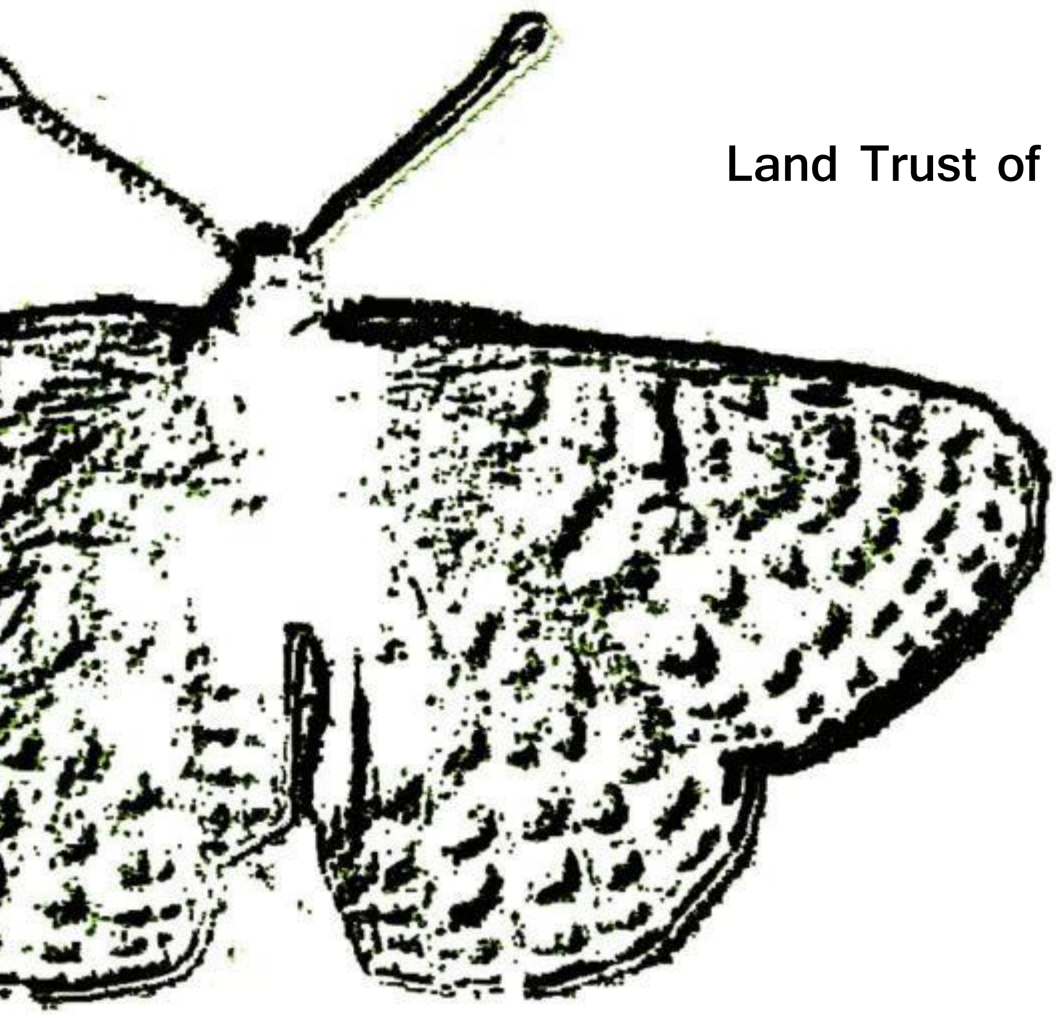
DOCKETED	
Docket Number:	99-AFC-03C
Project Title:	METCALF Energy Center Compliance
TN #:	241531
Document Title:	ANNUAL MONITORING REPORT FOR THE METCALF ENERGY CENTER ECOLOGICAL PRESERVE- 2021
Description:	BIO-11: 2021 ANNUAL MONITORING REPORT FOR THE METCALF ENERGY CENTER ECOLOGICAL PRESERVE
Filer:	Anwar Ali
Organization:	Metcalf Energy Center, LLC
Submitter Role:	Applicant
Submission Date:	2/14/2022 1:40:14 PM
Docketed Date:	2/14/2022

Year 2021

2021 ANNUAL MONITORING REPORT FOR THE METCALF ENERGY CENTER ECOLOGICAL PRESERVE AND LOS ESTEROS CRITICAL ENERGY FACILITY ECOLOGICAL PRESERVE

SANTA CLARA COUNTY, CALIFORNIA



Prepared for

Land Trust of Santa Clara Valley

117 Bernal Road, #70-181
San Jose, California, 95119

December 2021

Prepared by
Creekside Science
Stuart B. Weiss, Ph.D.,
Christal Niederer,
James Quenelle,
Marissa Kent
and Chris Schwind

Abstract

This report presents data from 2021 monitoring efforts for the Metcalf Energy Center Ecological Preserve (MEC Preserve/MEC) and Los Esteros Critical Energy Facility Ecological Preserve (LECEF Preserve/LECEF). These preserves were created to mitigate for impacts on nearby serpentine grasslands and the sensitive species they contain, including Bay checkerspot butterflies (BCB).

Highlights for 2021:

- The 2020-2021 water year saw about 44% of average precipitation, with most of the rainfall occurring in November through March.
- An analysis of the 6-year trend at eight sites showed a statistically significant ($p = 0.02$) decrease in nitrate, at a rate of -0.041 ppm/year.
- Grazing continues on the entirety of Tulare Hill. We recommend routine monitoring for cattle grazing pressure on jewelflower individuals, working with the grazing rancher to reduce cattle pressure at critical times, and RDM monitoring as a gauge for overall cattle impacts.
- Grazing regimes on Coyote Ridge continue with similar rates to previous years.
- Firelines from the Bayliss fire on Tulare Hill have passively revegetated, although some weed issues (yellow starthistle and tocolote) continue within the burned areas. In 2021 no stinkwort was found within the fire perimeter but surveys/treatment will continue in 2022.
- Weed management continues on Tulare Hill (*Arundo, Dittrichia, Centaurea* spp., etc.).
- Weeds in MEC-Coyote Ridge (MEC-CR) and the LECEF Preserve are largely restricted to nonnative annual grasses which are controlled by grazing.
- Dwarf plantain, the key BCB host plant, showed low cover across sites, with MEC-Tulare Hill (MEC-TH) hitting a historical low of 1.1% cover. We anticipate recovery in 2022 with changing weather patterns.
- Monitoring of long-term barbed goatgrass plots continues on Coyote Ridge. Multiple years of work in the LECEF Preserve has proven effective in goatgrass reduction, but eradication seems unlikely.
- Overall, Santa Clara Valley dudleya rosettes, inflorescences, and intact inflorescences increased in 2021. An ANOVA comparing 2021 with 2018 data still showed a significant change in the number of plants inside vs. outside of the fire perimeter. The intrinsic rate of increase was larger in the unburned plots.
- Metcalf Canyon jewelflower maintains its presence on Tulare Hill following a reintroduction project. Passive dispersal has been documented on MEC-TH. Seeding on MEC-TH took place on December 9, 2021. Two 400 square meter (20m x 20m) plots were seeded with about 40,000 seeds each.
- On Tulare Hill, a multiple-year BCB translocation project began in 2013 with the translocation of 5000 larvae and 60 adults (40 females and 20 males) from Coyote Ridge to the MEC Preserve and Pacific Gas and Electric Company (PG&E) properties. No larvae were released on Tulare Hill from 2017 through 2021. In 2021, one larva was found and a total of five adults were observed on official transects. This is compared with two larvae and five adults last year. We recommend additional monitoring, but at this point we do not anticipate translocating in 2022, although that decision could be changed based on dramatic increases in larvae at the source population or other factors. BCB activity has been documented in and around MEC-CR and the LECEF Preserve.
- No California red-legged frogs were observed in Fisher Creek, although habitat remains suitable. There is potential to create additional ponds on Tulare Hill that could greatly enhance regional dispersal corridors.

Contents

Tables

Figures

Maps

Photos

SECTION 1.0

Introduction

In consultation with the California Energy Commission (CEC) and U.S. Fish and Wildlife Service (USFWS), a habitat management and monitoring plan for the Metcalf Energy Center Ecological Preserve (MEC Preserve/MEC) was developed as part of Condition of Certification BIO-11 for the Metcalf Energy Center project. The plan was prepared and approved as Appendix G of the MEC Preserve Biological Resources Mitigation Implementation and Monitoring Plan (BRMIMP) in July 2001. The plan includes an annual monitoring report that is to be submitted to the USFWS, United States Environmental Protection Agency (EPA), California Department of Fish and Wildlife (CDFW), CEC, and Calpine Corporation (Calpine).

The following is the Year 2021 annual monitoring report for the MEC Preserve. The focus of this document is to further update the 2002-2020 reports with 2021 data. This effort will be ongoing (in perpetuity) to analyze habitat conditions and status of target species in the MEC Preserve on Tulare Hill and Coyote Ridge.

This report also continues to document monitoring results on a separate 40-acre parcel of Coyote Ridge that was preserved in 2005 for mitigation of impacts to serpentine species from the Los Esteros Critical Energy Facility (LECEF) developed by Calpine (Section 1.2).

1.1 Metcalf Energy Center Ecological Preserve Project

Calpine developed the Metcalf Energy Center, a 600-megawatt (MW) natural gas-fired power plant at the south edge of the City of San Jose in Santa Clara County, California (Map 1-1). Construction began in October 2001 and operations began in June 2005. The 20-acre plant site is located at the southeast corner of Tulare Hill, west of Monterey Road and north of the Blanchard Road junction. The Union Pacific Railroad right-of-way runs between Monterey Road and the site. Fisher Creek, a modified stream channel and tributary to Coyote Creek, flows along the northern and western boundaries of the project site. Tulare Hill, a serpentine outcrop formation and extension of the Santa Teresa Hills, lies directly west and north of this portion of Fisher Creek. Tulare Hill provides a “stepping-stone” connection between the serpentine habitats of the Santa Cruz Mountains to the west and the Diablo Range to the east (USFWS 1998). Coyote Ridge, an extension of the Diablo Range, contains large serpentine soil formations, and is located east of the Metcalf Energy Center site beyond Monterey Road, the Coyote Creek corridor, and U.S. 101 (Map 1-2).

The Metcalf Energy Center Application for Certification (AFC) was submitted to the CEC on April 30, 1999. The AFC addresses potential project impacts to biological resources in the project area. The AFC indicated that nitrogen oxides (NO_x) emissions from the Metcalf Energy Center could affect the sensitive serpentine habitats in the area by promoting growth of nonnative grasses. Serpentine habitats support a variety of special-status species in Santa Clara County that are adversely affected by excessive growth of nonnative grasses. In particular, studies have shown that nonnative grasses compete aggressively with the smaller serpentine plants such as dwarf plantain *(Plantago erecta)*, the primary host plant for caterpillars (larvae) of the federally-threatened Bay checkerspot butterfly (BCB [*Euphydryas editha* ssp. *bayensis*]). Strategic cattle grazing has become an important tool in managing these nonnative plant species in serpentine habitats and is a focus of the MEC Preserve management plan.

1.2 Los Esteros Critical Energy Facility Ecological Preserve Project

The Los Esteros Critical Energy Facility is a 320-MW natural gas-fired power plant located in northern San Jose, Santa Clara County. It was developed by Calpine Corporation on a 21-acre site within a light industrial zoned area. The emissions from the Los Esteros Critical Energy Facility during operations add nitrogen deposition effects to the Bay Area similar to the Metcalf Energy Center. The Los Esteros Critical Energy Facility was required to consult with USFWS on the potential impacts to the BCB and serpentine endemic plants. Habitat compensation was required to offset the impacts from nitrogen deposition, so a 40-acre parcel of serpentine habitat was purchased on Coyote Ridge. The location of the property is shown in Map 1-2. It lies at the base of the Coyote Ridge serpentine, between the Bailey Avenue and Coyote Creek Golf Drive exits from Highway 101. The parcel is contiguous with >5000 acres of continuous serpentine grassland habitat on Coyote Ridge that supports the core populations of the BCB. In addition to directly supporting serpentine habitats for protected species, this area has high strategic value for mitigation because of its proximity to Highway 101 and the Bailey Avenue interchange.

The management of the LECEF Preserve parcel is nearly identical to the 15-acre MEC Preserve parcel on Coyote Ridge (see Sections 1.4 and 5.0). Cattle grazing on Coyote Ridge is strategically conducted to manage serpentine habitat for BCB and serpentine endemic plants. Since the Land Trust of Santa Clara Valley (LTSCV) manages both the MEC and LECEF areas for Calpine through endowments, and much of the monitoring data and analyses are similar, continued annual reporting will include both MEC and LECEF mitigation areas.

A detailed site description of this parcel was included in Section 9.0 of the 2005 report. It is not repeated here in the interests of space and avoiding redundancy.

1.3 Agency Consultation and Establishment of the Metcalf Energy Center Ecological Preserve

The presence of federal special-status species and project effects to those species within the Metcalf Energy Center vicinity required Calpine to enter into formal Section 7 consultation under the federal Endangered Species Act (ESA) with the USFWS in 1999. A Biological Assessment was prepared to address project impacts on federal listed species, including the federal threatened Bay checkerspot butterfly, federal threatened California red-legged frog (CRLF [*Rana aurora draytonii*]), and federal endangered Santa Clara Valley dudleya (*Dudleya abramsii* ssp. *setchellii*). The USFWS Biological Opinion (BO) required mitigation for direct and indirect Metcalf Energy Center project impacts to federal threatened and/or endangered species in the Project Action area. The mitigation measures included, but were not limited to, preservation of habitat for the BCB; preservation and enhancement of the Fisher Creek riparian corridor for CRLF; and implementation of an appropriate management plan for natural resources in the preserved areas.

Calpine established the MEC Preserve to safeguard, enhance, and manage habitat for the special-status target species addressed in the BO. The MEC Preserve includes two parcels identified as Tulare Hill (MEC-TH) and Coyote Ridge (MEC-CR) (Map 1-2).

The MEC-TH parcel includes:

- Tulare Hill—an approximately 116-acre portion of Tulare Hill (that includes the flat areas at the top of Tulare Hill) which is to be managed for serpentine-associated species such as Bay checkerspot butterfly, Santa Clara Valley dudleya, and Opler's longhorn moth (*Adela oplerella*); and
- Fisher Creek Riparian Corridor—approximately 9 acres (after enhancement) of the Fisher Creek riparian corridor which is to be managed for wildlife including the California red-legged frog and Western pond turtle (*Clemmys marmorata*).

The MEC-CR parcel includes:

- Coyote Ridge—a 15-acre parcel on Coyote Ridge which is to be managed for serpentine-associated species including Bay checkerspot butterfly, Santa Clara Valley dudleya, and most beautiful jewelflower (*Streptanthus albidus* ssp. *peramoenus*).

The LECEF Preserve parcel includes:

- Coyote Ridge – a 40-acre parcel on Coyote Ridge which is to be managed for serpentine-associated species including Bay checkerspot butterfly. The parcel is contiguous with >5000 acres of continuous serpentine grassland habitat on Coyote Ridge that supports the core populations of the BCB.

The combined MEC Preserve parcels encompass approximately 138 acres that are protected from development under a Conservation Easement. The LECEF parcel encompasses 40 acres and is also protected under a separate

Conservation Easement. The total 178 acres of the preserves was donated by Calpine to LTSCV (previously known as the Silicon Valley Land Conservancy). LTSCV will manage the preserves in perpetuity with an endowment established by Calpine. The preserves are intended to maintain serpentine habitat for BCB and *Dudleya abramsii* ssp. *setchellii* as well as other special-status species known to occur, or with the potential to occur (or colonize), habitats within the preserves. Resource Management Plans for the preserves were developed during consultation with USFWS and CEC and subsequently approved. Stuart Weiss and other members of Creekside Science currently conduct the monitoring tasks as described in the Management Plan under LTSCV management.

1.4 Past Management of Preserve Lands

1.4.1 MEC-TH

The 339-acre Tulare Hill (TH) is currently zoned A-20 (Agriculture, 20-acre minimum) and is divided into four parcels: the approximately 116-acre MEC-TH; Pacific Gas and Electric Company's (PG&E) approximately 45-acre transmission line corridor; Santa Clara Valley Habitat Agency's (SCVHA) approximately 37 acres (purchased in 2019 from Tony Duong who previously purchased it from Tulare Hills Corporation); and Santa Clara County Park's approximately 141 acres (which was purchased from Whiskey Hill Associates, LLC, in 2009). Currently, SCVHA is in discussions with Santa Clara County Parks about transferring ownership of their newly acquired parcel to the County and reserving a conservation easement over the property to allow it to be enrolled in the Reserve system. MEC-TH includes Tulare Hill, south of the PG&E transmission line corridor (Map 1-2). PG&E's parcel includes 115, 230, and 500-kilovolt (kV) overhead electric transmission towers and lines that bisect Tulare Hill in an east-to-west corridor. PG&E also owns an easement on a graded, dirt road that crosses Fisher Creek to provide access to the transmission line corridor. Calpine installed a cross-fence defining the MEC-TH boundary with the PG&E corridor. Since the early 1990s, and most likely for many years prior, cattle were grazed on what is now the MEC-TH property. During that time, the cattle were free to graze all of Tulare Hill due to the absence of property fences. Approximately 100 or more cattle were grazed year-round on the entire 339 acres of Tulare Hill (~ one cow per 3 acres). Dr. Weiss considered this rate to be overgrazing, based on personal observations of very high bare ground, lack of forage, and extended need for supplemental feed for the herd. Cattle forage was supplemented with hay during the summer after existing grasses and serpentine vegetation dried up. The cattle obtained drinking water directly from Fisher Creek and natural springs on the hill. Under the MEC Preserve Management Plan, cattle are kept out of the creek and springs, and occupy MEC-TH at a lower stocking rate during the growing season as part of a strategic and adaptive grazing regime to enhance habitat for the target species. Drinking water is provided through a solar powered well and pump. The rancher providing cattle on MEC-TH is Justin Fields.

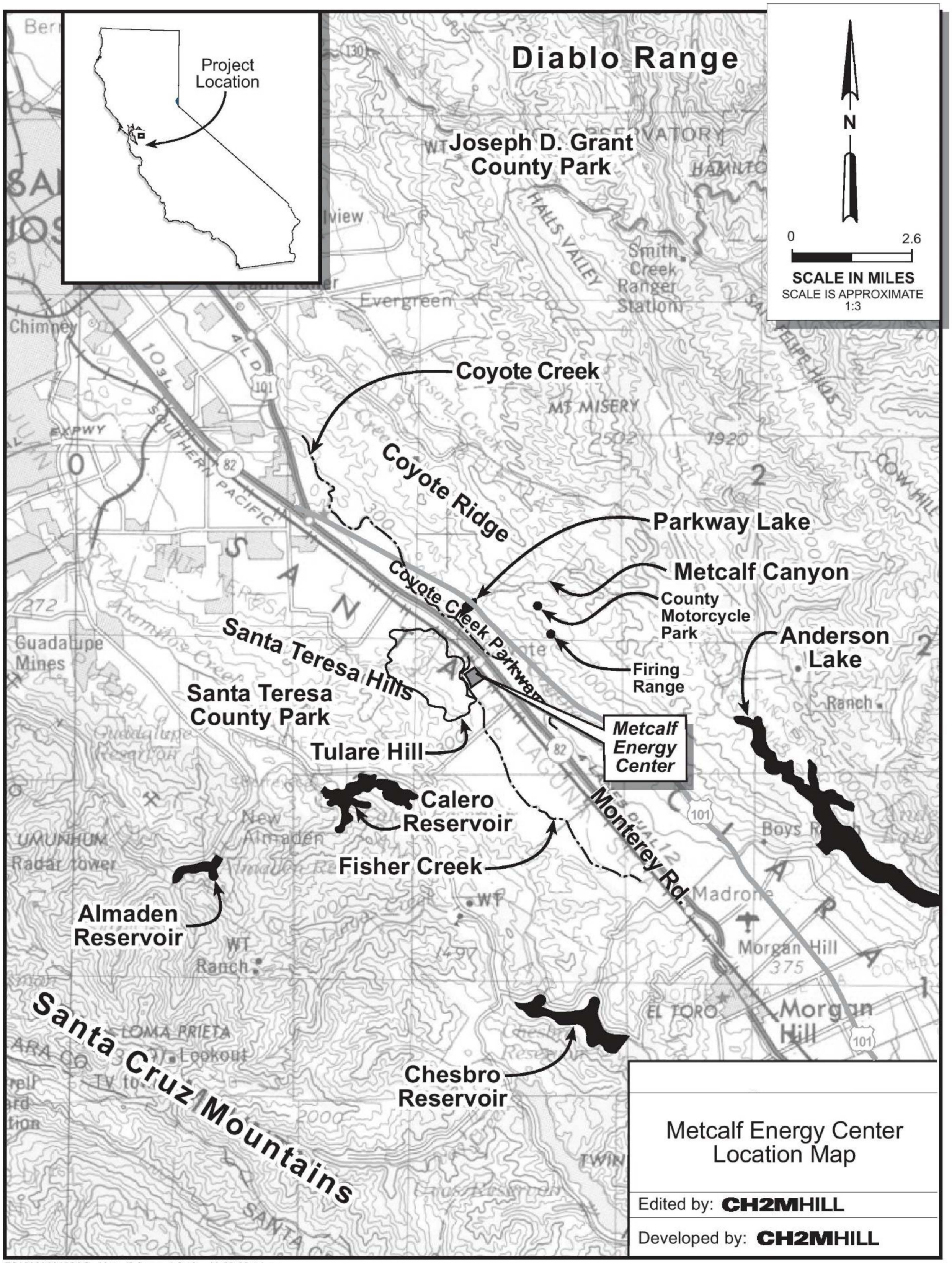
For BCB, the distribution of "topoclimates"—the gradient from warm, south-facing slopes to cool north-facing slopes—is a primary physiographic determinant of habitat potential and occupation by butterflies. A physiographic inventory—a quantitative analysis of the topography and geology of a landscape, which provides fundamental baseline data for inventory, monitoring, and management strategies—was presented in the 2003 and 2004 reports and has not been modified.

1.4.2 MEC-CR

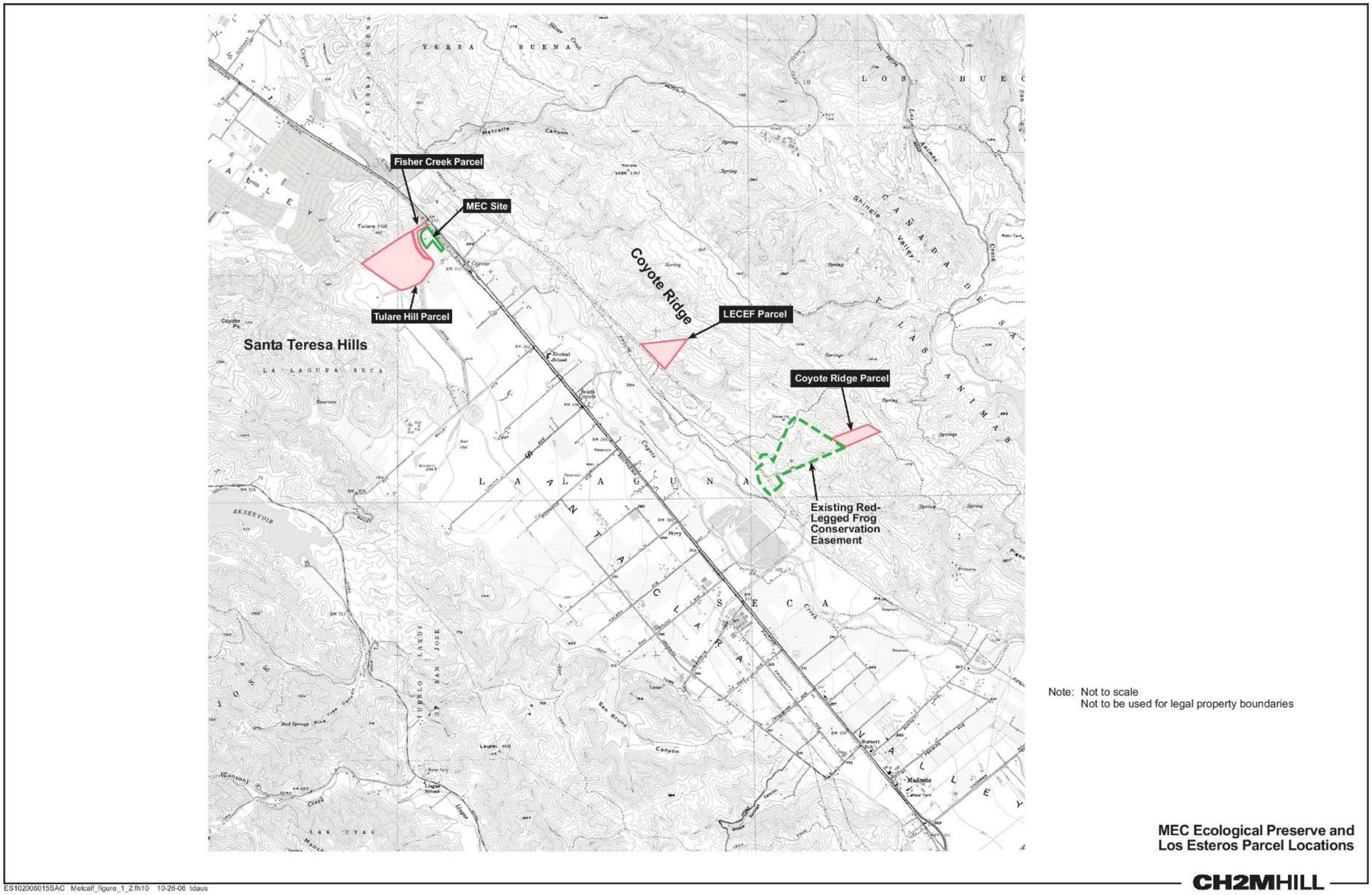
The Coyote Ridge parcel has been grazed by local cattle ranchers for many years, perhaps since the establishment of Spanish missions. Grazing focused on cattle production, which included rotationally grazing to ease pressure on serpentine grasslands. The current rancher, Richard Foreman (who previously worked under and replaced Tony Pierce in 2011) is familiar with the needs of serpentine species and maintains about 1 cow/calf pair per every 10 acres of land, grazed mainly in winter and spring. This grazing regime has been proven to benefit the serpentine habitat for BCB, as it is one of the core BCB population areas in the Santa Clara Valley (USFWS 1998). The MEC-CR parcel is part of a larger pasture, called the west ridge by local ranchers, consisting of approximately 1690 acres. It is also grazed mostly in winter and spring. While a fenceline separates this pasture from others, no fences separate the MEC-CR parcel from other parcels within this pasture. In general, fencelines on Coyote Ridge do not reflect property boundaries. There are currently no plans to fence the MEC-CR parcel as this would increase management efforts. Fencing and other cattle infrastructure (watering devices, salt blocks, etc.) would require extra maintenance.

1.4.3 LECEF

Past management of the LECEF parcel is nearly identical to the MEC-CR parcel, with a stocking rate of about 1 cow/calf pair per every 10 acres of land. The LECEF Preserve is part of a larger grazing pasture (named the second rockfield by local ranchers) that covers approximately 810 acres. In the past, the second rockfield received mainly summer and fall grazing, but that switched to spring and fall grazing in 2006, summer grazing in 2007, and spring grazing in 2008 and 2009. In subsequent years, grazing season has been altered slightly to account for annual precipitation, amount of forage, and availability of alternate pastures. The current rancher is Justin Fields. More details are given in Section 5.2.



Map 1-1 Metcalf Energy Center location map.



Map 1-2 MEC Preserve and LECEF Preserve parcel locations.

SECTION 2.0
Weather

2.1 Weather

Interannual changes in California annual grassland habitats tend to be driven by climatic variation (D'Antonio et al. 2006), and BCB habitat is no exception. Because weather can be a more important factor affecting habitat than management, we present yearly precipitation data here.

These data are presented for the Kirby Canyon Butterfly Reserve (Kirby Canyon or KC), located on Coyote Ridge adjacent to the Valley Transportation Authority (VTA) property (WestMap 2018, 2019, 2020, 2021) (Figure 2-1). From 1981 to 2010 (which we will consider a baseline), data show average precipitation at 58.9 cm, with a standard deviation of 22.5 cm (WestMap 2014). Each weather year runs from October to September. In 2020, precipitation was about 60% of average at 35.2 cm. Precipitation totals for 2021 were about 44% of average at 25.7 cm.

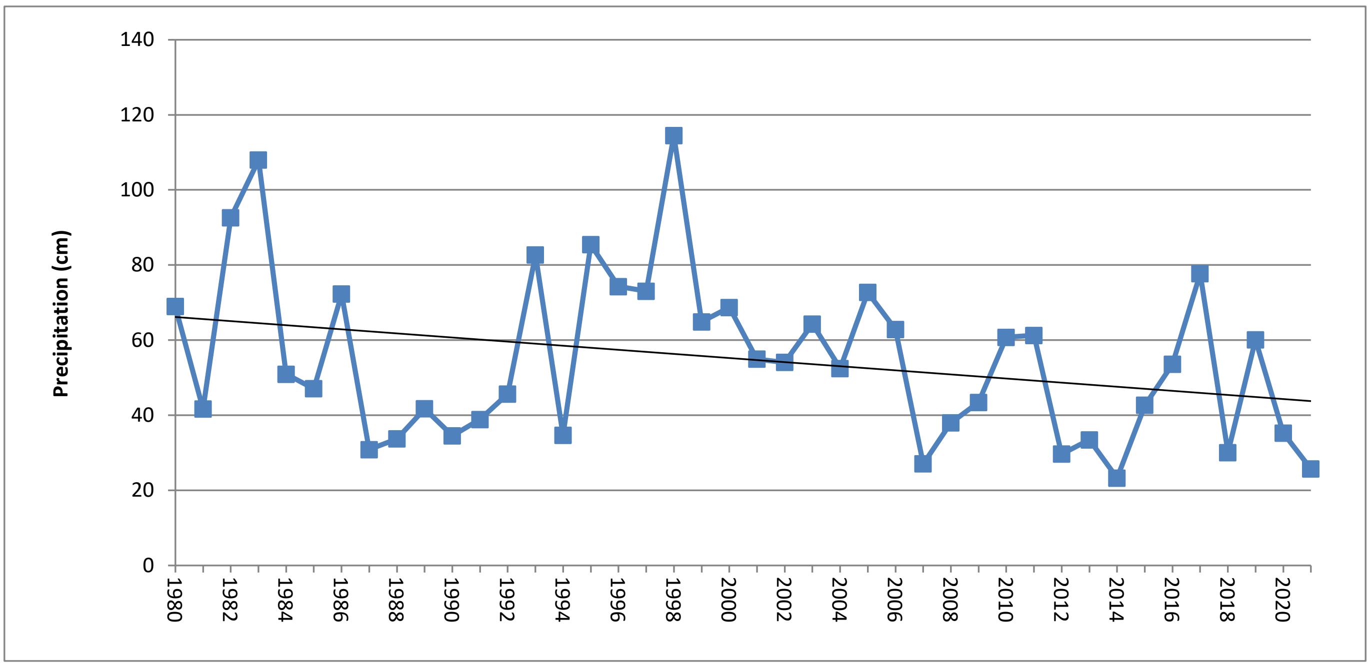


Figure 2-1 Annual precipitation at Kirby Canyon.

Perhaps more important than total precipitation is the pattern of precipitation, which also varies widely. Similar amounts of rainfall could have different effects on BCB (and associated vegetation) depending on when it occurs. For example, early rains are beneficial as germination events induce BCB to emerge from diapause, while heavy rains during the flight season could limit reproductive success.

Monthly patterns for 2020 and 2021 are shown in Figure 2-2 and Figure 2-3. Two years are shown because the previous year drives BCB, and the current year drives vegetation patterns. In 2020, precipitation was about 60% of average at 35.2 cm , with most of the precipitation occurring in December and March. In 2021, precipitation was even lower than last year at 25.7 cm, which is about 44% of average. Precipitation only fell in November through April and was well below average (and well below 5 cm) for all these months except for January, where precipitation was slightly above average at 14.8 cm. The last precipitation fell on April 26 (WestMap 2021). More extensive precipitation records are shown in Table 2-1.

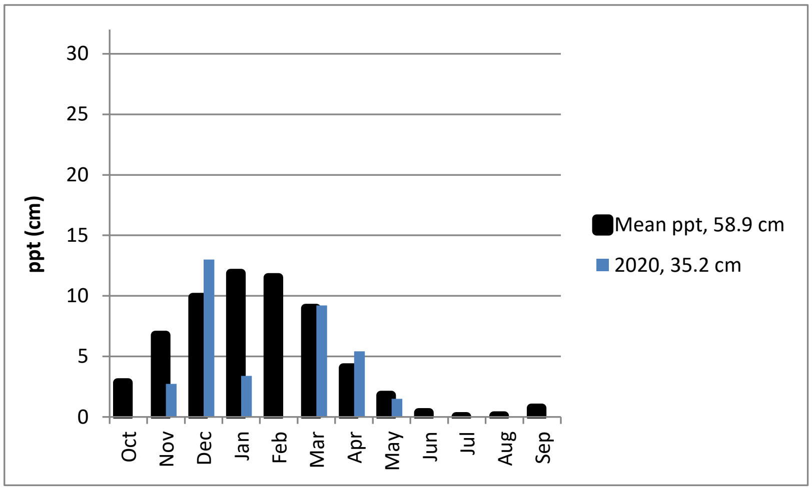


Figure 2-2 Precipitation in 2020 compared with average.

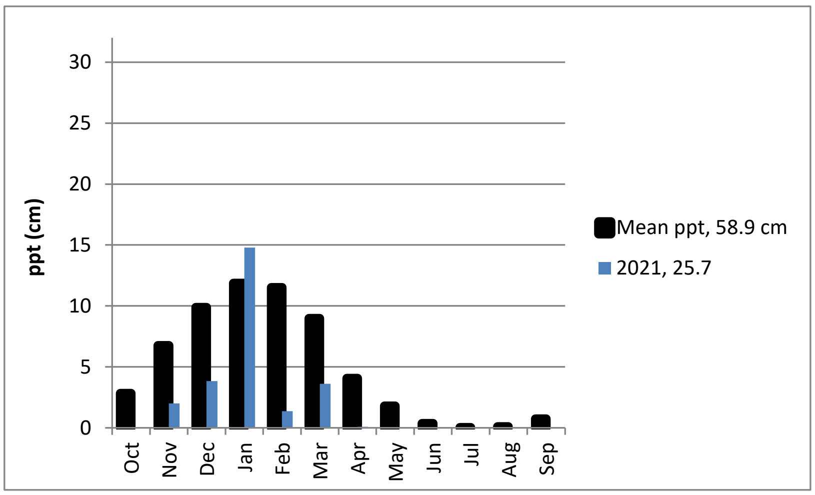


Figure 2-3 Precipitation in 2021 compared with average.

	Yearly Precipitation (cm)
Oct 2011-Sep 2012	29.6
Oct 2012-Sep 2013	33.4
Oct 2013-Sep 2014	23.3
Oct 2014-Sep 2015	42.6
Oct 2015-Sep 2016	53.6
Oct 2016-Sep 2017	77.7
Oct 2017-Sep 2018	30.0
Oct 2018-Sep 2019	59.7
Oct 2019-Sep 2020	35.2
Oct 2020-Sep 2021	25.7
Average 1981-2010	58.9

Table 2-1 Yearly precipitation records, 58.9 cm average for 1981-2010 (WestMap 2014, 2018, 2019, 2020, 2021).

Cool March and especially April temperatures favor checkerspots, as they allow host plants to stay fresh longer as prediapause larvae race to the fourth instar when they can enter diapause. In 2020, March was considerably cooler than average and April was slightly cooler than average. In 2021, March was cooler than average and April was slightly warmer than average (Table 2-2).

	March	**April**
2012	15.9	18.5
2013	19.6	21.7
2014	19.9	20.3
2015	21.9	19.9
2016	18.5	20.7
2017	18.8	19.1
2018	16.5	20.2
2019	16.3	21.4
2020	16.1	20.3
2021	16.8	21.0
Average 1981-2010	18.2	20.6

Table 2-2 Average maximum temperature (˚C) (WestMap 2014, 2018, 2019, 2020, 2021).

SECTION 3.0

Historical Range of Variability, Intersite Comparisons and Success Criteria

3.1 Background

Important baseline data for the MEC Preserve can be drawn from past studies of local serpentine habitat areas. Serpentine grasslands are notoriously variable in plant composition from year to year. Yearly snapshots can be potentially misleading, and only long-term data can provide estimates of the variability inherent in the ecosystem in response to weather, topography, nitrogen (N)-deposition, and resource management. This section presents a summary of long-term monitoring data from 1991 to 2000 from Kirby Canyon (located near MEC-CR), which provides the benchmark for high quality BCB habitat. These data give us Kirby Canyon's historical range of variability (HRV), which serves as success criteria for MEC-TH. As such, this section compares Kirby Canyon HRV data to 2021 monitoring data from MEC-TH.

A more complete presentation of the HRV at Kirby Canyon (and Jasper Ridge Biological Preserve) can be found in the 2003 and 2004 reports.

3.1.1 Biological Resources Mitigation Implementation and Monitoring Plan Success Criteria

The following is from the Resource Management Plan for the MEC Preserve, part of the BRMIMP:

> The success of the Management Plan will be determined by the stability, abundance, and persistence of Santa Clara Valley dudleya and Bay checkerspot butterfly and Opler's longhorn moth host plant populations (dwarf plantago, owl's clover, and California cream cups). Success will depend upon the maintenance of serpentine habitat and the continued function of Tulare Hill as an important corridor between areas of serpentine habitat on Coyote Ridge and the Santa Teresa Hills. In a regional context, Tulare Hill sits in the warmest and driest portion of the Coyote Valley. Bay checkerspot populations at low elevations around the Coyote Valley have been historically subject to wide fluctuations, including local extinctions, driven by weather extremes of drought and warmth. Therefore, it is expected that any Tulare Hill Bay checkerspot butterfly populations will always have a nontrivial probability of local extinction, even if habitat management provides high levels of hostplant and nectar resources…
>
> …Success of the grazing program on both Tulare Hill and Coyote Ridge will be judged by the maintenance of dense stands of larval hostplants and adult nectar sources that lie within or above the Historical Range of Variability (HRV) observed at Kirby Canyon since 1991.

3.2 Density of Plant Cover

The reference data from Kirby Canyon and MEC-TH presented here are taken from plant cover density measurements of five species that are representative of four categories of annual forbs: 1) dwarf plantain (*Plantago erecta*) and owl's clover (*Castilleja* spp.), the BCB host plants; 2) goldfields (*Lasthenia californica*), a significant BCB nectar source; 3) California cream cups (*Platystemon californicus*), the Opler's longhorn moth host plant; and 4) Italian ryegrass (*Festuca perennis*)[1], an invasive, non-native grass. Data on *Festuca perennis* are presented because it epitomizes the invasive annual grasses that can grow vigorously in serpentine soils, compromising the growth and density of native forbs on which the BCB and Opler's longhorn moth depend.

[1] Italian ryegrass (*Festuca perennis*) was previously reported as *Lolium multiflorum*. Prior to the 2011 report, nomenclature was from the 1993 edition of The Jepson Manual. Since 2011 nomenclature is from The Jepson Manual II (Baldwin, 2012).

See Table 3-1 for a summary of MEC-TH *Plantago*, *Castilleja*, *Lasthenia*, *Platystemon,* and *Festuca* cover ranges relative to Kirby Canyon HRVs.

Site	***Plantago erecta* cover**	***Castilleja* spp. cover**	***Lasthenia californica* cover**	***Platystemon californicus* cover**	***Festuca perennis* cover**
KC 1991-2000	1.2%-16%	0%-0.8%	1.5%-13%	0%-0.3%	1%-10%
MEC-TH 2021	1.1%	0%	0.5%	0%	3.1%

Table 3-1 Plant cover density ranges at Kirby Canyon and MEC-TH.

Allium serra and *Muilla maritima* (both BCB nectar sources) are present on MEC-TH with low but persistent cover. *Lomatium* spp. has not been detected in plots on MEC-TH since 2015.

Details on cover densities for these species and others at Kirby Canyon and MEC-TH from 2012 to 2021 are available in Section 6 of this report. Details on Kirby Canyon cover densities prior to 2012 are available in previous reports.

As mentioned before, the degradation of BCB habitat on other sections of Tulare Hill was the result of lack of grazing on the PG&E, Whiskey Hill, and Habitat Agency (formerly Duong) properties. These were circumstances beyond our control. With the return of grazing to these properties in 2008, habitat improved throughout Tulare Hill.

MEC-CR is subject to the same grazing regime as nearby Kirby Canyon. BCB are present at MEC-CR, and their host and nectar plants are abundant within the parcel.

Dudleya abramsii ssp*. setchellii* is well distributed across both MEC-CR and MEC-TH (see Section 8).

Except for *Lasthenia* and *Plantago* cover, the BRMIMP success criteria were achieved in 2021. These low values for *Lasthenia* and *Plantago* cover were seen regionally, and were likely due to the exceptional drought this year. *Castilleja* and *Platystemon* were within the success criteria but at the lowest end of the range this year (cover values have been higher in previous years so this year's zero has not been a multi-year trend). While these taxa were not found specifically in monitoring plots, they were observed around the hill. We expect values to recover in 2022. *Festuca perennis* cover remained low this year.

SECTION 4.0
Nitrogen Deposition Monitoring

Fuel-burning sources such as combustion vehicles and natural gas power plants produce airborne exhaust containing nitric oxide (NO_x) gas. Control of NO_x emissions by catalytic converters can also release ammonia gas (NH_3). These gases are a major component of smog. Both NO_x and NH_3 undergo further reactions and form nitric acid vapor (HNO_3), ammonium nitrate particulates (NH_4NO_3), and mediate ozone (O_3) production. These various nitrogen species dry deposit onto surfaces, as well as dissolve in rain and fog, and can add substantial amounts of nitrogen to serpentine soils (Weiss 1999).

Serpentine soils are characteristically low in nitrogen and thus nutrient deficient for the growth of most plant species. Species associated with serpentine habitat are more suited to low nitrogen levels. Nutrient amendment in the form of nitrogen deposition can have a significant impact on vegetative species composition. The deposition can further encourage the growth and spread of nonnative grasses that compete for space with native species such as BCB host and nectar plants (Weiss 1999).

The Resource Management Plan for the MEC Preserve includes plans to assess the nitrogen deposition at the MEC Preserve and other nearby serpentine grassland sites. In south San Jose, where the MEC Preserve is located, there are high background levels of nitrogen compounds in the air. In particular, the nitrogen dioxide and NO_x compounds can be seen on many days as the brown haze that sits over the Santa Clara Valley.

4.1 Nitrogen Monitoring Results

4.1.1 Work to Date

The activities that have been reported on in this section over the years are briefly condensed as:

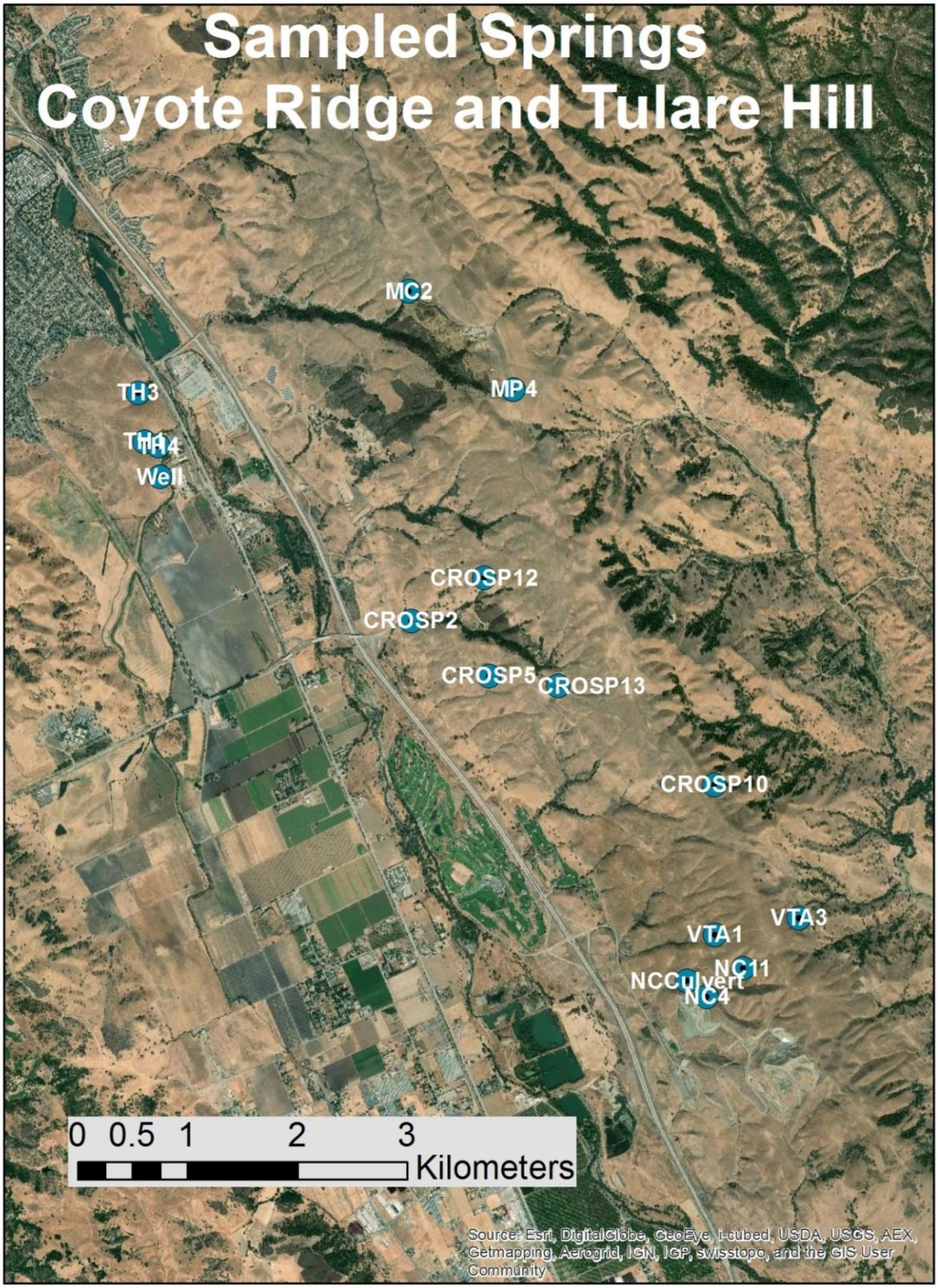
1) The results of passive sampler studies in 2002-2003, estimating that deposition at TH is 15-20 kg-N ha^{-1} $year^{-1}$, and MEC-CR is 10-15 kg-N ha^{-1} $year^{-1}$
2) The CMAQ 4 km map of N-deposition for year 2002, which matches the CR-high values of 10-12 kg-N ha^{-1} $year^{-1}$ (Fenn et al., 2010)
3) Connections to development and implementation of the Santa Clara Valley Habitat Plan
4) A review of the work done by UC Santa Cruz researchers, including repeat sampling of several passive monitor stations in 2010-11 and a series of experiments on nitrogen and grazing
5) Some other recent key scientific literature and ongoing presentations and conference sessions
6) A summary of the Local Assistance Grant (LAG) to the Santa Clara Valley Habitat Agency (presented in the 2018 report)
7) Nitrate sampling since the LAG grant

4.1.2 2021 Nitrate Sampling

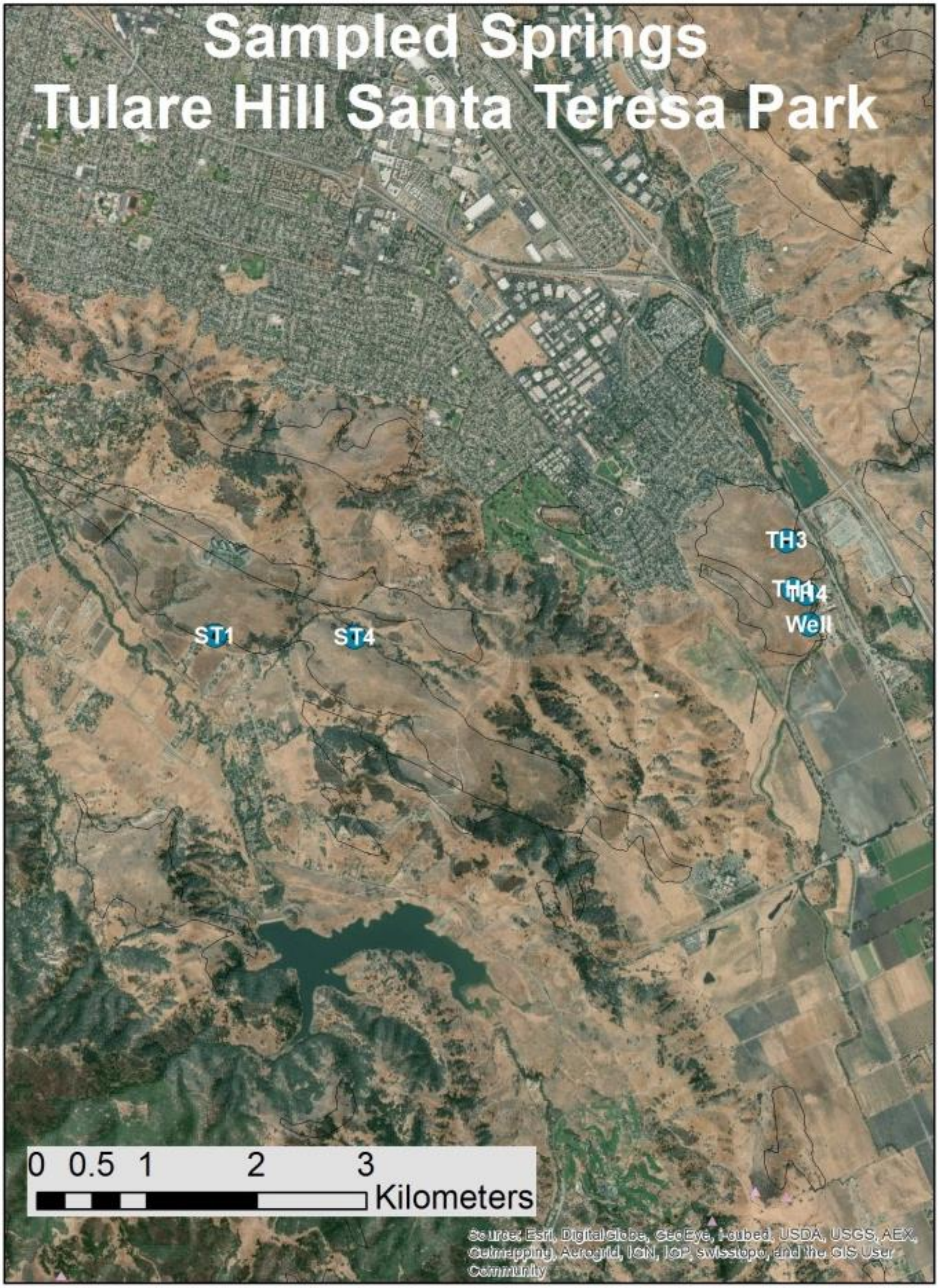
In 2021, a reduced round of nitrate sampling was completed with funding from LTSCV via deposition monitoring funds allocated in the MEC and LECEF budgets. The Santa Clara Valley Habitat Agency did not fund any nitrate work in 2020 and 2021, because of budget cutbacks driven by COVID-19 uncertainty.

