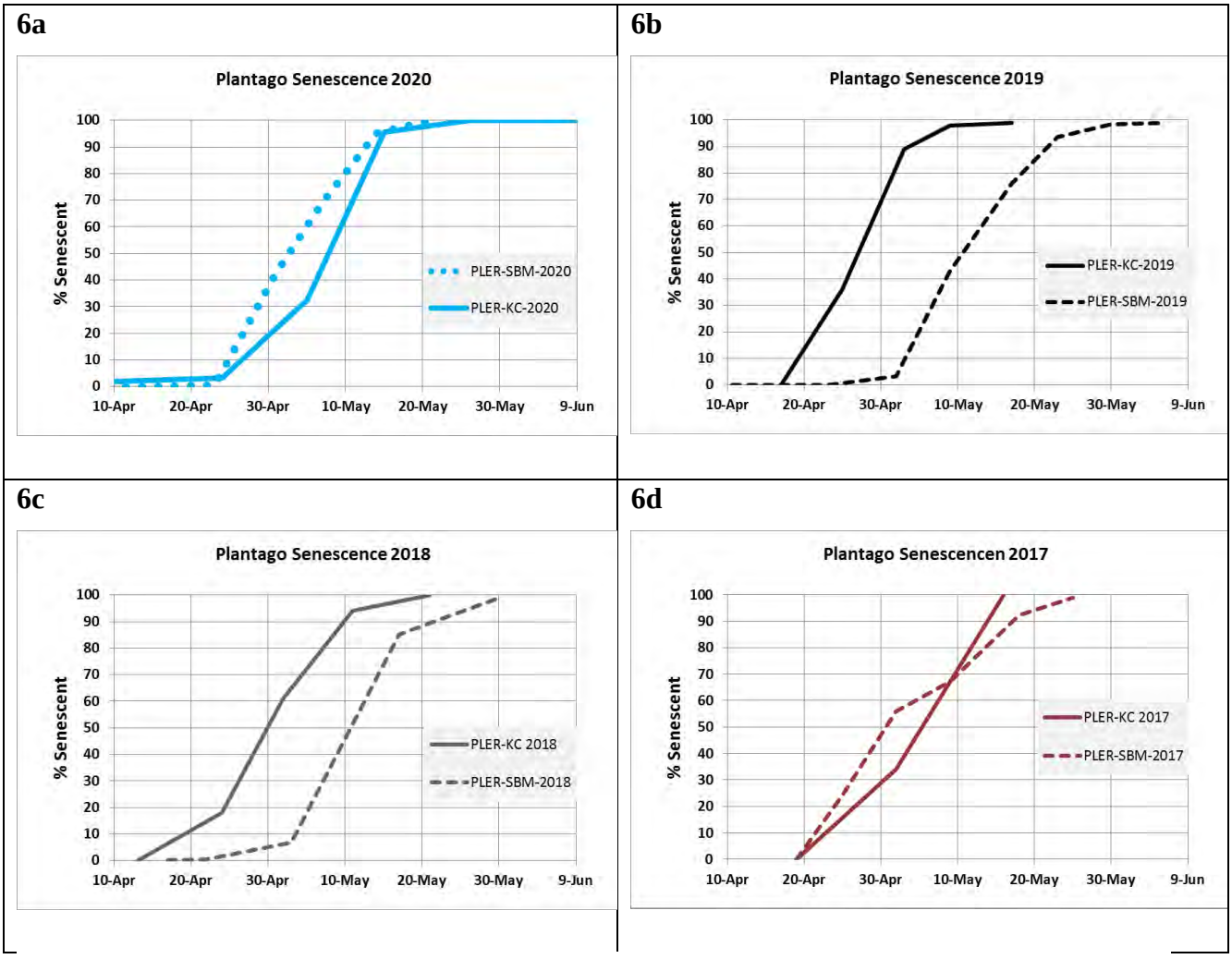


Figure 6a-d. *Plantago erecta* phenology at SBM (dashed lines) and Kirby Canyon (KC, solid lines) by year

