

Evaluation of population trends and potential threats to a rare serpentine endemic, crinite mariposa lily (*Calochortus coxii*), 2022 Annual Report



March
2023

Report to the Bureau of Land Management,
Roseburg District Agreement No. L19AC00085

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PREFACE

IAE is a non-profit organization whose mission is the conservation of native ecosystems through restoration, research, and education. IAE provides services to public and private agencies and individuals through development and communication of information on ecosystems, species, and effective management strategies. Restoration of habitats, with a concentration on rare and invasive species, is a primary focus. IAE conducts its work through partnerships with a diverse group of agencies, organizations, and the private sector. IAE aims to link its community with native habitats through education and outreach.



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ACKNOWLEDGEMENTS

The authors gratefully acknowledge the contributions and cooperation by the Roseburg District Bureau of Land Management, especially Ian Grinter. Field work was supported by Sophia Goss, Jordan Donaghy and Maria Johnson. We thank ESRI for their support of our GIS program. Maps were created using ArcGIS® software by Esri. ArcGIS® and ArcMap™ are the intellectual property of Esri and are used herein under license. Copyright © Esri. All rights reserved. For more information about Esri® software, please visit www.esri.com.

Cover photographs: Crinite mariposa lily (*crinite mariposa lily*). Photo by Laura Estrada.

SUGGESTED CITATION

Diaz, S., L. Estrada and S. Harris. 2022. Evaluation of population trends and potential threats to a rare serpentine endemic, *Calochortus coxii* (crinite mariposa lily). 2022 Progress Report. Prepared by Institute for Applied Ecology for the USDI Bureau of Land Management, Roseburg District. Corvallis, Oregon.

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Evaluation of population trends and potential threats to a rare serpentine endemic, crinite mariposa lily (*Calochortus coxii*)

EXECUTIVE SUMMARY

The objectives of this project are to visit known occurrences of crinite mariposa lily (*Calochortus coxii*) in spring 2022, assess trends in the populations at Bilger Ridge and the proposed pipeling sites and provide management recommendations.

- In 2022, IAE monitored five transects at the Bilger 1 site for the eighth year and six transects in an area north of Myrtle Creek named 'New Pipeline 1' for the third year.
- The Bilger 1 crinite mariposa lily population was higher than historically recorded in this study, with 448 observed plants, 157 reproductive and 291 vegetative plants.
- The New Pipeline population was also higher this year compared to 2021, with 373 observed plants, 189 reproductive and 184 vegetative.
- The 2011 overstory thinning at Bilger 1 shows signs in increasing the potential flowering of crinite mariposa lily. Overstory thinning should be considered for the New Pipeline site.
- Understory encroachment by shrubs and saplings continues to be the highest threat to the observed populations, understory thinning of shrubs and saplings at both sites should be considered.
- Bilger 1 and New Pipeline currently are dominated with a native understory. Future management should be cautious when working at this site to prevent non-native grass invasion.
- The proposed LNG Pipeline has been terminated as of December 2021, no longer creating a high threat to the New Pipeline population.

1. INTRODUCTION

1.1 Status

Calochortus coxii M. Godfrey & F. Callahan (Cox's or crinite mariposa lily, Figure 1) is listed as endangered by the Oregon Department of Agriculture, a Federal Species of Concern, and a Heritage Rank G1 species (critically imperiled throughout its range; Oregon Biodiversity Information Center 2019). This species is endemic to a ten-mile serpentine ridge system between Myrtle Creek and Riddle, Oregon (Fredericks 1992). Since the species' relatively recent discovery in 1988, 24 populations have been identified (USDI BLM and USDI FWS 2004).



Figure 1 Crinite mariposa lily flower

1.2 Background

Crinite mariposa lily is a perennial forb in the Liliaceae family. The vegetative form is composed of a single, simple leaf with a dark, smooth upper surface and a pubescent undersurface (Figure 2). When in flower, the species is showy with three cream-colored petals which appear yellow due to hairs on the inside surface (Figure 1; Fredericks 1992). Crinite mariposa lily can co-occur with pussy ears (*Calochortus tolmiei*), which when not in flower looks similar, but pussy ears does not have pubescent leaves (Appendix A). Another mariposa lily endemic to similar areas in Douglas County is Umpqua mariposa lily (*Calochortus umpquaensis*), though the two species have not been observed to co-occur (Kagan 1993).