4.1.2.1 Methods

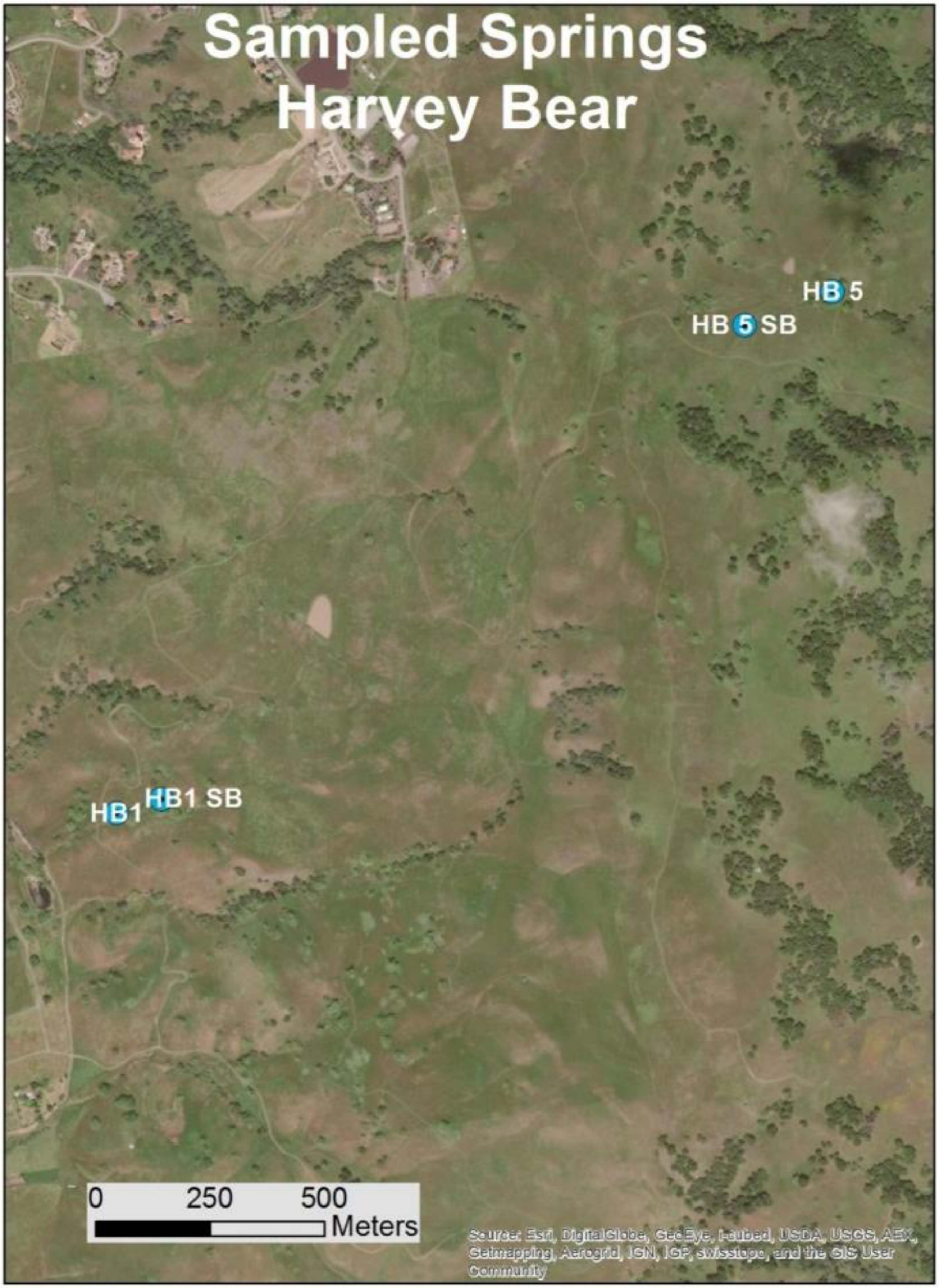
In 2021, 15 sites out of the ensemble of 21 springs and wells were sampled on October 18. All the sampled springs are shown below in Map 4-1 (KCwell was not sampled in 2021). The four springs in Santa Teresa Hills (Map 4-2) and the Harvey Bear Ranch (Map 4-3) were not sampled as a cost saving measure, but will be resampled when SCVHA provides funding for another round.



Map 4-1 Coyote Ridge and Tulare Hill springs in ensemble.



*Map 4-2 Springs on Tulare Hill and Santa Teresa County Park. *ST1 and ST4 were not sampled in 2020 and 2021.*



*Map 4-3 Springs at Harvey Bear County Park. *These springs were not sampled in 2020 and 2021.*

Statistical analyses included descriptive means, standard deviations (SD), and coefficient of variation (CV = SD/mean) across all sample years (for most sites 2017-2020) with several sites sampled in 2015 and 2016. An analysis of covariance (ANCOVA) examined the 6-year trend using eight sites.

Total deposition (TDEP) maps (3-year averages 2016-2018) produced by the US EPA were downloaded (National Atmospheric Deposition Program 2019). Total deposition was compared with 2012-2014 to document recent trends. These maps provide coarse spatial patterns (12 km for dry deposition, 4 km for wet) and include all nitrogen species so that the drivers of gradients can be determined. The 2017-2019 three-year averages are not yet available.

Bay Area Air Quality Management District (BAAQMD) data for San Jose stations document longer term trends in NO_x concentrations (Bay Area Air Quality Management District, 2021). The LAG report included data through 2018, and those data are updated to 2021 in this report.

More detail on the methods and rationales are found in the 2019 LAG report (Weiss, S.B. *Assessment of Nitrogen Deposition and Spring Water Nitrate for the Santa Clara Valley Habitat Plan*. March 2019). This report is essential background for interpretation of the 2021 data.

4.1.2.2 Results

Table 4-1 presents the nitrate concentrations for all years and sites. The UTM coordinates and elevation can be found in previous reports. Site locations are shown in Map 4-1, Map 4-2 and Map 4-3, above). Highlights for individual sites include:

1. The highest nitrate (9.4 ppm) was in the JQ Well, a 65' deep domestic supply well in the western foothills of Morgan Hill. This is used as a long-term reference site and is not directly relevant to the serpentine sites – N-sources here include septic systems and local agriculture in addition to atmospheric deposition. It increased by 0.9 ppm from 2020 to 2021, but was higher (9.8 and 9.7 ppm) in 2016 and 2018).
2. TH1 (5.1 ppm) and CROSP2 (4.9 ppm) had the highest nitrate of the serpentine sites, 50% of the drinking water nitrate standard (10 ppm). They are both rock outlet springs at low elevation close to San Jose. These sites have been consistently the highest since sampling began and did not change from 2020 to 2021.
3. CROSP12 (3.1 ppm) has decreased substantially from 2018 (4.7 ppm) and 2019 (3.5 ppm) and did not change from 2020 to 2021. The trough outlet is 300 m (1000 ft) from the actual springbox.
4. MC2 (4.3 ppm) had decreased from 4.5 in 2018 to 4.1 ppm in 2020, and increased in 2021.
5. VTA3 (3.8 ppm) held steady through the period (range 3.9-3.7 ppm).
6. The TH4 well (2.8 ppm) fell substantially from 2019 (4.5 ppm) and 2020 (3.3 ppm), and is now similar to 2017 (3.0 ppm). This site may require special sampling care because the pump that feeds the watering trough is not active in October – from now on it will be thoroughly flushed so that fresh well water is sampled. It also samples deeper water that may be affected by nearby agricultural sources.
7. CROSP5 (4.0 ppm) remained the same as in 2020 (4.1 ppm), and has been relatively variable (range 2.6 ppm). The 2019 anomaly (1.9 ppm) appears to be an issue with "plumbing", as the springbox is well upslope of the trough, and there may be surface exposure of the water.
8. NCCulvert (3.2 ppm) is a stream draining a low elevation catchment just north of the Kirby Canyon Landfill. It remained the same as in 2020, and has been relatively steady through the 2016-2021 period (range 0.3 ppm).
9. KCwell was dropped from sampling because of inconsistent values and unknown plumbing issues.
10. NC4 (1.5 ppm) has exhibited variable behavior including 2015 (1.3 ppm) and 2017 (2.1 ppm). This stream site drains an area of ~35 ha, and may have some complex dynamics as different subwatersheds flush out nitrate with varying precipitation.

Site	2015	2016	2017	2018	2019	2020	2021	Mean	S.D.	C.V.	Range
JQ well		9.8		9.7	8.8	8.5	9.4	9.20	0.65	0.07	1.30
TH1	5	5.2	5.4	5.2	5.2	5.1	5.1	5.20	0.13	0.03	0.40
CROSP2		5.2	5.5	5	5.4	4.9	4.9	5.28	0.25	0.05	0.60
CROSP12			4.2	4.7	3.5	3.1	3.1	4.13	0.71	0.18	1.60
MC2			4.4	4.5	4.3	4.1	4.3	4.40	0.17	0.04	0.40
TH4		4.6	3	4	4.5	3.3	2.8	4.03	0.71	0.18	1.60
VTA3		3.9	3.6	3.7	3.7	3.7	3.8	3.73	0.11	0.03	0.30
CROSP5		4.5	4.5	3.6	1.9	4.1	4	3.63	1.08	0.29	2.60
ST1			2.8	3.6	3.5			3.30	0.44	0.13	0.80
NC11		3.2	3.3	3.5	3.6	3.2	3.2	3.40	0.18	0.05	0.40
NCCulvert		3.2	3.5	3.4	3.3	3.2	3.2	3.35	0.13	0.04	0.30
CROSP13			3.6	3.4	4	4.2		3.67	0.37	0.10	0.80
HB1			3.7	3.3	3.3			3.43	0.23	0.07	0.40
MP4			3.5	3.2	3.6		3.1	3.43	0.21	0.06	0.40
VTA1	2.9	3.3	3.3	3.1	3.1	2.9	2.9	3.14	0.18	0.06	0.40
TH3			3.1	3	3.2	2.4	2.6	3.10	0.36	0.12	0.80
ST4			3.8	3	2.7			3.17	0.57	0.18	1.10
CROSP10			2.9	2.7	2.5	2.9	2.3	2.70	0.19	0.07	0.40
HB5			2.5	2.5	2.4			2.47	0.06	0.02	0.10
KC well			2.9	2.2	0.4	0.5	X	1.84	1.25	0.83	2.49
NC4	1.3	1.4	2.1	1.7	2	1.7	1.5	1.70	0.32	0.19	0.80

Table 4-1 Raw data from 2015-2021, all ppm NO_3-N. UTM coordinates and elevations can be found previous reports.

Site differences

Figure 4-1 is a graphical compilation of all data in Table 4-1 showing each year as a bar within each site, the black bar is the 2021 data. Note that with a few exceptions, nitrate levels within sites were broadly similar across years.

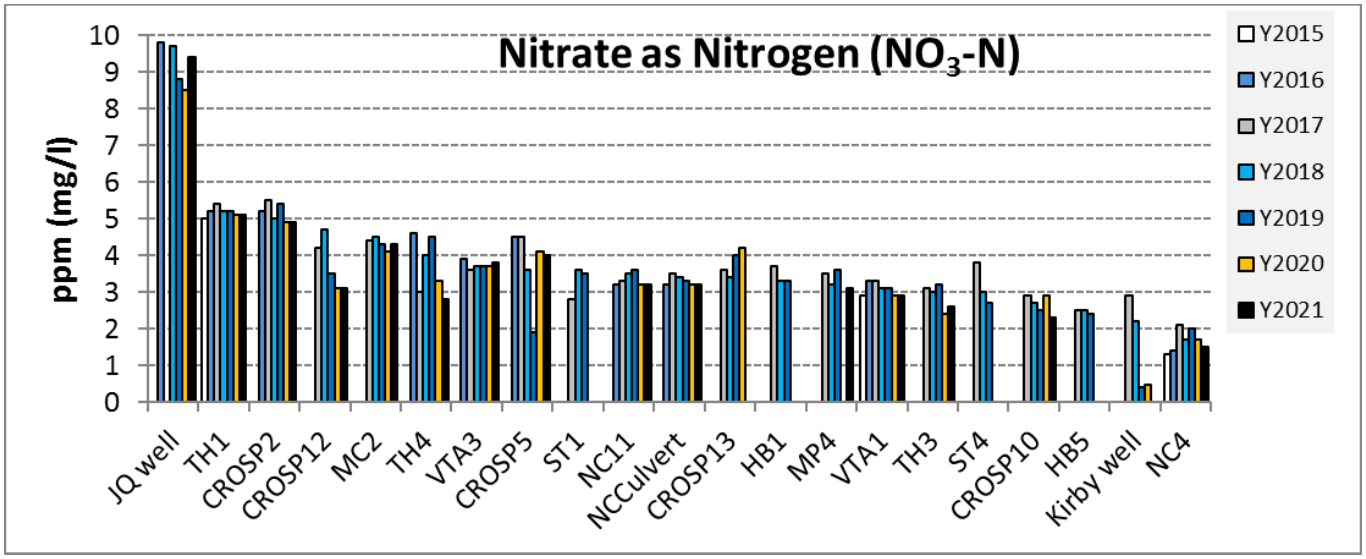


Figure 4-1 Nitrate concentrations in all sites and years.

Site outliers and potential sampling issues

Most sites stayed within a narrow range of ±1 ppm. Several sites showed large variability that suggests potential sampling errors. Site KC well – the water supply well at Kirby Canyon – dropped from 2-3 ppm to <0.5 ppm, and has been dropped from the sampling ensemble; we are unsure of the plumbing that brings the water to the hose outlet. And CROSP5 decreased from >4 ppm in 2016 and 2017 to 1.9 ppm in 2019 and then back up to 4.1 ppm in 2020 and 4.0 ppm in 2021; the plumbing here appears to be in poor shape. Many of the cattle troughs are going to be refitted with new spring boxes and plumbing.

Trends

An analysis of covariance (ANCOVA) of the eight seeps and springs over the 6-year period from 2016-2021 detected an overall significant downward trend (-0.041 ppm/year, $p = 0.02$) (Figure 4-2). This trend only became significant after six years using all eight sites. Five sites had downward trends and three sites held steady or had slight upward trends. The trend does correlate to the long-term decrease in NOx, considering the lag time and multi-year averaging of nitrate levels. NO_2 concentrations at Jackson Street decreased from 0.013 ppm in 2014 to 0.009 ppm in 2021 (see below Figure 4-4, as well as a discussion of COVID-19 lockdown impacts). This detection of a downward trend reinforces the utility of the nitrate sampling for monitoring atmospheric deposition.

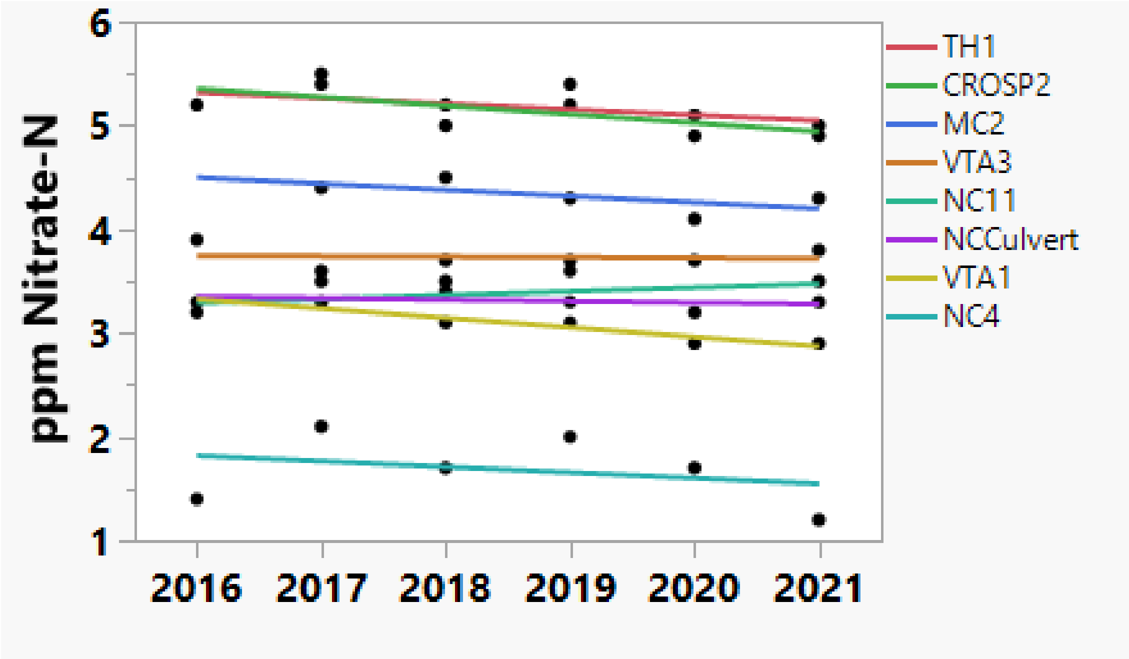


Figure 4-2 Selected time series of nitrate concentrations at spring and seep sites, 2016-2021. The overall downward trend was 0.041 ppm/year (p = 0.02).

Nitrate levels in these springs are estimated to reflect a 1-4 year average of deposition, based on the analysis of residence times presented in the 2019 LAG report. Deposition itself changes slowly from year to year. The comparison of 2012-2014 average and the 2016-2018 averages shows an increase on the order of 0.25 kg-N ha^{-1} yr^{-1} in the grid cells that contain the springs (Figure 4-3). Strong trends in nitrate (up or down) should only appear after many years of strong trends in deposition. The TDEP grids have not yet been updated to include a 3-year average from 2017-2019 or 2018-2020.

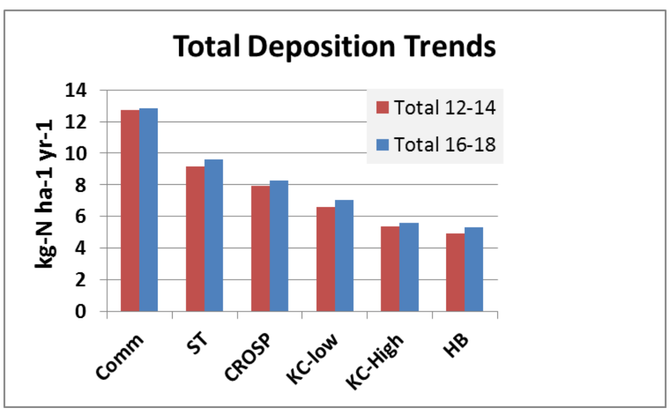


Figure 4-3 Trend in 3-year average total deposition from 2012-2014 to 2016-2018.

Spatial Patterns

The spatial analysis done in the 2019 report are not possible to repeat without the presence of Harvey Bear and Santa Teresa Hills, so spatial analysis will not be presented this year. The 2017-2019 analyses showed that nitrate levels were greater closer to San Jose and at lower elevations, consistent with the measured N-deposition gradients, TDEP, and inferences from air pollution meteorology (see LAG report for more details). The data in 2021 and 2020 are consistent with the 2017-2019 results, but the sample size does not have the statistical power and leverage for a complete spatial analysis.

Longer trends

BAAQMD data (annual concentrations) from 2003-2020 shows long term downward trends in both NO and NO_2 (Figure 4-4). Note that the downward trend has continued through 2021, despite some short periods of stability. Jackson St. is just north of downtown San Jose, and Knox Ave. is next to the 101-280-680 interchange.

The longer time series (Figure 4-5) shows that NO_2 concentrations have dropped from 0.032 ppm in 1988 to 0.009 ppm in 2021, about 3.5-fold. Note how there can be short-term (2-4 year) periods where concentrations remain steady, and upticks are only 1 year long. The overall long-term trend is 0.0007 ppm/year.

Unfortunately, NH_3 concentrations are not measured, and long-term trends can only be described from TDEP maps going back to 2000. NH_3 trends are upward over the long-term. The longer-term trends in NH_3 and HNO_3 and their causes are discussed in the LAG report.

Does the COVID-19 shutdown appear in the data?

The COVID-19 lockdown started in mid-March 2020, and led to a dramatic decrease in traffic and emissions. Several studies have detected broad-scale reductions in NO_x and NH_3 in response to COVID-19 lockdowns (i.e., Hoang et al. 2021, Muhammad et al. 2020, Cao et al. 2021). The annual rate of decline in San Jose NO and NO_2 in 2020 and 2021 (0 to 0.002 ppm/year) was not out of line with the long-term trend. Attributing any change in measured pollutants specifically to the lockdown requires a level of analysis beyond this report, at the monthly level and including differences in meteorology and potentially using satellite data (i.e., Cao et al. 2021). However, because the spring water nitrate represents a 1-4 year average in the catchment, any signal will be muted and subsumed in the longer-term trend discussed above.

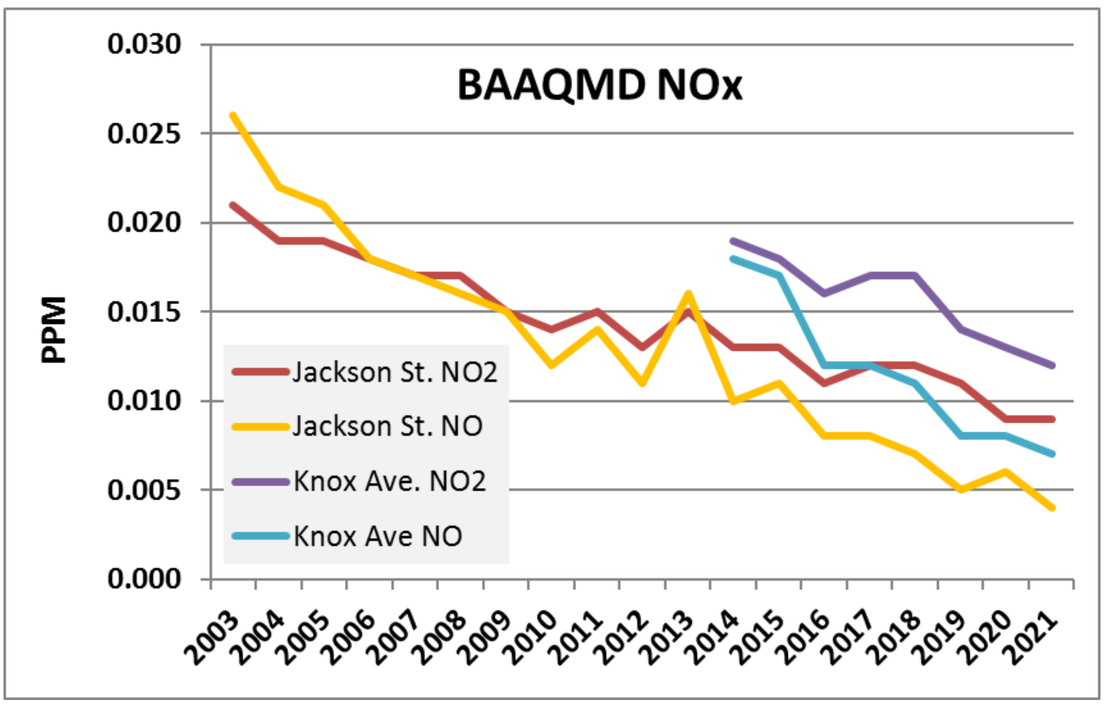


Figure 4-4 Measured NO_2 and NO at two San Jose BAAQMD stations. Jackson St. is the long- term station just north of Downtown San Jose. Knox Ave. is adjacent to the 280-680-101 interchange and represents a heavily polluted roadside environment.

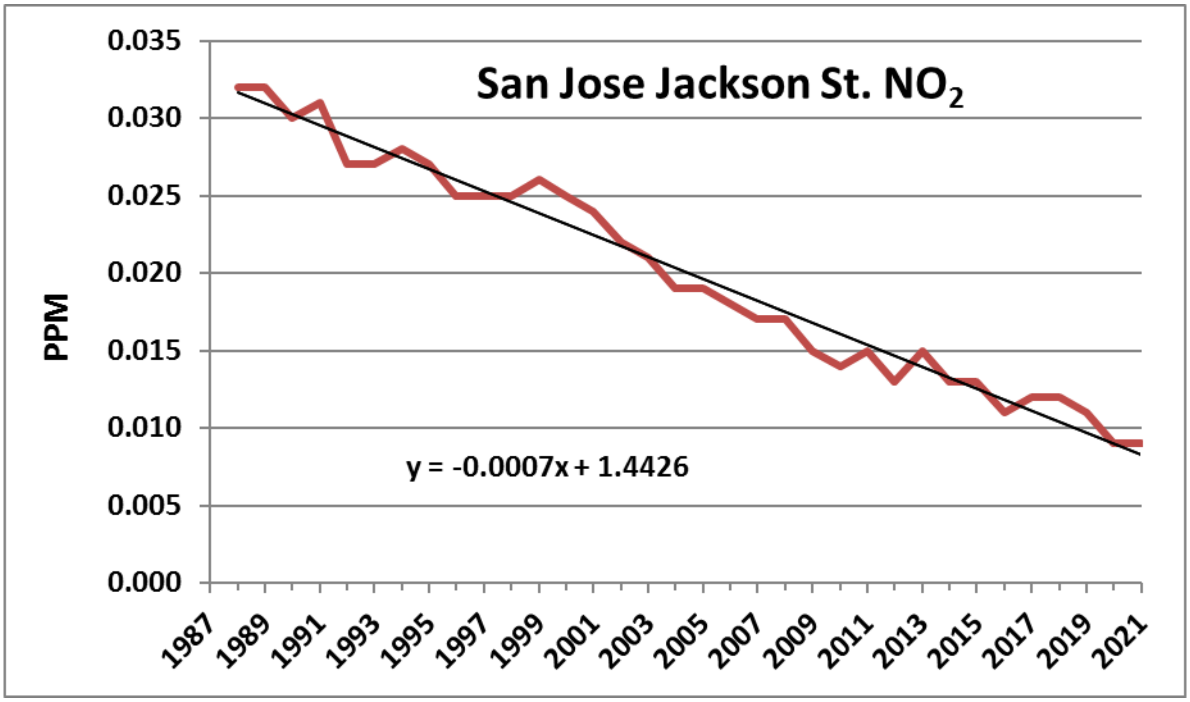


Figure 4-5 Longer term trend for NO_2 at Jackson Street. 1988-2021.

4.1.2.3 Discussion and Conclusions

This new year of data supplements the 2020 MEC and 2019 LAG reports, and extends the time series. Key observations and conclusions include:

1. Nitrogen deposition continues to be a factor in management of serpentine grasslands and will be over the foreseeable future.
2. The reduced sample ensemble in 2020 and 2021 nitrate data show similar patterns to previous years. The highest nitrate levels are > 5 ppm, half the drinking water standard. These levels are among the highest recorded from non-agricultural lands.
3. An analysis of the 6-year trend at eight sites showed a statistically significant ($p = 0.02$) decrease in nitrate, at a rate of -0.041 ppm/year. This detection was only possible because of the length of the time series at all eight sites.
4. The TDEP model shows slight deposition increases from 2012-2014 to 2016-2018, with a decrease in oxidized-N (NO_x derives compounds) but a larger increase in reduced-N (NH_3 derived compounds). A 2017-2019 TDEP average was not accessible at the time of writing this report. Three-year averages are appropriate metrics because the LAG report estimated that residence time of shallow groundwater feeding these springs is on the order of 1-4 years.
5. The reduced 2020 and 2021 sampling data were not sufficient to repeat the analysis of distance to San Jose and elevation. We are pursuing funding from SCVHA to expand the sampling to include points further south and west of Coyote Valley in 2022.
6. Long-term downward trends in NO_2 continued in 2021. There were likely COVID-19 lockdown impacts but a deeper analysis than possible here is needed.

4.1.3 Other Developments

Dr. Weiss continues to organize a nitrogen deposition session at the American Geophysical Union conference (19th year) where he maintains connections with the leading scientists in the field and has developed key collaborations over two decades.

We will approach the Santa Clara Valley Habitat Agency for funding in 2022 to complete the more extensive sampling and pursue an analysis of COVID impacts. And we are pursuing funding from the National Park Service Air Resources Division to develop lichen-based indicators of N-deposition.

SECTION 5.0

Vegetation Management

5.1 Grazing Observations

From 2001 to mid-2008, grazing on Tulare Hill had been restricted to the MEC-TH parcel, pending a Safe Harbor Agreement between USFWS and PG&E, which built a fence bordering their transmission corridor and the MEC-TH parcel. This fence eliminated grazing from the northern portions of the hill, leading to increased annual grass invasion and reduction of BCB host and nectar plants. This habitat degradation caused by lack of grazing has been well documented in previous reports. PG&E received their Safe Harbor Agreement in 2008, which requires PG&E to manage their property for BCB habitat while releasing them from “take” liability during normal business operations.

On June 25, 2008, 40 cows were returned to the northern side of Tulare Hill. This noteworthy event attracted local media crews, who documented rancher Justin Fields and his then 7-year-old daughter Jenna driving the cattle onto the hill on horseback.

In 2010, the northern parcel was sold to Santa Clara County Parks. They have been informed about history and grazing management issues on Tulare Hill as a whole and have been cooperative partners.

Although the northern portions of Tulare Hill fall outside of the purview of the MEC Preserve Management Plan, improving habitat on those parcels is seen as critical to maintaining the large, topographically heterogeneous habitat the BCB requires to survive. LTSCV has been deeply involved in coordinating management issues on Tulare Hill.

5.2 The 2021 Grazing Season

All of Tulare Hill has been exposed to the same grazing regime since the early summer of 2008. While the fence between MEC-TH and the rest of the hill is still in place to give the rancher flexibility in moving animals, the gates are usually left open to allow cattle to access the entire 339 acres. Stocking rates are shown for 2006-2021 in Table 5-1.

Year	Regime
2021	22 cow/calf pairs October 26 (2020) to May 1; 30 cows June 30 to November 1.
2020	13 cow/calf pairs January 1 to May 27 (2020); 21 cows October 26.
2019	24 cow/calf pairs December 1 (2018) to May 1. 15 dry cows July 8 to September 1. Cows start calving September 1 and will remain on Tulare Hill through December 31.
2018	25 cow/calf pairs December 1 (2017) to May 1.
2017	30 cow/calf pairs December 1 to May 1.
2016	5 cow/calf pairs January 1 to March 30; 35 cow/calf pairs April 1 to June 1. 30 cow/calf pairs November 23 (into 2017).
2015	25 dry cows March 25 to June.
2014	30 dry cows mid-April to August 1.
2013	5 cow/calf pairs January 1 to April. 30 dry cows May 15 to August 1.
2012	16 cow/calf pairs January 1 through mid-April. 23 dry cows (no calves) mid-June to September 5. 5 cow/calf pairs September 5 to December 31+.
2011	30 cow/calf pairs March to May. 8 bulls on the MEC portion in September to early December.
2010	30 cow/calf pairs + 1 bull mid-March to mid-May. 30 cow/calf pairs mid-June to September.
2009	32 cow/calf pairs. Mid-March to mid-May. Pulled animals for a month, then 32 cows back on June through mid-October.
2008	Grazing reintroduced to whole of TH June 25, 2008. 40 cow/calf pairs June-December.
2007	MEC side only: 7 bulls April to about December 1.
2006	MEC side only: 8 bulls on in early April, off end of November.

Table 5-1 Grazing regime on Tulare Hill.

From 2005-2012, we maintained our Tulare Hill monitoring categories (TH-BG, TH-BUG and TH-UBUG) for the purposes of tracking fire recovery at these sites. Starting in 2013, we dropped these categories because the burn effects had long since played out. The new Tulare Hill categories are TH-MEC (encompassing the MEC Preserve holdings on the southern part of the hill) and TH-North, which includes the PG&E, Santa Clara County Parks, and SCVHA properties. For purposes of annual comparison, the former classification TH-BG covered the same area as the new TH-MEC. But it is worth reiterating that at present, all of Tulare Hill is similarly exposed to grazing.

The standard winter-spring grazing continued at MEC-CR as part of the larger grazing pasture called the west ridge (Table 5-2). Foreman ran a similar number of cattle in 2021 as in 2020, although the number of dry cows grazing June to October was reduced by about half.

Year	Regime
2021	122 cow/calf pairs and 4 bulls December 5 (2020) to February 14; 122 cow/calf pairs and 103 yearlings February 15 to March 24; 82 pairs and 103 yearlings March 25 to May 14; no cattle May 15 to May 30; 40 dry cows June 1 to October 15.
2020	234 cow/calf pairs and 12 bulls November 22 (2019) to May 16 (2020); 75 cows June 10 to November 1 (2020).
2019	238 cow/calf pairs and 15 bulls November 27 (2018) to May 12 (2019); 65 two-year-old heifers June 1 to August 12 (2019).
2018	258 cow/calf pairs November 27 (2017) to May 10; 16 bulls December 1 (2017) to May 10; 45 dry cows May 20 to November 20.
2017	243 cow/calf pairs and 15 bulls November 26 (2016) to May 15; 45 dry cows May 16 to Oct. 10 (+).
2016	220 cow/calf pairs, 12 bulls, and 22 600-pound yearlings November 27 (2015) to May 10.
2015	195 cow/calf pairs December 1 (2014) to April 25; 10 bulls December 1 (2014) to April 25; 12 600-pound calves December 1 (2014) to April 25.
2014	174 cow/calf pairs December 5 (2013) to April 6; 9 bulls December 5 (2013) to April 6.
2013	166 cow/calf pairs November 15 (2012) to May 2; 12 bulls December 1 (2012) to May 2.
2012	120 cow/calf pairs and 41 heifers November 26 (2011) to May 10; 10 bulls December 1 (2011) to April 15.
2011	236 cow/calf pairs December 21 (2010) to May 10; 45 dry cows May 10-September.
2010	255 cow/calf pairs and 14 bulls December 15 (2009) to May 8; 20 dry cows May-December.
2009	269 cow/calf pairs November 19 (2008) to May 1.
2008	200 cow/calf pairs January 1- April 15.
2007	200 cow/calf pairs and 15 bulls November (2006) to June; July to November 100 dry cows.
2006	250 cow-calf pairs November 15 (2005) to June 15.

Table 5-2 Grazing regime on West Ridge.

The stocking rate in the Second Rockfield (the ~810-acre grazing pasture that includes LECEF) was very similar to 2020. This pasture is generally grazed spring through fall, although timing varies (Table 5-3).

Year	Regime
2021	92 cow/calf pairs February 15 to April 28; 89 dry cows September 15 to October 31.
2020	91 cow/calf pairs February 3 to April 1; 45 dry cows October 1 to December 1.
2019	102 cow/calf pairs February 8 to April 1; 93 dry cows September 1 to November 15. Cows start calving September 1.
2018	99 cow/calf pairs February 1 to April 1; 102 pairs September 1 to November 1.
2017	87 cow/calf pairs from March 10 to May 10; 99 dry cows September 1 to ~November 30.
2016	69 cow/calf pairs from February 25 to May 26. 93 dry cows September 30 to November 30.
2015	55 cow/calf pairs from March 1 through April 23, and 75 dry cows from June 4 through October 30.
2014	65 dry cows from May 1- September 1.
2013	65 cow/calf pairs February 11 to May 31; 30 dry cows June 1 to December 1.
2012	73 cow/calf pairs February 22 to June 1; 65 cow/calf pairs mid-August to October.
2011	100 cow/calf pairs March to May; 60 cows June to mid-November.
2010	133 cow/calf pairs June 1 to end of October (also using adjacent willow pasture).
2009	75-80 cow/calf pairs March-October.
2008	87 cow/calf pairs March-May.
2007	85-100 cow/calf pairs June-part of August.
2006	85-100 cow/calf pairs April-June; September thru November.

Table 5-3 Grazing regime on Second Rockfield.

It is important to note that though a parcel or group of parcels may be subject to the same grazing regime, actual grazing pressures experienced within these areas are different. There will be more on this in Section 6. In addition, any individual property is being managed within the greater context of adjacent properties, as well as the entire serpentine grassland ecosystem.

The flexibility of both ranchers to move their animals to other pastures when conditions warrant it, is appreciated and has created a rich mosaic of habitat conditions across Coyote Ridge. Multiple, flexible grazing regimes across pastures allow the ranchers to maximize the removal of grass biomass, which creates moderate disturbance, reduced competition, and bare soil for annual forbs to thrive. The results of such management are amply illustrated by the richness and high cover of wildflowers across the range of serpentine grasslands being moderately grazed, including the MEC-TH, MEC-CR, LECEF and adjacent Silicon Valley Power (SVP). Also, similarly managed are adjacent VTA, Kirby Canyon Butterfly Reserve (Waste Management, Inc.) and Coyote Ridge Open Space Preserve (CROSP, formerly United Technology Corporation [UTC]) properties.

This year on MEC-TH, staff observed high cattle grazing pressure throughout the hill and noticed that the primary Metcalf Canyon jewelflower population had been extensively grazed and trampled to the point that no seed could be collected from the site. Effects from the high grazing pressure include denuded vegetation, high soil compaction, extensive cattle trails, steep bank erosion and lots of stepping on hillsides (Photo 5-1 and Photo 5-2).

Because of the heavy impacts on Metcalf Canyon jewelflower reintroduction sites, we want to keep a close eye on the jewelflower through the growing season with a mind toward working with Justin Fields to minimize impacts. Furthermore, we recommend implementing Residual Dry Matter (RDM) monitoring on Tulare Hill as it is done on Coyote Ridge. This involves clipping and weighing one 33.65 cm diameter circular hoop-plot at various reference sites on the hill (Guenther and Hayes, 2008). We recommend establishing 12 reference sites on Tulare Hill to capture different slopes, aspects, topoclimates, etc. The target range for RDM is 500-700 lb/acre on the upper slope serpentine grasslands, 700-1000 lb/acre on the lower slope serpentine grasslands, and 1000-1500 lb/acre on the annual grass non-serpentine grasslands.

Photo 5-1 Cattle use trail and denuded vegetation through the main Metcalf Canyon jewelflower population at MEC-TH.

Photo 5-2 Eroded road bank on Tulare Hill.

5.3 Fire

In late May 2004, a fire started on the railroad tracks and burned across about half of Tulare Hill. The effects of the fire on vegetation were discussed most thoroughly in the Fire Studies section of the 2006 report. Fire has dramatic but mostly short-term effects on serpentine grasslands, which are documented in the vegetation management sections of the 2007 and 2008 reports.

The Bailey fire began and was extinguished August 17, 2016. The fire burned 88.4 acres over multiple properties, including SVP, VTA and CROSP. About 25 acres were burned on SVP. The fire did not burn any areas on LECEF but plots for Santa Clara Valley dudleya and most beautiful jewelflower were used as a reference in 2017 to compare with some plots burned on SVP. More details can be found in the annual SVP report (Kent et al. 2017).

The Bayliss fire started August 15, 2019 and was extinguished the same day. It consumed 60 acres total (including unmapped areas on the south side of Santa Teresa Boulevard) (Calfire 2019). It burned 45.0 acres on Tulare Hill, including 35.9 acres of the MEC Preserve owned by LTSCV. The fire perimeter on Tulare Hill was contained with 843 m of hand lines and 1,698 m of dozer lines, as well as 608 m along Santa Teresa Boulevard. The dozer line includes 649 meters on the southeast portion of the hill that is not perimeter and presumably was laid incidentally as the dozer accessed the summit, as well as 429 meters clearing vegetation among existing roads. Approximately 4 acres of retardant were dropped on Tulare Hill (with additional unmapped retardant found to the south on farmland) (Photo 5-3, Map 5-1).

Fires in California grasslands generally shift vegetation communities from grass to forbs (i.e., broadleaf plants like native wildflowers and nonnative thistles). Grasslands with high native forb cover (i.e., serpentine grasslands such as Tulare Hill) tend to respond favorably to fire (Niederer 2013). BCB host plants and nectar sources are in the dormant state by August, and seeds have dropped to the ground. Grass fires tend to move quickly and may not damage seeds on the ground (DiTomaso et al. 2001). Seeds still held aloft, such as federally endangered Metcalf Canyon jewelflower seeds, may be more likely to sustain damage from fire.

Firefighting efforts tend to pose more resource damage, with ground disturbance sustained from firelines and additional nutrient input from fire retardant. One study found ten times more phosphorous and ammonium in serpentine soil treated with Phos-Check retardant (Raposo et al. 2019). Studies have found the increase of nitrogen and phosphorus in serpentine grasslands leads to invasion and dominance of nonnative vegetation, with reduced cover and richness of native species (i.e., Huenneke et al. 1990).

Photo 5-3 Aerial view of Bayliss fire (photo by sfbay.ca).

60 acres total (includes unmapped areas on south side of Santa Teresa Boulevard),
45.0 on Tulare Hill, 35.9 on MEC
Dozer lines: 1,891.4 m; Hand lines: 843.1 m
4 acres of retardant on Tulare Hill (additional retardant south on farmland)

Map 5-1 Bayliss fire perimeter on Tulare Hill (additional area burned on the south side of Santa Teresa Boulevard, as well as additional fire retardant were not mapped).

5.3.1 Observations

By 2020, the firelines were revegetating well (Photo 5-4), and by the end of the growing season, even the larger dozer lines were largely obscured. No major erosion issues were noted. By 2021, firelines are only visible if one knows what one is looking for.

Photo 5-4 Handlines revegetating passively in spring.

5.3.2 Weed Concerns

Fire can have mixed results with nonnative plants. Well-timed fires can damage seeds but can also produce a nearly blank palette for incoming weed seeds. A yellow starthistle plant still holding seeds (Photo 5-5) may find excellent germination conditions when the rainy season begins. Properties to the south and west of Tulare Hill are infested with yellow starthistle, stinkwort, and Russian thistle (tumbleweed), which may take advantage of post-fire dispersal and establishment opportunities. The road immediately south of the hill was infested with yellow starthistle in July and was dozed in August during fire suppression (Photo 5-6 and Photo 5-7). Seeds were already viable, so the dozing is likely to have just dispersed seeds, likely along the extraneous dozer line through high quality Bay checkerspot habitat up to the summit and interior of the habitat.

Photo 5-5 Yellow starthistle seeds intact in a burned area.

Photo 5-6 Dense yellow starthistle invasion on the road south of Tulare Hill, July 2019.

Photo 5-7 Yellow starthistle dozed during fireline creation. This may have just aided seed dispersal into high quality BCB habitat.

By June 16, 2020, new weed infestations were mapped. The firelines themselves had low priority weeds such as prickly lettuce (*Lactuca serriola*), while the interior had higher priority weeds (Map 5-2). Creekside Science mapped 5.7 acres of tocolote (*Centaurea melitensis*), including 1.7 acres that also contained low density stinkwort (*Dittrichia graveolens*). These weeds were found mostly in burned California sagebrush (*Artemesia californica*) scrub (Photo 5-8 and Photo 5-9). Encroaching yellow starthistle was string cut (Photo 5-10). Stinkwort was pulled by hand. The tocolote was not treated.

Map 5-2 Weed (largely tocolote) polygons mapped in 2020.

Photo 5-8 The brown patches are largely invasive tocolote that expanded in the burnt sagebrush scrub.

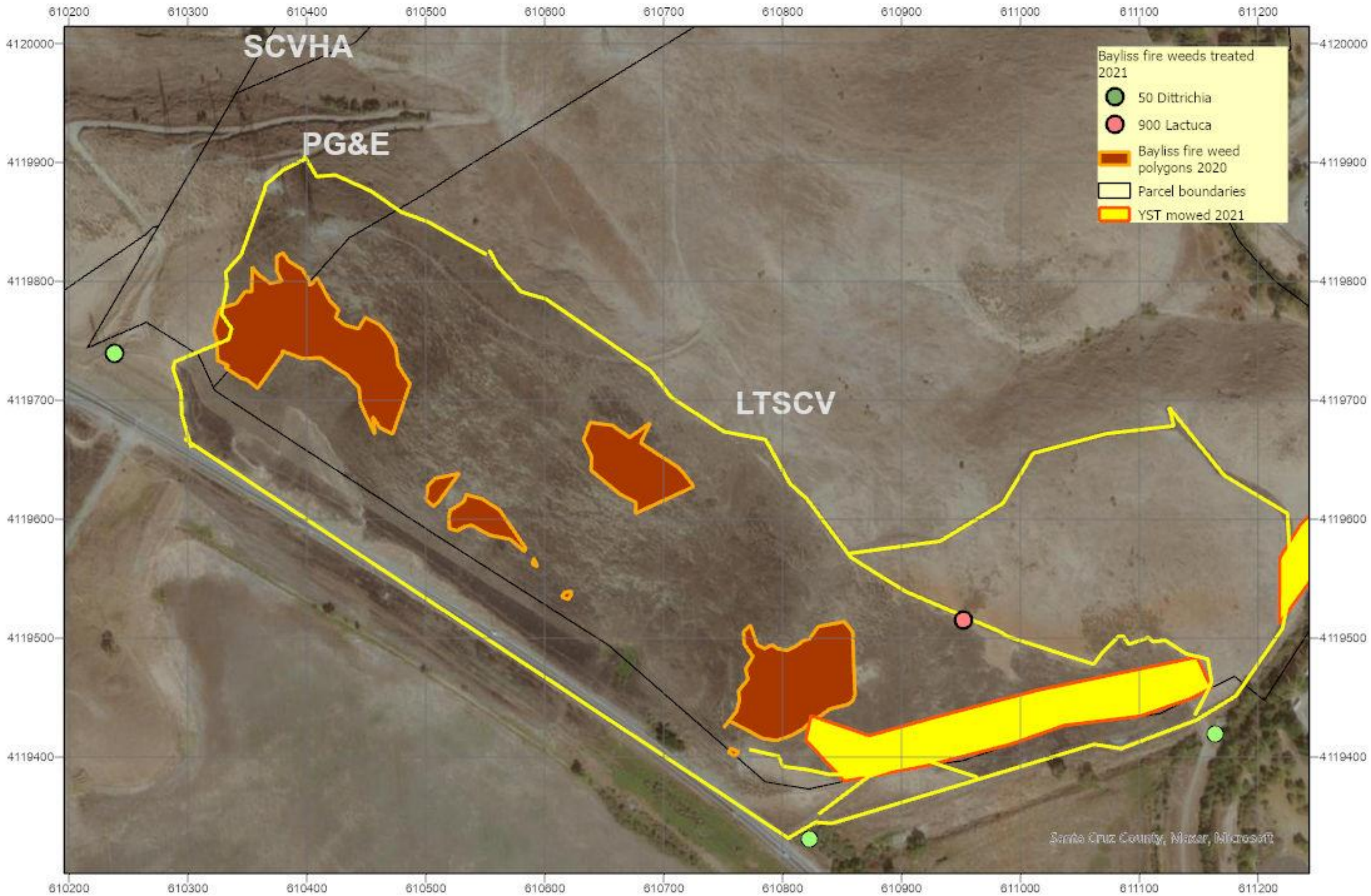
Photo 5-9 Close up view of the brown patches, filled with tocolote.

Photo 5-10 String cutting encroaching yellow starthistle.

Weed surveys were conducted again in 2021. Surprisingly, no stinkwort was found within the fire perimeter. The exceptional drought of the season did lead to a regional decrease in stinkwort, but it was certainly present in adjacent areas. Areas immediately adjacent to MEC-TH were treated. It’s not clear whether treatments in 2020 were so thorough that no seed dispersed, or if a seedbank is present and ready to germinate in the future. Surveys/treatment should continue into 2022 to confirm that this weed is under control (Map 5-3).

The burned weed polygons still have high cover of tocolote, which has not been treated. The associated California sagebrush is recovering, and we're hoping as these shrubs get larger, they will start to shade out the tocolote. We recognize it won't completely go away, but the weed was present before the fire and these polygons represent slopes that are too hot to support BCB (although they are valuable to Santa Clara Valley dudleya and jewelflowers, see Section 8.1).

Yellow starthistle mowing was performed in the lower fireline and in the flat area where the paddocks are located on July 5, 2021 (Map 5-3).



Map 5-3 Weed polygons (2020) and yellow starthistle mowing polygon (2021).

Monitoring in 2020 showed that dudleya numbers decreased within the fire perimeter. This and a lack of observed seedlings created concern that dudleya were not reproducing fast enough to sustain themselves on Tulare Hill. Dudleya were monitored again on MEC-TH in spring 2021. Overall dudleya rosettes, inflorescences, and intact inflorescences increased this year. An ANOVA comparing 2021 with 2018 data still showed a significant change in the of number of plants inside vs. outside of the fire perimeter. The intrinsic rate of increase was larger in the unburned plots. See Section 8.1.1 for current dudleya results.

Jewelflower increased within the fire perimeter in 2020 (Section 8.1.2.2).

Creekside Science plans additional weed surveys and treatment in 2022 to ensure the invasive plants within the fire perimeter stay at very low densities.

5.3.3 Recommendations

Fire is a natural process in California grasslands, although firefighting efforts increase impacts. We recommend conducting additional weed surveys/treatment in spring 2022.

5.4 Tulare Hill Weed Management

Creekside Science handpulled a small infestation of Bermuda buttercup (*Oxalis pes-caprae*) on the north side of Tulare Hill in the SCVHA parcel on February 24, 2020. We returned on February 4, 2021 and found none. We followed up a second time on April 6, 2021 and again found none (Photo 5-11). We will continue to check the area in 2022 and remove any individuals that may be present.