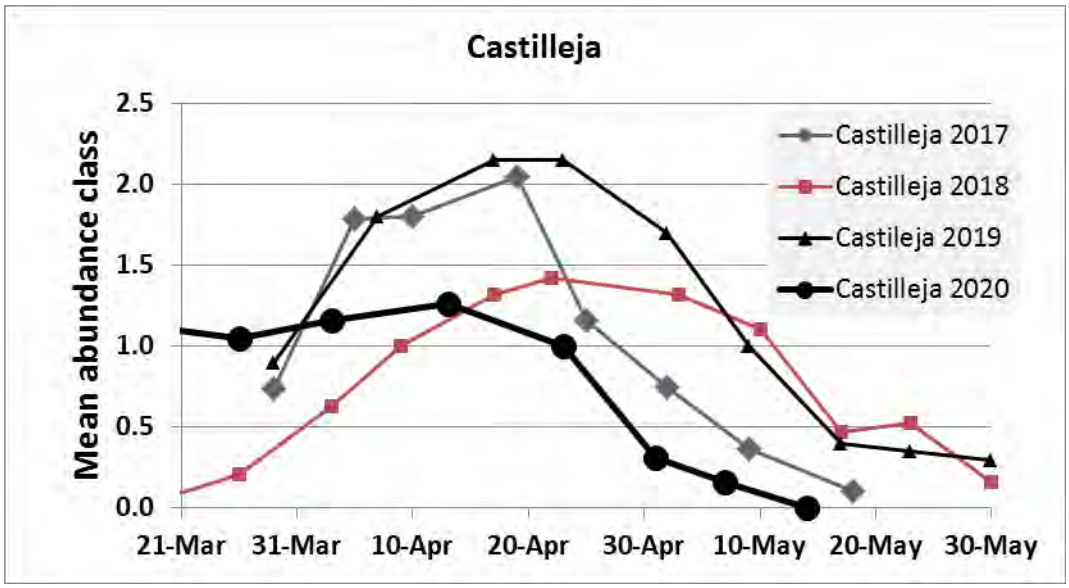


Figure 7. *Castilleja* phenology at SBM 2017-2020.

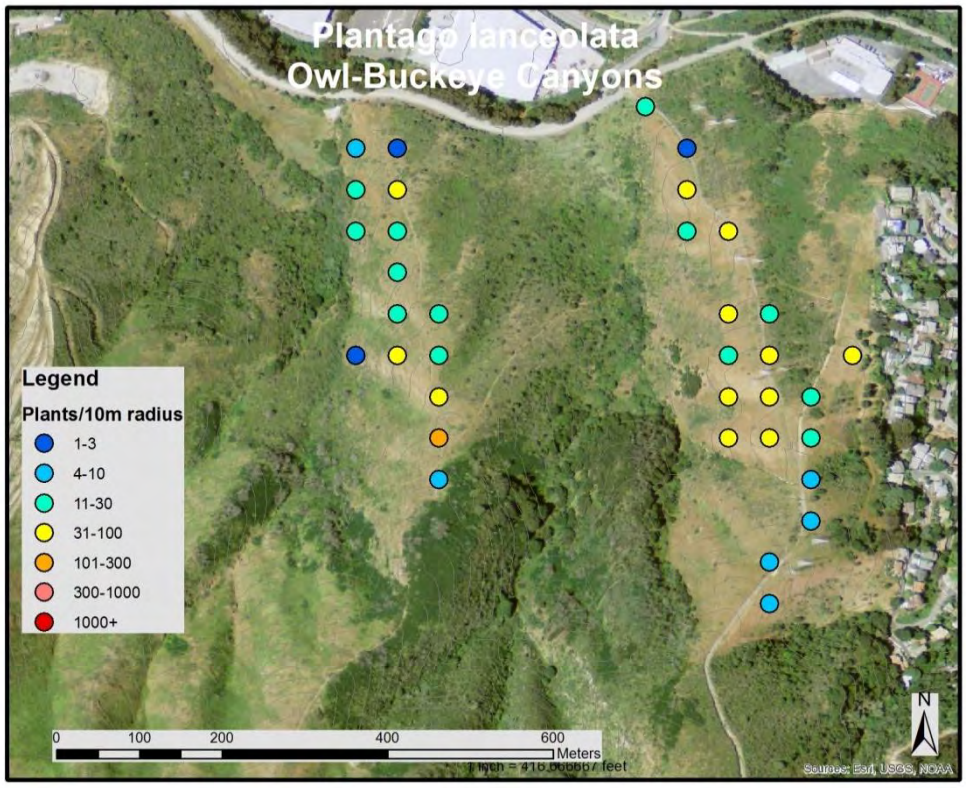
Year	90% KC	90% SBM	Difference days (SBM-KC)
2017	13-May	17-May	4
2018	10-May	22-May	12
2019	3-May	22-May	19
2020	13-May	13-May	0