Photo 5-11 Area of previous Oxalis infestation on second follow-up visit, April 6, 2021.

On August 5, 2021, Creekside Science staff once again sprayed all surviving Jubata grass (*Cortaderia jubata*) individuals on the southwest portion of Tulare Hill above Santa Teresa Blvd. We will follow up with any necessary treatments in 2022.

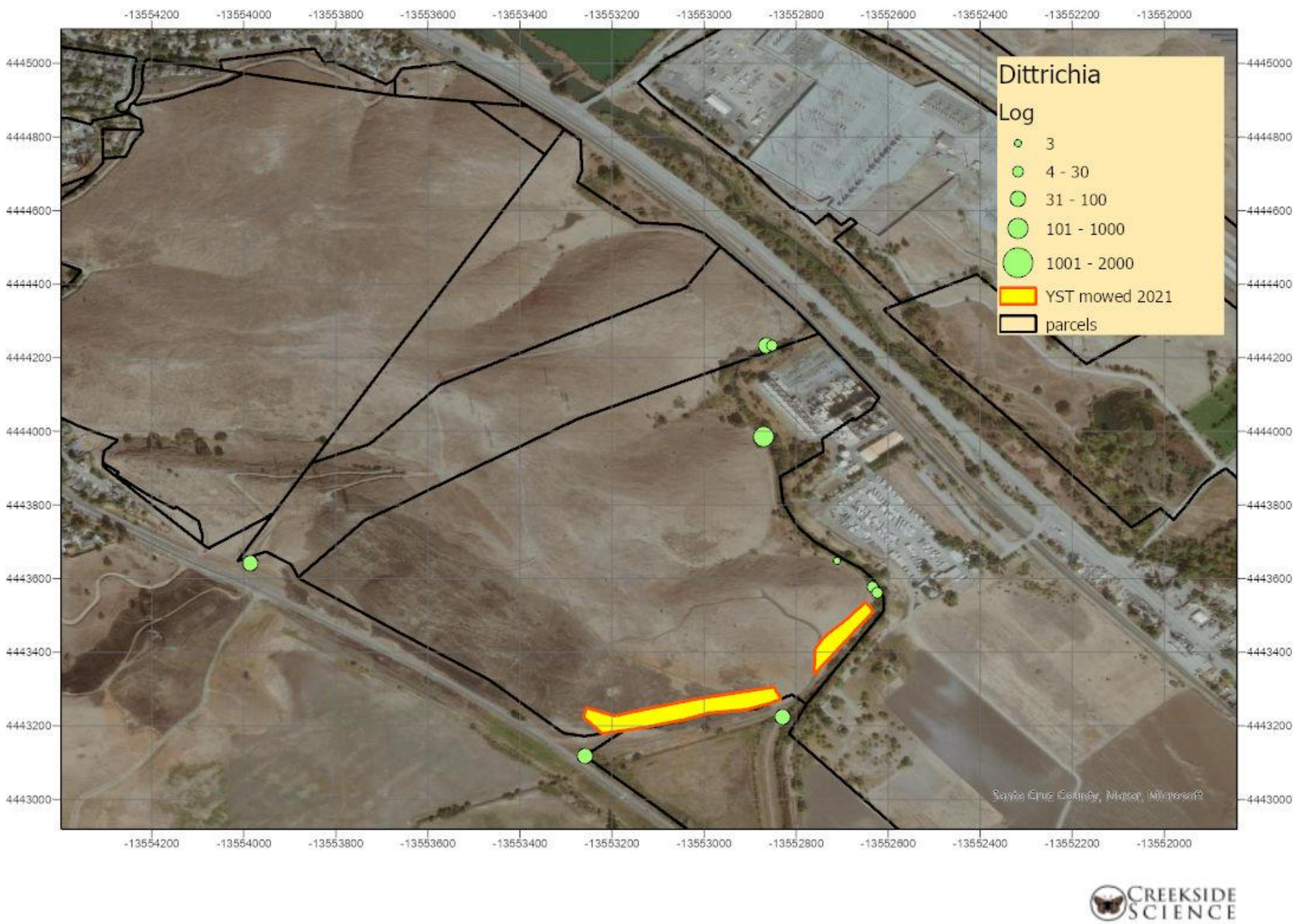
Creekside Science staff annually handpulls bull thistle (*Cirsium vulgare*) individuals in the seep recently fenced to exclude cattle (see Section 6.2 of this report).

Creekside Science also handpulled stinkwort (*Dittrichia graveolens*) infestations located along the southern and eastern borders of Tulare Hill (Map 5-4). Additionally, Creekside Science once again contacted three residential neighbors along the western border of Tulare Hill and received permission to treat stinkwort in those neighboring properties. This is the first year that none of the properties had stinkwort. Creekside Science has documented the spread of stinkwort onto serpentine soils.

Treatment of stinkwort will continue as long as there is a risk of potential spread onto serpentine habitat. We are pleased to report that in past years when regional infestations were increasing in distribution and density, the areas we have been treating on Tulare Hill and in adjacent suburban neighbor properties were decreasing to very low numbers. Santa Clara Valley Open Space Authority (SCVOSA) has also assumed ownership and management of several north Coyote Valley properties, and they have begun implementing stinkwort (and other weed) control. We have expressed our appreciation of their work, as it should decrease the pressure from dispersing propagules entering Tulare Hill. We will need to remain vigilant from outside pressure and to continue follow up from any missed plants.

No purple starthistle (*Centaurea calcitrapa*) plants were found in 2021. Creekside Science staff will continue to keep an eye on this in 2022.

On July 5, 2021, Creekside Science staff mowed swaths of yellow starthistle (*Centaurea solstitialis*) along the southern edge of Tulare Hill when the plants were at about 5%-10% flowering (Map 5-4). Creekside Science staff will continue to keep an eye on this infestation.



Map 5-4 Tulare Hill treated weeds (2021).

On September 4, 2020, Creekside Science staff cut giant reed (*Arundo donax*) down along Fisher Creek on the southeastern edge of Tulare Hill and immediately followed manual removal of above ground matter with glyphosate spraying per University of California recommendations (DiTomaso, J.M., G.B. Kysyer et al. 2013). We returned on July 6, 2021 and cut and sprayed any live shoots that had reemerged (Photo 5-12 and Photo 5-13). Creekside Science staff returned for a third time on October 19, 2021 to once again treat the giant reed infestation with glyphosate.

Photo 5-12 Arundo infestation before treatment, July 6, 2021.

Photo 5-13 Arundo infestation after treatment, July 6, 2021.

Three Mexican fan palms (*Washingtonia robusta*) were removed along Fisher Creek in fall 2017. On October 19, 2021 Creekside Science staff removed three more fan palms from Fisher Creek. Some fig trees have been identified along the creek and we aim to remove these in 2022.

In spring of 2014, Creekside Science staff handpulled nonnative mustards from the summit area of Tulare Hill. Creekside Science staff have not seen any mustards in this area since.

Creekside Science staff is continually assessing weed threats to MEC-TH and will conduct additional weed surveys/treatment in spring 2022, especially in response to the Bayliss Fire of August 2019.

5.5 MEC-CR Weed Management

MEC-CR is largely weed-free. While it does have its share of nonnative annual grasses, these are largely controlled through grazing. No additional weeding needs have been identified to date.

SECTION 6.0

Vegetation Monitoring of Serpentine Grassland

The purpose of monitoring the overall composition of the serpentine grassland is to provide a reliable system for detecting major changes in grassland composition habitat in response to climate, topography, and management. A standard methodology is being used at multiple sites in the region. The system is designed to monitor large changes in composition from year to year (interannual) and across topographic and edaphic (soil) gradients, while at the same time being efficient for data collection. Photographs of the sampling units (transects) are provided in Appendix A.

6.1 Vegetation Surveys 2021

The transect methodology is presented in full in the 2003 report (CH2M HILL, 2003). The discussion will highlight spatial and temporal changes in cover and the average number of species found at the monitored sites. The figures show a set of graphs with available data from all sites monitored from 2012 to 2021. We have dropped years 2001-2011 from the graphs for clarity but still comment on these data as appropriate. Please see previous reports for graphs with data from these years. All changes in cover reported in the text of this section are comparing 2020 and 2021 unless otherwise noted. A second set of graphs with 2021 data only is also presented to more easily compare current conditions across sites.

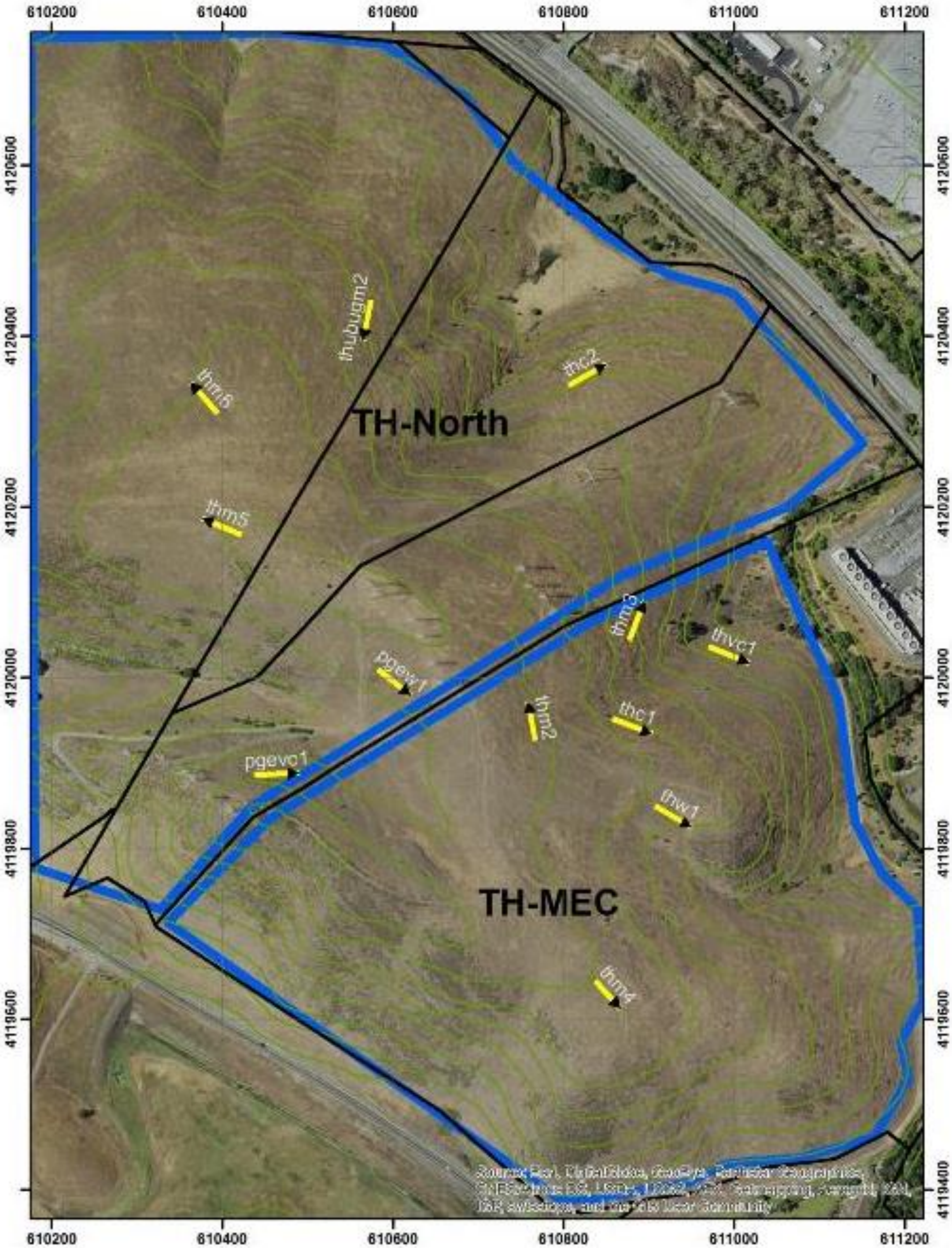
To examine the effects of the 2004 fire on vegetation on Tulare Hill, refer to the 2005-2009 annual reports. Vegetation on Tulare Hill is currently reported as TH-MEC and TH-North. There are six transects in the MEC Preserve, and six on the three properties to the north, with each side capturing a variety of topoclimates (Map 6-1).

There are five sites monitored on Coyote Ridge: Kirby Canyon (KC) (Santa Clara Valley Water District, leased by Waste Management, Inc./WMI), Kirby Canyon Ungrazed (KC-Ungrazed) (WMI), Coyote Ridge Open Space Preserve (CROSP), Los Esteros Critical Energy Facility (LE) (LTSCV), and Silicon Valley Power (SVP) (LTSCV) (Map 6-2). CROSP was referred to as UTC in previous reports and is currently reported as CROSP South in other regional reports. This parcel is owned by SCVOSA. Creekside Science collected all the presented data. Data from these non-MEC sites serve to provide regional context in this discussion.

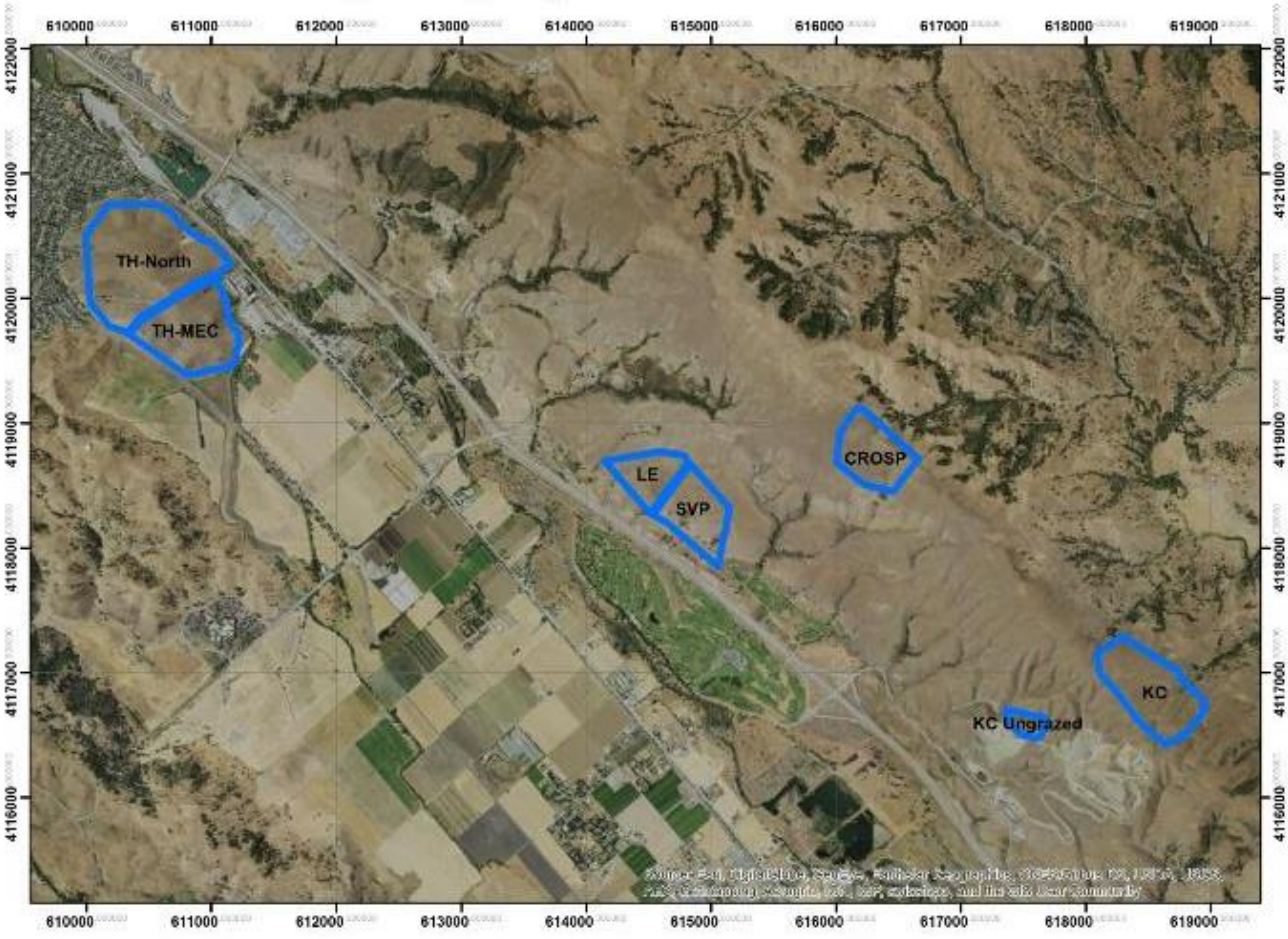
All Coyote Ridge sites are grazed (except for KC-Ungrazed) and unburned. KC is in the west ridge pasture and has a winter-spring grazing regime. CROSP, LE and SVP are in the second rockfield, which has a more variable grazing regime.

Starting in 2010, for purposes of data clarity, we have not included historical data collected at Edgewood (including two years at a site west of Highway 280) and Jasper Ridge. These historical data are available in prior reports.

Data with overlapping error bars are considered stable or mostly unchanged.



Map 6-1 Transect locations on Tulare Hill.



Map 6-2 Regional locations of additional transect clusters.

6.1.1 Bay Checkerspot Butterfly Host Plants

Overall, *Plantago* cover was low across sites again in 2021. Historical lows within sites were seen at TH-MEC, TH-North, LE and SVP (1.1%, 1.7%, 0.5% and 0.5%, respectively). The highest cover value this year was observed at KC-Ungrazed (2.4%) (Figure 6-1 and Figure 6-2). Across sites since 2001, cover values have ranged from 0.5% (at LE and SVP this year) to 32.9% (at TH-MEC in 2003)) (cover values for 2001 through 2011 can be found in earlier reports such as Creekside Science and CH2MHill 2016).

Castilleja was not detected at TH-MEC, TH-North, or LE in 2021. At the other four sites it was present at very low cover values (0.03% at KC, KC-Ungrazed and CROSP, and 0.02% at SVP). The highest *Castilleja* cover value since 2001 was 1.6% at TH-MEC in 2003. Although it is not uncommon for it to go undetected in a given year, this year was the third lowest year overall since 2001 (0.1% total cover value for all sites) (Figure 6-3 and Figure 6-4).

6.1.2 Bay Checkerspot Butterfly Nectar Plants

Lasthenia cover mostly remained stable at low cover values this year. TH-North was the only site that saw a change in cover (from 1.4% to 0.7%). CROSP saw a historical low of 0.2% cover (Figure 6-5 and Figure 6-6). Across sites since 2001, cover values have ranged from 0.03% (at KC-Ungrazed last year) to 13.2% (at KC in 2001).

Layia was only found in quadrats at KC this year. Cover was 0.01%. It has been under 1% in all of the last ten years (Figure 6-7 and Figure 6-8).

Allium cover values remained unchanged at low to moderate values in 2021. This year it was detected at all sites except for SVP. The highest cover value was 0.2% at KC-Ungrazed (Figure 6-9 and Figure 6-10).

Muilla values were low to moderate this year. Cover values remained stable at all sites except for KC and SVP, where cover decreased from high values (1.2% to 0.7% and 2% to 0.9%, respectively). Across sites, the highest cover value was 0.9% at SVP. No *Muilla* was observed at KC-Ungrazed this year (Figure 6-11 and Figure 6-12).

6.1.3 Grasses

Bunchgrasses maintained moderate to low cover values across sites this year. It was relatively stable at all sites. As is common, KC had the highest cover at 1.8%. KC-Ungrazed had the lowest cover value this year at 0.2% (Figure 6-13 and Figure 6-14). All bunchgrasses reported are native perennials.

In 2021 nonnative annual grass cover was at moderate cover values across sites. Substantial increases in cover were observed at KC, TH-MEC, TH-North, and CROSP. The highest increase was at TH-North (9.5% to 18.2%). Cover values were stable at KC-Ungrazed and SVP. The only site that saw a decrease was LE where cover dropped from 21.6% to 16.6%. Across sites values ranged from 8.0% at KC to 32.1% at TH-MEC (Figure 6-15 and Figure 6-16).

In 2021, thatch cover was moderate to high across all grazed sites with values ranging from 3.6% at KC to 10.8% at TH-MEC. It increased at CROSP from 5.7% to 8.3%, remained stable at TH-North and SVP, and decreased at KC, KC-Ungrazed, TH-MEC and LE. At KC-Ungrazed thatch cover decreased from a historical all-site high of 39.7% down to 25.2%, a moderate value for the site, but the highest value regionally (Figure 6-17 and Figure 6-18).

Festuca perennis remained stable in 2021 at all sites except TH-North which increased from 1.8% to 5.2% and LE which saw a decrease from 17.1% to 14.2%. Overall values for grazed sites were low at KC, TH-MEC and TH-North and high at CROSP, LE and SVP. KC-Ungrazed remained stable at 16.9% (Figure 6-19 and Figure 6-20).

Bromus hordeaceus either increased or remained stable in 2021 at all sites except for LE where it decreased slightly. Overall values were moderate to high and ranged from 0.8% (SVP) to 22.7% (TH-MEC) (Figure 6-21 and Figure 6-22).

In previous years, we have reported on *Vulpia* cover. Due to taxonomic changes in which *Vulpia* became *Festuca*, in 2012 we shifted the focus from *Vulpia* (the vast majority of which was *Vulpia microstachys*, a native annual grass) to native annual grass. The only other native annual grass found in transects is *Deschampsia danthonioides,* which is very uncommon. Previous reports can be perused for what was mostly native annual grass cover.

In 2021, native annual grass remained stable or increased at all sites. Cover at LE increased the most from 0.4% to 1.9%. Cover values ranged from 0.03% at KC-Ungrazed to 2.7% at CROSP (Figure 6-23 and Figure 6-24).

6.1.4 Species Richness and Plant Cover

Native species richness generally fits an elevation gradient, with the ridgetops (KC and CROSP) being most diverse. In 2021, native species richness either decreased or remained stable. Overall values were moderate at all sites. This year KC had the highest species richness at 11.9 species per quadrat and CROSP had the next highest at 10.5 species. KC-Ungrazed had the least native species richness with an average of 7.7 species per quadrat (Figure 6-25 and Figure 6-26).

Native plant cover was low in 2021. It decreased at all sites except for LE where it remained stable. Cover was highest at KC at 21.4% and lowest at TH-MEC at 12.7% (Figure 6-27 and Figure 6-28).

2021 total plant cover either remained steady or decreased. Decreases were recorded at KC (from 35.5% to 29.5%), TH-MEC (from 57.0% to 45.0%), TH-North (from 46.9% to 35.3%) and LE (from 38.9% to 31.1%). Across sites, cover ranged from 29.5% at KC to 45.0% at TH-MEC. These are low to moderate values (Figure 6-29 and Figure 6-30).

Bare ground cover was high this year, increasing at all sites except for CROSP where it remained stable at a moderate value. KC, KC-Ungrazed, TH-North and LE all had historical highs within sites at 65.1%, 36.3%, 46.7% and 52.2%, respectively. KC's 65.1% cover is the highest cover value of all sites since 2001 when data was first collected. The lowest cover value of sites this year was 36.3% at KC-Ungrazed (Figure 6-31 and Figure 6-32).

6.1.5 Other Functional Groups

In addition to annual and perennial grasses, cover data are presented for geophytes, perennial forbs, annual forbs, and legumes. All geophytes, perennial forbs, and legumes are native. The annual forbs are nearly entirely native. Nonnative cover on Tulare Hill and Coyote Ridge is driven by annual grasses.

A geophyte is a plant that has bulbs, corms, tubers, or similar underground structures. Soap plant (*Chlorogalum pomeridianum*) and blue-eyed grass (*Sisyrinchium bellum*) are two common examples. While technically a type of perennial forb, here geophytes are calculated separately from that category. Forbs are herbaceous (non-woody) plants that are not grasses, sedges, or rushes. Legumes are members of the pea family, which are biologically important because they have nitrogen-fixing bacteria in their root nodules. The legumes found on these sites are all annual forbs, but again are not double counted in that category.

Geophyte cover remained stable or decreased in 2021. Values were low to moderate. KC had the highest cover at 2.6% and TH-MEC had the lowest cover at 1.2% (Figure 6-33 and Figure 6-34).

Perennial forb cover in 2021 changed only at KC-Ungrazed (increased from 0.9% to 1.4%) and TH-North (decreased from 4.2% to 1.8%). Across all sites, values were low to moderate. KC had the highest cover at 3.3% and KC-Ungrazed and TH-MEC had the lowest cover (1.4% at both sites) (Figure 6-35 and Figure 6-36).

Annual forb cover values decreased to very low cover across sites in 2021. Every site except KC-Ungrazed hit historical lows. The highest value was seen at TH-North at 10.2% and LE had the lowest value at 5.3% (Figure 6-37 and Figure 6-38). Among all sites since 2001, cover values have ranged from 5.3% (at LE this year) to 50.1% (at TH-MEC in 2002).

Legume cover stayed the same at KC and decreased to low or moderate values at all other sites in 2021. The highest value was observed at KC this year (2.5%). KC-Ungrazed had the lowest value (0.6%) (Figure 6-39 and Figure 6-40).

6.1.6 Summary

Rainfall in 2021 was even lower than 2020. Precipitation was substantially below average in every month except for January, which had 14.8 cm. The total for the water year was 25.7 cm, compared with the 1981-2010 average of 58.9 cm (Westmap 2021). This exceptional drought affected vegetation, making overall plant cover very low. Even with the low rainfall, nonnative annual grass cover largely increased from last year. Regionally, BCB host and nectar sources were low, although they appeared adequate to support the life cycle. As always, the effects of this year's weather and vegetation availability are reflected in next year's larval monitoring numbers.

Plantago had very low cover across all sites again this year. *Castilleja* cover was also very low and went undetected at three of the seven sites this year.

Nectar sources remained low regionally. Total native cover remained low this year at all sites.

Thatch cover was moderate to high this year. Nonnative annual grass cover increased at many sites although values were still considered moderate.

Management differences remain important, although this year regional habitat declines from drought muted management effects. The KC-Ungrazed parcel once again demonstrates the poor habitat quality inherent in unmanaged sites, with lowest perennial forbs, bunchgrasses, native richness and bare ground. KC-Ungrazed also had the highest thatch and lowest *Lasthenia* and *Muilla*, important BCB nectar sources. This year, however the highest *Plantago* and among the highest *Castilleja* cover values were found here.

Tulare Hill habitat quality declined. Last year, TH-MEC had the highest *Plantago* cover of all sites and TH-North had the highest *Castilleja*. *Lasthenia* were also relatively high compared to other sites. This year TH-MEC had low *Plantago* and low to moderate nectar. *Castilleja* was undetectable. It had the lowest native cover and highest nonnative annual grass. TH-North fared better with moderate (for this year) *Plantago,* the highest *Lasthenia,* and highest annual forbs. It also had undetectable *Castilleja* and moderate nonnative annual grass.

The two grazing regimes on Coyote Ridge continue to maintain high quality BCB habitat. While there are often some differences between key metrics, the different sites have different strengths in different years, and continue to illustrate the range of parameters that will support BCB.

KC remains high-quality BCB habitat, with low but adequate *Plantago* cover, among the highest *Castilleja,* and moderate nectar sources. This year KC had the highest bunchgrass, native cover and richness, geophyte, perennial forb and bare ground cover. It also had the lowest nonnative annual grass and thatch.

We continue to see similarly high quality habitat characteristics at CROSP. Here we have also low but adequate BCB host and nectar plant availability, regionally high native species richness and moderate bunchgrass, geophyte, perennial forb, and bare cover. The downside this year was high nonnative annual grass.

Increasing transect numbers at LE and SVP has enhanced our understanding of plant composition in these parcels. LE and SVP encompass quality serpentine habitat, as evidenced by low but adequate BCB host and nectar cover, as well as moderate native cover and richness, plus high bare. This year nonnative annual grass and thatch were moderate.

Host and Nectar Plants

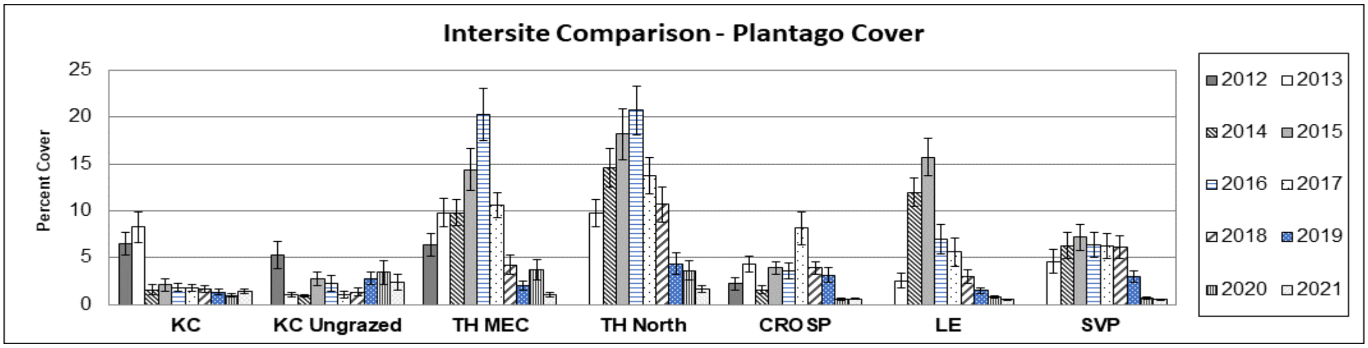


Figure 6-1 Host and nectar plants: Intersite comparison - Plantago cover.

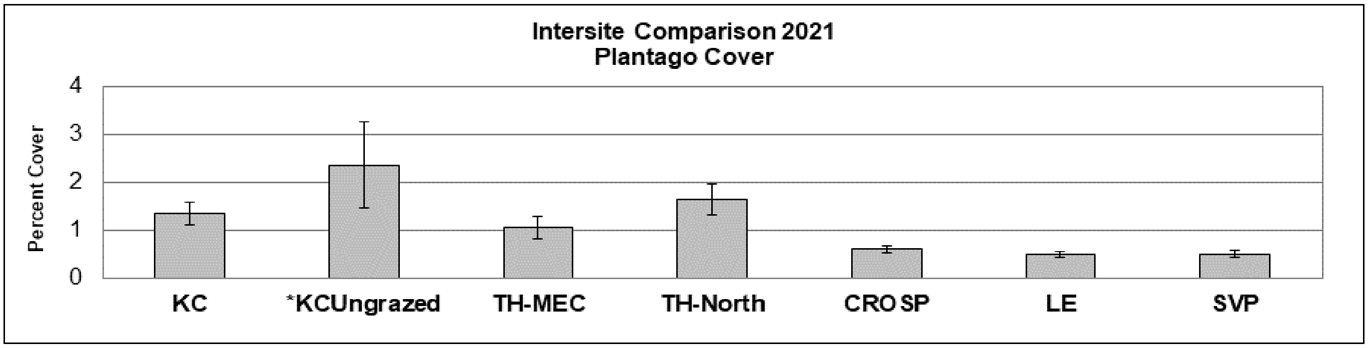


Figure 6-2 Host and nectar plants: Intersite comparison 2021 - Plantago cover.

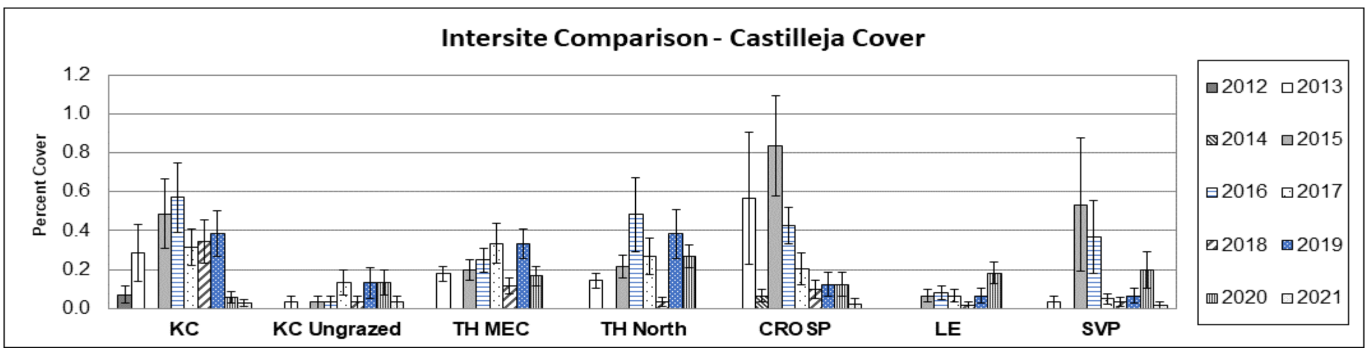


Figure 6-3 Host and nectar plants: Intersite comparison - Castilleja cover.

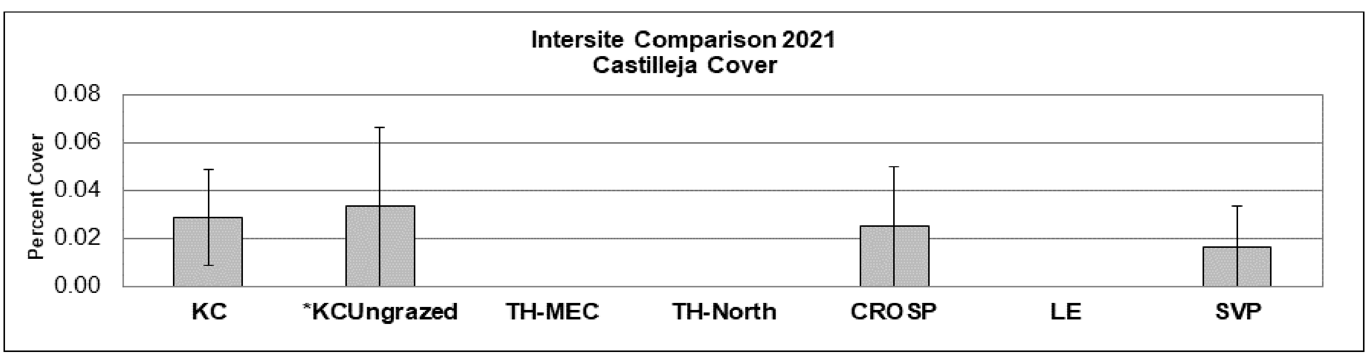


Figure 6-4 Host and nectar plants: Intersite comparison 2021 - Castilleja cover.

KC= Kirby Canyon, winter-spring (W-S) grazing
TH-MEC = MEC portion of Tulare Hill, grazed
CROSP = Coyote Ridge OSP, spring-fall (S-F) grazing
SVP = Silicon Valley Power, S-F grazing
KC, CROSP, LE and SVP are on Coyote Ridge.

*KC-Ungrazed= Kirby Canyon, ungrazed
TH North = Northern portions of Tulare Hill, grazed
LE* = Los Esteros, S-F grazing

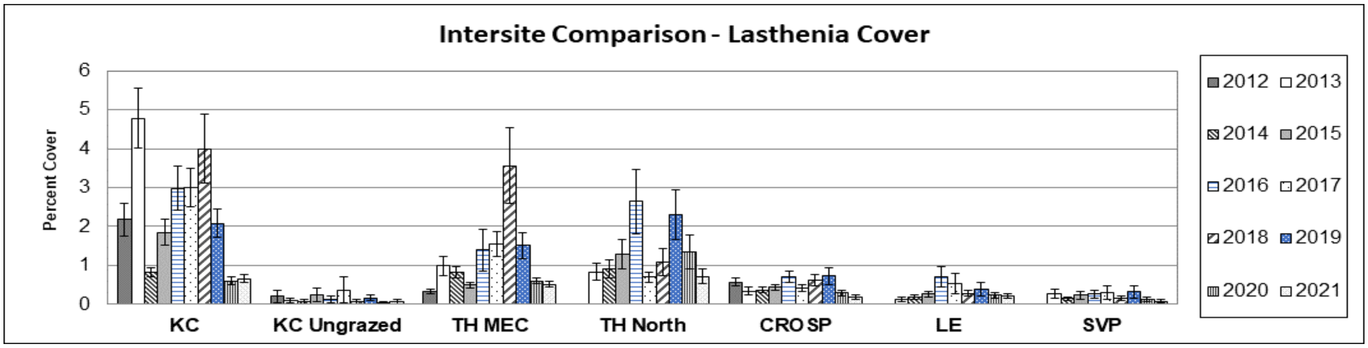


Figure 6-5 Host and nectar plants: Intersite comparison - Lasthenia cover.

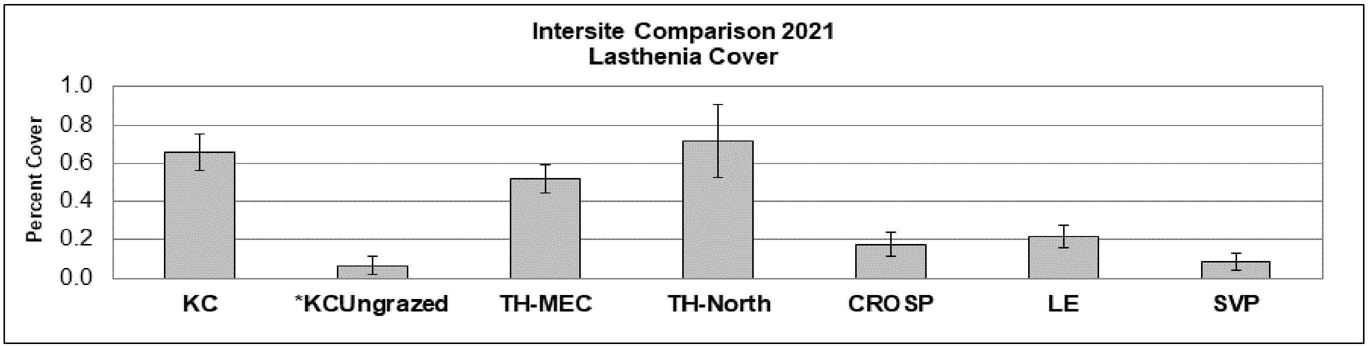


Figure 6-6 Host and nectar plants: Intersite comparison 2021 - Lasthenia cover.

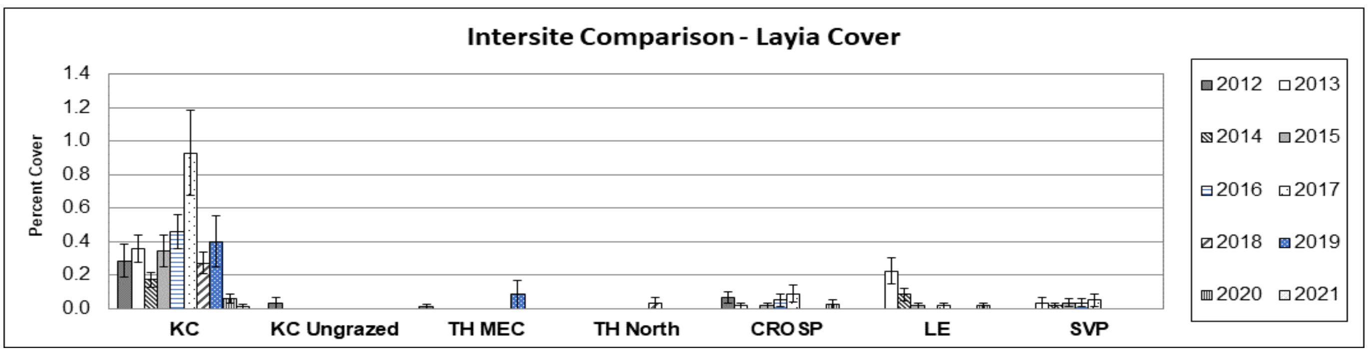


Figure 6-7 Host and nectar plants: Intersite comparison - Layia cover.

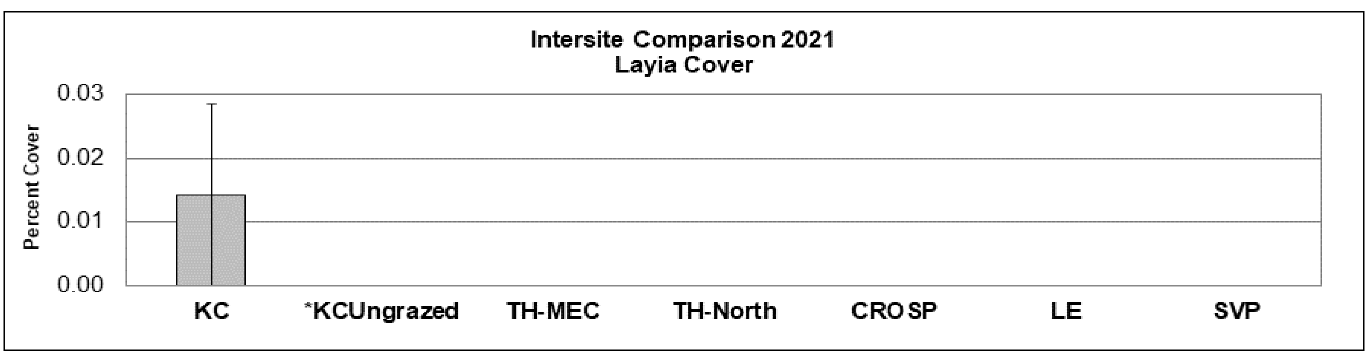


Figure 6-8 Host and nectar plants: Intersite comparison 2021 - Layia cover.

KC= Kirby Canyon, winter-spring (W-S) grazing
TH-MEC = MEC portion of Tulare Hill, grazed
CROSP = Coyote Ridge OSP, spring-fall (S-F) grazing
SVP = Silicon Valley Power, S-F grazing
KC, CROSP, LE and SVP are on Coyote Ridge.

*KC-Ungrazed= Kirby Canyon, ungrazed
TH North = Northern portions of Tulare Hill, grazed
LE* = Los Esteros, S-F grazing

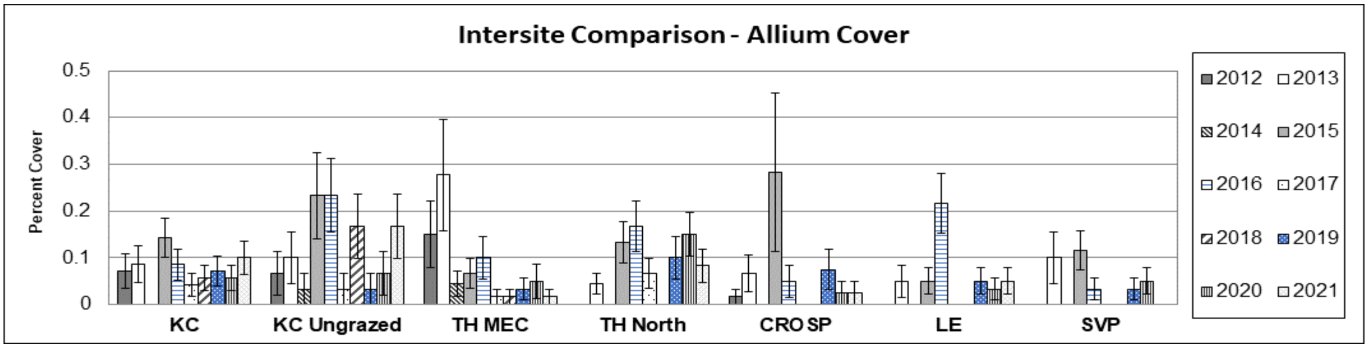


Figure 6-9 Host and nectar plants: Intersite comparison - Allium cover.

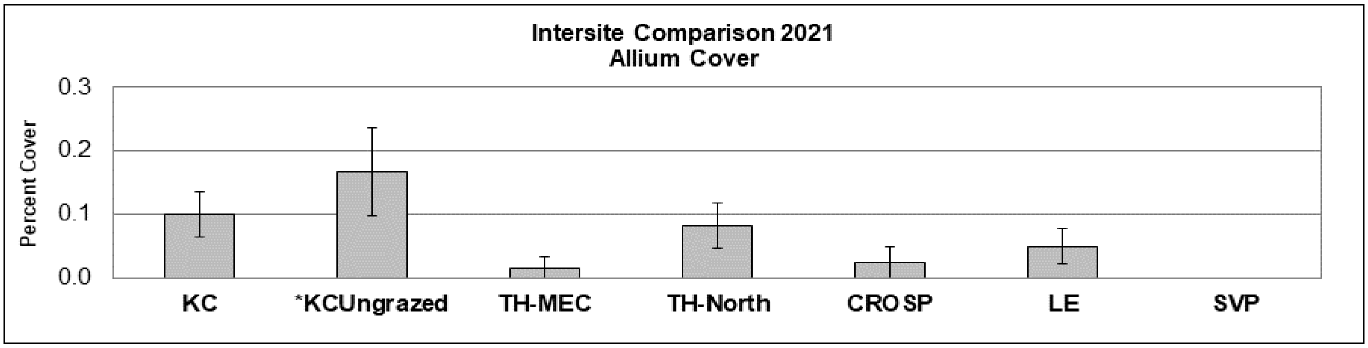


Figure 6-10 Host and nectar plants: Intersite comparison 2021 - Allium cover.

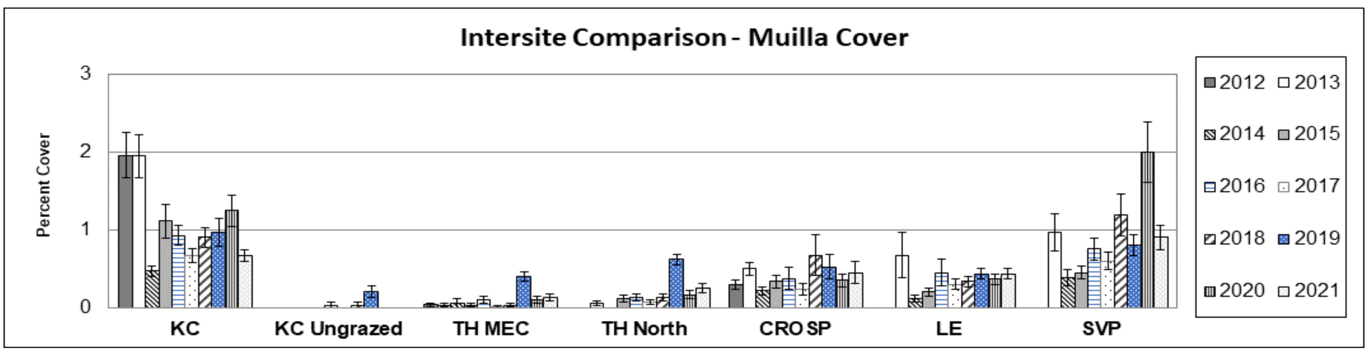


Figure 6-11 Host and nectar plants: Intersite comparison - Muilla cover.

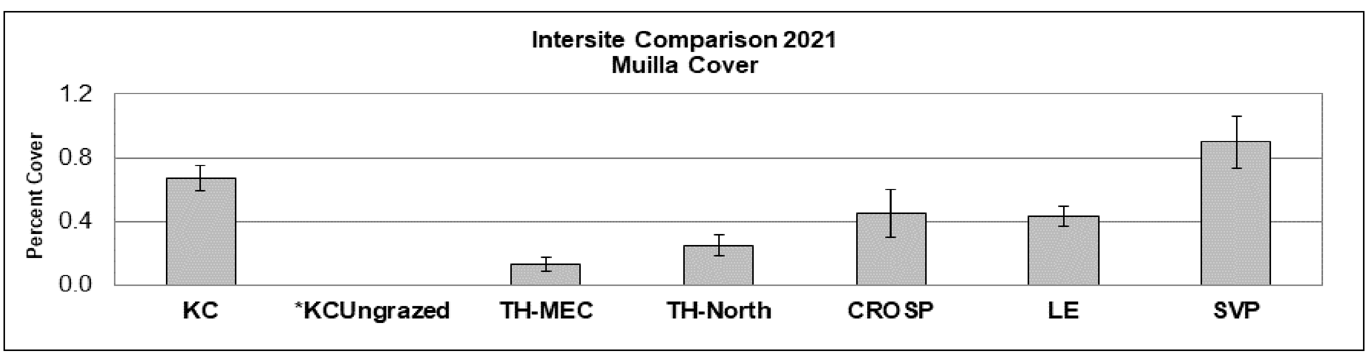


Figure 6-12 Host and nectar plants: Intersite comparison 2021 - Muilla cover.

KC= Kirby Canyon, winter-spring (W-S) grazing
TH-MEC = MEC portion of Tulare Hill, grazed
CROSP = Coyote Ridge OSP, spring-fall (S-F) grazing
SVP = Silicon Valley Power, S-F grazing
KC, CROSP, LE and SVP are on Coyote Ridge.

*KC-Ungrazed= Kirby Canyon, ungrazed
TH North = Northern portions of Tulare Hill, grazed
LE* = Los Esteros, S-F grazing

Grasses

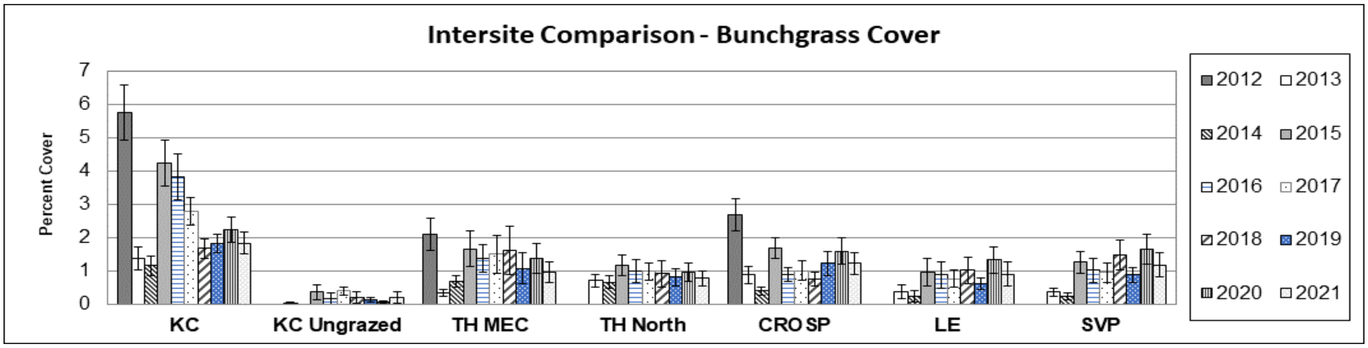


Figure 6-13 Grasses: Intersite comparison - Bunchgrass cover.

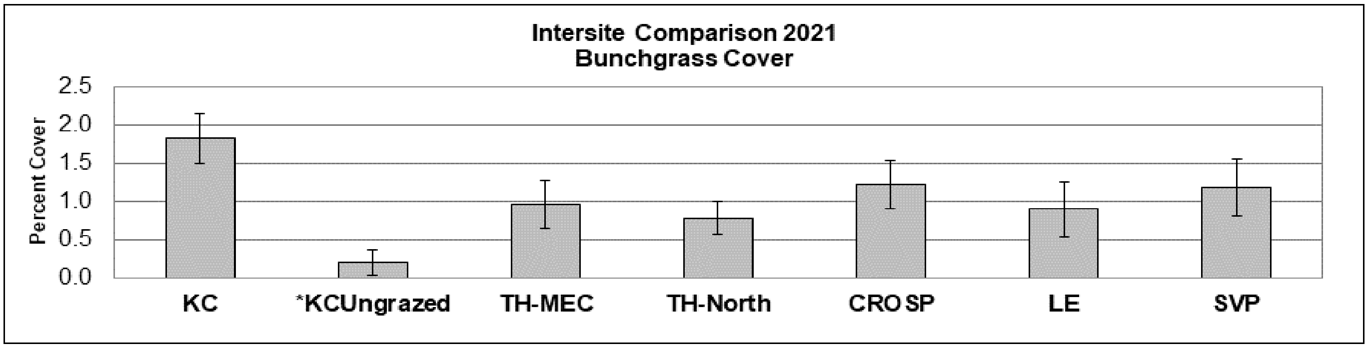


Figure 6-14 Grasses: Intersite comparison 2021 - Bunchgrass cover.

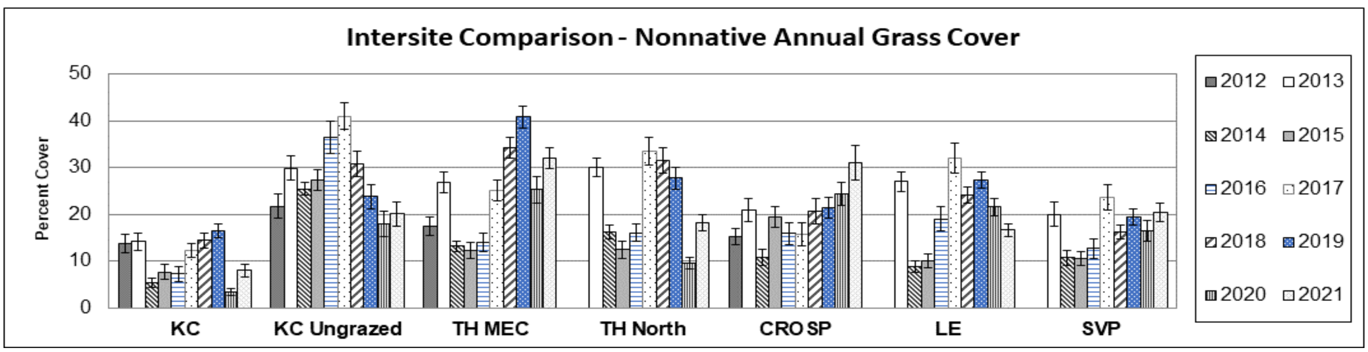


Figure 6-15 Grasses: Intersite comparison - Nonnative annual grass cover.

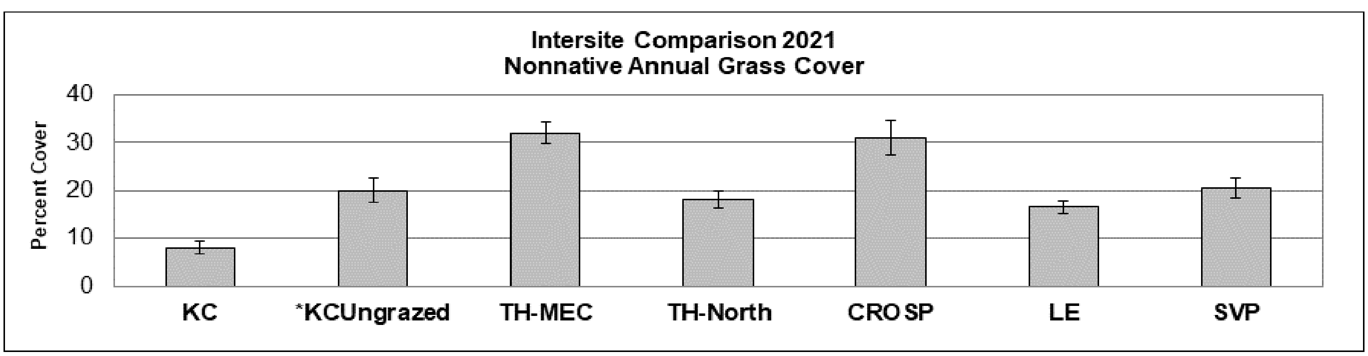


Figure 6-16 Grasses: Intersite comparison 2021 - Nonnative annual grass cover.

KC= Kirby Canyon, winter-spring (W-S) grazing
TH-MEC = MEC portion of Tulare Hill, grazed
CROSP = Coyote Ridge OSP, spring-fall (S-F) grazing
SVP = Silicon Valley Power, S-F grazing
KC, CROSP, LE and SVP are on Coyote Ridge.

*KC-Ungrazed= Kirby Canyon, ungrazed
TH North = Northern portions of Tulare Hill, grazed
LE* = Los Esteros, S-F grazing

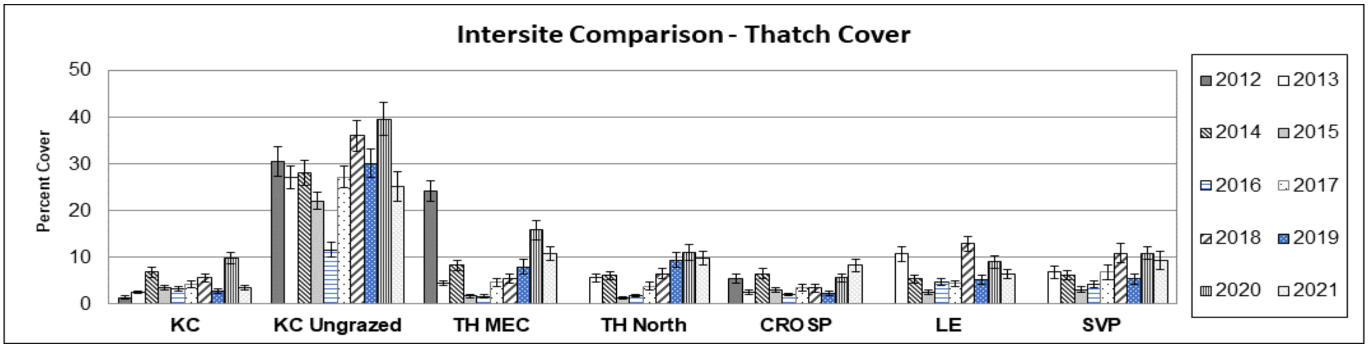


Figure 6-17 Grasses: Intersite comparison - Thatch cover.

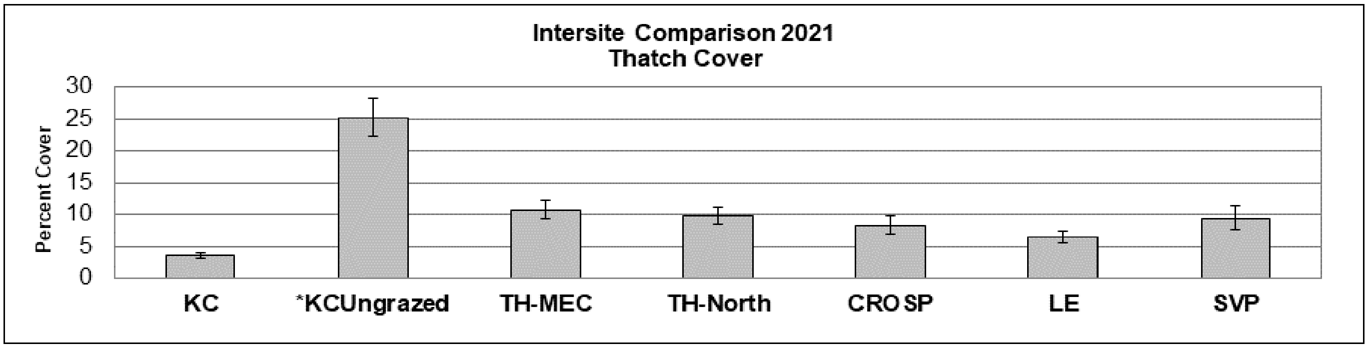


Figure 6-18 Grasses: Intersite comparison 2021 - Thatch cover.

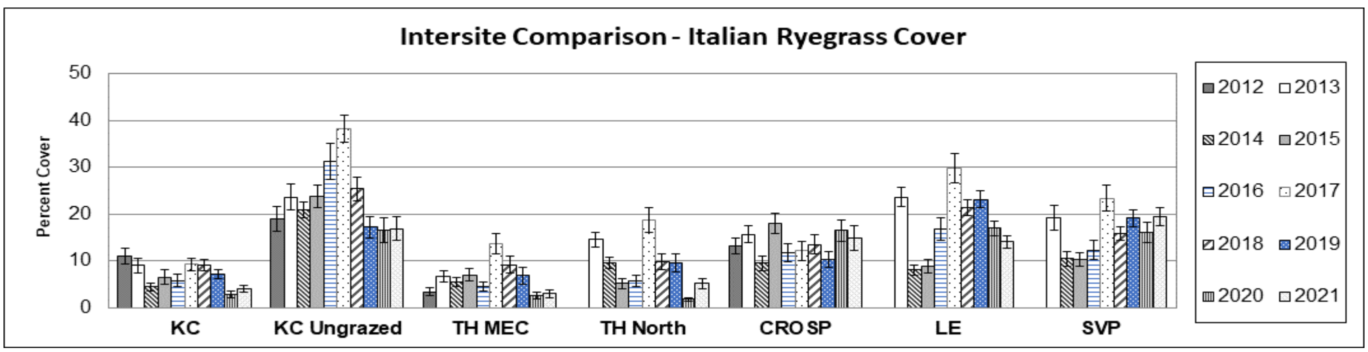


Figure 6-19 Grasses: Intersite comparison - Italian ryegrass cover.

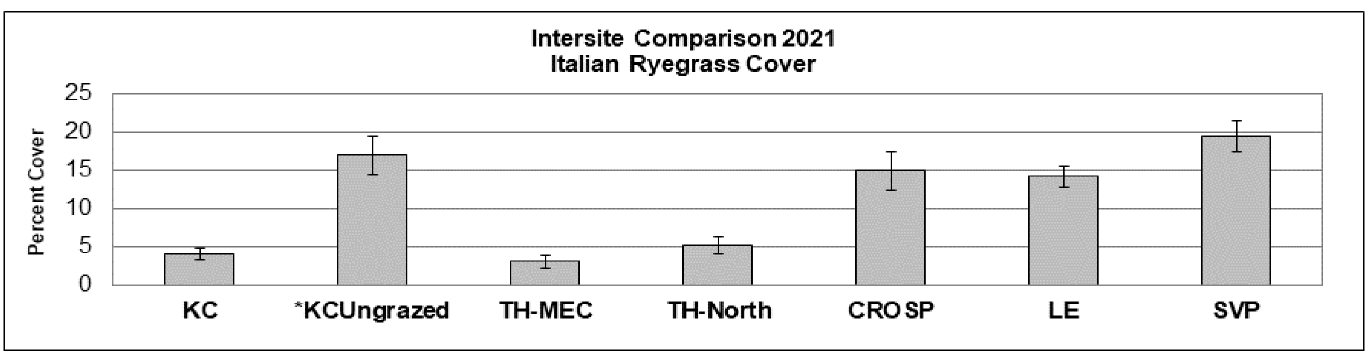


Figure 6-20 Grasses: Intersite comparison 2021 - Italian ryegrass cover.

KC= Kirby Canyon, winter-spring (W-S) grazing
TH-MEC = MEC portion of Tulare Hill, grazed
CROSP = Coyote Ridge OSP, spring-fall (S-F) grazing
SVP = Silicon Valley Power, S-F grazing
KC, CROSP, LE and SVP are on Coyote Ridge.

*KC-Ungrazed= Kirby Canyon, ungrazed
TH North = Northern portions of Tulare Hill, grazed
LE* = Los Esteros, S-F grazing

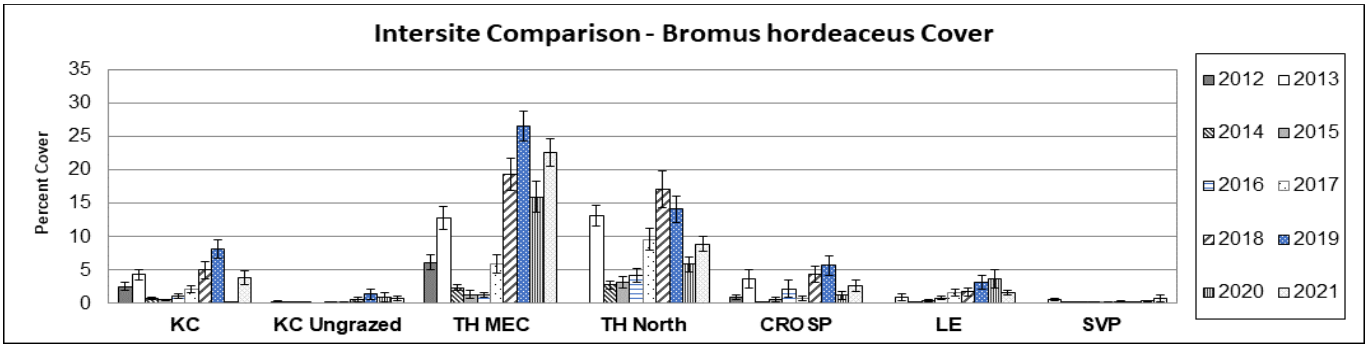


Figure 6-21 Grasses: Intersite comparison - Bromus hordeaceus cover.

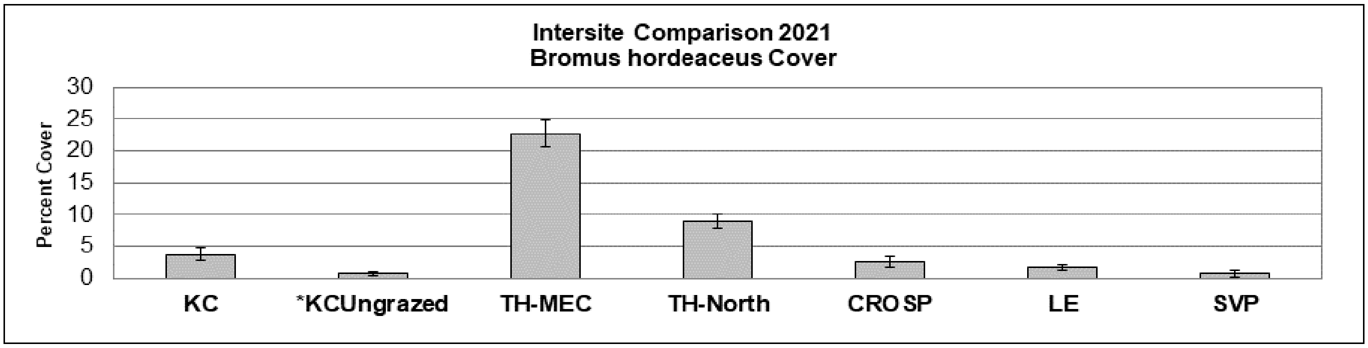


Figure 6-22 Grasses: Intersite comparison 2021 - Bromus hordeaceus cover.

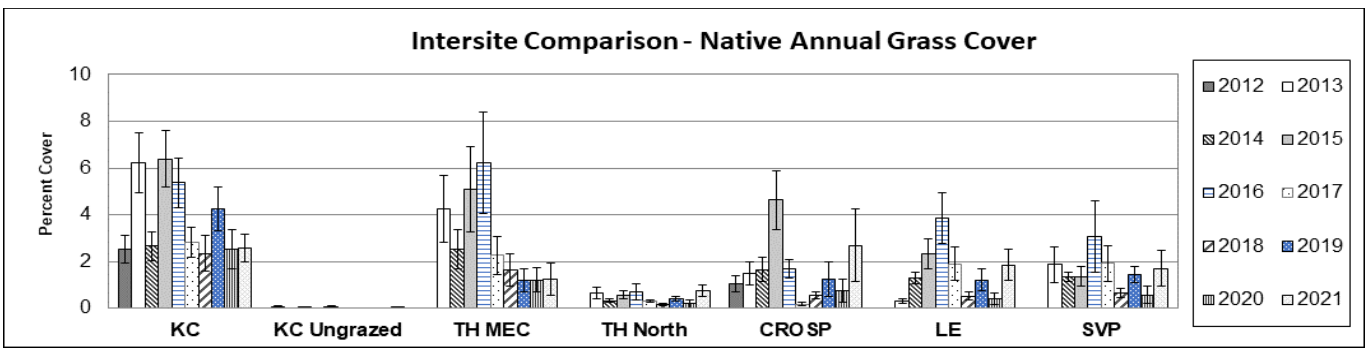


Figure 6-23 Grasses: Intersite comparison - Native annual grass cover.

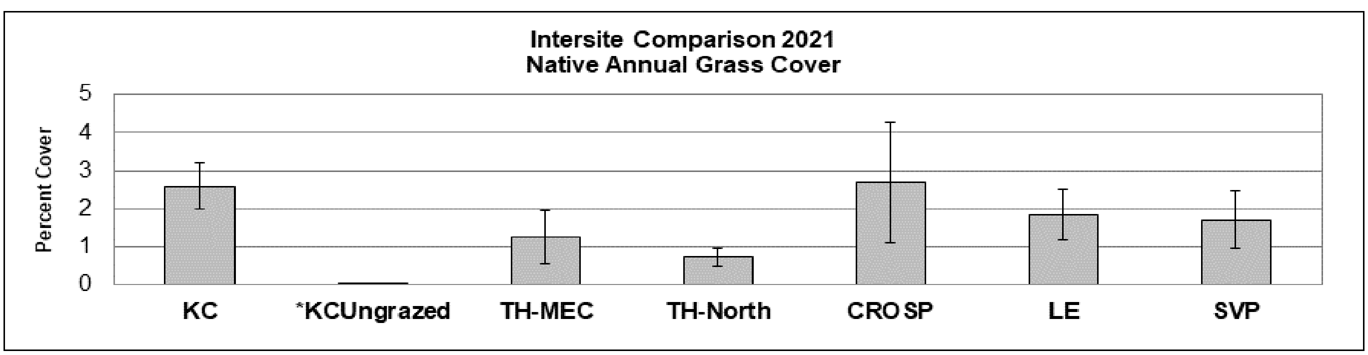


Figure 6-24 Grasses: Intersite comparison 2021 - Native annual grass cover.

KC= Kirby Canyon, winter-spring (W-S) grazing
TH-MEC = MEC portion of Tulare Hill, grazed
CROSP = Coyote Ridge OSP, spring-fall (S-F) grazing
SVP = Silicon Valley Power, S-F grazing
KC, CROSP, LE and SVP are on Coyote Ridge.

*KC-Ungrazed= Kirby Canyon, ungrazed
TH North = Northern portions of Tulare Hill, grazed
LE* = Los Esteros, S-F grazing

Native Species and Overall Plant Cover

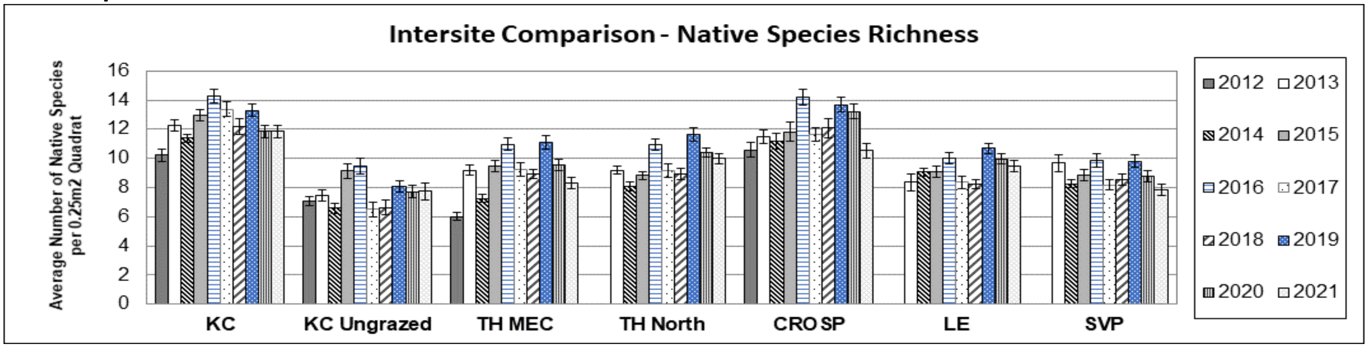


Figure 6-25 Native species and overall plant cover: Intersite comparison - Native species richness.

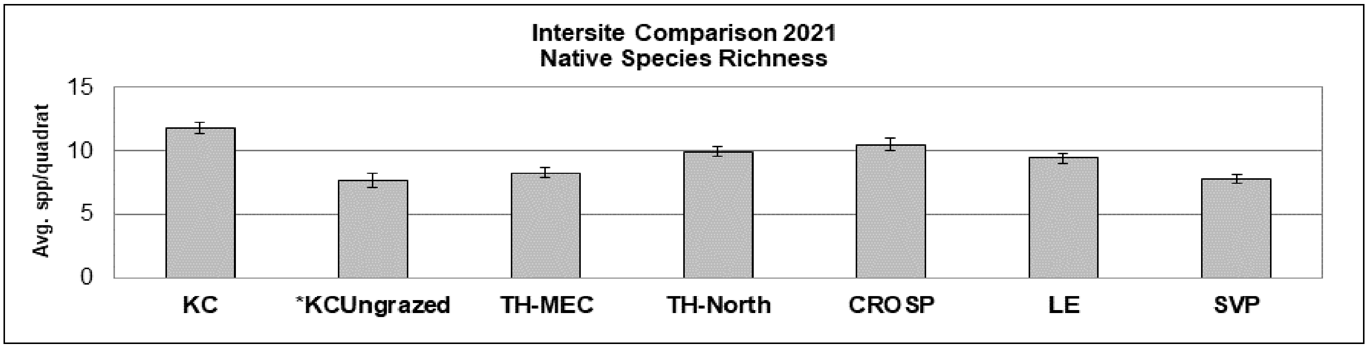


Figure 6-26 Native species and overall plant cover: Intersite comparison 2021 - Native species richness.

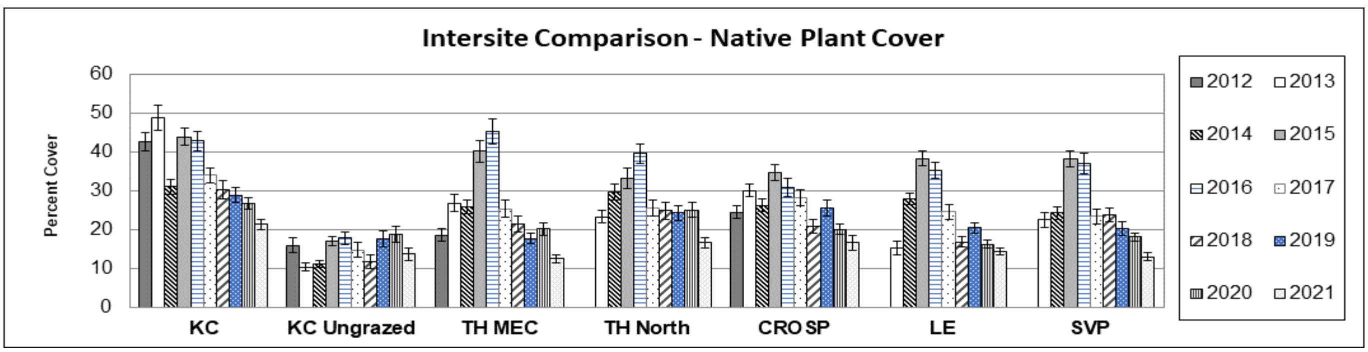


Figure 6-27 Native species and overall plant cover: Intersite comparison - Native plant cover.

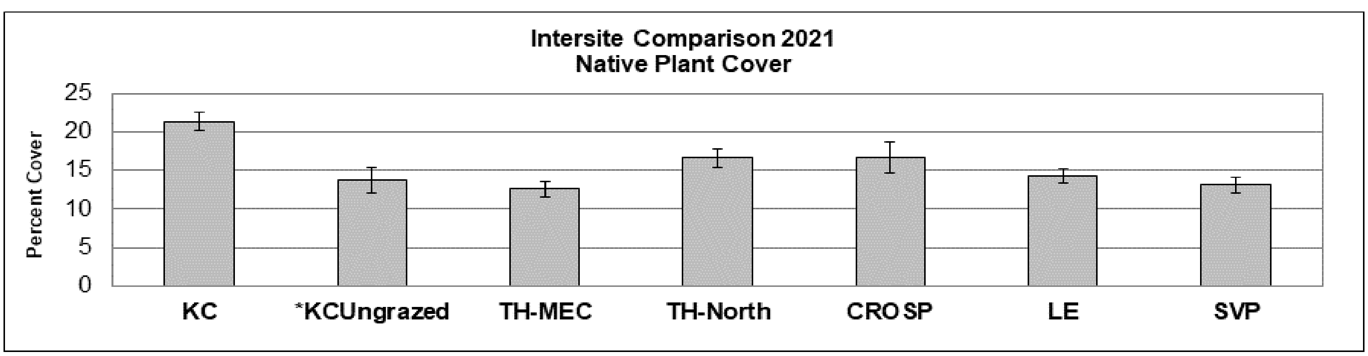


Figure 6-28 Native species and overall plant cover: Intersite comparison 2021 - Native plant cover.

KC= Kirby Canyon, winter-spring (W-S) grazing
TH-MEC = MEC portion of Tulare Hill, grazed
CROSP = Coyote Ridge OSP, spring-fall (S-F) grazing
SVP = Silicon Valley Power, S-F grazing
KC, CROSP, LE and SVP are on Coyote Ridge.

*KC-Ungrazed= Kirby Canyon, ungrazed
TH North = Northern portions of Tulare Hill, grazed
LE* = Los Esteros, S-F grazing

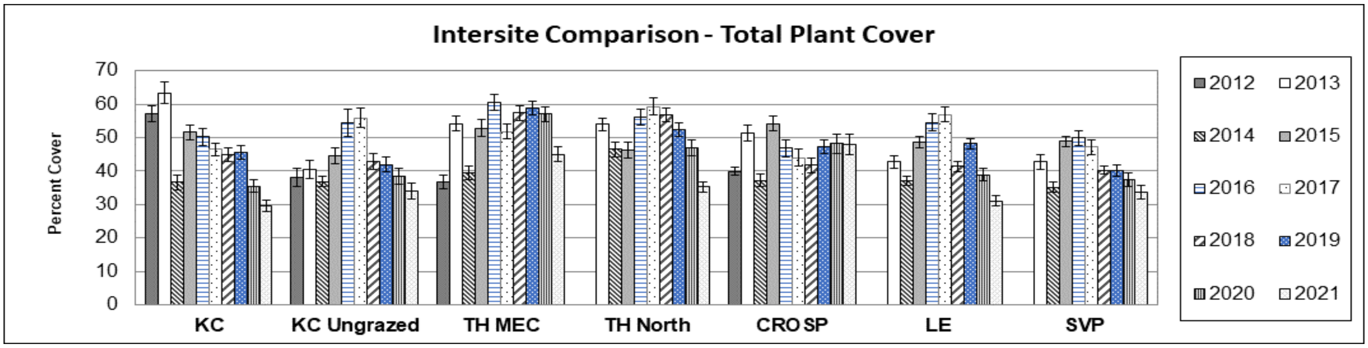


Figure 6-29 Native species and overall plant cover: Intersite comparison - Total plant cover.

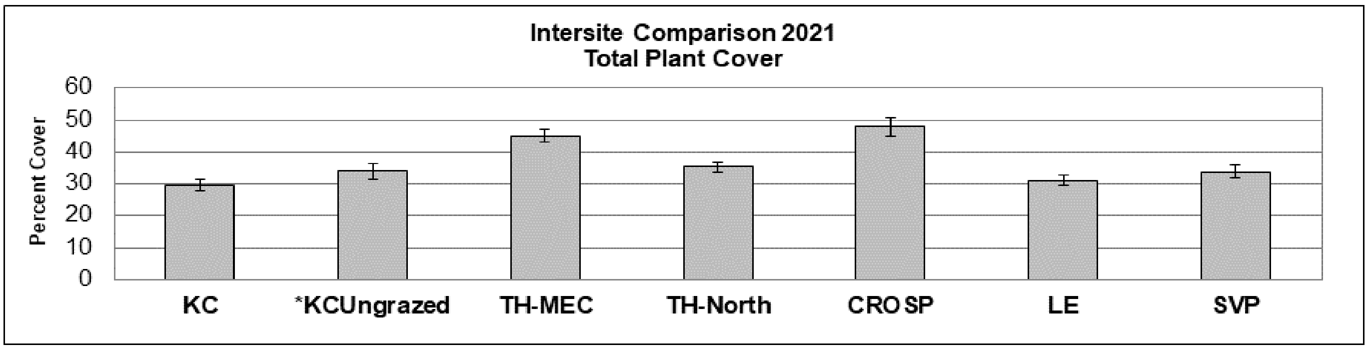


Figure 6-30 Native species and overall plant cover: Intersite comparison 2021 - Total plant cover.

Abiotic Conditions

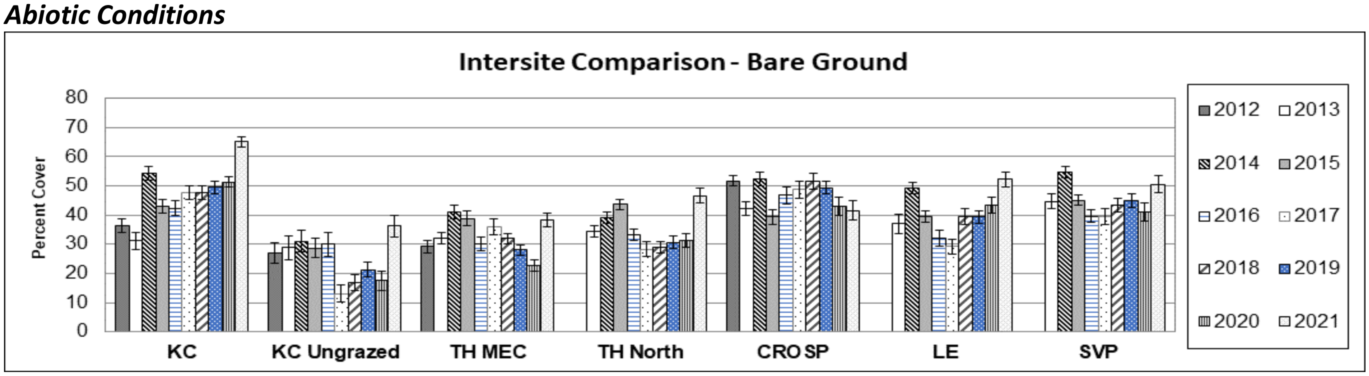


Figure 6-31 Abiotic conditions: Intersite comparison - Bare ground.

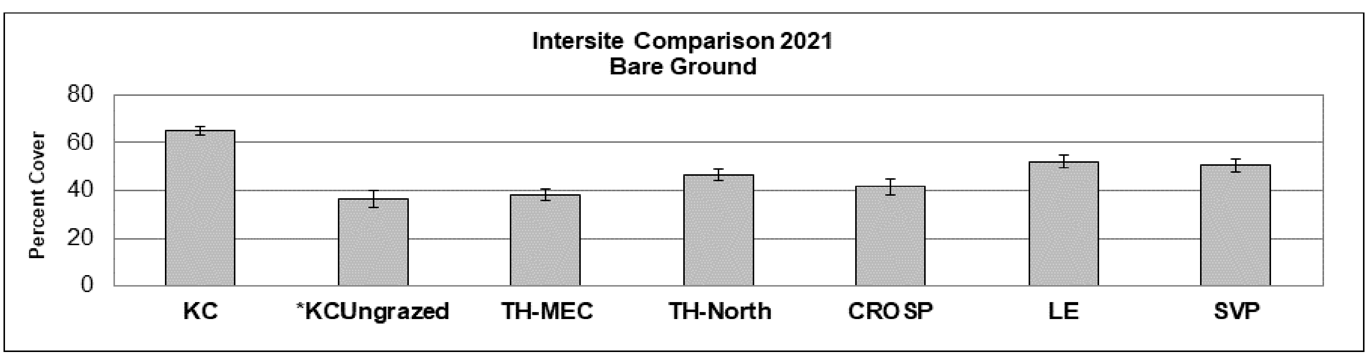


Figure 6-32 Abiotic conditions: Intersite comparison 2021 - Bare ground.

KC= Kirby Canyon, winter-spring (W-S) grazing
TH-MEC = MEC portion of Tulare Hill, grazed
CROSP = Coyote Ridge OSP, spring-fall (S-F) grazing
SVP = Silicon Valley Power, S-F grazing
KC, CROSP, LE and SVP are on Coyote Ridge.

*KC-Ungrazed= Kirby Canyon, ungrazed
TH North = Northern portions of Tulare Hill, grazed
LE* = Los Esteros, S-F grazing

Other Functional Groups

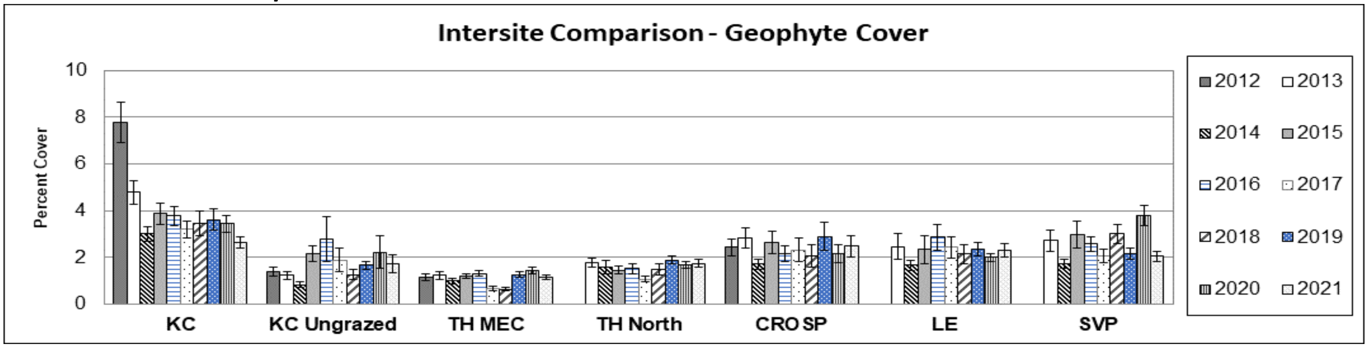


Figure 6-33 Other functional groups: Intersite comparison - Geophyte cover.

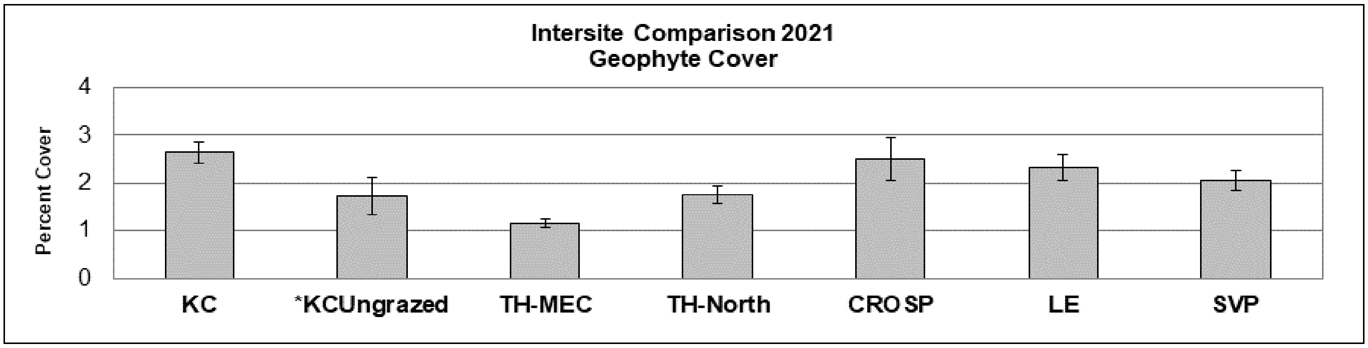


Figure 6-34 Other functional groups: Intersite comparison 2021 - Geophyte cover.

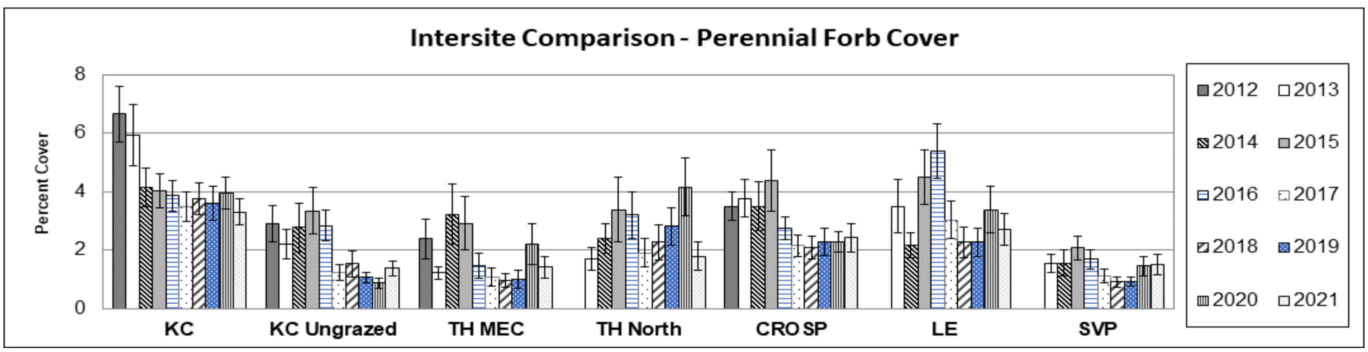


Figure 6-35 Other functional groups: Intersite comparison - Perennial forb cover.

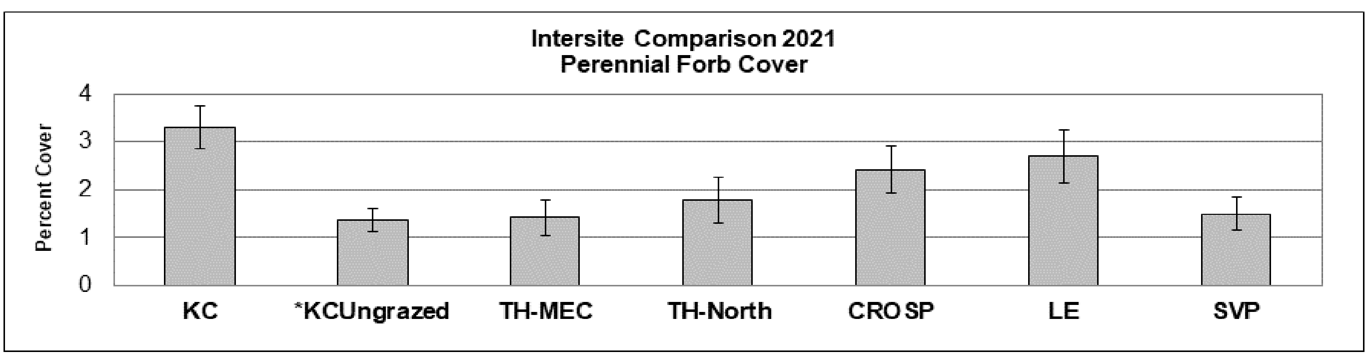


Figure 6-36 Other functional groups: Intersite comparison 2021 - Perennial forb cover.

KC= Kirby Canyon, winter-spring (W-S) grazing
TH-MEC = MEC portion of Tulare Hill, grazed
CROSP = Coyote Ridge OSP, spring-fall (S-F) grazing
SVP = Silicon Valley Power, S-F grazing
KC, CROSP, LE and SVP are on Coyote Ridge.

*KC-Ungrazed= Kirby Canyon, ungrazed
TH North = Northern portions of Tulare Hill, grazed
LE* = Los Esteros, S-F grazing

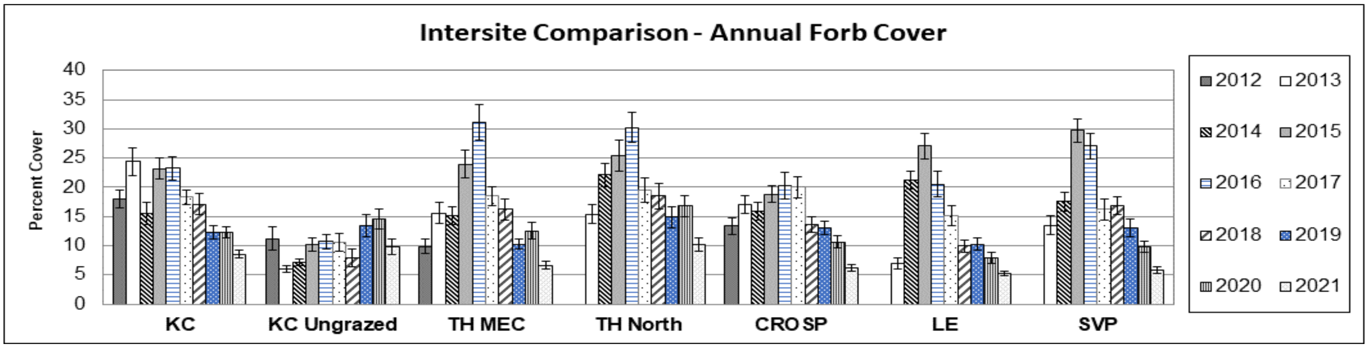


Figure 6-37 Other functional groups: Intersite comparison - Annual forb cover.

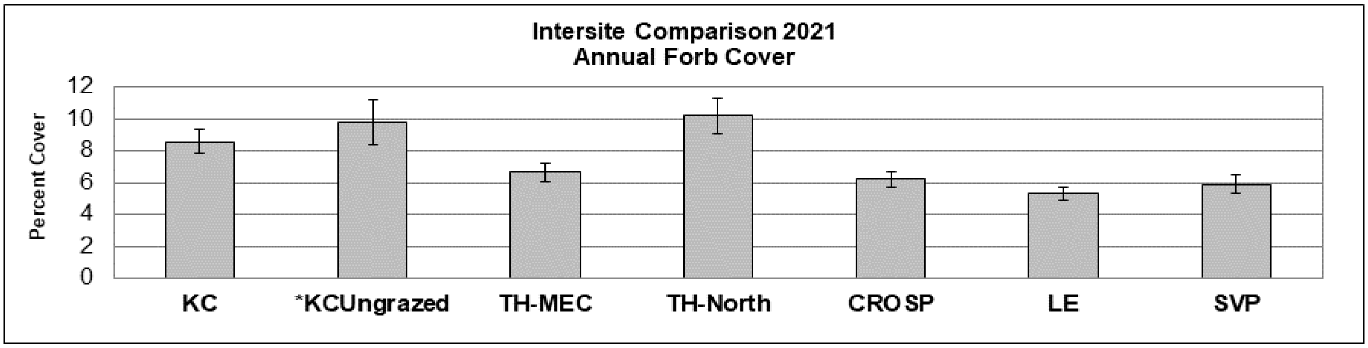


Figure 6-38 Other functional groups: Intersite comparison 2021 - Annual forb cover.

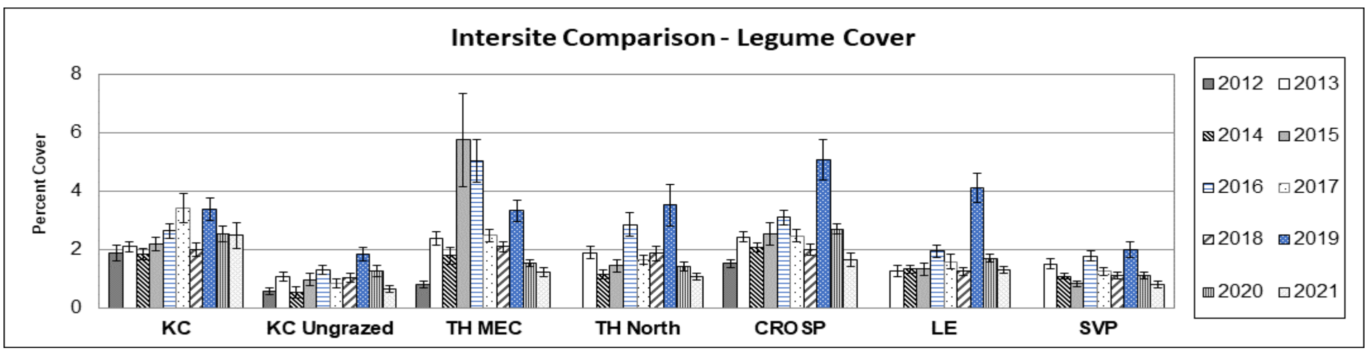


Figure 6-39 Other functional groups: Intersite comparison - Legume cover.

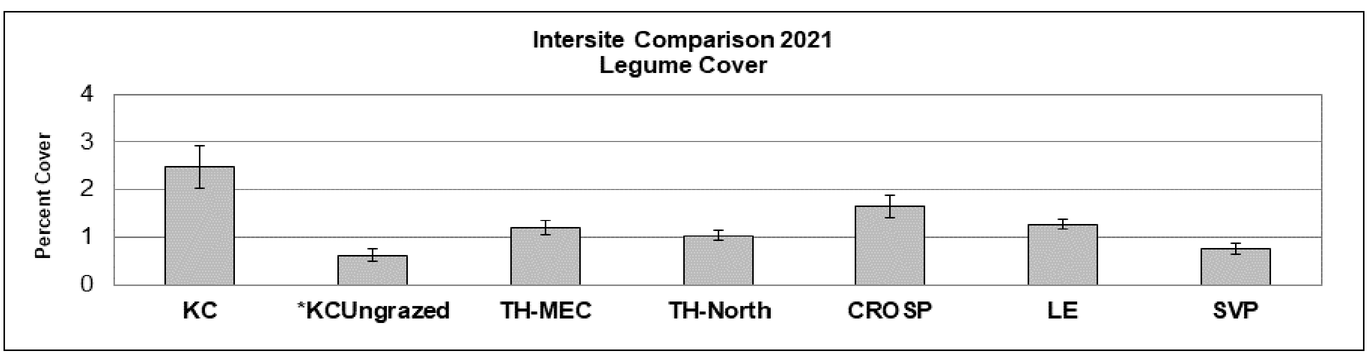


Figure 6-40 Other functional groups: Intersite comparison 2021 - Legume cover.

KC= Kirby Canyon, winter-spring (W-S) grazing
TH-MEC = MEC portion of Tulare Hill, grazed
CROSP = Coyote Ridge OSP, spring-fall (S-F) grazing
SVP = Silicon Valley Power, S-F grazing
KC, CROSP, LE and SVP are on Coyote Ridge.

*KC-Ungrazed= Kirby Canyon, ungrazed
TH North = Northern portions of Tulare Hill, grazed
LE* = Los Esteros, S-F grazing

6.2 Seep Fencing and Monitoring

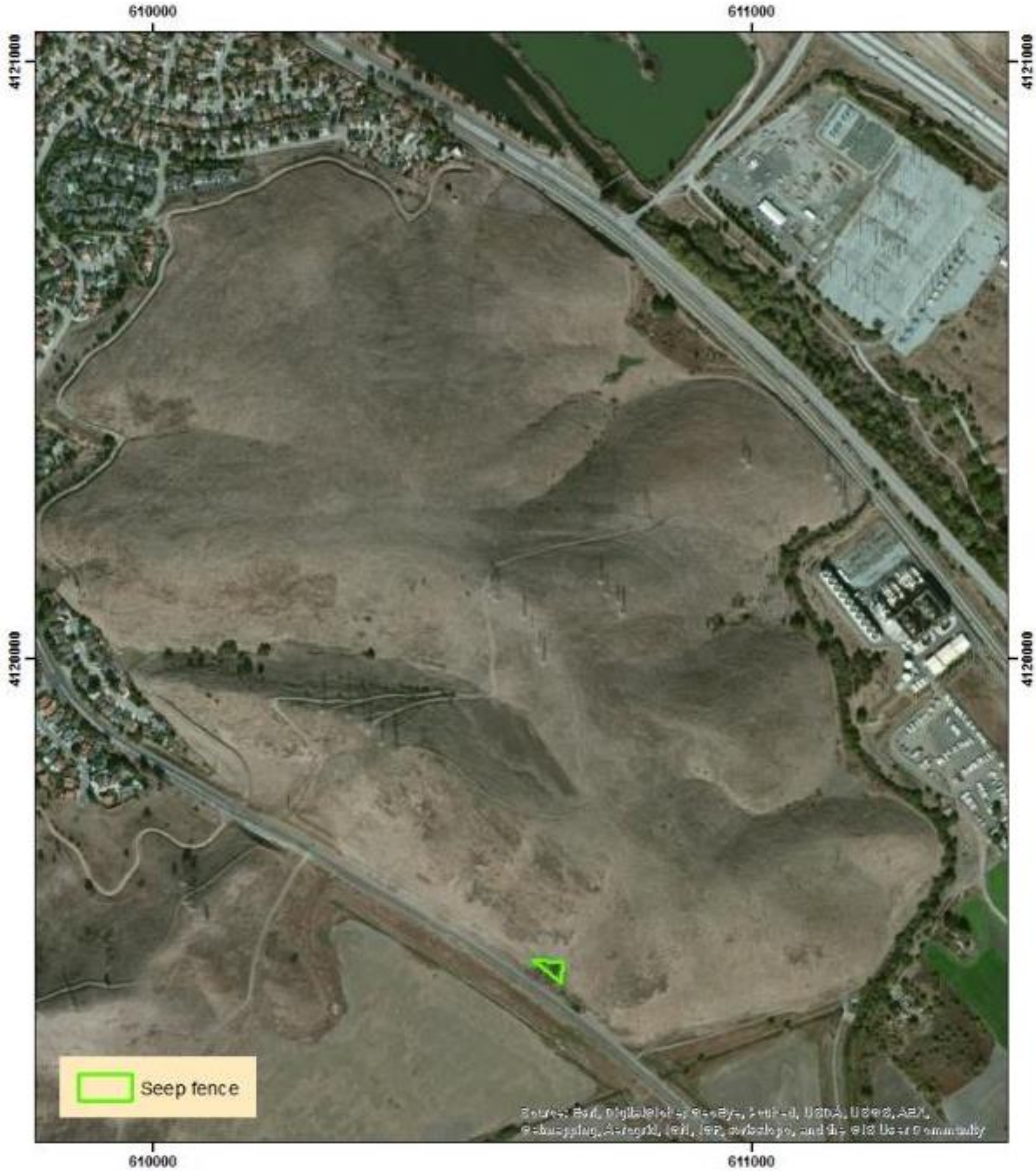
A large seep located on the southwest side of the property, adjacent to Santa Teresa Boulevard (Map 6-3), was showing signs of trampling and weed invasion compared with the largely native ungrazed portion of the seep outside the fence (immediately adjacent, downhill toward Santa Teresa Blvd.). Consultation with rancher Justin Fields confirmed that this was not a critical water source for the cattle. While seep access probably increases grazing pressure on this section of the MEC Preserve, the steep south-facing slope above the seep has low annual grass cover (and high California sagebrush cover) and is mostly too hot to support BCB.