Table 9. Comparison of 90% *Plantago erecta* senescence dates between Kirby Canyon and San Bruno Mountain

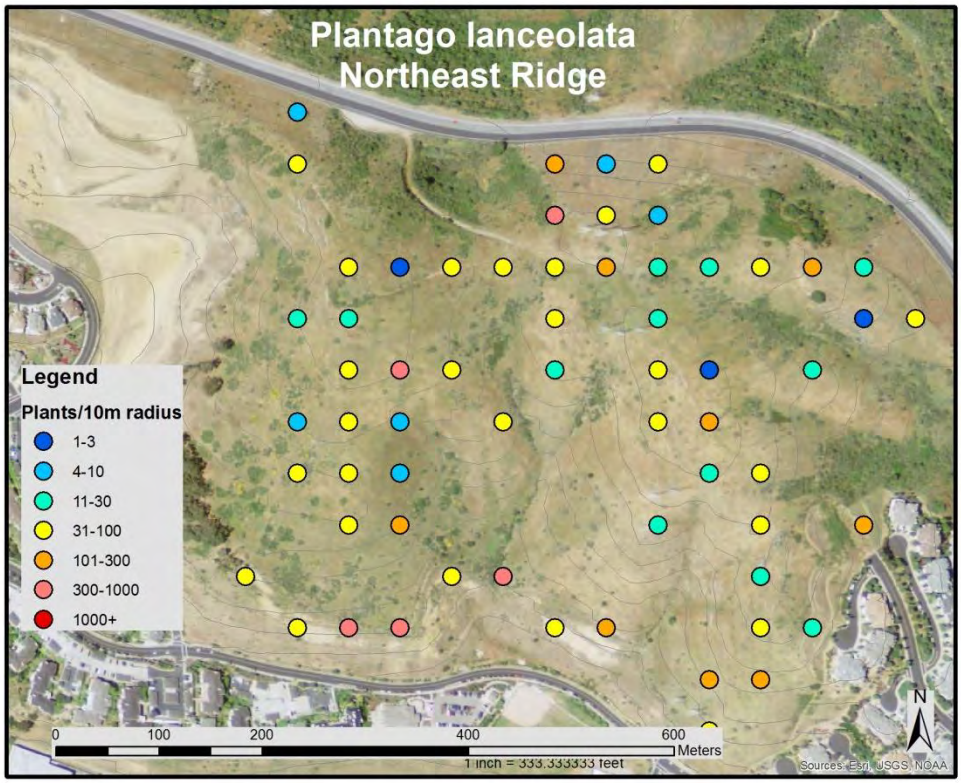
Future Translocation Sites

The available habitat along the Main Ridge is now occupied, and Lower Owl and Buckeye Canyons were chosen as the translocation sites in 2020 based on mapping *P. lanceolata* in 2019. Each site contained ~4000+ hostplants (Map 6) and larvae were released in the densest stands (yellow and orange). These sites nicely complement the established population on the Main Ridge.

Map 1 shows the location of each of the following areas discussed. For 2021, the Northeast Ridge (NER) is ecologically ideal for BCB reintroduction, with large stands of *P. lanceolata* (~ 30,000 total plants) and local hilltops for aggregation (Map 7). But the NER is not yet dedicated to San Mateo County Parks, and it is not clear whether a BCB translocation can be done prior to transfer of ownership. The question is under consideration by San Mateo County Parks staff.