A 290-foot-long fence was installed on March 26, 2013 to incorporate 0.21 acres. This fence sustained some damage in 2016 and was repaired and fortified in 2017. It was repaired again by Creekside Science on August 13, 2019. In August of 2021, the fence was found to be in disrepair with a cow inside the exclosure, and evidence of substantial cattle grazing and trampling was observed in the vicinity. On September 1, we returned to repair the fence. This fence, however, is decaying rapidly beyond repair. If it is to remain functional, it will need to be replaced with sturdier materials. We have proposed this work to LTSCV for 2022.

The purpose of the fence is to exclude cattle and therefore reduce trampling. Combined with manual weed work, we also expect the fence to lead to increased native cover at the seep, more similar to the ungrazed area.

Bull thistle in particular was establishing in the grazed area. Creekside Science manually removes plants annually and they are currently at low density.

Baseline and reference monitoring data are available in the 2013 through 2017 reports.



Map 6-3 Seep location.

SECTION 7.0

Barbed Goatgrass and other Nonnative Grasses

Barbed goatgrass (*Aegilops triuncialis*) was first identified on Coyote Ridge in 2002 on the ridgetop near where the VTA property borders the CROSP property (formerly UTC). By 2005, late season field work led to a greater understanding of the extent of the goatgrass infestations on Coyote Ridge, and local biologists became increasingly aware of the ability of barbed goatgrass to establish itself in serpentine habitats. A control program consisting of handpulling began that year, but it quickly became apparent that the main infestations were too large for handpulling to be effective.

In 2006, a more comprehensive goatgrass management plan was designed and implemented by Creekside Science and SCVOSA with the goal of local eradication of smaller fringe infestations (particularly along the southern part of Coyote Ridge) and reduction of goatgrass cover in larger, more dense infestations. This USFWS-approved plan used a combination of spraying, handpulling, string cutting and, to a much lesser extent, burning.

In 2016 we began long-term monitoring to better assess the risks and impacts of goatgrass and other nonnative grasses on serpentine habitat with the goal of having those data drive our management over the years and decades to come.

7.1 Status, Biology, and Impacts

The California Department of Food and Agriculture lists barbed goatgrass as a B-rated noxious weed. This calls for eradication, containment, control or other holding action at the discretion of the commissioner. The California Invasive Plant Council gives it a pest rating of high.

Barbed goatgrass is regarded among the wildland weed community as particularly invasive and difficult to control. It sets seed later than most annual grasses, remaining green into May or June in most years. The seeds remain viable in the soil for two or more years (DiTomaso and Healy 2007). Its roots reach deeper than many other annual grasses, allowing it to use high amounts of soil moisture and further enhancing its competitive ability. Barbed goatgrass can decrease forage production in rangelands from 50% to more than 75%, especially after it flowers and develops its sharp, long, barbed awns. Heavy grazing, either throughout the season or in short durations, appears to increase density (DiTomaso and Healy 2007). It can be dispersed by livestock, wild animals, people, and vehicles (Peters et al. 1996).

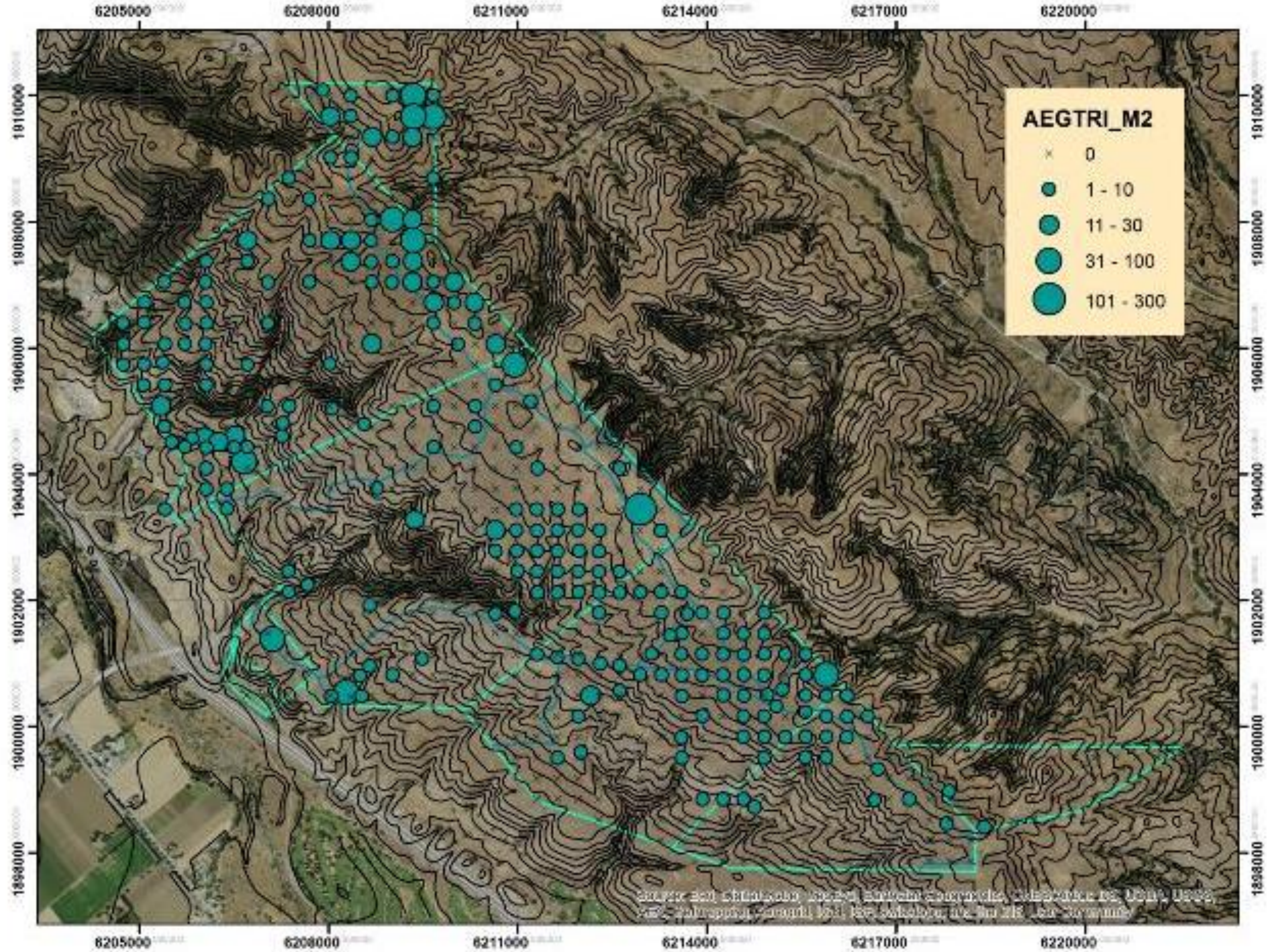
7.2 Known Distribution on Coyote Ridge

The infestation is estimated to be on the order of many hundreds of acres, although the entire ridge has not been mapped. The worst infestation south of Metcalf Road, on CROSP, was mapped at a 50-meter grid resolution in 2016 (Map 7-1).

Goatgrass has not been found on MEC-CR, although it is near infestations that have been found along the ridgetop road (Map 7-1). This infestation is small, near high quality habitat, and has been treated by SCVOSA in the past. The LECEF Preserve parcel has an infestation on the order of tens of acres.

A small infestation was found on the SVP parcel in 2013. Prior to that, there were no known infestations in SVP.

Goatgrass is not currently found on Tulare Hill.



Map 7-1 Goatgrass infestations on Coyote Ridge Open Space Preserve, 2016.

7.3 Control Methods

Several control methods are appropriate for this species and other nonnative grasses. Control strategies are assessed for their efficacy, total cost, and impacts to sensitive species. Years of work (see previous reports) show that the most effective regime in any high density or large-scale infestation involves spraying Envoy for 2-3 consecutive years, followed by handpulling. In lieu of spraying Envoy, mowing can reduce cover, but far less effectively. The phenological window for mowing is quite small: cutting too early runs the risk of goatgrass resprouting, and cutting too late can allow for seed set. Goatgrass treatment on virtually any scale without the use of fire is highly intensive and expensive, as treatment of any nonnative grass would be.

Handpulling is a useful follow-up tool, or main management tool for very small infestations. Plants should be pulled by the root and bagged, as viable seeds can remain in the rootstock. Plants are very cryptic, so handpulling can be ineffective over larger scales because it's so easy to miss individuals.

Because of the pernicious nature of goatgrass, grazing may not be as effective a management tool as it is for other nonnative annual grasses. Due to its high silica content and sharp, barbed awns, this species is both unpalatable and potentially injurious to livestock. Heavy grazing can promote spread of this species (DiTomaso and Healy 2007), perhaps because livestock is forced to eat everything else. Cows do appear to graze on the plants early in the season, perhaps before the awns harden, and precisely timed mob stocking has been used to control this species in small pastures. Rancher Justin Fields noticed his cattle grazing on goatgrass in June 2011. This may be more likely in a dry year when other forage quickly dies off, and the goatgrass remains relatively green for a longer period (Niederer, Weiss, personal observations), although goatgrass remains relatively green for a longer period no matter the yearly weather. While cattle grazing is an extremely important management tool, and likely the only truly pragmatic, cost-effective, long-term treatment for grass control on Coyote Ridge, it does have limitations. California weather is known for its interannual variability. Changes in annual vegetation (i.e., grass cover) are largely weather driven. Cattle herds need lag time to build up after drought years, and sometimes grass gets to very high levels during that period. Having other large-scale grass treatments in the mix to supplement grazing may be important in maintaining BCB and its associated host and nectar sources. Some thin-soiled areas on the ridge are likely to exclude nonnative annual grass regardless of grazing or other management.

BCB larvae are in diapause during the appropriate window for mowing, burning, and much of the handpulling. Effects of these and other treatments can be found in previous reports. Creekside Science is conducting research to determine if and how goatgrass should be managed on CROSP and elsewhere on Coyote Ridge (see section 7.4 below).

Due to liability concerns, burning has not been conducted since 2007. In the current socio-political climate, it is highly unlikely that burning can be used to any significant degree. Creekside Science staff has recommendations on the use of fire for nonnative grass control (outlined in previous reports) should serious discussions on the use of fire arise.

7.4 Monitoring

7.4.1 Long-term Monitoring Plots Methods

In 2016 Creekside Science established six long-term monitoring plots on Coyote Ridge where goatgrass is well established (CROSP property) with the intent of evaluating the current status of goatgrass and other nonnative grasses relative to other habitat quality markers (forbs, bare ground, etc.) within these plots and of monitoring trends over time. Two blocks (2 and 5) were placed in more densely occupied habitat, and the remaining blocks were installed in light to moderate occupied habitat. These plots are monitored annually.

The plots are each 100 meters by 50 meters, within which 36 quarter meter quadrats are read: 6 quarter meter quadrats are read across the 50 m stretch every ten meters starting at 0 m (-0.5 m to 0 m, 9.5 m to 10 m, 19.5 m to 20 m, 29.5 m to 30 m, 39.5 m to 40 m, 49.5 m to 50 m), repeated every 20 meters along the 100 meter sides (0 m, 20 m, 40 m, 60 m, 80 m, 100 m). A GPS grid allows data collectors to navigate to each of the 36 quadrat locations.

The following data are recorded in percent cover (0, 1%, 2%, 5%, 10% and in increments of 10% from there): bare, rock, forbs, goatgrass (*Aegilops triuncialis*), wild oats (*Avena barbata*), other nonnative grasses, *Festuca microstachys* (native annual grass) and bunchgrass. Total cover must add up to between 95% and 105%.

7.4.2 Paired Plot Monitoring Methods

In 2017 staff installed six paired spray/control plots to monitor and assess impacts of Envoy Plus when applied at larger scales on serpentine habitats. Previous efforts by Creekside Science staff have shown Envoy to be very effective at reducing goatgrass cover, but potential impacts upon the habitat were not studied, such as impacts on bunchgrasses and native annual grasses, most notably *Festuca microstachys*. Furthermore, we wish to better understand the most desirable number of successive years for Envoy treatment to have success against goatgrass and other nonnative grasses but to minimize impacts on bunchgrasses and other impacted plant species.

We established six sets of paired plots in habitat occupied by goatgrass, in which two 10 meter by 10 meter plots were set adjacent to each other for an overall set size of 10 meters by 20 meters. All corners are marked by rebar and were mapped by GPS. One 10 meter by 10 meter plot was to be sprayed annually (typically in March to early April), the other was not. To reduce edge effect, we incorporated a 2m buffer zone around the monitored portions of each plot, so the effective surveyed area is 6m x 6m for each plot. Staff run tapes through the paired plots at the same time, creating three half meter wide transects which are run from the A line to the B line. They are between 2 and 2.5m, 4.5 and 5m, and 7.5 and 8m along the 10m side. Due to the buffer, each transect is only read from 2m to 8m and from 12m to 18m along the 20 meter length. Staff members use 0.5 meter x 1 meter quadrats to read the plots.

The following data are recorded in percent cover (0, 1%, 2%, 5%, 10% and in increments of 10% from there): bare, rock, forbs, flowering goatgrass, other annual grasses, *Stipa pulchra*, *Elymus multisetus*, other bunchgrasses. Total cover must add up to between 95% and 105%.

7.5 Results

7.5.1 Long-term Monitoring Plots Results

Goatgrass was down this year in 4 of the 6 plots. Plots 4 and 6 showed continued growth similar to the growth they showed last year (Figure 7-1).

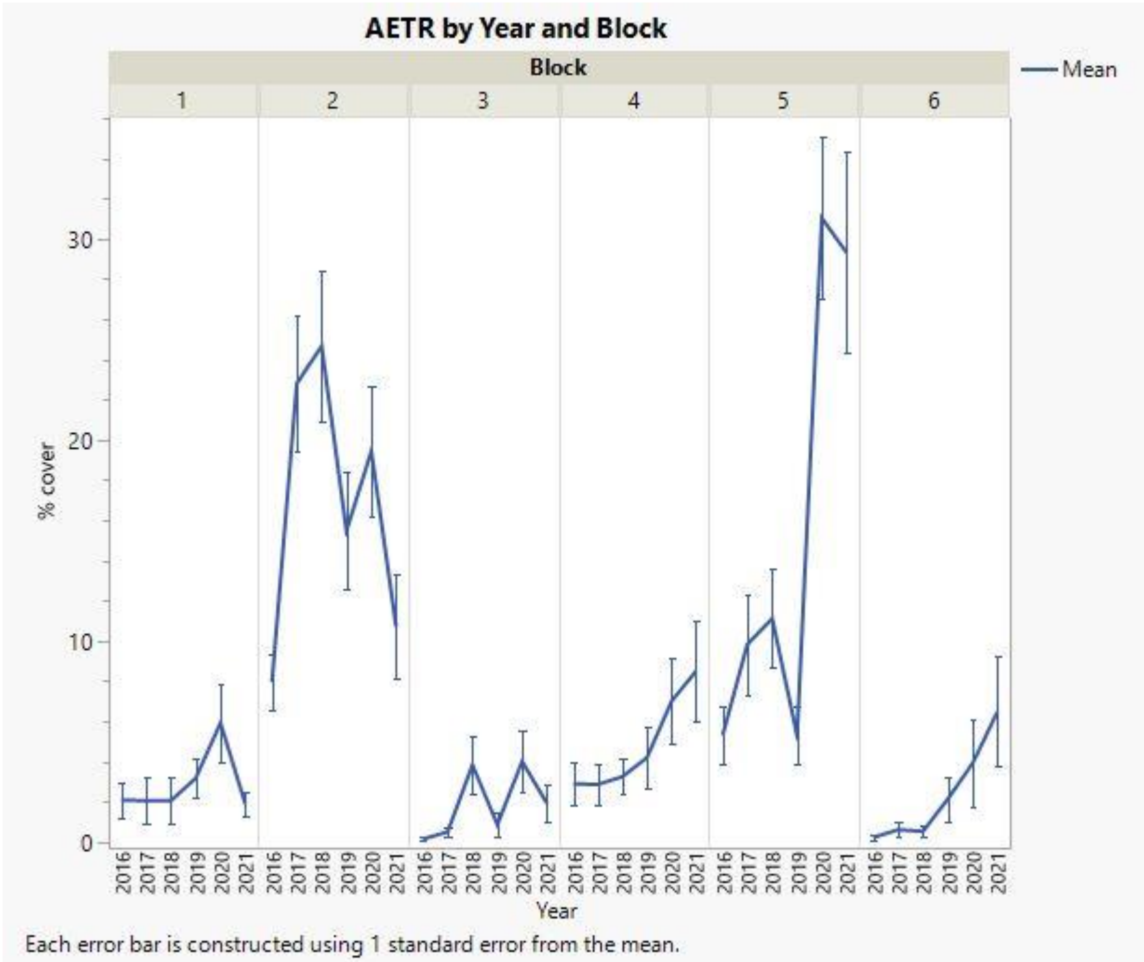


Figure 7-1 Mean goatgrass cover (AETR) over time by block.

Other nonnative grasses (excluding goatgrass) were generally up from 2020. Blocks 1-4 all showed increases from the relatively low year in 2020. Block 5 decreased slightly, and Block 6 stayed nearly the same as last year (Figure 7-2). The winter of 2020-2021 was another extreme drought year, this time with the only large storm of the season occurring in late January. It was an extremely dry late winter and spring. The other nonnative grasses benefited from the mid-season rain while the later season grasses like goatgrass were stressed. In fact, the other nonnative grasses were the only guild that did better in 2021 than in 2020 (Figure 7-3).

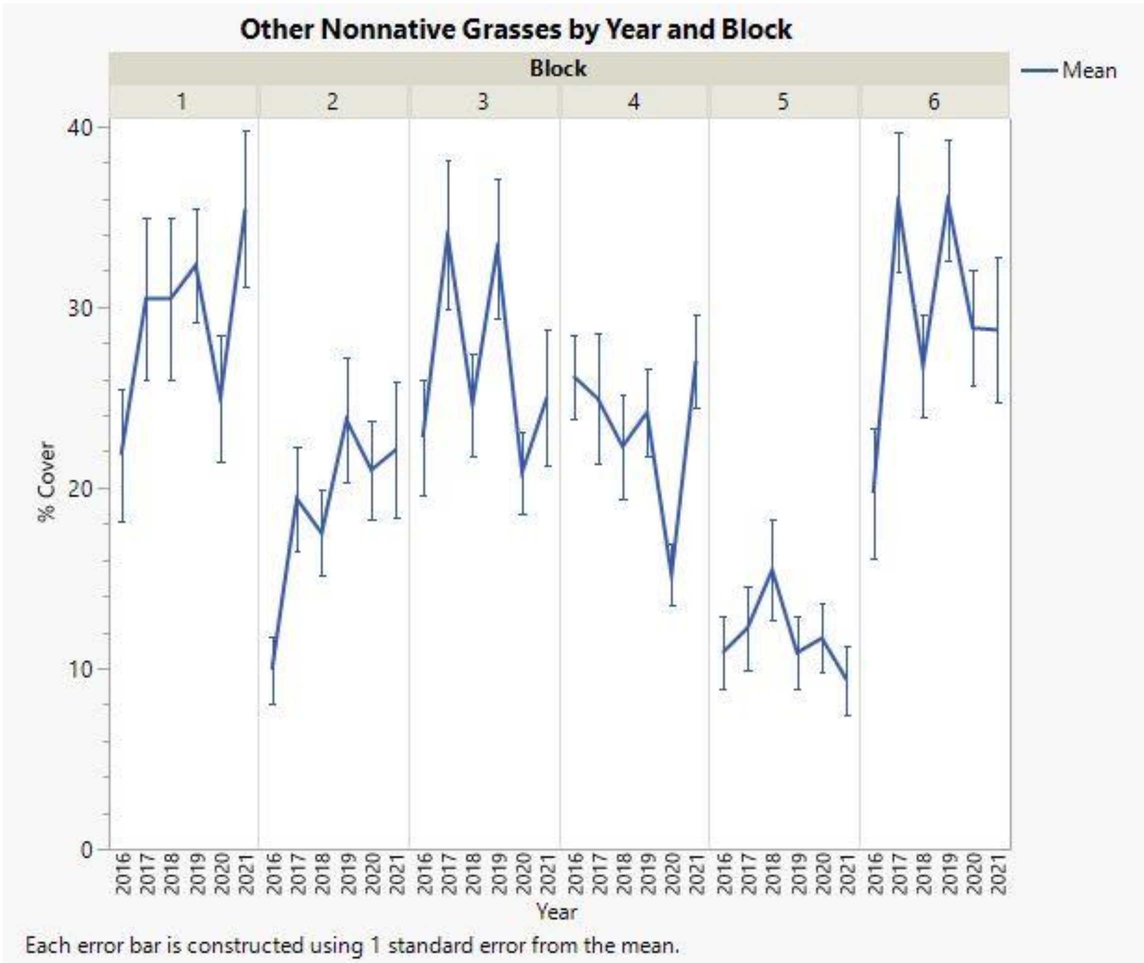


Figure 7-2 Mean nonnative grass cover over time by block.

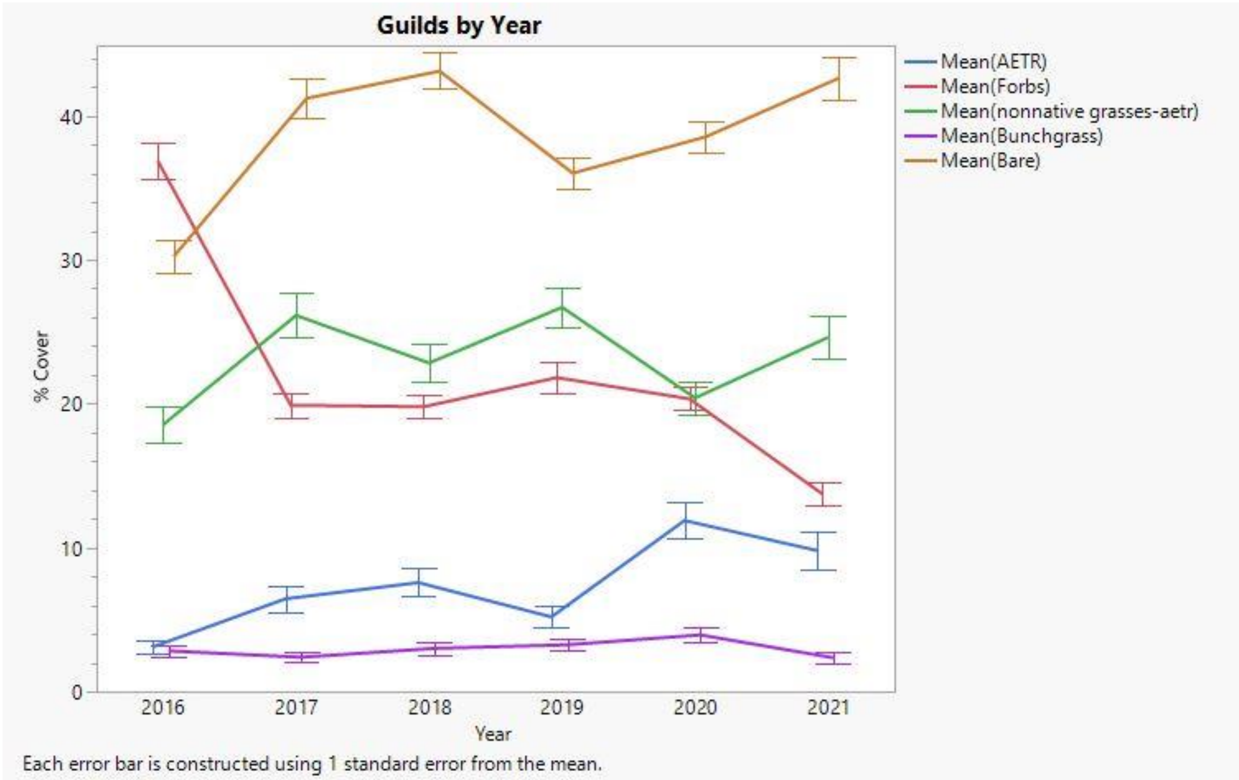


Figure 7-3 Vegetation trends in goatgrass monitoring plots.

7.5.2 Paired Plot Monitoring Results

Unfortunately, in early 2018 only half of the paired plot sets were treated (Blocks 4, 5 and 6). All the blocks were treated in early 2019. None were treated in early 2020 or 2021. As such, blocks 1 through 3 have one less year of data than blocks 4 through 6. Keep in mind that for blocks 1 through 3, the 2018 control to 2018 Envoy comparison does not reflect treatment as no spraying was performed here. The key data point in this regard is the drop in goatgrass in the 2019 Envoy plots. For all sites, the 2020 and 2021 Envoy plots just show passive responses.

For the purposes of clearly showing legacy effects, in this year's report we've decided to compare the baseline data (from 2017 or 2018, depending on the blocks) to this year's data. What we see is that in nearly every block, AETR increased considerably in the control plots, and was reduced or kept similar in the Envoy plots, demonstrating lasting legacy effects of the spraying. In every block, the Envoy plots did better than the control plots (Figure 7-4 and Figure 7-5).

Just as it reduces goatgrass cover, Envoy is highly effective in reducing cover of all annual grass species, most of which are nonnative (Photo 7-1). Native annual grasses are also impacted by Envoy, and in the areas containing these experimental plots, *Festuca microstachys* is the primary native annual grass. Because degradation of serpentine habitat is primarily driven by nonnative grass presence, in particular *Festuca perennis*, the negative impacts of Envoy spraying on the native annual grasses that may be present are likely outweighed by the potential overall habitat quality improvement.

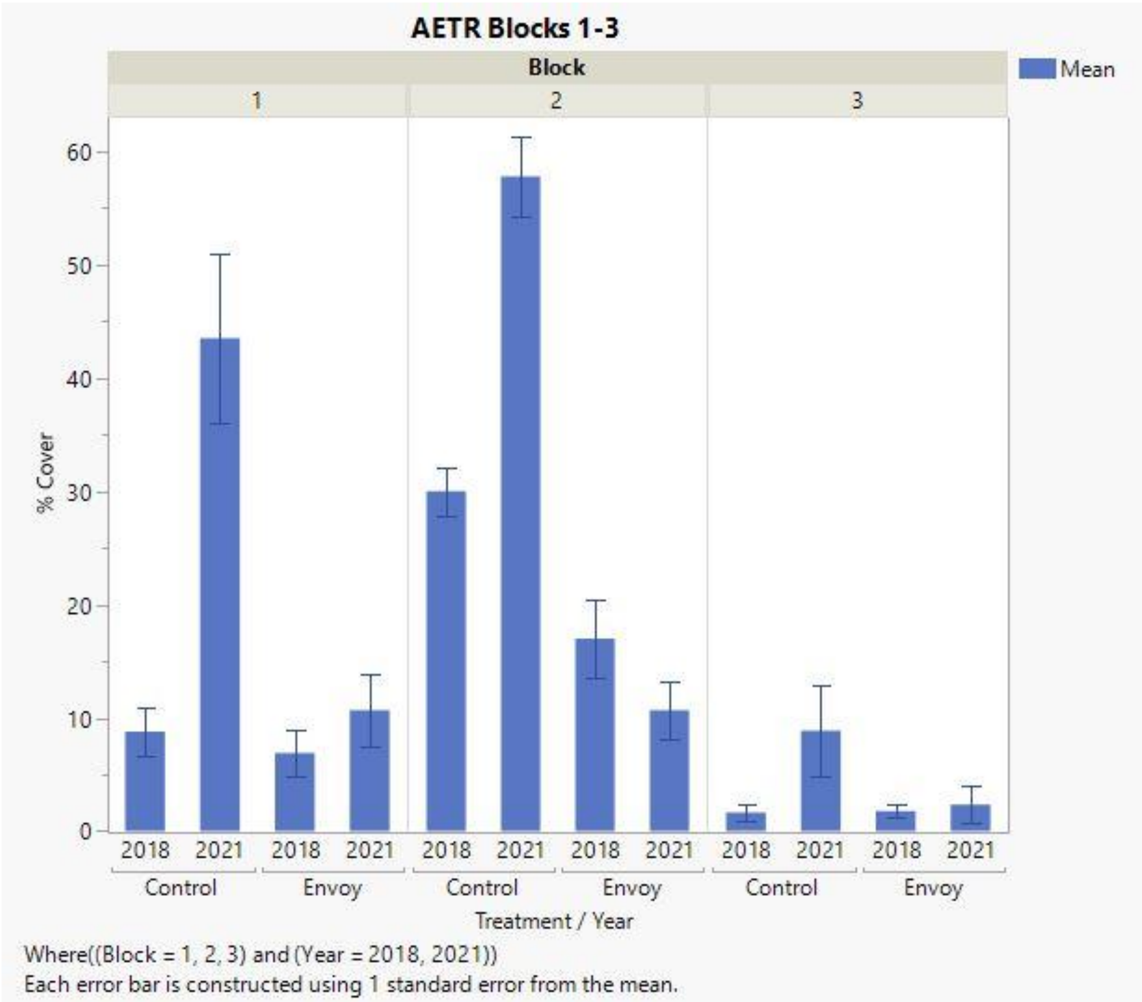


Figure 7-4 Mean goatgrass (AETR) cover in control vs. Envoy treatment over time, blocks 1 through 3.

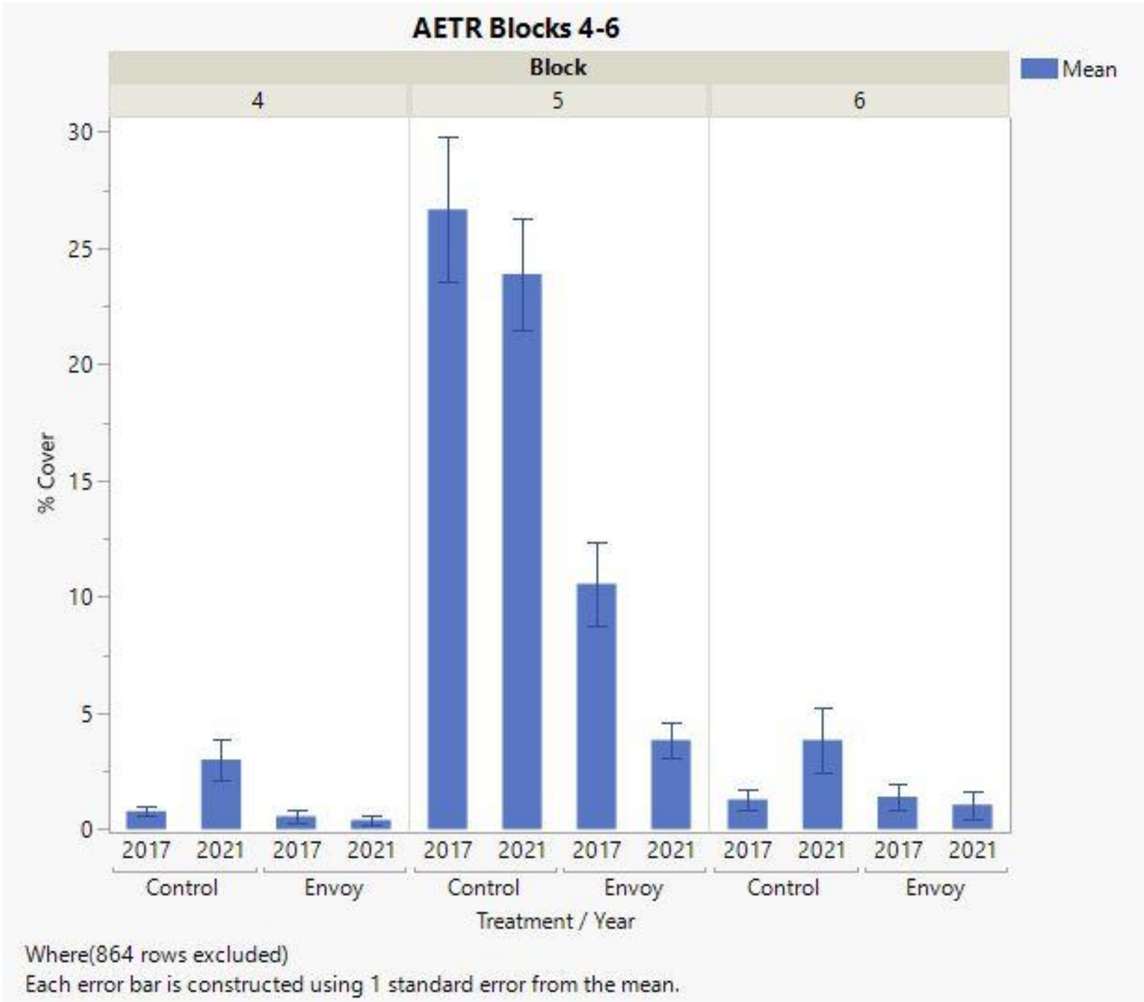


Figure 7-5 Mean goatgrass (AETR) cover in control vs. Envoy treatment over time, blocks 4 through 6.

Photo 7-1 Spray line between treated (left) and control (right) highlighting effect of Envoy on annual grasses.

In Figure 7-6 and Figure 7-7, we see increases of bare ground in the Envoy plots (despite steady or even declining forbs and bare ground in the control plots) while seeing the dips in nonnative annual grasses in the years when sprayed. There is a passive rebound of goatgrass in 2020 and 2021, years in which plots were not sprayed. There appears to be a legacy effect in the other nonnative grasses in the Envoy plots, where seed set in 2019 was greatly reduced by spraying. However, that effect is lessening from last year.

One of the concerns of using Envoy to treat goatgrass is its effect on native bunchgrasses. There is an overall downward trend in bunchgrasses in the Envoy plots that we do not see in the controls, suggesting that Envoy spraying does begin to reduce bunchgrass cover, even after only one year of spraying. The effect is more pronounced in Blocks 4-6, which were sprayed consecutively in 2018 and 2019. This year, bunchgrasses are down in both the control and the Envoy plots, so it is difficult to tell what the effects of the Envoy are. That said, we have clearly not eliminated the bunchgrasses with one or two years of spraying.

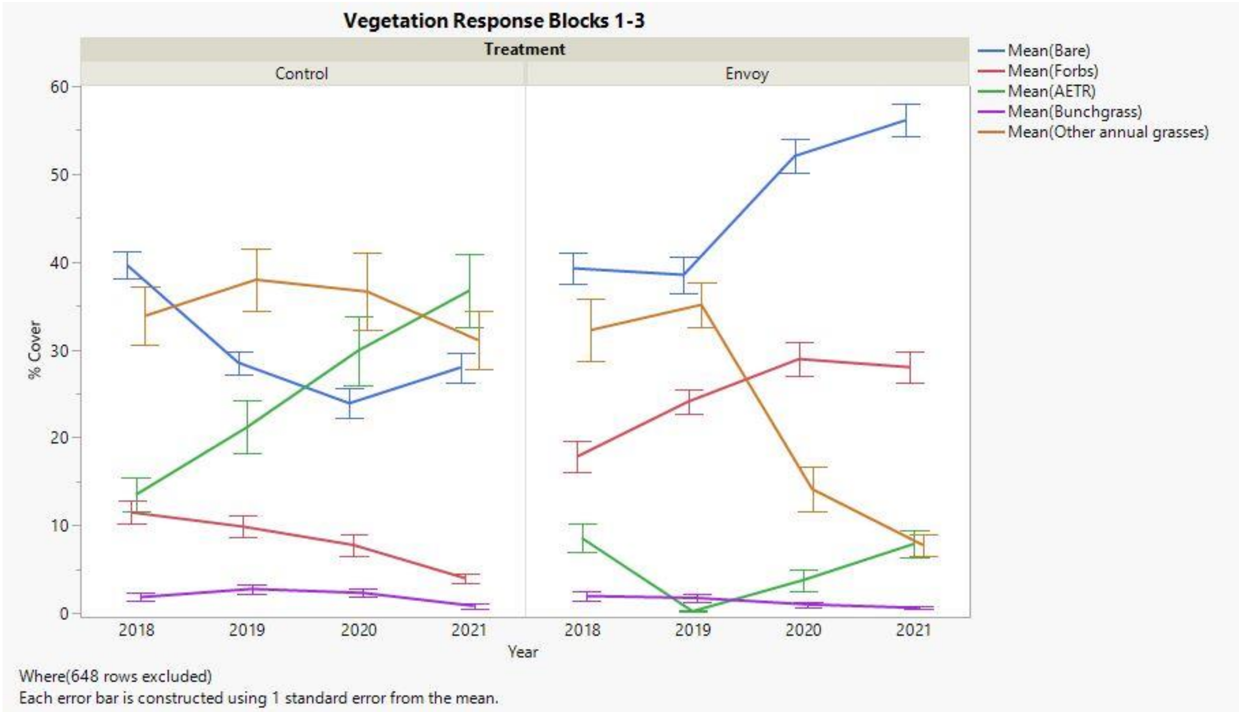


Figure 7-6 Mean vegetations responses in control vs. Envoy treatment over time, blocks 1 through 3.

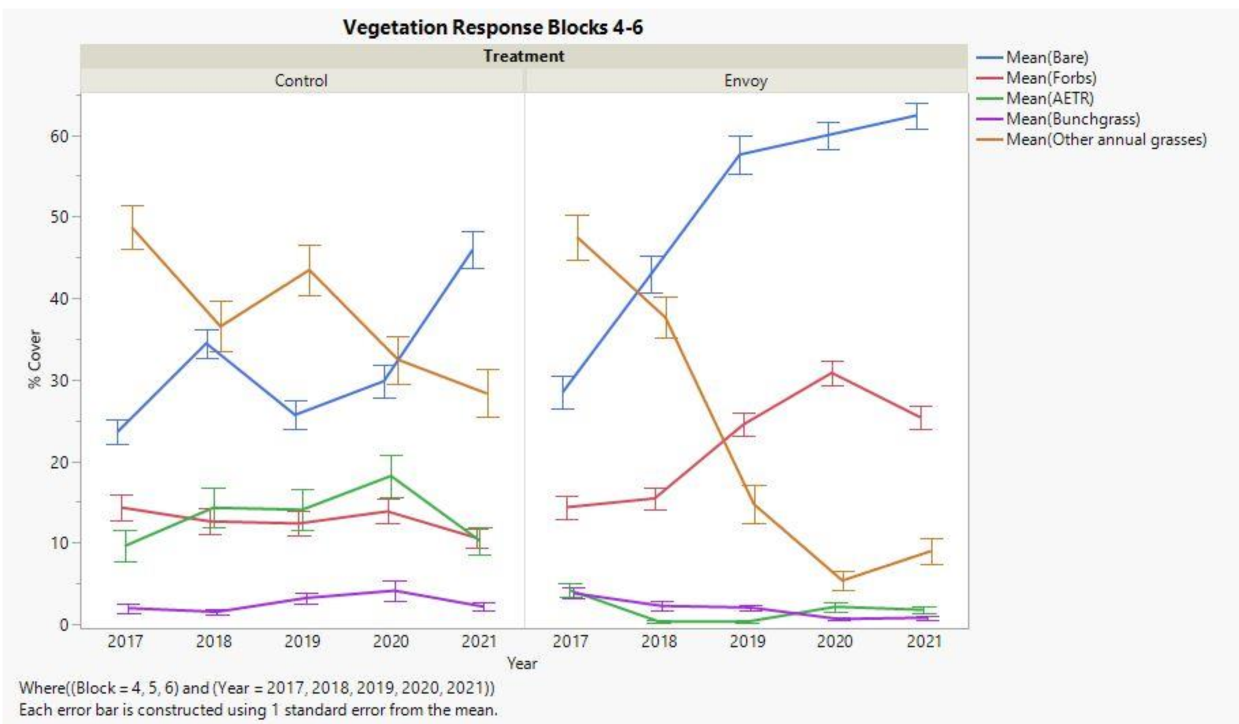


Figure 7-7 Mean vegetation responses in control vs. Envoy treatment over time, blocks 4 through 6.

7.6 Future Plans

Creekside Science will continue to monitor all the plots that we installed in 2016 and 2017. We will not treat the Envoy plots in 2022 but will track passive responses in these plots for another year. We envision monitoring the long-term plots for many years to come.

We advise using the cautionary principle to minimize spread along roads. Barring evidence to the contrary, large-scale non-grazing grass treatments (graminicide, prescribed burning) will not be species specific, but will take place with the overall goal of reducing nonnative annual grass cover and increasing forb cover. Barbed goatgrass may be the species used to pinpoint phenology of treatment, but the treatments (and anticipated benefits) will focus on guild more than species.

SECTION 8.0

Special-Status Species

The MEC Preserve (including the LECEF parcel) was established to conserve and manage serpentine habitat for several target species listed as threatened or endangered under the federal ESA, including Santa Clara Valley dudleya (*Dudleya abramsii* ssp*. setchellii*), California red-legged frog (*Rana aurora draytonii*), and Bay checkerspot butterfly (*Euphydryas editha* ssp. *bayensis*). These three species were identified as target species in the USFWS biological opinion for management of the MEC Preserve.

Other special-status species that could benefit from management of the MEC Preserve include most beautiful jewelflower (*Streptanthus albidus* ssp. *peramoenus*), Opler's longhorn moth (*Adela oplerella*), California tiger salamander (*Ambystoma californiense*), Western pond turtle (*Clemmys marmorata*), and Western burrowing owl (*Athene cunicularia*).

The following paragraphs provide species information and describe the status of the target species within the two preserves as determined by historical records and recent surveys.

8.1 Rare Plants

8.1.1 Santa Clara Valley Dudleya

Santa Clara Valley dudleya (*Dudleya abramsii* ssp*. setchellii*) is a federally endangered and state listed (CNPR 1B.1) perennial plant. This highly endemic Stonecrop family forb is restricted to rocky serpentine outcrops in southern Santa Clara County. It is found on MEC-TH, MEC-CR, and LECEF.

8.1.1.1 MEC-TH

Distribution mapping across MEC-TH was conducted in 2010, and 30 permanent plots were installed for long-term population monitoring in 2012. Creekside Science staff monitored the 30 permanent dudleya plots again in 2018. The Bayliss fire in 2019 (Section 5.3) impacted about fourteen of the plots with either burning, handlines and/or retardant drops. Creekside Science monitored all the plots June 12, 2020 to compare the changes in burned/impacted plots to changes in unaffected plots.

Total rosettes, inflorescences, and intact inflorescences decreased from 2012 to 2020 (Figure 8-1). A closer look using one-way analysis of variance (ANOVA) showed a significant difference in the change of number of plants inside vs. outside of the fire perimeter. The intrinsic rate of increase was larger in the unburned plots (Figure 8-2). A range of dudleya health is shown in Photo 8-1 thru Photo 8-3.

A few days later, Marissa Kent of Creekside Science observed high numbers of broken inflorescences (~80%) on the adjacent Wedge parcel owned by SCVHA. This and a lack of observed seedlings creates concern that dudleya are not reproducing fast enough to sustain themselves on Tulare Hill. Based on these concerns, plots were reread June 30, 2021. Overall dudleya rosettes, inflorescences, and intact inflorescences increased from 2020 to 2021 (Figure 8-1). An ANOVA comparing 2021 with 2018 data still showed a significant change in the number of plants inside vs. outside of the fire perimeter. Again, the intrinsic rate of increase was larger in the unburned plots (Figure 8-3).

It is important to note that the Bayliss fire occurred on very hot and dry, steep southwest exposures. While some burned dudleya were documented, the declines could also be the result of the stronger effects of the exceptional drought on those southwest exposures.

We recommend monitoring in 2023 to check on the trends, and returning to the regular 5-year monitoring cycle in 2026.

Figure 8-1 Santa Clara Valley dudleya rosettes, total inflorescences, and intact inflorescences increased from 2020 to 2021.

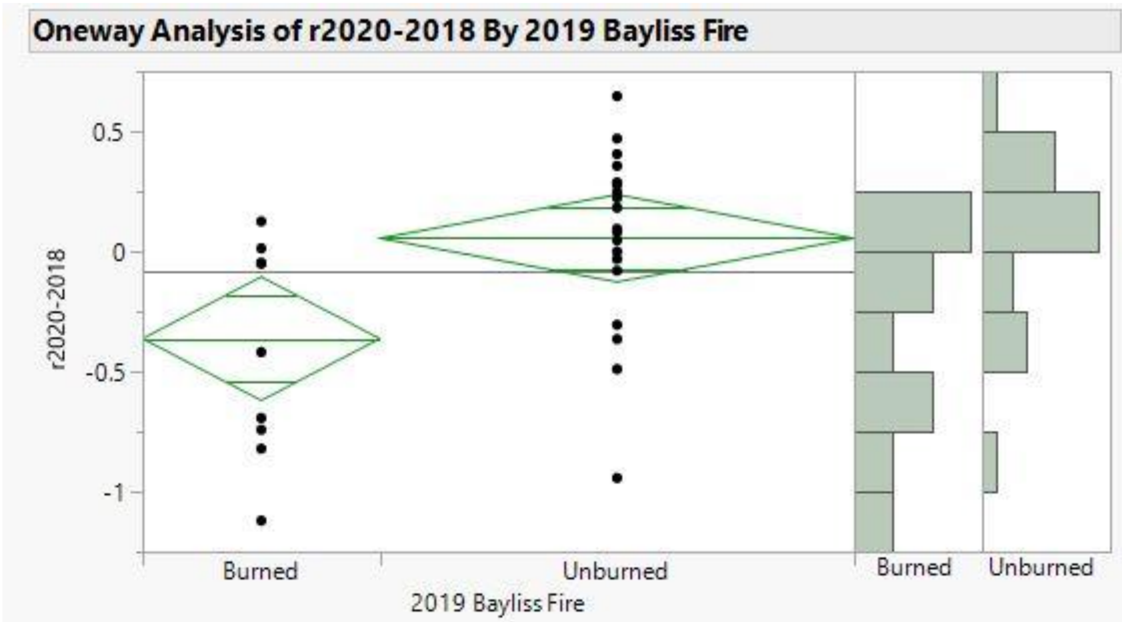


Figure 8-2 Comparing 2020 with 2018 data, the intrinsic rate of increase is larger in unburned plots on MEC-TH, ANOVA p = 0.0111.*

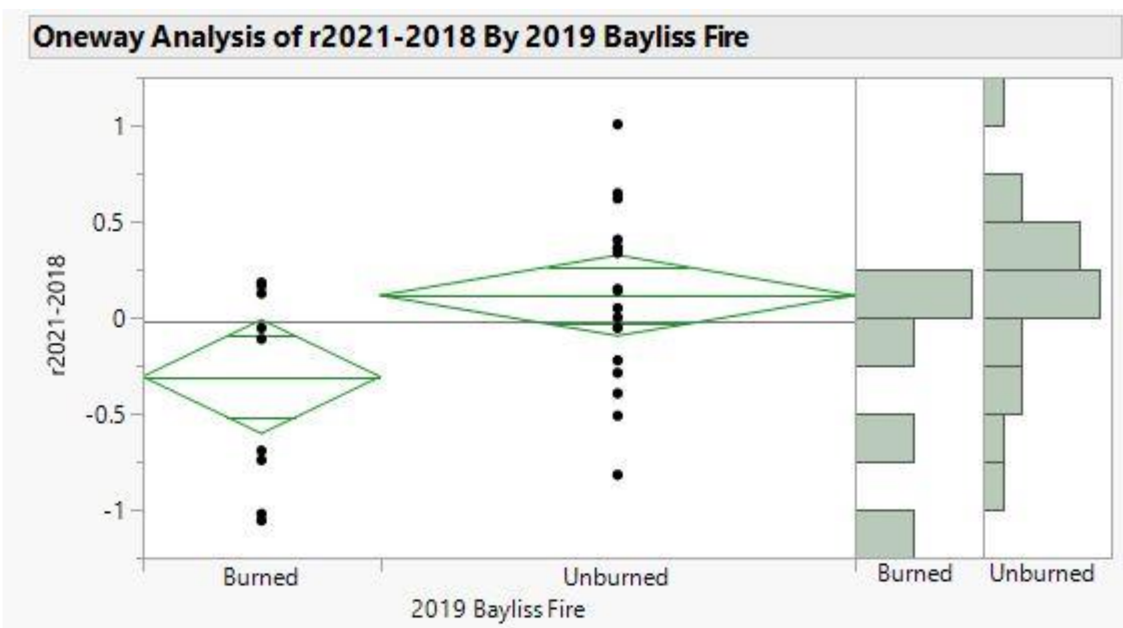


Figure 8-3 Comparing 2021 with 2018 data, the intrinsic rate of increase is larger in unburned plots on MEC-TH, ANOVA p = 0.0241.*

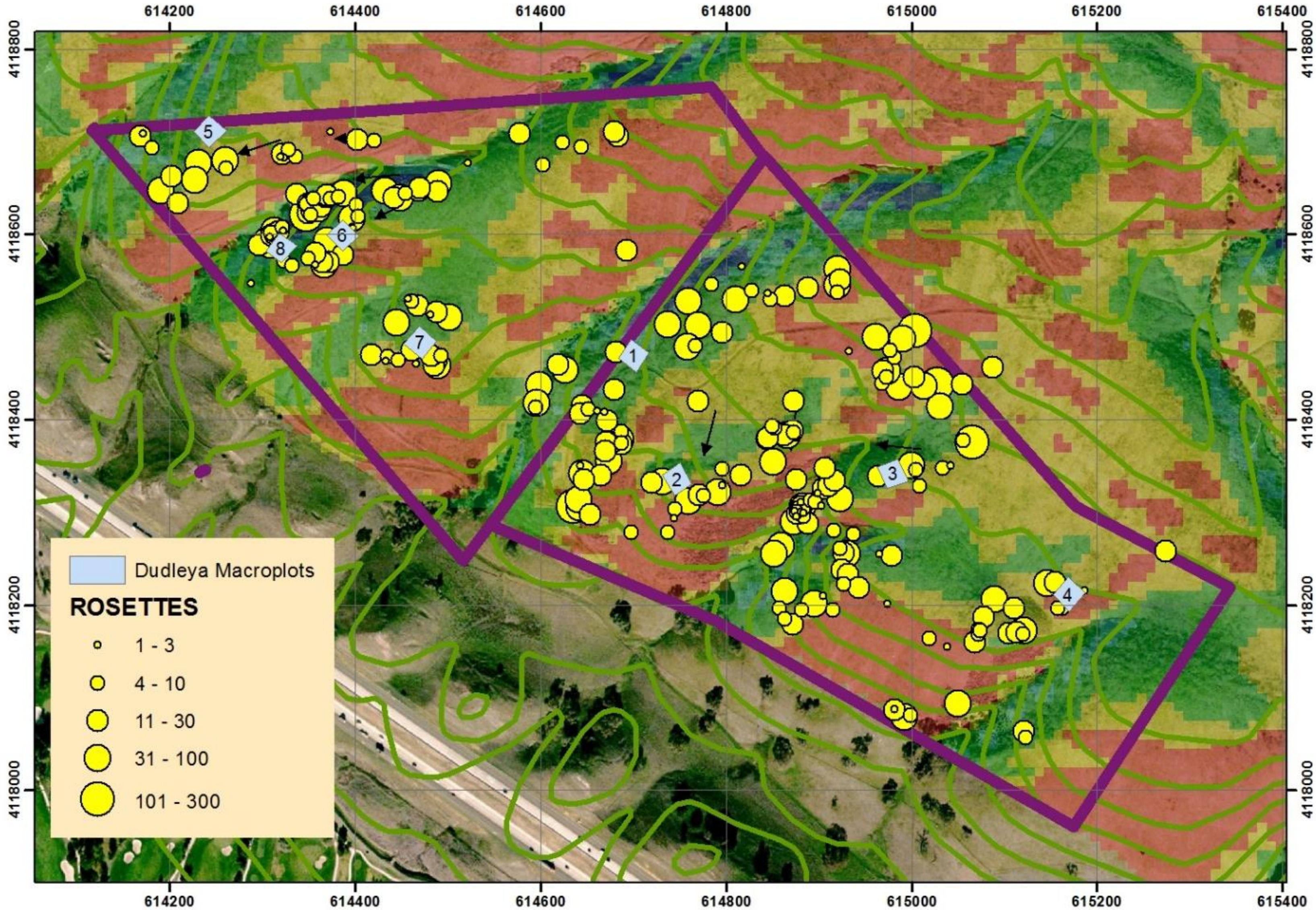
Photo 8-1 A cluster of dudleya rosettes that appears completely destroyed by fire.

Photo 8-2 A cluster of dudleya rosettes that appears damaged by fire, alive but not able to reproduce.

Photo 8-3 A cluster of dudleya rosettes that shows leaf damage from fire, but still reproduced.

8.1.1.2 MEC-LECEF

Santa Clara Valley dudleya distribution mapping took place in 2013. These maps were used to inform installation of four permanent monitoring macroplots (Map 8-1). Baseline data were collected in 2013. They were read again in 2017 to detect responses to the Bailey Fire, which burned two of the adjacent SVP plots and no plots on LECEF. (No clear effects of the fire were found: one of the burned plots increased and the other decreased). Macroplot monitoring took place in 2021, the same time as neighboring properties, and will continue at five-year intervals as throughout the region (i.e., 2026, 2031, etc.). Dudleya are regularly encountered throughout the property.



Map 8-1 Dudleya macroplot locations on LECEF (left) and SVP (right) with 2013 distribution also shown.

Population monitoring used a similar protocol to that was developed by Creekside for dudleya on the Coyote Ridge VTA property (Weiss et al. 2012). Four 25 x 25m permanent monitoring plots were established throughout the property to capture population trends over time. In each plot, the number of dudleya rosettes and individuals were censused and mapped on a 1-m grid. Densities were low enough that a census was deemed more useful than sampling. The 0,0 origin was placed in the southwest corner of each plot. Baseline tapes were run from along the west side (southwest to northwest) and east side (southeast to northeast). The counting transect ran from west to east and was moved manually as each 25m transect was recorded. At each plot, percent of plants vegetative, flowering, and in fruit are estimated. Any identified threats, such as overgrazing, extensive trampling or erosion, changes in water quality or quantity, severe insect infestations, etc., are recorded in the comments (Figure 8-4). Excessive threats should be discussed as soon as possible between land managers, biologists, and regulators.

Data were collected June 2-3, 2021. Plants were in peak bloom.

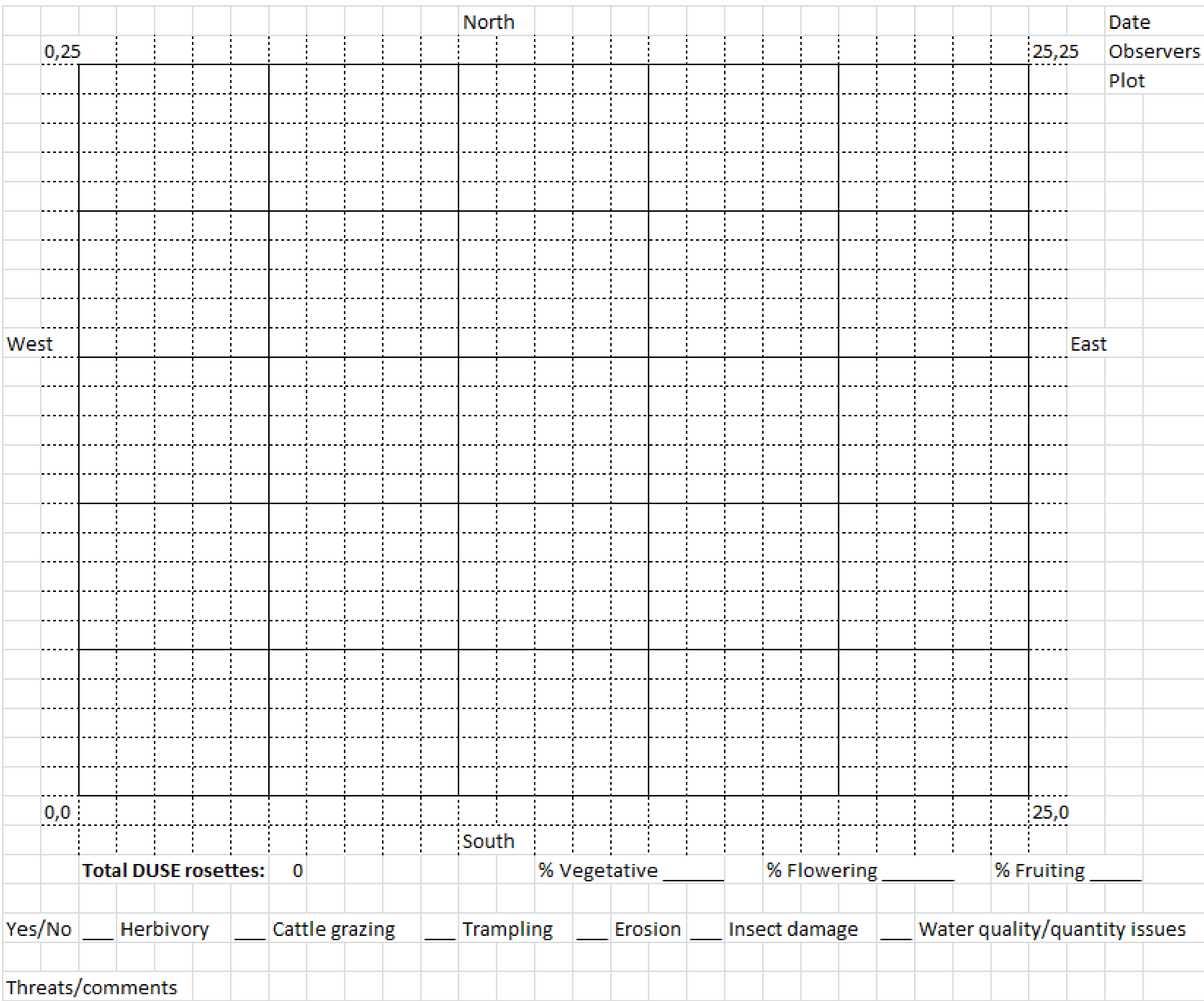


Figure 8-4 Sample data sheet.

In each plot, staff count the number of dudleya rosettes (Photo 8-4). Creekside Science has chosen rosettes as the counting unit because they are easily identifiable, definable, and therefore repeatable measures.

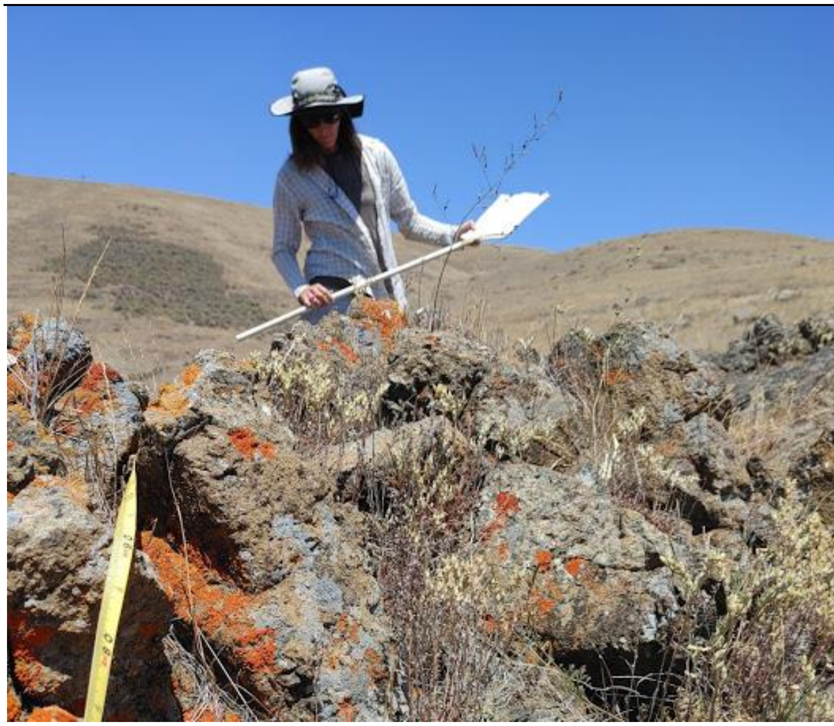


Photo 8-4 Monitoring Santa Clara Valley dudleya.

Santa Clara Valley Habitat Agency defines individuals as clusters of plants that are touching each other. We see an issue with this definition because separate plants could be growing together and still give the appearance of an "individual." Rosettes also provide a measure of vigor and implied fecundity (i.e., an "individual" may have one or 41 rosettes and still be counted as one (Photo 8-5). Digging them up to definitively determine individuals is obviously not acceptable. Because we do recognize the benefit of using a standard method, we also used the Habitat Agency definition to collect data on individuals. We also wanted to explore whether a standard multiplier could be used to convert data between rosette and individual. Dead tissue was prevalent in 2021, and we further defined an "individual" as a group of rosettes touching with either live or dead tissue (Photo 8-6).

Photo 8-5 Santa Clara Valley dudleya with 41 rosettes, also counted as one "individual".

Photo 8-6 Santa Clara Valley dudleya rosettes connected by dead tissue considered an "individual".

Results

Table 8-1 and Figure 8-5 show census results from the four macroplots.

	Year	Plot LE 5	Plot LE 6	Plot LE 7	Plot LE 8	Total
Rosettes	2013	106	294	217	190	807
Rosettes	2017	148	345	231	227	951
Rosettes	2021	165	288	251	147	851
"Individuals"	2021	41	89	86	75	291

Table 8-1 Santa Clara Valley dudleya census results.

In 2021, LECEF dudleya plots showed mixed results. Two plots (LE5 and LE 7) have increased each year since 2013. The two other plots (LE 6 and LE 8) increased in 2017, then fell slightly below 2013 numbers (Figure 8-5). The decreases do not create an immediate concern, especially with the associated increases. Ongoing monitoring will detect longer trends.

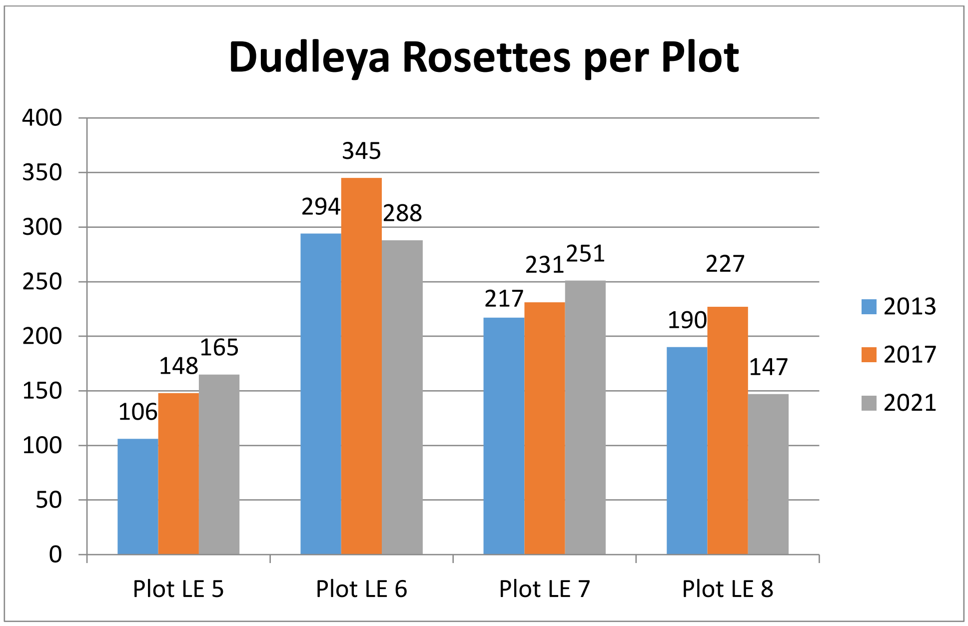
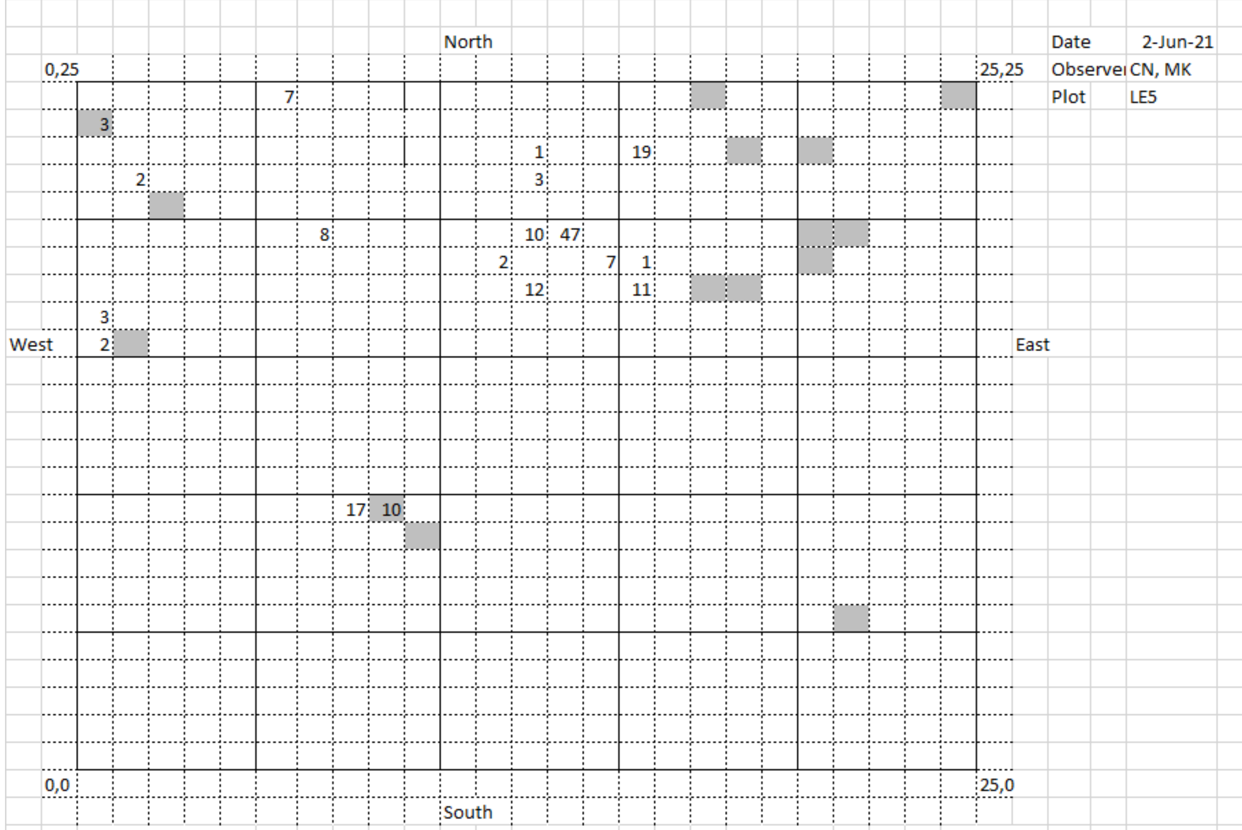


Figure 8-5 Dudleya rosettes over time at LECEF.

Figure 8-6 through Figure 8-9 shows the raw data for each macroplot. Each small square is a square meter. Shaded areas show plots occupied by Santa Clara Valley dudleya in 2013. Some movement between adjacent plots may be due to recorder error as plot tapes may shift slightly between years.



Total DUSE rosettes: 165 % Vegetativ 75 % Flowering 25 % Fruiting _ 0

Yes/No Y Herbivory Y Cattle grazing ___ Trampling Erosion ___ Insect damage Y Water quality/quantity issues

Threats/comments

Some nibbled leaves, unclear what animal. Shriveled leaves, dry, drought stress

Figure 8-6 Raw data for Plot LE 5.

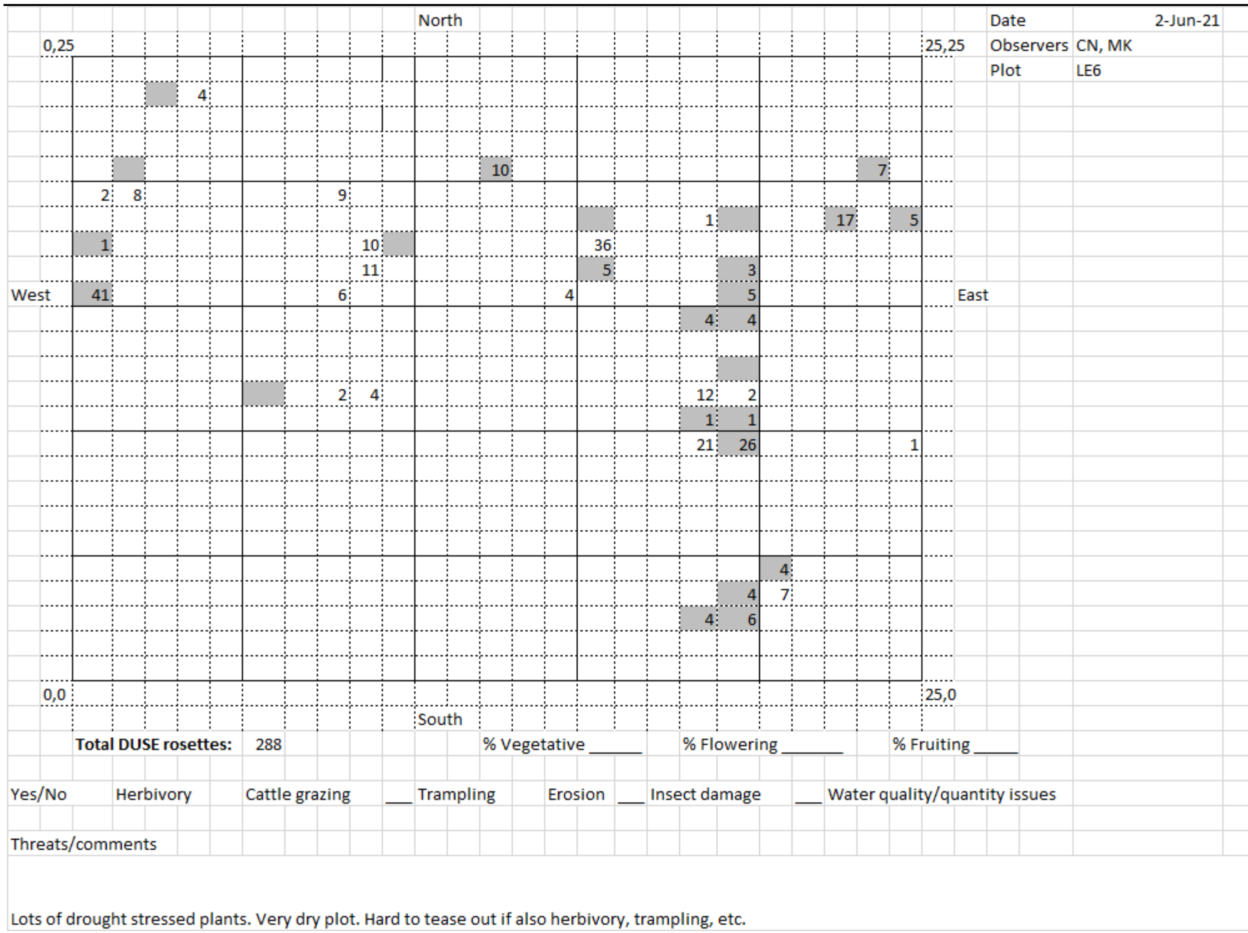
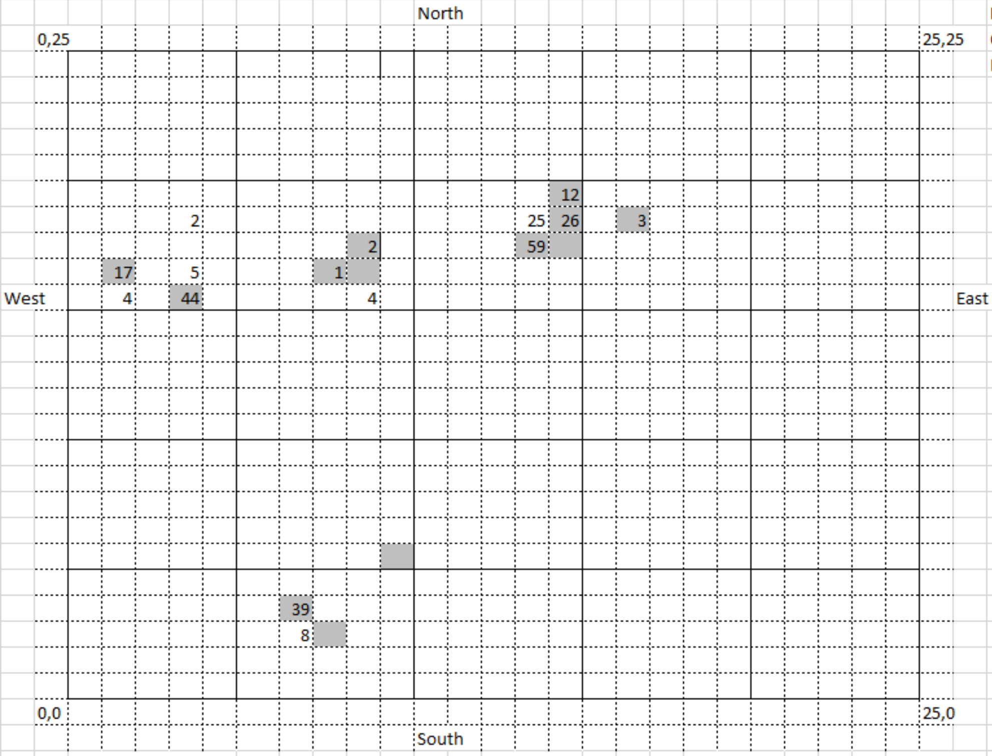


Figure 8-7 Raw data for Plot LE 6.



Date 2-Jun-21
Observers CN, MK
Plot LE7

Total DUSE rosettes: 251 % Vegetativ 50 % Flowering 50 % Fruiting __ 0

Yes/No Y Herbivory Y Cattle grazing ___ Trampling Erosion ___ Insect damage Y Water quality/quantity issues

Threats/comments

Drought stress, shriveled leaves. Some dislodged plants (cows and/ or wildlife). Definitely phenology for flowering peak, vegetative plants aren't going to reproduce

Figure 8-8 Raw data for Plot LE 7.

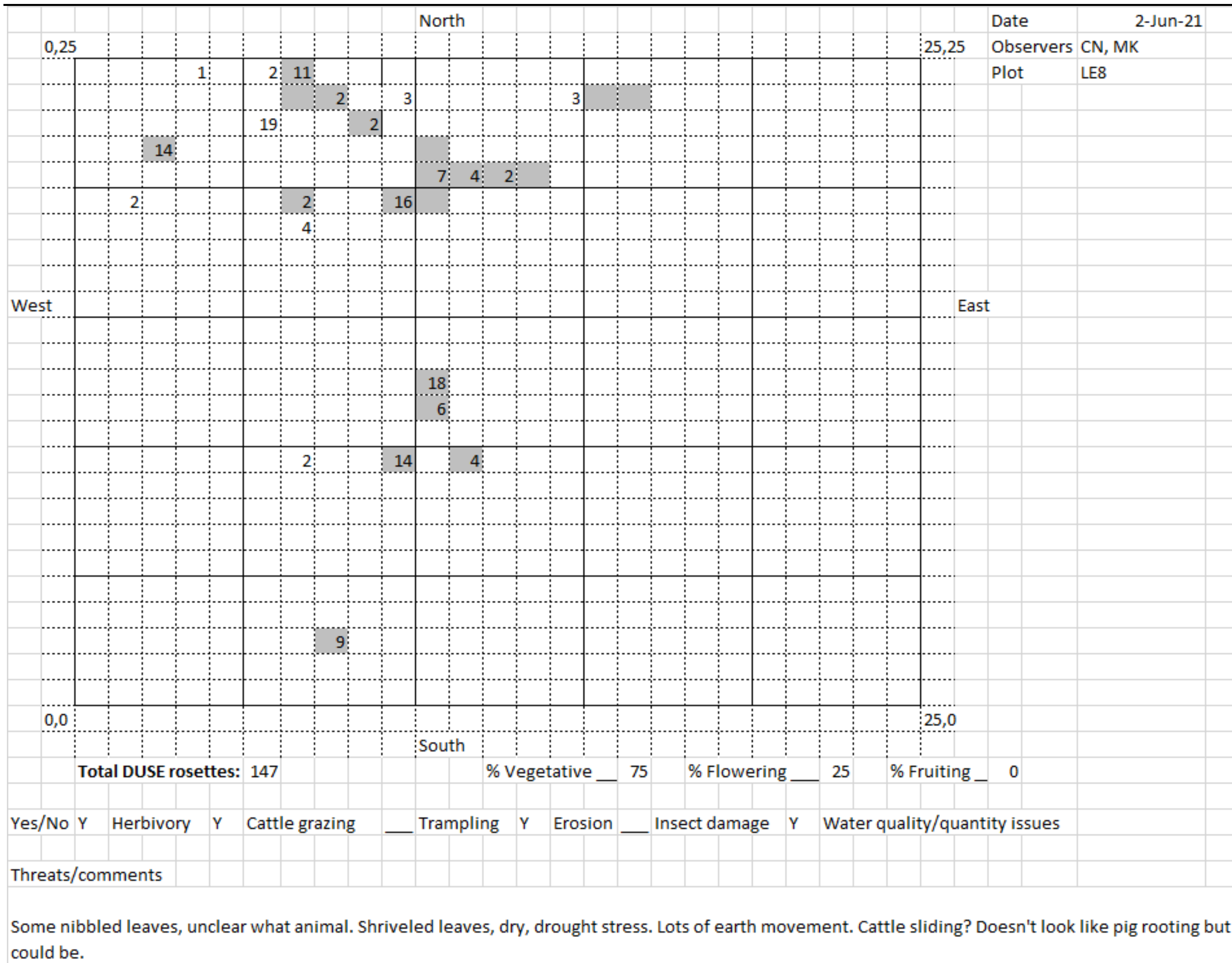


Figure 8-9 Raw data for Plot LE 8.

Discussion

Plots were largely recorded as 50% vegetative and 50% flowering. Plants were considered in peak bloom; the vegetative plants did not appear that they would flower later.

Two of the four macroplots show a steady rise since 2013. One increased in 2017 and then dropped to essentially its baseline number. Only one macroplot is substantially below the baseline.

The number of plants may be misleading if the extant plants are drought stressed and possibly unlikely to persist and/or reproduce. Even plots that maintained or increased their numbers since 2013 were filled with drought-stressed plants that appear unlikely to survive to the next monitoring cycle in 2026. The healthiest plants seemed to be on cooler exposures.

In the last nine years since baseline data were recorded, only two years (water year 2017 and 2019) have been above the regional average of 58.9 cm precipitation. Six have been below 60%, with water year 2021 being only 44%.

It should be noted that even with declines and drought-stressed plants, some apparent recruitment is noted in the plot maps.

Cattle grazing is present throughout the property, and is not believed to be a specific threat, although cattle surely occasionally nibble and trample the plants. None of the plots had signs of excessive cattle use at the time of monitoring (large patches of bare dirt, absence of fodder, etc.). Herbivory is noted at all sites. Drought stress may be making the succulent leaves more appealing to herbivores. It's not clear what is eating the plants. Deer have been caught on wildlife cams before, but lagomorphs and rodents are likely culprits as well.

Insects and pathogens don't seem to be obvious stressors.

When baseline data were collected, dudleya seemed abundant and widespread on the property and throughout Coyote Ridge, with little concern that they would decline. Some of their adaptations, like succulent leaves and crassulacean acid metabolism (opening stomata at night to reduce water loss during photosynthesis), are specifically designed for drought resilience. While we don't believe specific measures beyond regular monitoring need to be taken yet on LECEF, we are aware that long-term drought stress could trigger additional management.

Note that the ratio of rosettes to individuals per plot varied from 2.0 to 4.0. This is a relatively constrained ratio, especially considering occasional large individuals could have dozens of rosettes. This compares regionally to the adjacent SVP ratio of 2.0 to 3.8 and the VTA ratios of 1.7 to 3.1.

8.1.2 Metcalf Canyon and Most Beautiful Jewelflowers (*Streptanthus albidus* ssp. *albidus* and *Streptanthus albidus* ssp. *peramoenus*)

Nomenclature in this report generally follows *The Jepson Manual* II (Baldwin et al. 2012) conventions with exceptions made for the genus *Streptanthus* where disagreements among taxonomists persist.

The first edition of the Jepson Manual (Hickman 1993) recognized most beautiful jewelflower (*Streptanthus albidus* ssp. *peramoenus*) and Metcalf Canyon jewelflower (*Streptanthus albidus* ssp. *albidus*) as distinct taxa. The second edition of the Jepson Manual lumped most beautiful jewelflower with a more common taxon, bristly jewelflower (*Streptanthus glandulosus* ssp. *glandulosus*), while Metcalf Canyon jewelflower was retained as a distinct taxon (*Streptanthus glandulosus* ssp. *albidus*).

Creekside Science biologists and other botanists are not entirely satisfied with new *Streptanthus* taxonomic designations found in the second edition of the Jepson Manual. We feel the Coyote Ridge phenotype (with distinct sepal colors) is intermediate between *Streptanthus glandulosus* ssp. *glandulosus* and *Streptanthus glandulosus* ssp. *albidus*. Molecular research by Dr. Justen Whittall of Santa Clara University supports this position. Based on his findings and other comments, the California Native Plant Society (CNPS) inventory will retain the taxonomic nomenclature from the first edition of the Jepson Manual. This means that the Metcalf Canyon jewelflower and the most beautiful jewelflower will remain as California Rare Plant Rank 1B (formerly known as the "CNPS list") and retain the same protection under California environmental statutes they previously held. They are both covered under the Santa Clara Valley Habitat Plan.

Creekside Science and Dr. Whittall have received, through SCVHA, a CDFW LAG that will allow them to further examine the distinction between the two taxa, especially in areas where they intermix.

8.1.2.1 MEC-CR

At this point, we consider the taxon found on MEC-CR to be most beautiful jewelflower (*Streptanthus albidus* ssp. *peramoenus*).

8.1.2.2 MEC-TH

Creekside Science collaborated with Justen Whittall of Santa Clara University on a project to reintroduce *Streptanthus albidus* ssp. *albidus* to Tulare Hill, a site where they were last documented in 1980. Improved grazing regimes, soil tests, vegetation surveys, and other steps led this team to believe habitat was favorable again for this taxon. At the beginning of this project, Metcalf Canyon jewelflower was found in only six occurrences. Two previously funded research projects identified (1) a positive response in growth and reproduction of the closely related subspecies *Streptanthus albidus* ssp. *peramoenus* to simulated moderate grazing (Weiss et al. 2007), (2) that Tulare Hill soil has similar physical and chemical characteristics to existing *S. albidus* ssp. *albidus* populations (Whittall and Strauss 2011), and (3) Tulare Hill soil consistently fosters increased growth and flowering of *S. albidus* ssp. *albidus* compared to soil from existing populations (Whittall and Straus 2011). These results, coupled with the recently improved grazing regime at Tulare Hill, strongly suggested that this site would support a healthy population of Metcalf Canyon jewelflower given the appropriate reintroduction protocols. We proposed a multi-year project to reintroduce the Metcalf Canyon jewelflower. In fall 2012, we began generating seeds for the reintroduction by establishing a captive population of 235 individuals at Santa Clara University (SCU) from a small amount of wild collected seed. We also updated the California Natural Diversity Database (CNDDB) occurrences. Plants were started in pots at the SCU greenhouse and matured outside to allow pollinator access. Plots were seeded at four locations on Tulare Hill in 2014 through 2015, in grazed and ungrazed plots, at different seeding densities. After only two years of seeding, plants have continued to persist. The 2019 survey documented 588 plants, with some found in each of the four blocks. Another ~520 plants were found outside the seeded areas. These plants were more than 200m from the closest seeding plot and represent unaided dispersal and establishment. They were also inside the perimeter of the Bayliss fire.

In 2020, a total of 5110 plants were found in the four blocks. At the MEC Preserve block, plants had increased considerably from 442 plants to approximately 4609 plants. Here they were seen outside of plots to about 20 meters away down the slope. Another 3520 plants were documented outside of the blocks in three separate areas. Again, these plants represent unaided dispersal and establishment. Some of these plants outside the planted blocks had pink pigment (Photo 8-7 and Photo 8-8) and may therefore represent the results of a separate dispersal effort, i.e., cattle hooves.

Photo 8-7 Jewelflower plant with a small amount of pink pigment observed outside of plots.

Photo 8-8 Very pink jewelflower plant observed outside of plots

The total number of jewelflower documented on Tulare Hill in May 2020 was approximately 8630 plants (Table 8-2).

Block	Name	# Streptanthus Sep 2015	# Streptanthus June 2016	# Streptanthus June 2017	# Streptanthus May 2018	# Streptanthus May 2019	# Streptanthus May 2020
1	Santa Teresa	161	0	68	260	35	96
2	MEC	236	9	271	857	442	4609*
3	Neighborhood	220	47	73	130	44	95
4	Golf Course	543	31	0	65	67	310
	Plot totals	**1160**	**87**	**412**	**1312**	**588**	**5110***
	Outside blocks*	0	0	0	0	520*	3520*
Total		**1160**	**87**	**412**	**1312**	**1108***	**8630***

Table 8-2 Jewelflower (Streptanthus) population on Tulare Hill over time.

Note the high number of plants in the southeast corner are within the Bayliss fire perimeter, indicating the fire and its suppression efforts did not seem to have a negative impact on the plants (Map 8-2). In fact, the fire could have had a positive impact on the plants. Unfortunately, the area was not thoroughly surveyed before the fire occurred, so we can’t confidently document an increase, although we can confidently say the plants are present in reasonably large numbers after the fire.

Map 8-2 Tulare Hill jewelflower survey yielded about 8630 individuals in 2020, including ~3520 outside of the four seeded blocks and inside the Bayliss fire perimeter.

Propagation and Seeding

The persistence of this taxon on Tulare Hill, and its documented spread, confirm this location is suitable habitat. We recommend more reestablishment efforts to increase numbers and therefore resilience. Future efforts should include seeding on areas less attractive to or accessible by cattle, higher seeding densities, and multiple year efforts to capture favorable conditions. Furthermore, future efforts should include routine monitoring for cattle grazing pressure on jewelflower individuals, working with the grazing rancher to reduce cattle pressure at critical times, and RDM monitoring as a gauge for overall cattle impacts (see the grazing section for more details). More information can be found in our final report and adaptive management plan (Niederer and Weiss, 2017).

Propagation efforts began with seeds collected on Tulare Hill on October 23, 2020. We planted them in the Creekside Science Conservation Nursery primarily in 21-gallon concrete mixing tubs that we converted to planting pots. (The tubs are 84 cm (33 inches) long, 53 cm (21 inches) wide and 20 cm (8 inches) tall. We drilled a series of 1.27 cm (1/2 inch) holes through the bottom of all the tubs. 12 of these tubs were prepared for a total of ~6.5 square meters planted in this manner. Pots were filled with about a half inch layer of Perlite and rock to promote drainage and topped with a mix of Gardner and Bloom potting soil, premium planting mix and too much (as we were to later discover) soil building conditioner. We also prepared two raised beds (one was 0.6 m (2 feet) by 1.8 m (6 feet), the other was 1.2 m (4 feet) by 1.5 m (5 feet), totaling 3 square meters) with a similar soil mix overlaying the native clay soil at the nursery (Photo 8-9). A total of 9.5 square meters of area was planted, and everything was outside, subject to ambient temperature swings, with no shade structures. We installed ¼" drip tubing on all of the tubs and raised beds and watered as needed through an extremely dry season.

The soil building conditioner that we used contained too much wood matter, which reduced water retention and promoted the growth of mats of mycelium that restricted water uptake and aeration. This in turn restricted growth of a lot of individuals. Furthermore, many plants were attacked by aphids, which were treated with Safer brand insecticidal soap. Aphid infestations on members of this plant family are common. For the 2022 growing season, we completely emptied all the tubs and raised beds of the 2021 soil and refilled them with tried-and-true G&B potting soil. These newly filled tubs were seeded on November 5, 2021 with F1 seeds.

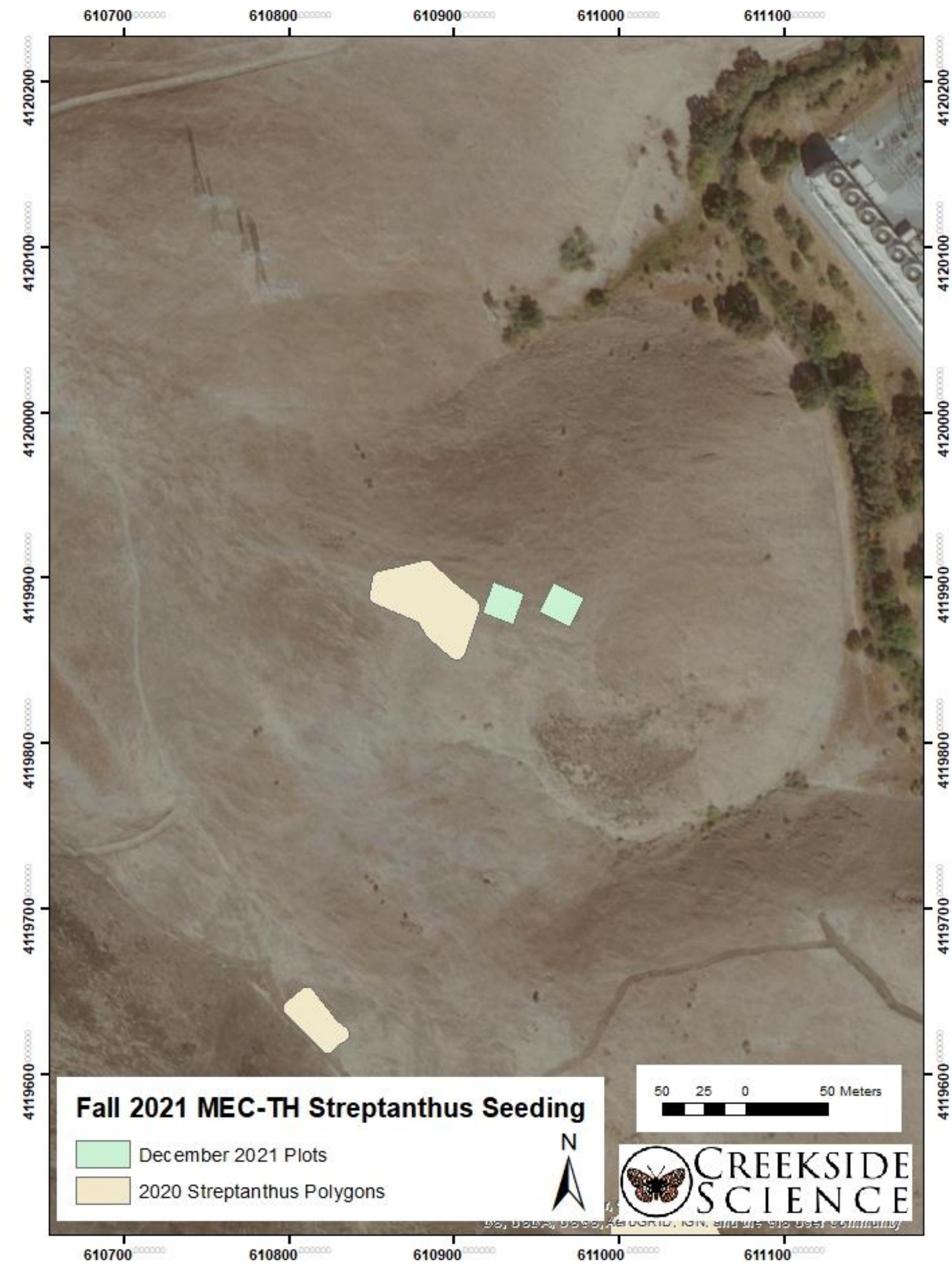
Despite some difficulties along the way, in 2021, we propagated 91,560 seeds from approximately 150 plants. We believe that we can propagate more seeds next year with the same area now that we've fixed the soil issues.

On October 19, 2021, staff returned to Tulare Hill to collect additional seed for the 2022 propagation season. No jewelflower seeds were found, due to high cattle pressure during the exceptional drought of 2021. This has led us to recommend RDM monitoring in 2022 (see Grazing section).

Seeding on MEC-TH took place on December 9, 2021. Two 400 square meter (20m x 20m) plots were seeded with about 40,000 seeds each, which is a seeding rate of about 100 seeds per square meter. We avoided seeding areas of thick vegetation and focused more on rocky areas and areas with more bare ground (Photo 8-10 and Map 8-3).

Photo 8-9 Streptanthus growing in raised bed area of Creekside Science Conservation Nursery.

Photo 8-10 Streptanthus seeding on Tulare Hill in one of the two 20x20m plots.



Map 8-3 Metcalf Canyon jewelflower plots seeded in December 2021 (green polygons).

8.1.2.3 LECEF

Metcalf Canyon jewelflower and the most beautiful jewelflower appear to hybridize on Coyote Ridge. The Metcalf Canyon jewelflower has white sepals, and the most beautiful jewelflower has pink sepals, ranging from a deep pink to quite pale. Occasionally a small number of white-sepaled individuals are found within larger populations of pink-sepaled plants. Dr. Whittall hypothesizes there is a hybrid zone between Metcalf Canyon jewelflower and most beautiful jewelflower (or what may historically be bristly jewelflower) starting somewhere around the Kirby Canyon Recycling and Disposal Facility (roughly) extending to the north on Coyote Ridge to its historical range limit at Communications Hill, with most beautiful jewelflower and bristly jewelflower being south of Kirby Canyon and westward. This could be tested with molecular markers, but Whittall states the sepal color (which is the only consistently distinguishing trait besides geography) is indicative of a broad hybrid zone. Until such testing is done, he recommends that anything south of Metcalf Road that has a predominance of sepals with pigment should be called most beautiful jewelflower. Single white-sepaled individuals in a mixed colony are unlikely reproductively isolated from the pinks, and therefore should not be recognized as taxonomically distinct (Whittall, pers. comm., 2013).

On May 2, 2019, Creekside Science took part in a stakeholder workshop hosted by SCVHA discussing these two taxa, especially because they have specific mitigation goals for each taxon and they are so difficult to differentiate. It was also attended by members of USFWS and Santa Clara Valley Water District. CDFW representatives were invited but could not attend. The workshop led to Creekside Science and Dr. Whittall submitting a grant application to further study the two taxa, as mentioned above.

This grant project (titled Name that Jewelflower) has been funded by CDFW's LAG grant program. Initial work began in 2021 documenting color variations throughout the Coyote Ridge vicinity. Results will available in 2023.

In the meantime, plants on the LECEF Preserve property are currently considered most beautiful jewelflower, because white-sepaled individuals are less common.

Macroplots were read and installed in 2015, and again opportunistically in 2017 in response to the 2016 Bailey fire. Macroplots were read again in 2020 and the next time they will be read will be in 2025.

8.2 Bay Checkerspot Butterfly

8.2.1 MEC-TH

8.2.1.1 2021 Translocation Project

The goal of this project is to enhance a small BCB (*Euphydryas editha bayensis*) population in restored habitat at Tulare Hill in San Jose, CA (Map 8-4). Extant populations from Coyote Ridge in Santa Clara County numbering in the hundreds of thousands were the source of the translocated larvae.

Map 8-4 Tulare Hill property boundaries.

8.2.1.2 Coyote Ridge Source Population

Larval numbers throughout the source population (Coyote Ridge) are shown in Table 8-3. Coyote Ridge numbers have been in the moderate range for the last three years. The Kirby Canyon Butterfly Reserve within Coyote

Ridge has continued to increase since a historic low in 2018. Kirby Canyon is shown as an example of a subarea with the longest population record.

	Kirby Canyon	Coyote Ridge*
2011	94,399 ± 32,025	533,426
2012	131,627 ± 37,606	473,344
2013	246,697 ± 46,487	1,252,149
2014	91,755 ± 35,136	776,478
2015	190,756 ± 70,059	2,102,400
2016	45,281 ± 15,827	377,082
2017	11,882 ± 4,343	377,841
2018	5,457 ± 3959	222,806
2019	15,568 ± 10,155	894,475
2020	108,148 ± 53,190	694,777
2021	186,547 ± 41,580	791,529

*Confidence intervals across Coyote Ridge have not been calculated.

Table 8-3 Larval numbers throughout source population, 2011-2021.

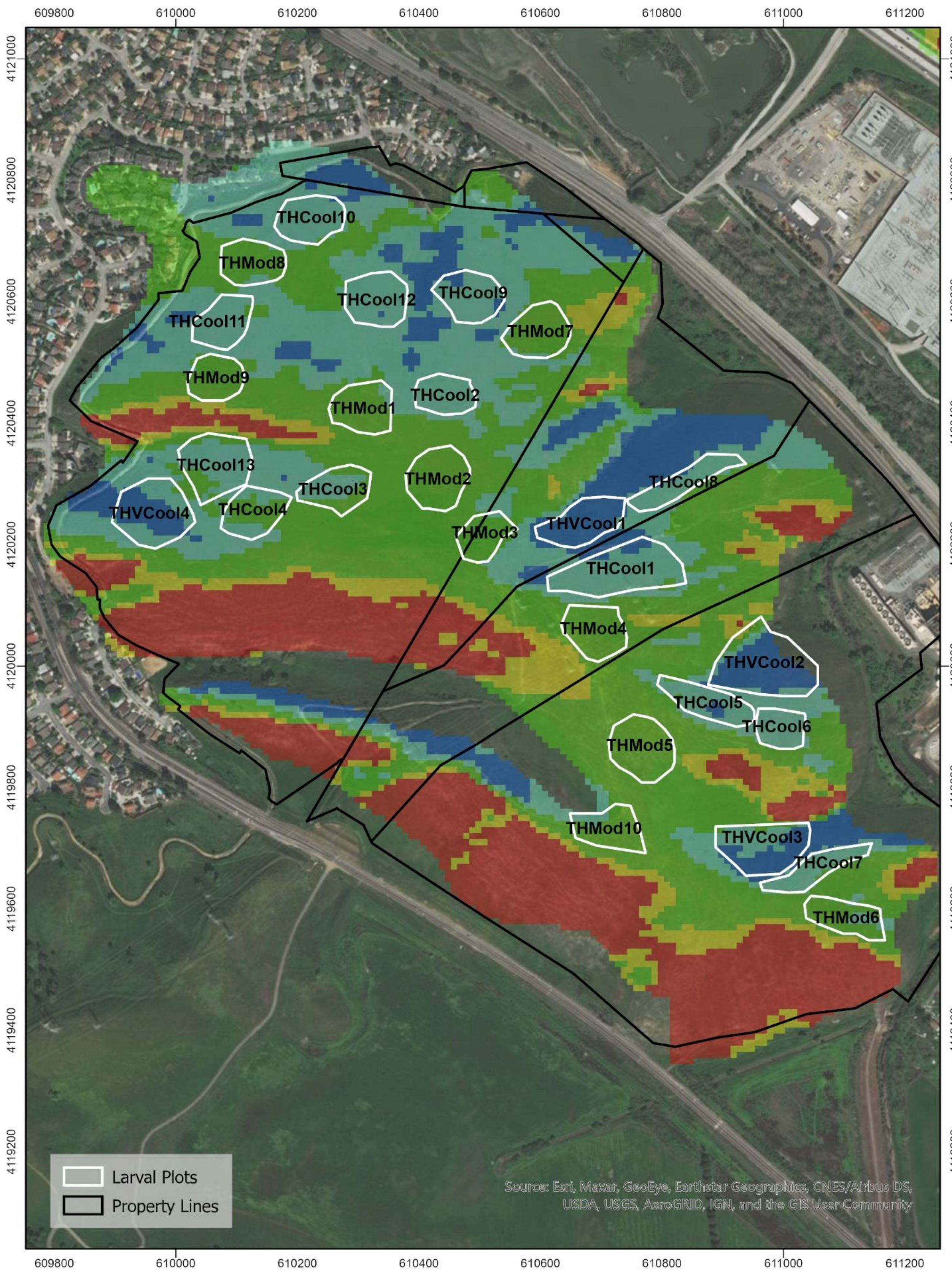
8.2.1.3 Previous BCB Monitoring at Tulare Hill

Postdiapause larvae were detected during surveys in 2002 and 2003. One adult was observed in flight each year from 2005-2008. Larvae counts were not conducted on Tulare Hill in full from 2008 to 2013. (In 2008, some cool and very cool plots were surveyed.) No adults were observed from 2009-2010. In 2011, two adults were observed, and in 2012 one adult was observed. The presence of these adults suggested the Tulare Hill population was persisting at very low density, on the order of <100 individuals. Even with habitat improvements, the BCB population was not passively increasing.