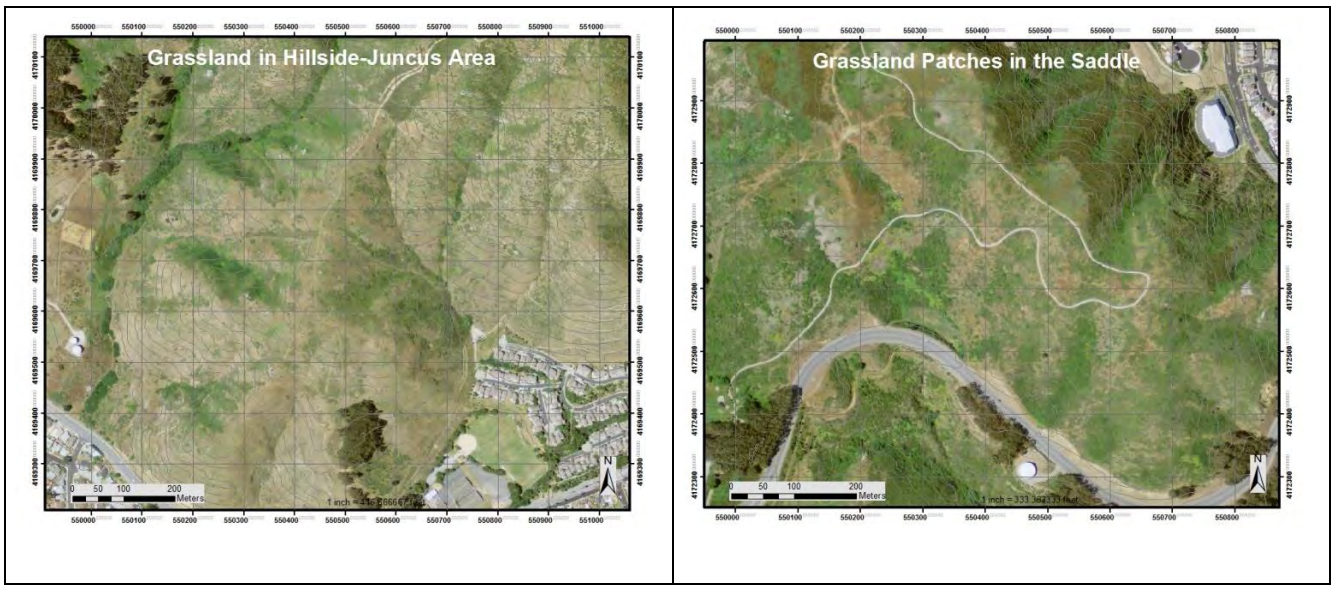


Map 6. Owl-Buckeye *P. lanceolata* abundance in 10-m radius circle at each 50 m point, 2019



Map 7. Northeast Ridge *P. lanceolata* abundance in 10-m radius circle at each 50 m point, 2019

If translocation to NER is not institutionally feasible in 2021, then two other areas are under consideration. Hillside-Juncus (Map 8a) was originally identified in the feasibility study (Niederer et al. 2015), but dense grass growth following recovery from a fire covered over much of the *P. lanceolata*, except along road/trail verges. The Saddle area (Map 8b) has many acres of grassland, but has not been mapped for *P. lanceolata*. In fall 2020, both of these areas will be scouted and evaluated.



Maps 8a, b. Other 2021 potential release sites

Additionally, there is a network of patches of *Plantago erecta* and *Castilleja* in the April Brook area (Map 9). At present, the extent and quality of these patches is undetermined, and some scrub control would be advisable to maintain grasslands. Additional patches of *P. erecta* are known from the area east and north of Pacific Rock. These areas merit investigation for future translocation potential, as they represent the ancestral conditions on SBM, similar to Upper Owl and Buckeye Canyons.

Map 9. Grassland patches near April Brook, just west of the Summit Rd.