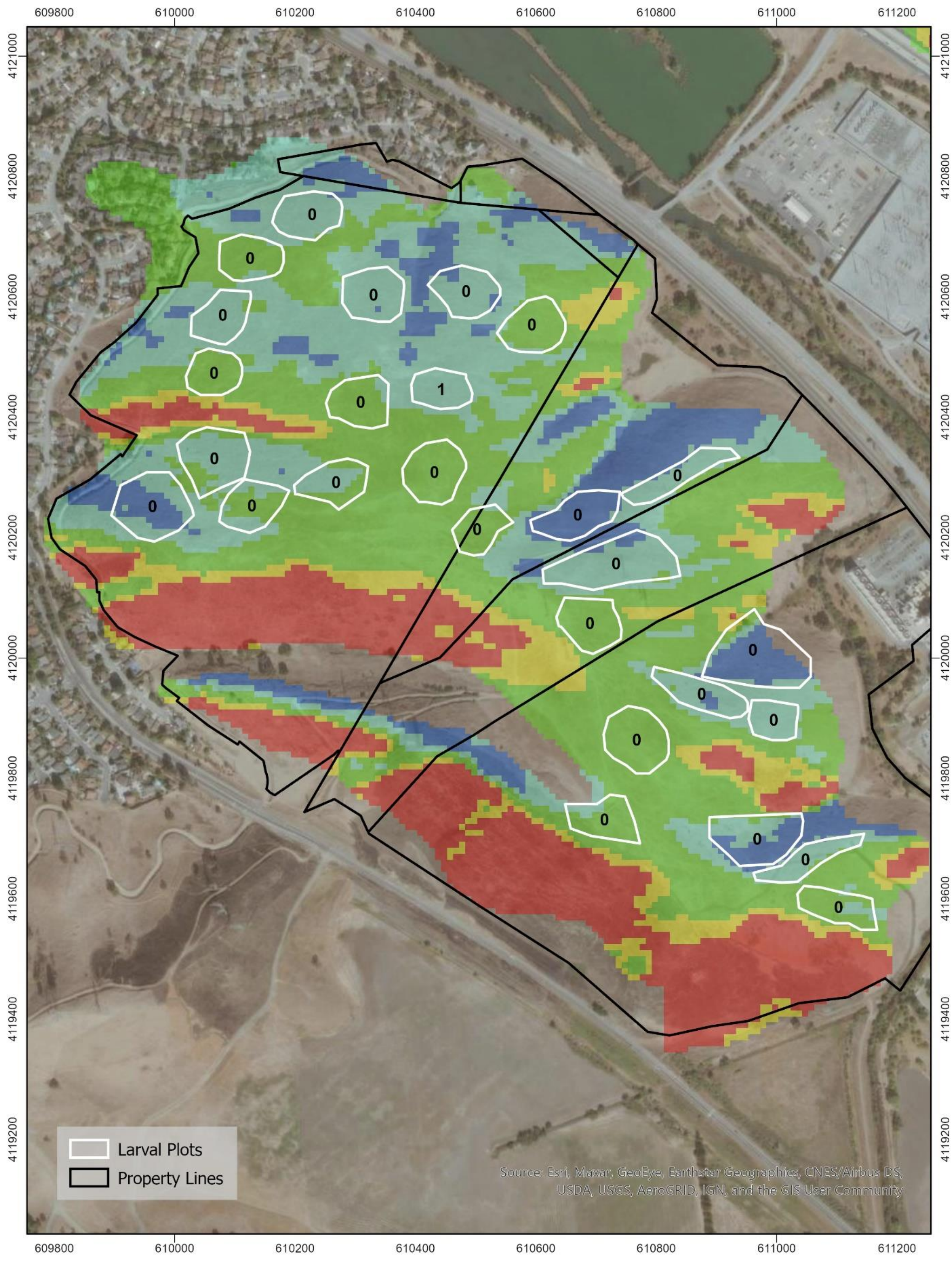
8.2.1.4 Larval Monitoring at Tulare Hill

Formal postdiapause larvae monitoring began in 2014 after larval introductions were initiated. This year, monitoring took place March 4, 2021. Monitors spend ten person-minutes searching for the first larva in a plot. Then the clock is reset and the official ten person-minute clock begins. If none are found, the monitors spend a full 20 person-minutes searching. There are 27 larval plots on Tulare Hill, stratified by topoclimate (very warm to very cool, based on spring equinox insolation). Areas of higher solar insolation (steep, south-facing slopes) are mapped in red, with low insolation (steep, north-facing slopes) shown in blue (Map 8-5). In 2021, one larva was found (Map 8-6). This is compared with two larvae in 2020, and a high of 44 larvae in 2015. In 2016 four larvae were found, in 2015 44 larvae were found, and in 2014 six larvae were found (Table 8-4). Maps of sightings from 2014 to 2020 can be found in previous reports.

Considering that in 2021 only one larva was found, we estimate the larval population was in the low 100s. This is down from an estimated high of 20,000 in 2015 (Table 8-5).



Map 8-5 The 27 larval plots on Tulare Hill.



Map 8-6 Larval monitoring results, 2021.

Plot	# larvae 2014	# larvae 2015	# larvae 2016	# larvae 2017	# larvae 2018	# larvae 2019	# larvae 2020	# larvae 2021
THCool1	0	1	0	0	0	0	0	0
THCool10	0	0	0	0	0	0	0	0
THCool11	0	2	0	0	0	0	0	0
THCool12	0	5	2	0	0	0	0	0
THCool13	0	0	0	0	0	0	0	0
THCool2	0	7	0	0	0	0	1	1
THCool3	0	3	0	0	0	0	0	0
THCool4	0	0	0	0	0	0	0	0
THCool5	0	3	0	0	0	0	0	0
THCool6	0	2	0	0	0	0	0	0
THCool7	1	1	0	0	0	0	0	0
THCool8	0	2	0	0	0	0	0	0
THCool9	0	1	0	0	0	0	0	0
THMod1	0	6	0	0	0	0	0	0
THMod10	0	0	0	0	0	0	0	0
THMod2	0	3	0	0	1	0	1	0
THMod3	0	2	0	0	0	0	0	0
THMod4	0	1	0	0	0	0	0	0
THMod5	0	0	0	0	0	0	0	0
THMod6	0	0	0	0	0	0	0	0
THMod7	0	0	0	0	0	0	0	0
THMod8	0	1	0	0	0	0	0	0
THMod9	0	0	0	0	0	0	0	0
THVCool1	3	2	0	0	0	0	0	0
THVCool2	0	0	1	0	0	0	0	0
THVCool3	2	2	0	0	0	0	0	0
THVCool4	0	n/a	1	0	0	0	0	0
Total	**6**	**44**	**4**	**0**	**1**	**0**	**2**	**1**
Larval estimate	**~3,000**	**~20,000**	**~2,300**	**<100**	**~100**	**<100**	**~200**	**~100**

Table 8-4 Locations of postdiapause larvae by year.

8.2.1.5 Larval Transfers

No larvae were transferred in 2021. A total of 15,629 larvae have been released since 2013 (Table 8-5). Larvae were relatively easy to collect in all years, based on dense populations at Coyote Ridge. Postdiapause larvae are the focus of the translocation because they are the easiest life stage to locate, handle, and transfer. Larvae are captured by hand and placed in groups in vented plastic containers kept in coolers until same day release.

Year	Larvae introduced	Estimated larval numbers prior to introduction
2013	5000	0
2014	3450	~3,000
2015	3833	~20,000
2016	3346	~2,300
2017	0	<100
2018	0	~100
2019	0	<100
2020	0	~200
2021	0	~100

Table 8-5 Summary of larval introductions and population estimates.

8.2.1.6 Adult Transfers

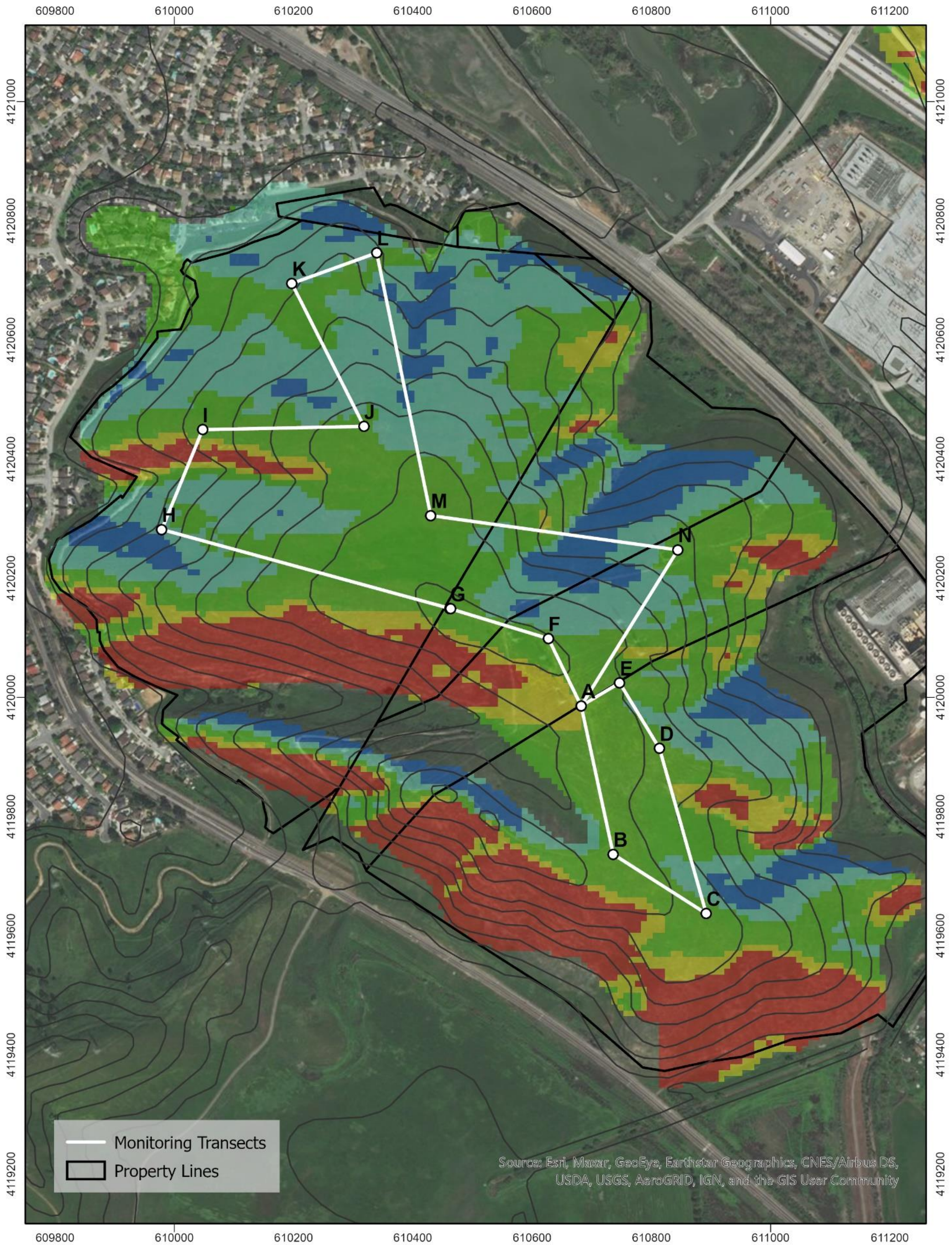
No adults were transferred to Tulare Hill from 2016 through 2021.

8.2.1.7 Adult Monitoring

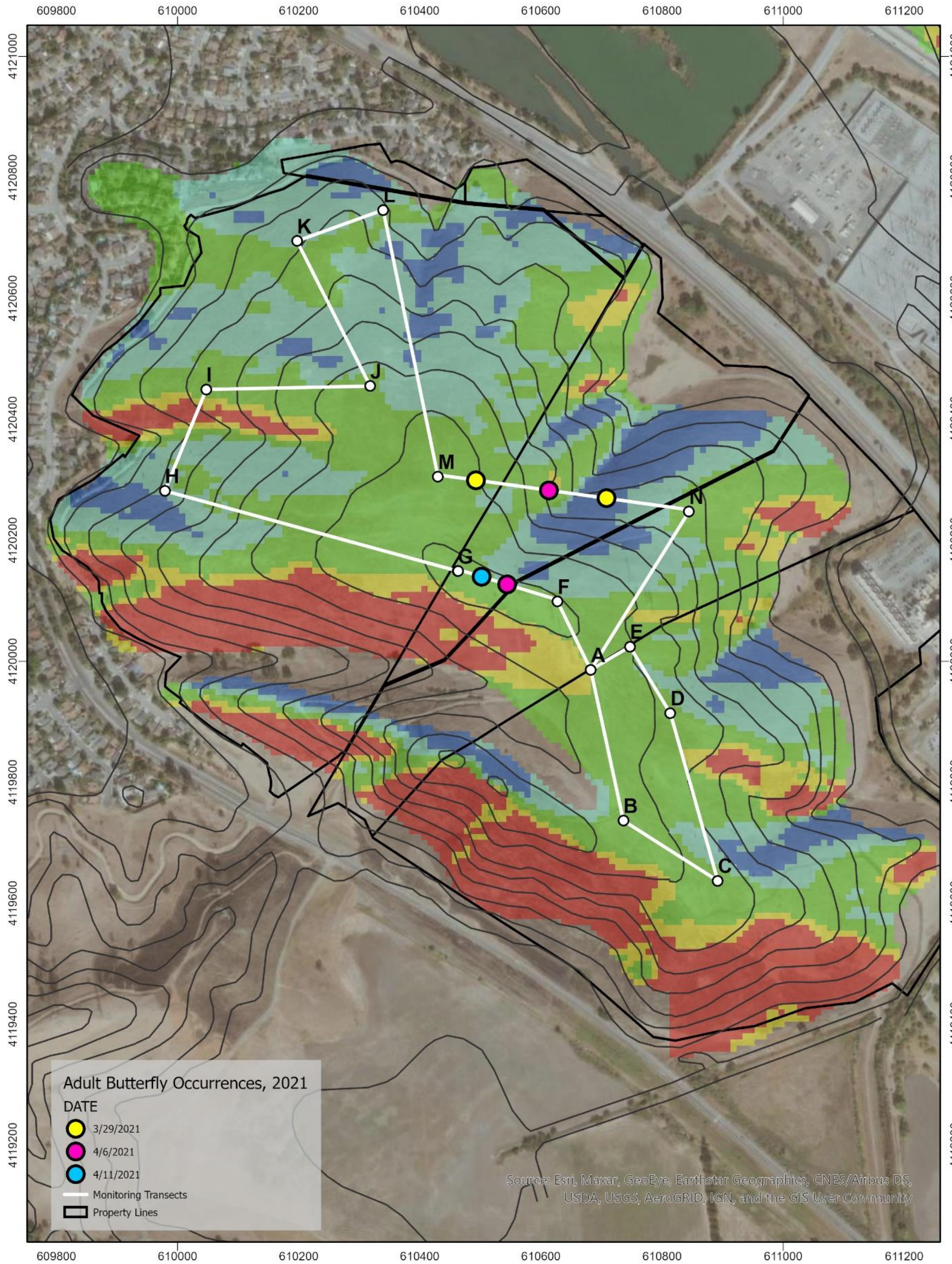
Over the course of the flight season, adults were surveyed weekly. The adult monitoring consisted of an observer walking a 4400-m long figure-8 pattern around a large portion of Tulare Hill over approximately one and a half hours, noting butterfly occurrences within 5 meters of each side of the transect (Map 8-7). Areas of higher solar insolation (steep, south-facing slopes) are mapped in red, with low insolation (steep, north-facing slopes) shown in blue. The observer works on calm, sunny days when possible.

Map 8-8 shows where adults were found in 2021. Maps of sightings from 2013 to 2020 can be found in previous reports.

In all translocation years, adults and larvae were released only on LTSCV and PG&E property. Table 8-6 shows how they dispersed throughout the hill on other properties during the project. They exhibit hilltopping behavior. Especially in 2013, they were more likely to be found on the steeper, cooler slopes later in the season.



Map 8-7 Adult BCB monitoring course at Tulare Hill.



Map 8-8 Adult BCB occurrences along the monitoring transects, 2021.

Segment	# BCB 2013	# BCB 2014	# BCB 2015	# BCB 2016	# BCB 2017	# BCB 2018	# BCB 2019	# BCB 2020	# BCB 2021
A-B	3	21	27	63	1		3		
B-C	8	9	14	4	1				
C-D	7	1	13	21					
D-E	2	5	13	6	1		1		
E-A	1	3	8	12		1	1		
A-F		8	4	20	3		1		
F-G	2	4	17	17			4	2	2
G-H	7	9	15	12				2	
H-I		2	6						
I-J		13	3	3					
J-K	1	8	11					1	
K-L			2						
L-M	10	9	79	7					
M-N	19	9	13	3			2		3
N-A	1	23	43	4					
Total	**61**	**124**	**268**	**172**	**6**	**1**	**12**	**5**	**5**

Table 8-6 Number of BCB adults per transect segment by year (doesn't include incidentals).

In 2021, monitoring was conducted March 12, 21, 29, April 6, 11, 19 and 28. Adults were only found on March 29, April 6 and April 11. Five adult butterflies were observed on transects this year which is the same number of observations as last year (Table 8-7). Two additional adults were observed on the hill during other monitoring activities. These observations are considered "incidental" and are not included in the official total. Encounter rates were also calculated (Table 8-8). The protocol for calculating monitoring hours was standardized last year across projects. Monitoring hours used for the encounter rate begin at the first sighting thru the last sighting, including incidental sightings that establish beginning and ending of flight season. Monitoring days before the first sighting or after the last sighting are not included in the encounter rates (because they are occurring outside the flight season), and incidental sightings are not included in the total adults observed. Days with zero counts are important to establish the beginning and ending of the flight season, but are not included in the encounter rates.

Year	Total BCB adults
2013	61
2014	124
2015	268
2016	172
2017	6
2018	1
2019	12
2020	5
2021	5

Table 8-7 Summary of BCB adult sightings at Tulare Hill.

Year	Total BCB adults observed	Total monitoring hours	BCB adults/hour
2013	61	8	7.6
2014	124	9.3	13.3
2015	270	14	19.3
2016	172	11.8	14.6
2017	6	6	1.0
2018	1	6	0.2
2019	12	8.3	1.4
2020	5	2.9	1.7
2021	5	3.3	1.5

Table 8-8 Total number of BCB adults sighted during timed monitoring sessions at Tulare Hill, with encounter rates.

More total butterflies have been sighted at Kirby Canyon than at Tulare Hill every year. Both Kirby Canyon and Tulare Hill are monitored weekly, however Tulare Hill has a longer monitoring course. For this reason total adult sightings are not directly comparable, but the encounter rate of butterflies/hour shows that Kirby Canyon has consistently more butterflies observed (Table 8-8 and Table 8-9). As an additional comparison, the reintroduction effort at Edgewood Preserve ranged from a low of 0.2 butterflies/hour in 2020 to a high of 19.8 butterflies/hour in 2013 (Niederer and Kent 2021). In contrast, the newer reintroduction at San Bruno Mountain has ranged from 5.0 butterflies/hour in 2020 to 32.8 butterflies/hour in 2019, although it should be noted translocations occurred both those years (Weiss et al. 2020).

Year	Total BCB adults observed	Total monitoring hours	BCB adults/hour
2013	637	2	318.5
2014	235	2	117.5
2015	412	2	206
2016	257	2.8	91.8
2017	21	1.6	13.1
2018	6	1.2	5.0
2019	62	2	31.0
2020	267	2.4	111.3
2021	399	1.6	249.4

Table 8-9 Total number of BCB adults sighted during timed monitoring sessions at Kirby Canyon on Coyote Ridge, with encounter rates.

The timing of the flight season relative to host plant growth and senescence is critical. An early start and/or an early finish increase the likelihood the new generation of larvae will grow large enough to enter diapause before their host plants dry out. The flight season is compared with a reference site at Kirby Canyon on Coyote Ridge in Figure 8-10 and Figure 8-11. The asterisk denotes the midpoint of the flight season, when 50% of the year's butterflies had been encountered. In 2021, Tulare Hill's flight season peaked on April 6 and Kirby's flight season peaked one week earlier on March 31. This peak is considered late for Tulare Hill records and average for Kirby Canyon records.

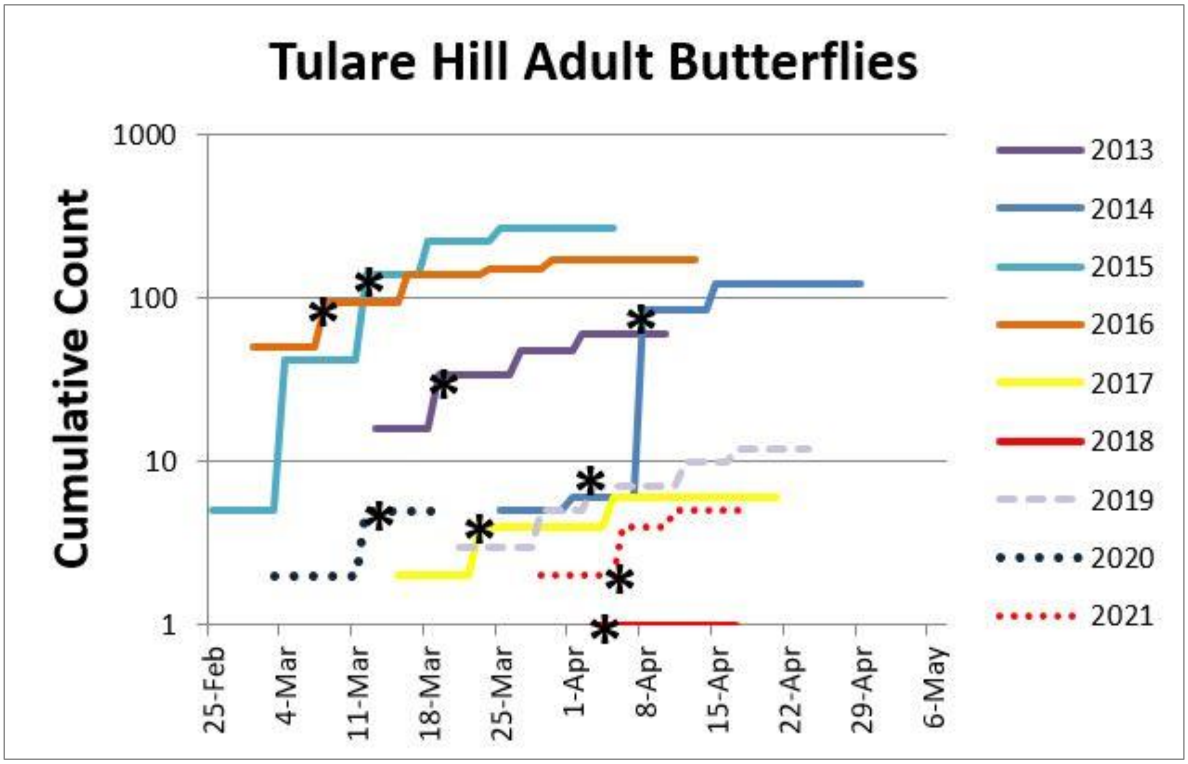


*Figure 8-10 Tulare Hill adult BCB. * marks the midpoint of the flight season, where 50% of BCB adults were observed.*

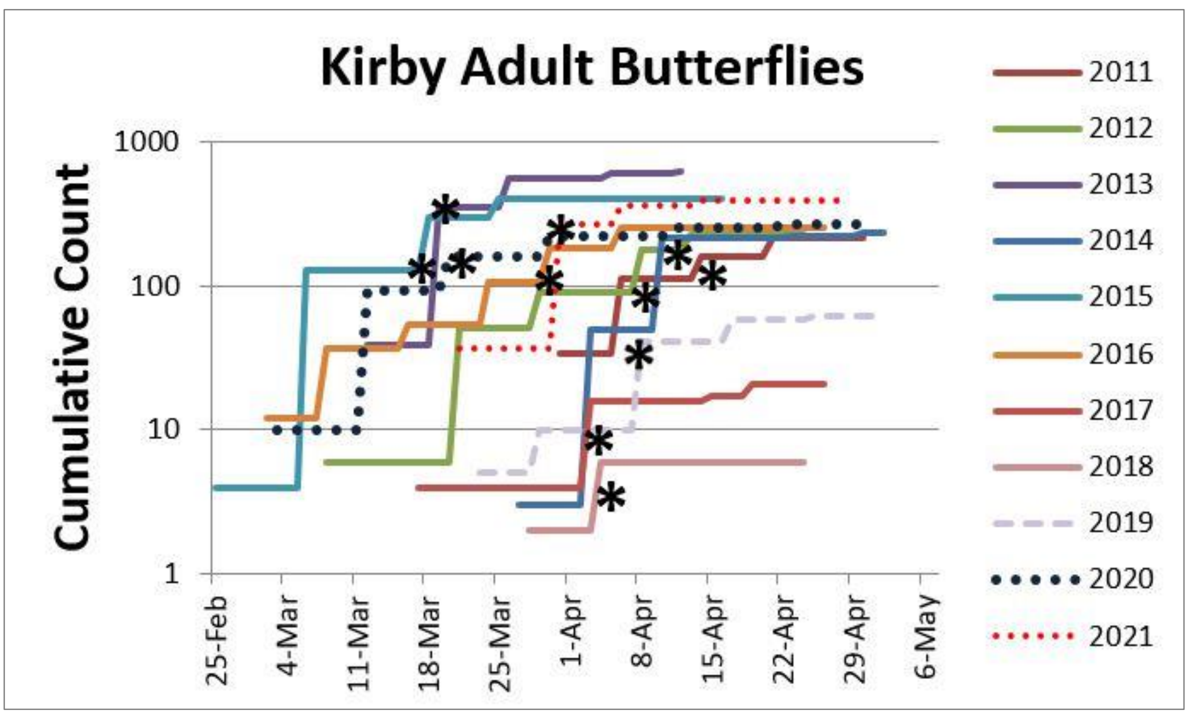


*Figure 8-11 Kirby Canyon adult BCB. * marks the midpoint of the flight season, where 50% of BCB adults were observed.*

This year Tulare Hill butterflies had a three week flight season and Kirby Canyon butterflies had a four week flight season. Table 8-10 shows peak flight and total weeks of flight for both sites.

Year	Weeks of flight, Tulare Hill	Weeks of flight, Kirby	Peak flight, Tulare Hill	Peak flight, Kirby
2013	4	4.5	19-Mar	19-Mar
2014	4	5	8-Apr	10-Apr
2015	7	6.5	12-Mar	18-Mar
2016	7	7	8-Mar	30-Mar
2017	3	5	23-Mar	3-Apr
2018	3	2	3-Apr	3-Apr
2019	5	5	2-Apr	8-Apr
2020	4	6	12-Mar	20-Mar
2021	3	4	6-Apr	31-Mar

Table 8-10 Flight season comparisons at Tulare Hill vs. Kirby Canyon.

8.2.1.8 Host Plant Phenology Monitoring

Again, the timing of the flight season relative to host plant growth and senescence is critical. An early start and/or an early finish increase the likelihood the new generation of larvae will grow large enough to enter diapause before their host plants dry out. Hostplants and nectar sources are monitored along transects at different topoclimates (warm to very cool) to determine how long they are available to adult BCB and prediapause larvae. These data are compared with flight season data to estimate whether most individuals survived to diapause. Low rainfall is less of a concern than continuing cool temperatures.

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. We compare Tulare Hill to Kirby Canyon on Coyote Ridge, which has a large BCB population. We use its host plant phenology as a reference.

In 2021, Tulare Hill had the lowest densities of *Plantago* in any year, although densities were still comparable with Kirby Canyon. *Plantago* dipped below the 10 plants/m^2 critical threshold by the second week of April at Tulare Hill, but lasted until the first week of May at Kirby Canyon (Figure 8-12 and Figure 8-13).

Tulare Hill has traditionally had lower densities of *Castilleja* compared with Kirby Canyon. This year, *Castilleja* was at historically low densities at both Tulare Hill and Kirby Canyon. *Castilleja* densities were so low at Tulare Hill that they did not register on the graph below. The barely detectable amounts of *Castilleja* that were present were only present for a little under two weeks. They senesced before the third week of April, three weeks earlier than the *Plantago*, which means this year they did not play the critical role of extending host plant availability later into the season. At Kirby Canyon, *Castilleja* only stayed fresh into the first week of May, senescing with *Plantago*. Kirby Canyon has steeper high elevation north-facing slopes, which allow host plants to stay fresh longer than other sites (Figure 8-14 and Figure 8-15).

The main nectar source, *Lasthenia californica,* stayed fresh beyond the end of the flight season at both Tulare Hill and Kirby Canyon (Figure 8-16 and Figure 8-17). *Layia* spp. also stayed fresh beyond the end of the flight season at Kirby Canyon but was only available for about one week at historically low densities that also are not visible on the graph. It is not found along phenology transects on Tulare Hill (Figure 8-18). Nectar tends not to be limiting for BCB.

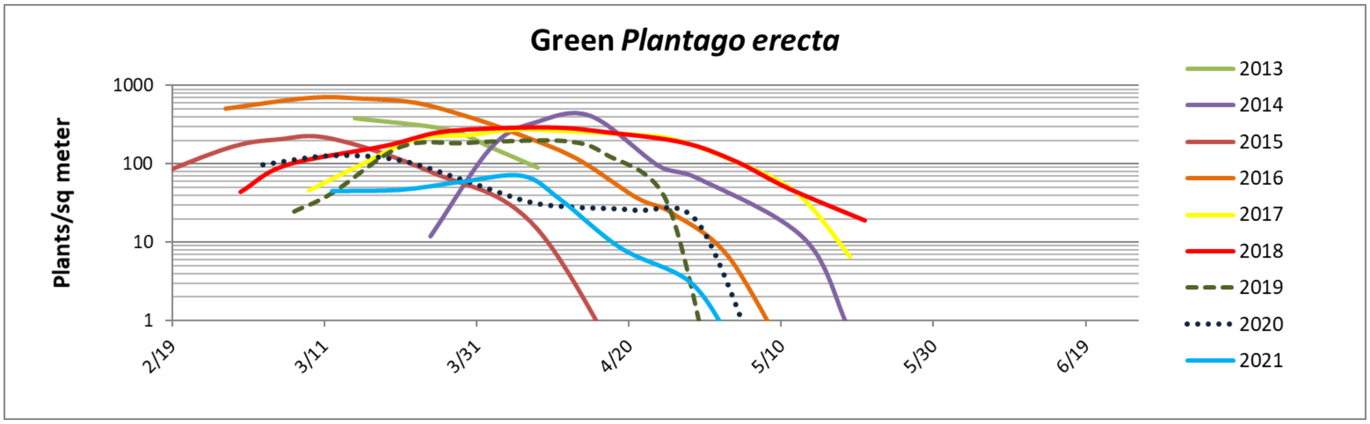


Figure 8-12 Tulare Hill host plant phenology (Plantago erecta). Ten plants/sq meter is a critical threshold for BCB larval use.

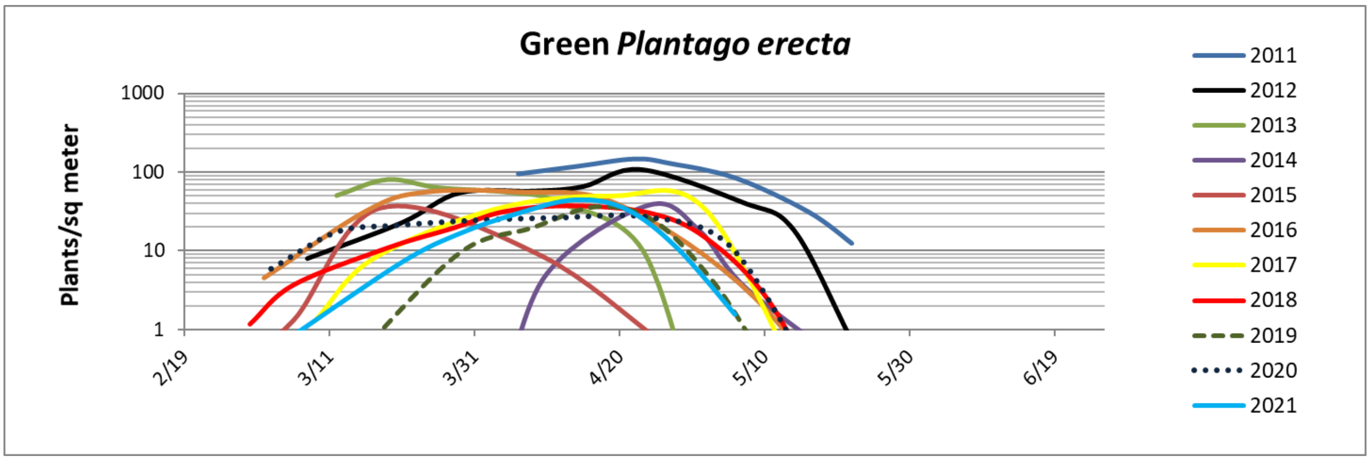


Figure 8-13 Kirby Canyon host plant phenology (Plantago erecta).

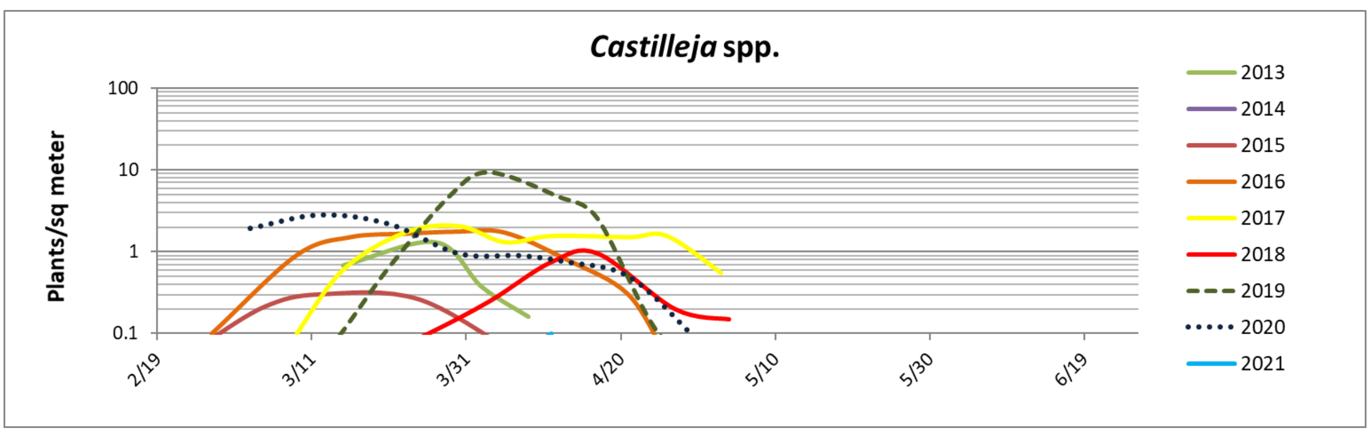


Figure 8-14 Tulare Hill host plant phenology (Castilleja spp.).

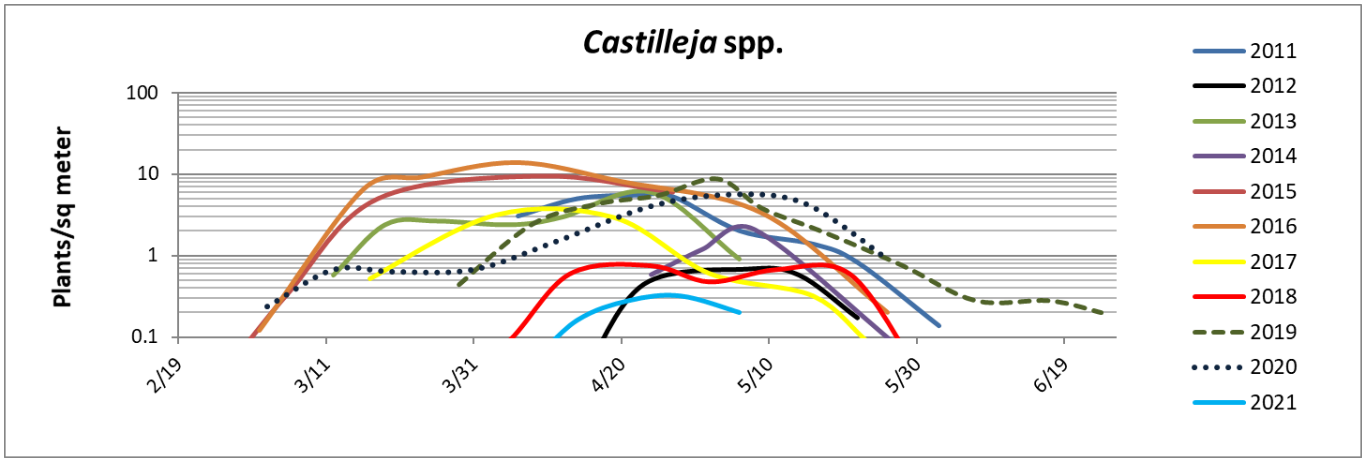


Figure 8-15 Kirby Canyon host plant phenology (Castilleja spp.).

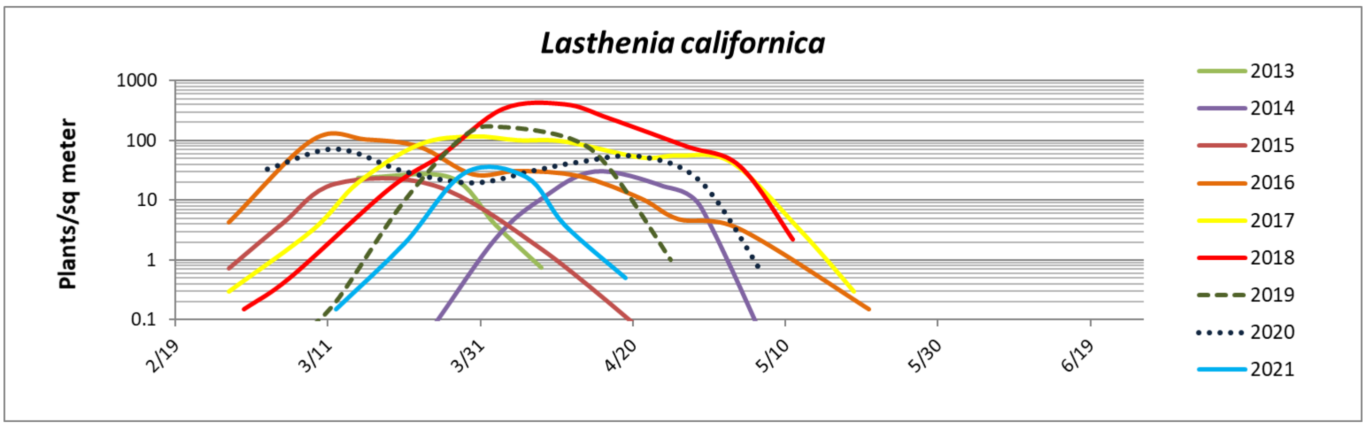


Figure 8-16 Tulare Hill nectar phenology (Lasthenia californica).

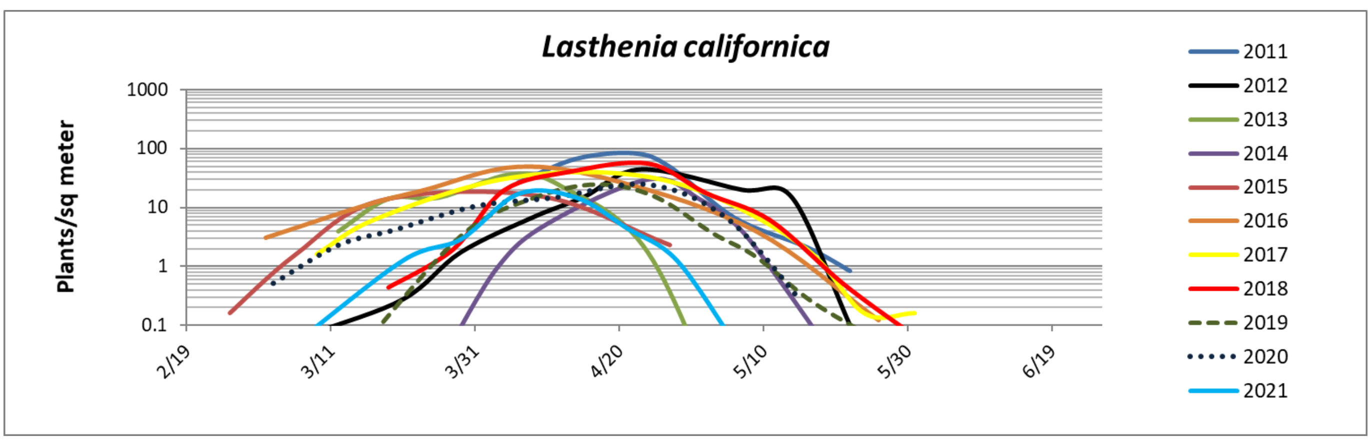


Figure 8-17 Kirby Canyon nectar phenology (Lasthenia californica).

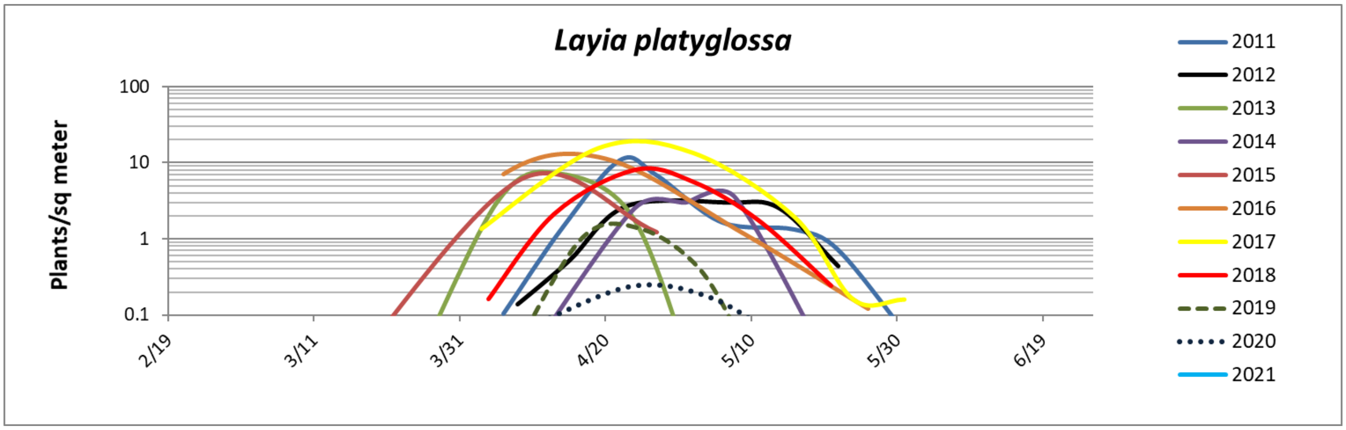


Figure 8-18 Kirby Canyon nectar phenology (Layia platyglossa). Note that this nectar source is not found along transects on Tulare Hill.

8.2.1.9 Discussion and Next Steps

The grazing regime on Tulare Hill continues to support high quality Bay checkerspot habitat, with cover of the key host plant *Plantago erecta* comparable with that of the reference site at Kirby Canyon. However, this year again had disappointingly low numbers of larvae and adults, suggesting a population persisting in the low hundreds. We are concerned that despite the abundance of host plants and the presence of some steep north-facing slopes, the low elevation and overall trend of increasingly warm spring temperatures may lead to premature host plant senescence. Climate change could render this site inhospitable. The low cover of *Castilleja* on Tulare Hill, which generally stays fresh much longer in the season, may be a key obstacle to checkerspot recovery. We have observed Bay checkerspots persisting at low densities at the lower elevations of nearby Coyote Ridge, so it's possible this population can persist indefinitely without further human intervention. Due to proximity of source populations, however, the low Coyote Ridge metapopulations are more likely to receive immigrants from denser metapopulations just on the top of the ridge, rather than serve as sources for Tulare Hill.

At Tulare Hill, this year there was only one larva documented (compared to two larvae last year), and five adults were observed during official monitoring (which was the same as last year). While the Kirby Canyon reference site has been steadily increasing from a historic low in 2018, Tulare Hill has been maintaining low numbers. Tulare Hill has not been recovering in sync with Kirby Canyon and the larger Coyote Ridge. In the past, the population responses at Tulare Hill have mirrored those across Coyote Ridge. Populations on Coyote Ridge generally declined from 2013 to 2014, increased from 2014 to 2015, and sharply declined (by a factor of 5-10) from 2015 to 2016. These regional-scale fluctuations are primarily a response to weather, which determines the phenology of the butterflies and hostplants, as well as the abundance of *Castilleja*.

The 2020 flight season was an average length at four weeks, host plants were at moderate densities and senesced considerably more than three weeks after the midpoint of flight season which resulted in no change in observed adults in 2021 on Tulare Hill, while Kirby Canyon numbers increased to moderately high levels.

The 2021 flight season was relatively short at three weeks and the number of adults (5) was the same as last year. March was considerably cooler than average and April was slightly warmer than average. Precipitation allowed for timely germination of *Plantago,* however both *Plantago* and *Castilleja* densities were at historical lows at Tulare Hill this year. *Plantago* had already dipped below the 10 plants/m^2 critical threshold by the second week of April, merely one week after peak flight and just a week before the small amounts of *Castilleja* had fully senesced. The early drying of *Castilleja* negated its usual advantage of extending the host plant season. This year's historically limited availability of host plants for larval use, combined with a late and short adult flight season, does not bode well for next year's larvae and adult numbers on Tulare Hill.

We note that the number of butterflies estimated on Tulare Hill in 2021 is within the historical range of variability observed since 1987, and it is important to acknowledge for the long-term that this population has historically been vulnerable to crashes and local extirpation following poor weather.

The observed local extinction following the 1987-1992 drought years is an example of the volatility of the Bay checkerspot population on Tulare Hill. At the other end of the spectrum, the large increase to 20,000 larvae from 2014 to 2015 shows that habitat can afford prime conditions for Bay checkerspot. The translocation in 2016 augmented the population in response to the crash of 2015-2016, and has given the population a chance to persist through that weather extreme. Low numbers seen since 2016 create a troubling trend, but are not outside the realm of fluctuations seen in other populations.

At this point we do not anticipate translocating in 2022, although that decision could be changed based on dramatic increases in larvae at the source population or other factors.

We also wish to reiterate that the entire Tulare Hill is unified BCB habitat, as evidenced in previous years by adults dispersing beyond release properties throughout the whole hill. It will remain important to continue working cooperatively with all landowners to see this project succeed.

Funding for this project was provided from the MEC Preserve (Calpine), as procured through LTSCV. We remain grateful to our many partners who help with permitting, funding, management, and volunteer hours: Santa Clara County Parks, USFWS, LTSCV, Calpine, and PG&E.