Conclusions

The reintroduction of the Bay checkerspot butterfly to San Bruno Mountain has been successful to date. Translocations in 2017, 2018, 2019, and 2020 led to adult flight seasons. Reproductive success from the 2017, 2018, and 2019 releases were documented by postdiapause larvae observations in subsequent years and inferred by the distribution of adults across the entire release area. Use of *Plantago lanceolata* by prediapause larvae was documented in 2018 and 2019. Additionally, the larger patches of *P. erecta* provided reproductive success in Upper Owl and Buckeye Canyons. The phenology of *P. erecta* was favorable with senescence following peak flight by 5-6 weeks, meaning many prediapause larvae would have had sufficient fresh host plants until reaching diapause. In 2020, postdiapause larval surveys only found eight larvae along the Main Ridge, compared with 91 in 2019. But, the number of adults observed (and the sampling intensity) in 2020 was similar to 2017, when 3,630 larvae were released into empty habitat and produced 47 observed adults. We

therefore conclude that well more than the goal of 600 postdiapause larvae were present along the Main Ridge in 2020, and that detectability of postdiapause larvae in the denser grassland is lower than in sparse serpentine grassland. Breeding BCB are now established over two kilometers of suitable habitat along the Main Ridge. Hilltops are important features that serve as foci that help retain adult butterflies locally, and local hilltops along the Main Ridge have been hotspots for butterfly observations over three years.

The 2020 releases in lower Owl and Buckeye Canyons produced adult flights in numbers commensurate with the number of larvae released, and butterflies did not spread far from the release areas and aggregated at local hilltops. In general, adult butterflies were rarely found more than 100 m from the original release sites in any release year.

The hostplant switch to *Plantago lanceolata* has been successful so far. That plant species provides excellent prediapause larval habitat because it is locally abundant, and remains green and edible well beyond the time necessary for larvae to reach diapause. There was also successful reproduction on the native *P. erecta* and *Castilleja* spp. in the Upper Buckeye and Upper Owl areas (where *P. lanceolata* is not present) in all years; *P. erecta* and *Castilleja* phenology was favorable in those areas. Access to both species of *Plantago* will allow the butterflies choice and flexibility in oviposition preferences, depending on where they are.

For 2021 (the final year of CVPCP funding), the Northeast Ridge is the first choice for release because of its dense stands of *P. lanceolata* and local hilltops. But the NER is not yet dedicated habitat, and the proposed release needs to be approved by San Mateo County Parks. Other areas under consideration as backups are Hillside-Juncus and the Saddle. These areas will be surveyed in fall 2020 for distribution and abundance of *P. lanceolata*.

In addition, some patches of *P. erecta* rich grassland have been identified in the western reaches of SBM. April Brook supports a network of grassland patches with hostplants and nectar sources. A few patches near Pacific Rock also have *P. erecta* stands. But the areas are small, only a few hectares at most. In the long run, once the BCB is established firmly elsewhere, these might be targets for introduction.

Literature Cited

Ehrlich, P.R. and I. Hanski. (eds.) 2004. *On the Wings of Checkerspots*. Oxford Press, New York.

Niederer, C. 2020. Bay Checkerspot Reintroduction: Coyote Ridge to Edgewood Natural Preserve. Report to USFWS.

Niederer, C., L. Naumovich, S.B. Weiss. 2015. Bay checkerspot butterfly reintroduction feasibility study at San Bruno Mountain. Report to USFWS.

Severns. P.M and D. Grosboll. 2011. Patterns of reproduction in four Washington State populations of Taylor's checkerspot (*Euphydryas editha taylori*) during the spring 2010. Report submitted to the Nature Conservancy. 81 pp.

TRA Environmental Science. 1986. San Bruno Mountain Area Habitat Conservation Plan Activities Report 1986 http://www.traenviro.com/sanbruno/hcp/ann_reports/1986_report.pdf

TRA Environmental Sciences. 2008. San Bruno Mountain Habitat Management Plan 2007, Revised. Prepared for San Mateo County Parks in support of the San Bruno Mountain Habitat Conservation Plan.

Weather Underground (accessed 10/25/2020) https://www.wunderground.com/history/monthly/us/ca/san-francisco/KSFO