8.2.2 MEC-CR

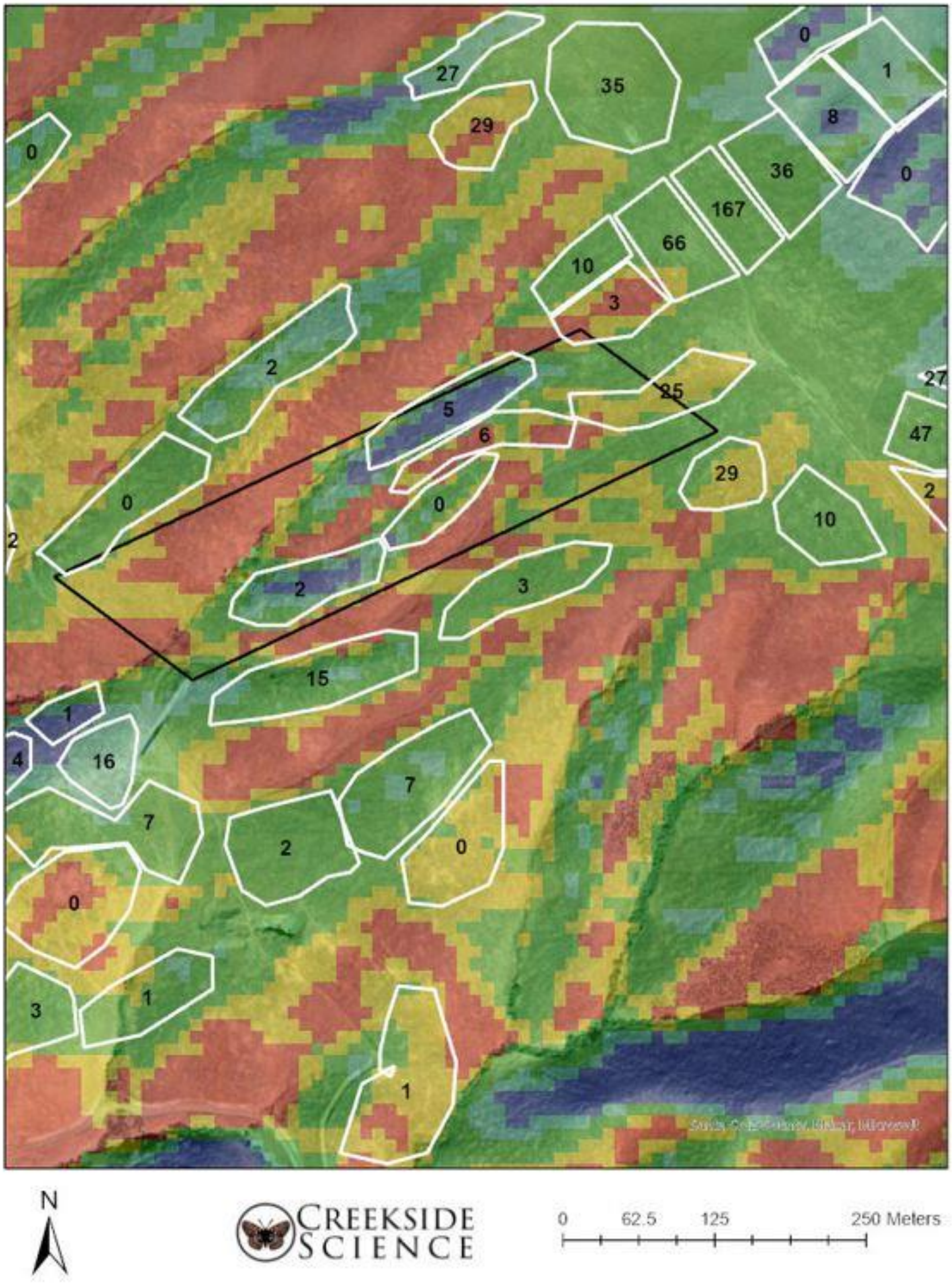
8.2.2.1 2021 Survey Results

All the changes of larval densities on Coyote Ridge in 2021 were within normal fluctuations, and we are pleased to report additional recovery from 2018's extremely low numbers in this part of Coyote Ridge. Plots in and around MEC-CR, delineated by topoclimatic variation, were surveyed with 10 person-minute searches. Thirteen larvae were observed in the plots (Map 8-9). The population estimate of larvae on the adjacent Kirby Canyon (~250 acres, 44 larvae plots) is compared with the number of larvae observed in MEC-CR plots (~15 acres, 4 larvae plots) in Table 8-11. Larval fluctuations at the two sites are largely synchronized. Population estimates use a density conversion of 1 larva = ~100 larvae/ha (Weiss 2009).

Low to moderate numbers of larvae were found on the nearby mid-slopes.

Kirby Canyon (in close proximity to the south of MEC-CR) supported 186,548 ± 41,580 larvae in 2021. This is up from ~108,148 ± 53,190 larvae in 2020, up from 15,568 ± 10,155 larvae in 2019. The 2017 and 2018 population numbers were record lows (11,882 ± 4,343 in 2017 and only 5,457 ± 3,959 in 2018). Previous lows were in 1997 (27,000 ± 12,000) and 1991 (32,000 ± 11,000). With this year's increase, the larval population numbers are back up around 2015 numbers (190,756 +/- 70,059 larvae) (Figure 8-19). Regional analysis of population trends showed that the sharp declines from 2015 to 2018 were a regional-scale phenomenon, driven primarily by weather with some local asynchrony in the magnitude of change. Population numbers on the northern end of the Coyote Ridge population complex did not decline as much.

The BCB population along the ridgetop has had a volatile history of population dynamics. It fell precipitously from 2004 (2000/ha) to 2008 (<20/ha) because of unfavorable weather in 2006. Starting in 2009, the ridgetop population entered another boom cycle, increasing each year. By 2015, local densities reached 1000-5000 larvae/ha on the NE slopes of the ridgetop. Overall densities in 2016 decreased from 2015 across most BCB habitats on Coyote Ridge, by a factor of 5-10. During low population years, the mid-slopes around MEC-CR were only intermittently occupied by larvae, but dispersing adults were likely present in the area. The southern portion of Coyote Ridge hit very low numbers in 2018, but saw recovery in 2019 and 2020. The recovery continued in 2021, roughly in line with 2015 numbers.



Map 8-9 BCB larvae densities at MEC-CR, 2021.

	# Observed larvae in MEC-CR plots	Larval Population Estimate for Kirby Canyon
2001	0	253,882 ± 49,229
2002	0	452,619 ± 93,114
2003	0	540,891 ± 95,903
2004	0	633,281 ± 131,925
2005	0	166,624 ± 59,665
2006	3	100,709 ± 28,834
2007	0	48,293 ± 26,707
2008	0	56,441 ± 19,607
2009	0	34,285 ± 16,782
2010	3	78,504 ± 39,984
2011	0	94,399 ± 32,025
2012	4	131,627 ± 37,606
2013	1	246,697 ± 46,487
2014	1	91,755 ± 35,136
2015	12	190,756 ± 70,059
2016	1	45,281 ± 15,827
2017	1	11,882 ± 4,343
2018	0	5,457 ± 3,959
2019	0	15,568 ± 10,155
2020	3	108,148 ± 53,190
2021	13	186,548 ± 41,580

Table 8-11 Comparison of number of observed larvae in MEC-CR plots with population estimates of larval population for nearby Kirby Canyon.

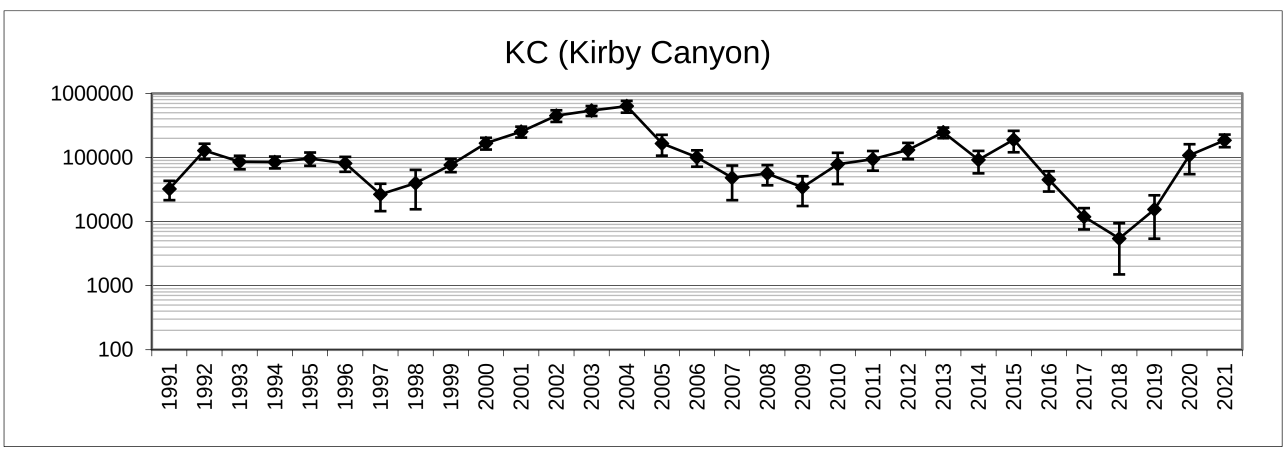


Figure 8-19 BCB larvae fluctuations at nearby Kirby Canyon.

8.2.3 LECEF

8.2.3.1 2021 Survey Results

One BCB larva was found in LECEF in 2012, and the LECEF population proceeded to climb over the next 3 years: 3 larvae in 2013, 31 in 2014 and 52 larvae in 2015. In 2016, the LECEF numbers declined back to 2013 levels, with 2 larvae found in the parcel, and none in 2017 and 2018. Seven larvae were then observed in 2019, and in 2020 14 larvae were observed. In 2021, 3 larvae were found on the LECEF parcel (Map 8-10, Figure 8-20).

On the adjacent SVP parcel, 34 larvae were found in 2021, down from 47 larvae in 2020 and 51 larvae in 2019. In 2018 only 14 larvae were found, and only 1 larva was found in 2017. 17 larvae were found here in 2016, down from 267 larvae in 2015 and 69 larvae in 2014 (Map 8-10, Figure 8-20).

The LECEF Preserve was estimated to support ~2300 larvae in 2021, down from ~3000 larvae in 2020 and ~6000 larvae in 2019. Estimates in 2018 were lower at ~850 larvae in 2018, and <100 in 2017. The adjacent SVP parcel supported ~3500 larvae in 2021, down from ~4750 larvae in 2020 and ~6000 larvae in 2019. Estimates in 2018 were lower at ~1200 larvae in 2018, and ~100 in 2017. These estimates are large declines from peak (and unusual) numbers observed in 2015 (>20,000 in each parcel). These fluctuations are largely congruent with the changes observed across the region from 2015 through 2021.

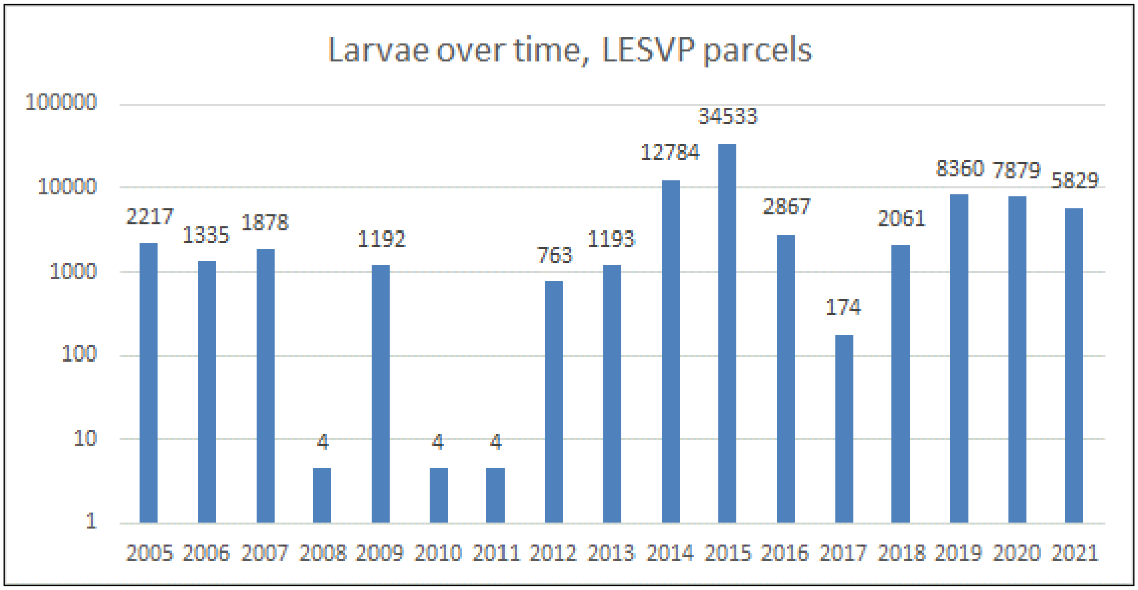
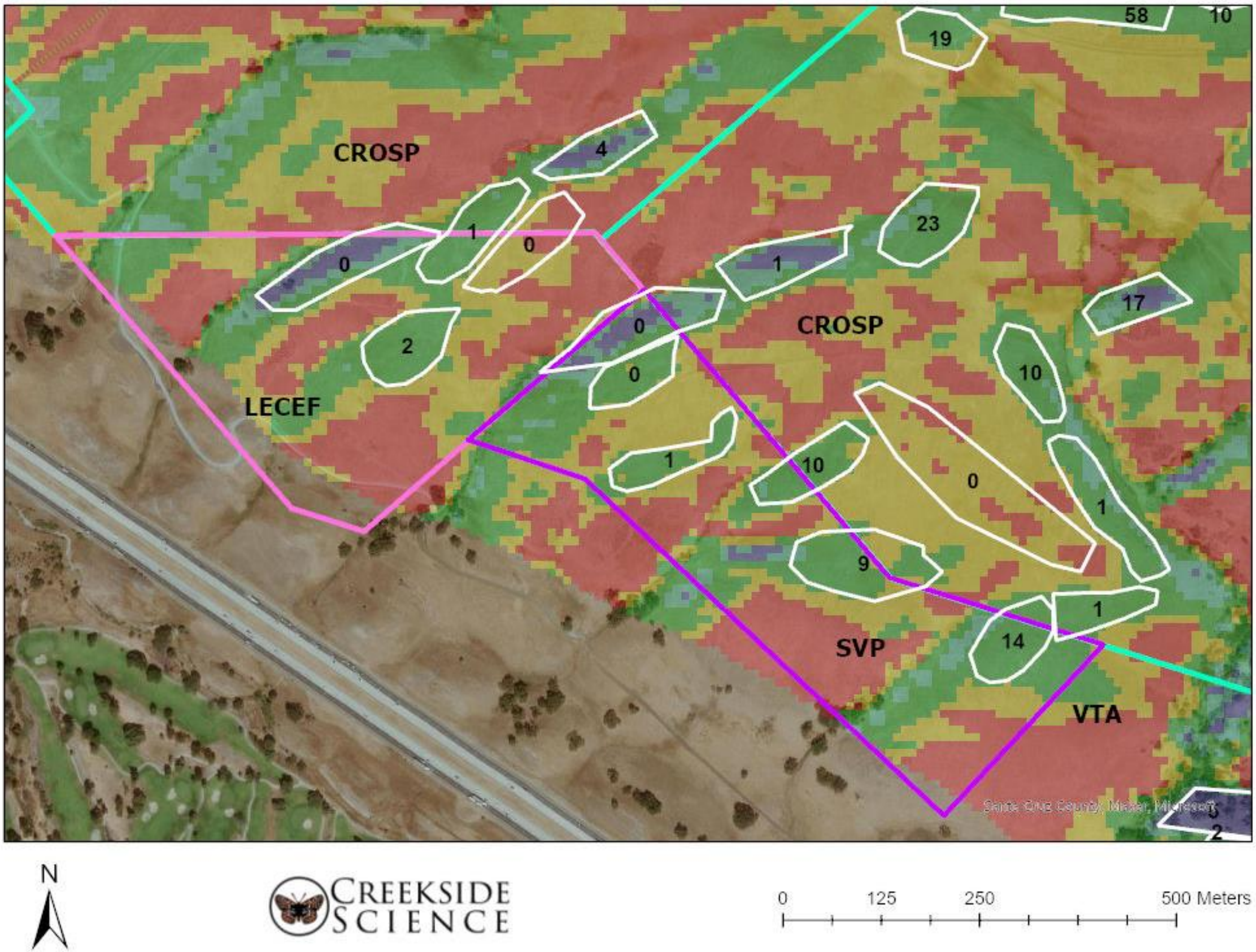


Figure 8-20 Change in larvae over time on combined LECEF/SVP parcels. Note log scale.



Map 8-10 BCB larvae densities at LECEF and SVP properties, 2021.

8.3 Opler’s longhorn moth

On April 15, 2014, two Creekside Science biologists spent about 15-20 minutes netting longhorn moths in the vicinity of *Platystemon californicus* on the MEC Preserve portion of Tulare Hill. Three moths that seemed like Opler’s longhorn moths (*Adela oplerella*) were captured and submitted to Dr. Jerry Powell of UC Berkeley for positive identification. Dr. Powell confirmed that two of the three moths were Opler’s longhorn moths (one female and one male). The third moth was a male Scythrididae (flower moth), possibly genus *Arotrura*. No further searches were conducted from 2015 through 2020.

On March 25, 2021 we conducted another survey for presence and found multiple individuals (Photo 8-11).

The next survey for presence will be in 2026 and and at five-year intervals after that.

From March 29 through April 18, 2018 cream cups (*Platystemon californicus*) were mapped on Tulare Hill. It continues to persist throughout the hill but is significantly more abundant on the south half of the hill. We will repeat hostplant mapping at five-year intervals so the next mapping effort will be in 2023.

Photo 8-11 Opler’s longhorn moth on cream cup hostplant.

8.4 California Red-legged Frog

The California red-legged frog (CRLF) is a federal listed threatened species and is a California Species of Special Concern. It inhabits areas containing ponds and permanent pools in streams and marshes with emergent vegetation from near sea level to approximately 8,000 feet in elevation. It ranges throughout the Coast Ranges and the western foothills of the Sierra Nevada, from near the Oregon border to northern Baja California, but is thought to be most prevalent in the lower foothills and lowlands. CRLF feed on aquatic and terrestrial insects, crustaceans, snails, worms, fish, tadpoles, and smaller frogs along highly vegetated shorelines (CH2M HILL, 1991; Zeiner, et al., 1988; Stebbins, 1985).

There are CNDDB-recorded observations for this species in the Coyote Ridge area, approximately 4 miles east of the project site, from the Metcalf Canyon area, Coyote Creek north of Metcalf Road, and from the Fisher Creek drainage west of Santa Teresa Boulevard (Jennings et al., 1997). A CNDDB search with January 30, 2022 CDFW data shows no CRLF occurrences, either extant or extirpated, on Tulare Hill or Fisher Creek. The nearest sightings (within 2000m of Tulare Hill) are on the lower slopes of Coyote Ridge. Various sightings have been reported in Coyote Creek, stock ponds, and the Santa Clara Valley Water District water canals over the years, with the most recent CNDDB record being in an in-channel pool of the Coyote Canal in 2012, about 1.5 km east of Tulare Hill, beyond U.S. 101 and Monterey Highway. Only two locations are within 1km of Tulare Hill. Both are at the base of Coyote Ridge, east of U.S. 101. Frogs were documented here in 1999 and 2000 (Map 8-11). Over 25 night surveys conducted in Fisher Creek since 1997 showed introduced bullfrogs (*Rana catesbeiana*) were abundant (Jennings, 2000). Bullfrogs and fish prey on amphibian larvae, including tadpoles of red-legged frogs.

The Fisher Creek riparian corridor is included in the MEC Preserve and the habitat was enhanced with plantings of native riparian trees and shrubs (see tree planting section in previous reports). With the enhancement efforts, the riparian corridor could become suitable habitat for CRLF that may use Fisher Creek as a future dispersal/travel corridor. As required by the USFWS Biological Opinion, a qualified biologist assesses the enhanced riparian corridor on the west and east sides of the creek to determine if CRLF are, or could be, present.

Mark Jennings of Rana Resources is conducting CRLF surveys and habitat assessment on an annual basis. Protocol surveys for CRLF were conducted by Rana Resources on the following dates in 2021: October 21 and November 30 (daytime surveys), and October 31 and December 8 (night surveys).

Due to the exceptional drought conditions, throughout much of 2021 the site was found to be completely dry until water was released into the creek (about 1.20 cfs) beginning on November 20. These conditions were much like the ones observed in 2015 when Fisher Creek remained dry throughout until the end of the year. This has resulted in no aquatic vegetation, amphibians, or other aquatic life being seen in Fisher Creek this year. In fact, the only places where water remained present on site through the summer and fall were in the livestock watering troughs and the spring on the hill. These two locations provided suitable moisture for the remaining resident Pacific treefrog (*Hyla regilla*) population and they will certainly recolonize the stream now that it has started flowing again.

The significant rainstorms we had in October 2021 weren't enough to saturate the ground and cause Fisher Creek to contain water. Instead, rainfall did maintain the upper spring on the hill and there was enough water present to result in an extensive growth of vegetation around the spring and downstream in the nearby drainage channel.

As mentioned in previous reports, the current and prior drought conditions certainly eliminated any bullfrogs (*Lithobates (Rana) catesbeianus*) from the immediate area. During earlier surveys (2001-2007), one or more juvenile bullfrogs were noted in this stretch of Fisher Creek. Bullfrogs probably remain present upstream of the site in the deep irrigation ponds located in the vicinity of the old golf course (on the Sobrato Property), just south of Bailey Road (across the street from the current IBM facility). However, once again, no juvenile bullfrogs were observed during surveys this year (which is the same result as in years 2018-2020). Perhaps they may start recolonizing the lower portion of Fisher Creek sometime next summer or early fall (after first overwintering as larvae in upstream breeding sites), as long as the riparian area continues to contain running water throughout the year.

Adult and juvenile CRLF continue to be observed to the east of nearby Hwy 101 in the drainage channels that flow into the Coyote Creek Parkway (e.g., in the Basking Ridge Ecological Preserve) during the spring and summer months. Thus, although no CRLF were found in 2021 due to the wetlands being dry during the summer and fall of this year, there remains the potential that dispersing juvenile CRLF could colonize the Metcalf Energy Center Ecological Preserve via the Coyote Creek Parkway corridor during the winter and spring rainy seasons. The Preserve continues to contain dense thickets of vegetation for CRLF to hide in, willow branches over the stream for them to sit on, and many deep pools for them to breed in or use as escape cover as long as water is present. There is also a sufficient small mammal prey base present for adult CRLF to feed on.

Also noted during the 2021 survey was the presence of goats (*Capra hircus*) being used to remove vegetation on the south side of Fisher Creek next to the Metcalf Energy Center. This is a standard fire fuel control policy for local resource managers and no adverse impacts to the wildlife and plants within the MEC Preserve area were observed, due to the use of suitable temporary fencing.

The continued presence of three introduced edible fig (*Ficus carica*) trees were noted along the stream under the power line near the railroad bridge at Monterey Road. In addition, greater periwinkle (*Vinca major*) plants near the second gate (next to Fisher Creek) continue to send up new shoots and spread. The clump of introduced giant reed (*Arundo donax*) in this area has been treated by Creekside Science in 2020 and a follow-up treatment was performed in 2021 (see Section 5.4). SCVOSA has also begun treating giant reed along Fisher Creek. The three introduced fan palms (*Washingtonia* sp.) that were cut down prior to 2017 are now completely dead and have not re-sprouted. However, there is a single fan palm located next to the creek and upstream of the second gate, which Creekside Science plans to address in 2022. Adjacent but outside of the Preserve on the other side of Fisher Creek two clumps of pampas grass are also present. Normally, the goats crop down the plants each year, but this is another invasive that has caused harm to CRLF populations on the Central Coast by colonizing large areas of riparian and upland habitats.

The threat to CRLF from invasive plants is based on cumulative threats over time. That is, the invasive plants crowd out native plant and animal species and thus lower the diversity and number of edible invertebrates for frogs (especially young ones) to eat. In worse case scenarios (e.g., cape ivy), invasive plant species can completely dominate riparian areas to the point that native plants (and the organisms that depend on them) can no longer survive.

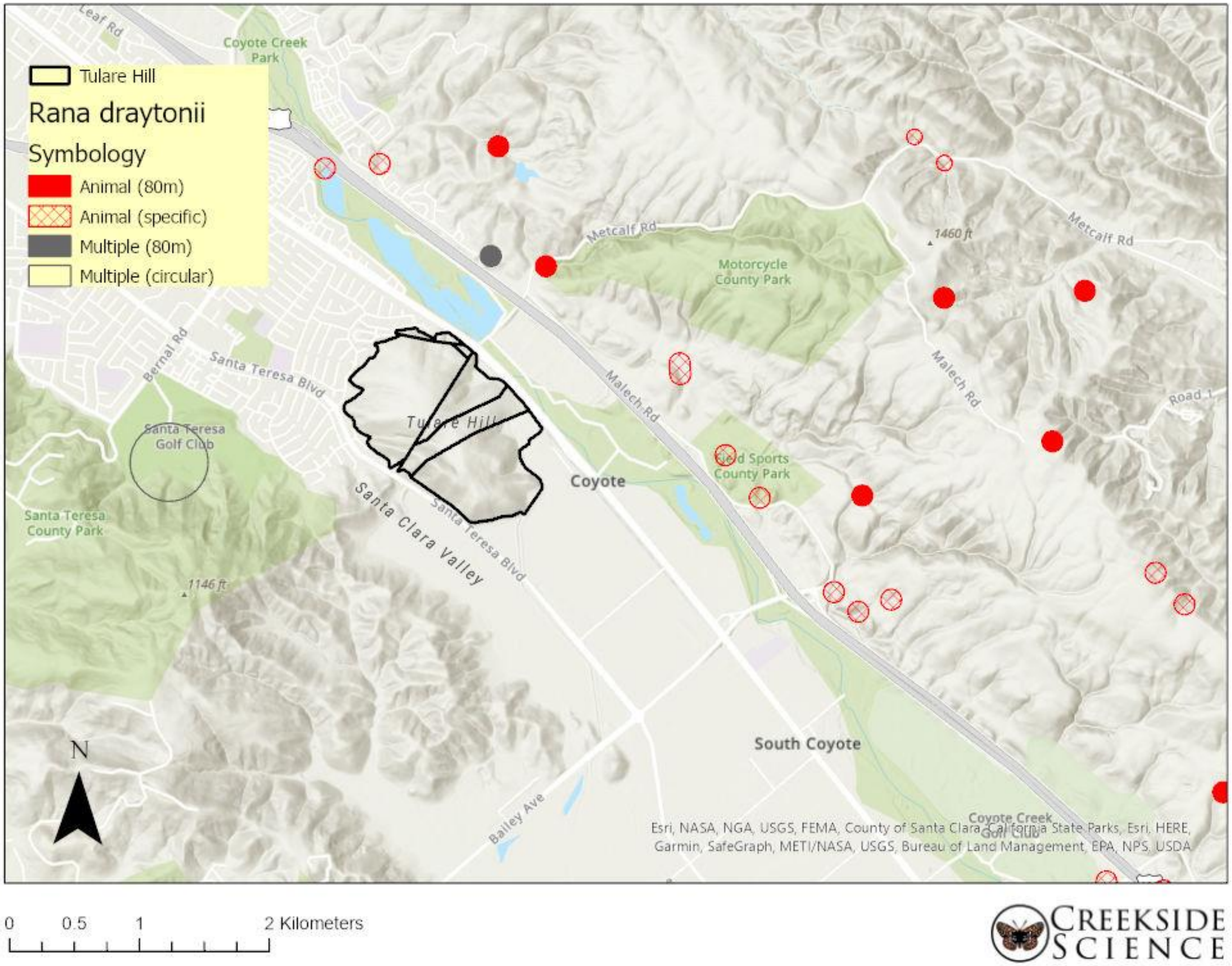
Mark Jennings ranks the level of threat as follows for the invasive plants found on the Metcalf Energy Center Ecological Preserve: 1) giant reed, 2) edible fig, 3) fan palm, and 4) greater periwinkle. Giant reed is of most concern as it often creates dense thickets in riparian areas which harbor introduced invertebrates such as Argentine ants. The spread of giant reed plants can be relatively quick during times of greater than average rainfall. This has been a big problem in southern California (such as at Camp Pendleton Marine Corps Base) where habitat that was once suitable for endangered arroyo toads has been changed by giant reed infestation to such a point that the habitat is no longer suitable for toads, and their major food supply (native ants) is eliminated, via the harboring of introduced ants that kill off any native ant populations they encounter.

Edible figs are a magnet for potential CRLF predators such as common crows and ravens. They also attract mammals such as introduced black rats and Norway rats which crowd out the native mice that CRLF feed on as adults (and are important for gaining enough energy reserves for successful reproduction). Introduced rats and mice can also spread diseases that are more harmful to native rodents. Getting rid of these fig trees now will prevent them from being spread further by birds and mammals which often carry away the fruits to dine on them.

The fan palm also attracts introduced rats and will deposit seeds for future plants if it isn't removed.

Greater periwinkle plants would mostly be a problem of crowding out native plants and thus negatively affecting the invertebrate food base for CRLF. The infestation is not expected to spread very rapidly. However, over time, it could become an issue. Copies of Rana Resources' CRLF reports from previous years are available upon request.

LTSCV has expressed interest in funding a feasibility study to create CRLF habitat on Tulare Hill. H.T. Harvey and Associates recently completed a habitat survey for neighboring SCVOSA properties in Coyote Valley, and reported that creating habitat on Tulare Hill would greatly enhance regional dispersal corridors (Steve Rotternborn, pers. Comm). This opportunity should be pursued.



Map 8-11 CRLF occurrences.

SECTION 9.0

Fisher Creek Riparian Corridor Tree Plantings

In 2019 the MEC Preserve Tree Mitigation and Enhancement Plan area met the success criteria of at least 254 trees alive for a period of at least five years for all planting areas. Since annual monitoring is complete, previous reports can be referenced for information related to monitoring activities that took place from 2007 through 2019.

9.1 Bird Nest Monitoring

Thirteen next boxes were constructed and installed on trees within the MEC Preserve riparian corridor as part of mitigation measures for the Metcalf Energy Center construction. Some of the nest boxes were attached to planted mitigation trees; others were attached to mature trees in the riparian corridor. Calpine and the Santa Clara Valley Audubon Society (Audubon) monitor the nest boxes annually. Due to the Shelter in Place Order and health concerns related to COVID-19, in 2020 the volunteer monitors that are usually responsible for monitoring the nest boxes were unable to monitor the site.

In 2021, Mark Jennings of Rana Resources observed a number of downed and broken wooden bird nesting boxes within the Preserve while performing his annual CRLF surveys. He also noted several dozen wood ducks (*Aix sponsa*) in Fisher Creek in 2020.

In 2021, none of the intact boxes were used by nesting birds. Reports from previous years have shown that the last time Western Bluebirds utilized the next boxes was in 2012, and House Sparrows have otherwise been the most frequent of the residents to use the boxes at the site. Copies of Audubon's bird nesting reports from previous years are available upon request.

SECTION 10.0
References

Baldwin, B.G., D.H. Goldman, D.J. Keil, R. Patterson, T.J. Rosatti, and D.H. Wilden, editors. 2012. The Jepson manual: Vascular plants of California, second edition. University of California Press, Berkeley.

Bay Area Air Quality Management District. 2021. Accessed on November 27, 2021. https://www.baaqmd.gov/about-air-quality/current-air-quality/air-monitoring-data/#.

California Department of Forestry and Fire Protection (Calfire). 2019. Incident database, accessed September 12, 2019. https://fire.ca.gov/incidents/2019/8/15/bayliss-fire/

Cao, H., Henze, D.K., Cady-Pereira, K., McDonald, B.C., Harkins, C., Sun, K., Bowman, K.W., Fu, T.M. and Nawaz, M.O., 2021. COVID-19 Lockdowns Afford the First Satellite-Based Confirmation That Vehicles Are an Under-recognized Source of Urban NH3 Pollution in Los Angeles. *Environmental Science & Technology Letters*.

Creekside Science and CH2MHill. 2016. 2015 Annual Monitoring Report for the Metcalf Energy Center Ecological Preserve and Los Esteros Critical Energy Facility Santa Clara County, California. Prepared for Silicon Valley Land Conservancy. July 2016.

CH2M HILL. 1991. Baseline Study Report: Calero County Park Master Plan EIR. Prepared for the Santa Clara County Parks and Recreation Department. September.

CH2M HILL. 2003. Annual Monitoring Report for the Metcalf Energy Center Ecological Preserve Santa Clara County, California. Prepared for Land Trust for Santa Clara County. March 2003.

D'Antonio, C. M., S. J. Bainbridge, C. Kennedy, J. W. Bartolome, and S. Reynolds. 2006. Ecology and Restoration of California Grasslands with Special Emphasis on the Influence of Fire and Grazing on Native Grassland Species. A report to the David and Lucille Packard Foundation University of California, Santa Barbara.

DiTomaso, J.M. and E.A. Healy. 2007. Weeds of California and other western states. University of California: Oakland, CA.

DiTomaso, J. M., K. L Heise, G. B. Kyser, A. M. Merenlender, and R. J. Keiffer. 2001. Carefully timed burning can control barb goatgrass. California Agriculture. November-December 2001, pp. 47-53.

DiTomaso, J.M., G.B. Kysyer et al. 2013. *Weed Control in Natural Areas in the Western United States.* Weed Research and Information Center, University of California. 544 pp.

Fenn, M.E., Allen, E.B., Weiss, S.B., Jovan, S., Geiser, L.H., Tonnesen, G.S., Johnson, R.F., Rao, L.E., Gimeno, B.S., Yuan, F. and Meixner, T., 2010. Nitrogen critical loads and management alternatives for N-impacted ecosystems in California. *Journal of Environmental Management*, *91*(12), pp.2404-2423.

Guenther, K. and Hayes, G. 2008. Monitoring annual grassland residual dry matter: a mulch manager's guide for monitoring success, second ed. Wildland Solutions, Brewster, WA. 34pp.

Hickman, J. C., editor. 1993. The Jepson manual: Higher plants of California. University of California Press, Berkeley.

Hoang, A.T., Huynh, T.T., Nguyen, X.P., Nguyen, T.K.T. and Le, T.H., 2021. An analysis and review on the global NO2 emission during lockdowns in COVID-19 period. *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects*, pp.1-21.

Huenneke, L. F., S. P. Hamburg, R. Koide, H. A. Mooney, and P. M. Vitousek. 1990. Effects of soil resources on plant invasion and community structure in Californian serpentine grassland. Ecology 71(2), pp. 478-191.

Jennings, M. R., S. Townsend, and R. R. Duke. 1997. Santa Clara Valley Water District California red-legged frog distribution and status – 1997. Final report prepared for the Santa Clara Valley Water District, San Jose, California. H.T. Harvey and Associates, Alviso, California. 22 pp.

Jennings, M.R. 2000. Metcalf Energy Center Amphibian and Fishes Report. March 7.

Jennings, M.R. 2020. Letter of Survey Results for California Red-Legged Frog at MEC Ecological Preserve. November 17.

Kent, M., C. Niederer, J. Quenelle, and S. B. Weiss. 2017. Monitoring Report on Mitigation Lands for Donald Von Raesfeld Power Plant, Silicon Valley Power. 2016 Report. Prepared for the Silicon Valley Land Conservancy and Silicon Valley Power. January 2017.

Muhammad, S., Long, X. and Salman, M., 2020. COVID-19 pandemic and environmental pollution: A blessing in disguise?. *Science of the total environment*, *728*, p.138820.

National Atmospheric Deposition Program. 2019. Accessed on February 1, 2019. https://nadp.slh.wisc.edu/committees/tdep/tdepmaps/.

Niederer, C. 2013. Use of fire in managing California grasslands. Literature search prepared for Midpeninsula Regional Open Space District. 15 pages.

Niederer, C. and M. Kent. 2021. Bay checkerspot reintroduction. Coyote Ridge to Edgewood Natural Preserve. Report to U.S. Fish and Wildlife Service, Permit TE-30659A-1. 24 pages.

Niederer, C. and S. B. Weiss. 2017. Reintroduction of the Metcalf Canyon Jewelflower (*Streptanthus albidus* ssp. *albidus*) at Tulare Hill in southern Santa Clara County. *Final Report and Adaptive Management Plan, January 2017.* Report submitted to Bureau of Reclamation, Grant #R12AP20022.

Peters, A., D.E. Johnson, and M.R. George. 1996. Barb goatgrass: a threat to California rangelands. Rangelands 18(1), February 1996. pp. 8-10.

Raposo, Z., C. Howington, P. Walsh, A. Ferrero, L. Negoita, and N. Rajakaruna. 2019. Post-fire plant diversity across serpentinite and metavolcanics substrates under the influence of fire retardant—San Luis Obispo, California. Poster presented at California Botanical Society's Annual Graduate Student Symposium, April 6, 2019, San Luis Obispo, CA.

sfbay.ca. 2019. Bayliss fire aerial image https://s3-us-west-1.amazonaws.com/sfbay-media-library/2019/08/15142042/Bayliss_CalFire-400x200.jpg

Stebbins, Robert C. 1985. A Field Guide to Western Reptiles and Amphibians. Houghton-Mifflin Co.

USFWS (United States Fish and Wildlife Service) 1998. Draft Recovery Plan for Serpentine Soil Species of the San Francisco Bay Area; February 1998.

WestMap. 2014. Climate Analysis and Mapping Tool. Accessed on March 3, 2014. http://www.cefa.dri.edu/Westmap/Westmap_home.php.

WestMap. 2018. Climate Analysis and Mapping Tool. Accessed on August 22, 2018. http://www.cefa.dri.edu/Westmap/Westmap_home.php.

WestMap. 2019. Climate Analysis and Mapping Tool. Accessed on August 6, 2019. http://www.cefa.dri.edu/Westmap/Westmap_home.php.

WestMap. 2020. Climate Analysis and Mapping Tool. Accessed on July 21, 2020. http://www.cefa.dri.edu/Westmap/Westmap_home.php.

WestMap. 2021. Climate Analysis and Mapping Tool. Accessed on August 24, 2021. http://www.cefa.dri.edu/Westmap/Westmap_home.php.

Weiss, S.B. 1999. Cars, Cows, and Checkerspot Butterflies: Nitrogen Deposition and Grassland Management for a Threatened Species. Conservation Biology 13:1476-1486.

Weiss, S.B. 2009. Kirby Canyon Butterfly Trust Annual Reports for 2006-2008: Population Trends and other Conservation Activities; April 2009.

Weiss, S. B. 2019. Assessment of Nitrogen Deposition and Spring Water Nitrate for the Santa Clara Valley Habitat Plan; March 2019.

Weiss, S. B., C. Niederer, and J. Quenelle. 2012. VTA-Coyote Ridge Property Year 5 (2011) Monitoring Report. Prepared for Santa Clara County Open Space Authority.

Weiss, S. B., D. H. Wright, and C. Niederer. 2007. Serpentine Vegetation Management Project, Final Report. (CVPCP/HRP Grant Agreement # 814205G240, Bureau of Reclamation, Dept. of the Interior).

Weiss, S. B., K. Swenerton, and C. Niederer. 2020. 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. 38 pages.

Whittall, J. B., S. Y. Strauss. 2011. Final Project Report: Determining the optimal conditions for propagation and reproduction of the endangered serpentine endemic Metcalf Canyon jewelflower (*Streptanthus albidus* ssp. *albidus*) of Santa Clara County and genetic assessment of its taxonomic status. (CVPCP/HRP Grant Agreement #R10AP20616, Bureau of Reclamation, Dept. of the Interior).

Wildlands Solutions. (2008). Monitoring Annual Grassland Residual Dry Matter: A Mulch Manager's Guide for Monitoring Success. (2nd ed.) [Brochure 34 pp.]. Brewster, WA: Guenther, K. and Hayes, G.

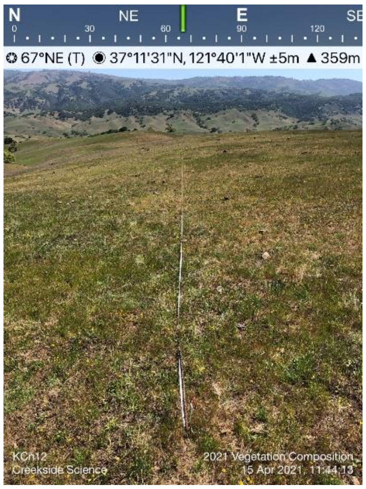
Zeiner, D et. al. 1988. California's Wildlife. Volume I. Reptiles and Amphibians. California Statewide Wildlife Habitat Relationships System.

APPENDIX A

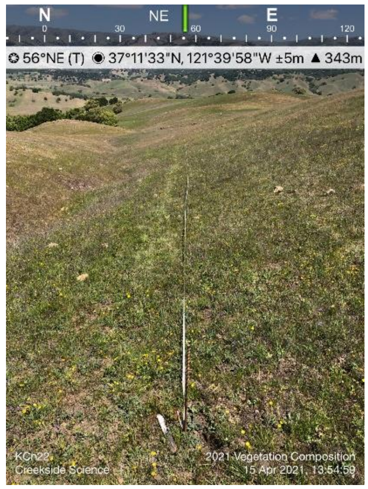
2021 Photopoints

Kirby Canyon Transects

KCN12



KCN22



KCN30

KCS12

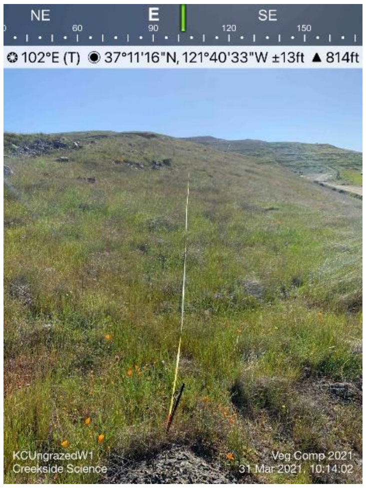
KCS22

KCS30

KCFlat

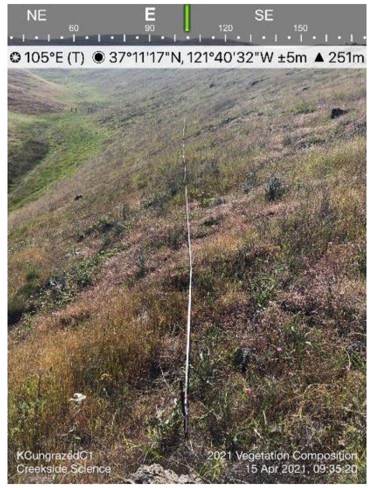
Kirby Canyon Ungrazed Transects

KCUngrazedW1



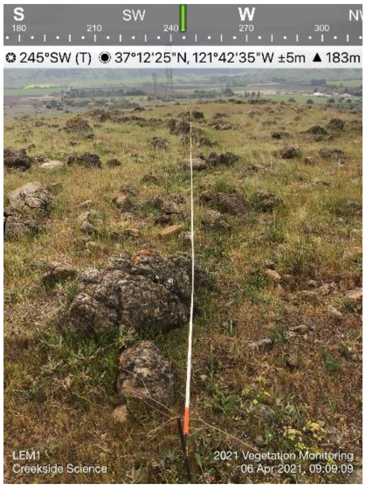
KCUngrazedM1

KCUngrazedC1

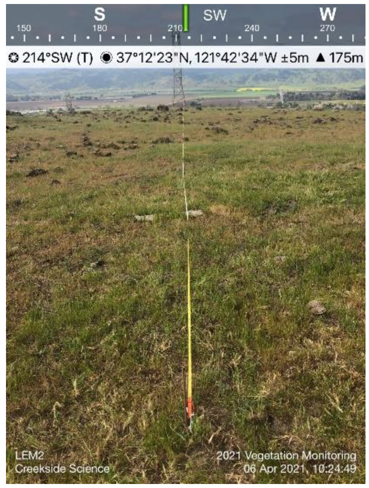


Los Esteros Critical Energy Facility and Silicon Valley Power Transects

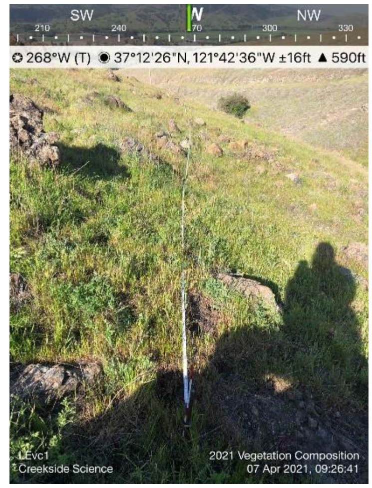
LECEFM1



LECEFM2



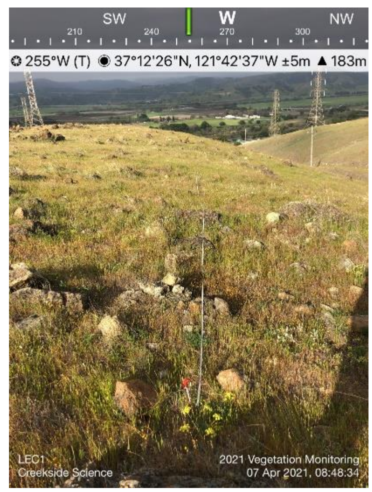
LECEFVC1



LECEFW2

LECEFVW2

LECEFC1

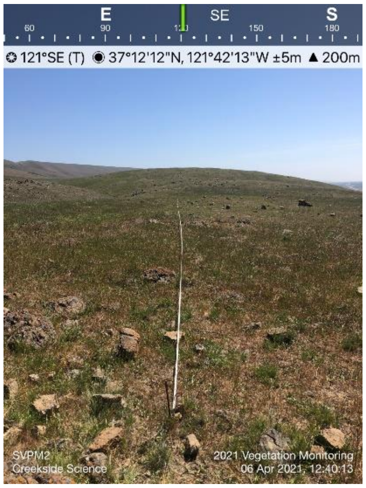


SVPW1

SVPC1

SVPM1

SVPM2

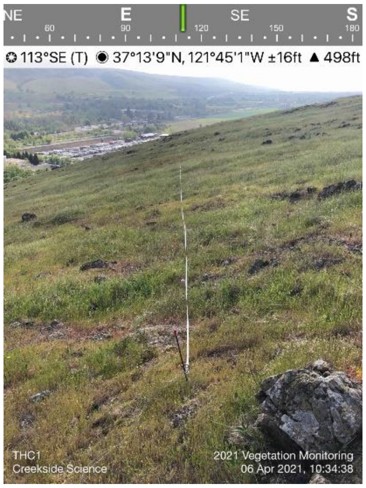


SVPW2

SVPVC1

Tulare Hill Transects

THC1



THC2

THVC1

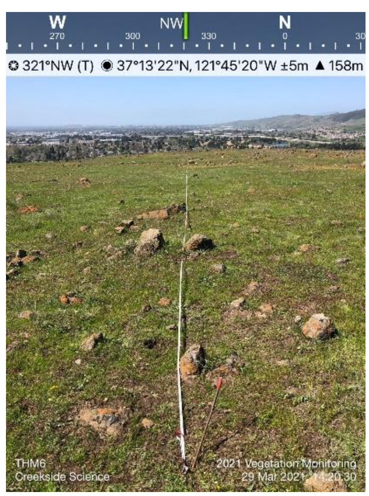
THM2

THM3

THM4

THM5

THM6

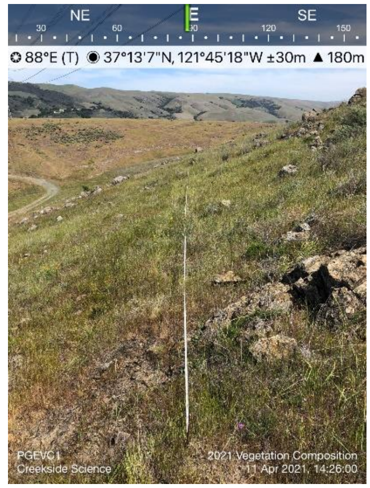


THW1

THUBUGM2

PGEW1

PGEVC1



APPENDIX B

2021 Land Trust Alliance Inspection Reports

MEC Inspection Reports

CREEKSIDE SCIENCE
P.O. BOX 1553, LOS GATOS, CA 95031

June 30, 2021

Inspection Report

Metcalf Energy Center Ecological Preserve (MEC) Property

Quarter 2: April 1 – June 30, 2021

Date of Inspection:	Name of Inspector/s:
4/6/21	Marissa Kent
4/9/21	Christal Niederer
4/11/21	Marissa Kent
4/19/21	Marissa Kent
4/28/21	Marissa Kent
5/3/21	Marissa Kent
5/12/21	Marissa Kent
5/21/21	Marissa Kent
6/30/21	Marissa Kent, Christal Niederer, Chris Schwind

Please see our annual report for observations related to the property's condition and conservation values. Observations related to conservation easement violations or property ownership challenges are not applicable.

Sincerely,

Stuart Weiss

www.creeksidescience.com

CREEKSIDE SCIENCE
P.O. BOX 1553, LOS GATOS, CA 95031

September 30, 2021

Inspection Report

Metcalf Energy Center Ecological Preserve (MEC) Property

Quarter 3: July 1 – September 30, 2021

Date of Inspection:	Name of Inspector/s:
7/5/21	Christal Niederer
7/6/21	Marissa Kent, Chris Schwind
7/7/21	Marissa Kent, Christal Niederer
7/29/21	Christal Niederer
8/4/21	Christal Niederer, Chris Schwind
8/5/21	Marissa Kent, Chris Schwind
8/25/21	Marissa Kent, Chris Schwind
9/1/21	James Quenelle, Chris Schwind
9/7/21	Christal Niederer, Chris Schwind

Please see our annual report for observations related to the property's condition and conservation values. Observations related to conservation easement violations or property ownership challenges are not applicable.

Sincerely,

Stuart Weiss

CREEKSIDE SCIENCE
P.O. BOX 1553, LOS GATOS, CA 95031

December 31, 2021

Inspection Report

Metcalf Energy Center Ecological Preserve (MEC) Property

Quarter 4: October 1 – December 31, 2021

Date of Inspection:	Name of Inspector/s:
10/18/2021	Chris Schwind, Jimmy Quenelle
10/19/2021	Chris Schwind, Jimmy Quenelle
11/07/2021	Stuart Weiss, Jimmy Quenelle
12/9/2021	Jimmy Quenelle, Marissa Kent

Please see our annual report for observations related to the property's condition and conservation values. Observations related to conservation easement violations or property ownership challenges are not applicable.

Sincerely,

Stuart Weiss

LE Inspection Reports

CREEKSIDE SCIENCE
P.O. BOX 1553, LOS GATOS, CA 95031

June 30, 2021

Inspection Report

Los Esteros Critical Energy Facility Ecological Preserve (LE) Property

Quarter 2: April 1 – June 30, 2021

Date of Inspection:	Name of Inspector/s:
4/6/21	Christal Niederer
4/7/21	Marissa Kent, Christal Niederer
4/9/21	Christal Niederer
6/2/21	Marissa Kent, Christal Niederer
6/3/21	Marissa Kent, Christal Niederer

Please see our annual report for observations related to the property's condition and conservation values. Observations related to conservation easement violations or property ownership challenges are not applicable.

Sincerely,

Stuart Weiss

www.creeksidescience.com

CREEKSIDE SCIENCE
P.O. BOX 1553, LOS GATOS, CA 95031

September 30, 2021

Inspection Report

Los Esteros Critical Energy Facility Ecological Preserve (LE) Property

Quarter 3: July 1 – September 30, 2021

Date of Inspection:	Name of Inspector/s:
(No inspections were made during this period)	N/A

Please see our annual report for observations related to the property's condition and conservation values. Observations related to conservation easement violations or property ownership challenges are not applicable.

Sincerely,

Stuart Weiss

www.creeksidescience.com

CREEKSIDE SCIENCE
P.O. BOX 1553, LOS GATOS, CA 95031

December 31, 2021

Inspection Report

Los Esteros Critical Energy Facility Ecological Preserve (LE) Property

Quarter 4: October 1 – December 31, 2021

Date of Inspection:	Name of Inspector/s:
11/07/2021	Stuart Weiss, Jimmy Quenelle

Please see our annual report for observations related to the property's condition and conservation values. Observations related to conservation easement violations or property ownership challenges are not applicable.

Sincerely,

Stuart Weiss