Figure 2 Crinite mariposa lily in bud

Crinite mariposa lily habitat is narrowly restricted to serpentine-derived soils in meadows to open woodlands and the ecotone between forest and meadow habitat, often with rocky substrate and a north-facing aspect (Fredericks 1992). Common associated species include Jeffery pine (*Pinus jeffreyi*), Douglas fir (*Pseudotsuga menziesii*), incense cedar (*Calocedrus decurrens*), Romer's fescue (*Festuca roemerii*), Indian's dream (*Aspidotis densa*), rosy plectritis (*Plectritis congesta*), wormleaf stonecrop (*Sedum stenopetalum*), Hooker's silene (*Silene hookeri*), and death camas (*Zigadenus venenosus*).

1.3 Threats

There are numerous threats to crinite mariposa lily. Historical fire suppression has resulted in encroachment of woody plant species, decreasing the open woodland and meadow habitats that this species relies on. Additional threats include logging, grazing, mining, and road construction, which could bring in non-native invasive species ultimately disrupting the habitat quality. Several noxious weeds have been observed adjacent to and within crinite mariposa lily habitat, including yellow star-thistle (*Centaurea solstitialis*), rush skeleton weed (*Chondrilla juncea*), medusa-head (*Taeniatherum caput-medusae*), Canada thistle (*Cirsium arvense*), bull thistle (*Cirsium vulgare*), and Italian thistle (*Carduus pycnocephalus*).

In recent past the Pacific Gas Connector Pipeline proposed construction of a Liquefied Natural Gas (LNG) pipeline through the population north of Myrtle Creek (called "New Pipeline 1") and neighboring private

lands that may support populations of crinite mariposa lily. There were concerns that the LNG pipeline could fragment crinite mariposa lily populations and habitats (Hatt 2008). The transects at New Pipeline 1 are immediately adjacent to or near the proposed pipeline. The construction of the pipeline could result in significant disturbance of sensitive habitat and populations of this species. While the pipeline project was terminated in December 2021, human development in the area is still a threat to this area.

1.4 Population locations

The primary sites where the species is known to occur include Bilger Ridge (Appendices B and C), Langell Ridge, Myrtle Creek (Appendix D), and Red Ridge. Two of these areas, Bilger and Myrtle Creek, are large and sufficiently patchy that subareas have been delineated for descriptive purposes.

1.5 Monitoring

One of the challenges for managing this species is that accurate population estimates are unavailable. The most complete population surveys were conducted by Nancy Fredricks in the late 1980's to early 1990's. Some of these populations have not been revisited since. Although Bilger Ridge and Langell Ridge were monitored in 1991, 1992, and 1993, these efforts resulted in only rough estimates of population size and extent (S. Carter, *personal communication*).

2. GOALS AND OBJECTIVES

This study reports current population estimates that can be used to determine if additional measures are needed to conserve this unique endemic species. The objectives of this project are to:

1. Visit Bilger 1 and New Pipeline populations in spring 2022.
2. Assess trends in crinite mariposa lily populations.
3. Provide crinite mariposa lily population estimates for the proposed pipeline areas and suggest management recommendations.

3. METHODS

3.1 Transect establishment

Permanent monitoring transects were established to (1) observe the associated plants in crinite mariposa lily habitat, (2) evaluate the association of canopy cover and crinite mariposa lily presence, (3) measure changes in the total number of crinite mariposa lily plants, and (4) monitor the ratios of vegetative to reproductive individuals over time. Five permanent transects were established at Bilger 1 and Bilger 4 in 2011 and were monitored each June from 2011 to 2015. In June 2020 - 2022 Bilger 1 transects were monitored, Bilger 4 was not monitored due to time constraints. Each transect location was selected *a priori* based upon surveys conducted a few weeks prior to the first sample in 2011.

In June 2020 six permanent monitoring transects were established along the route of the proposed LNG Pipeline. These transects were monitored each June from 2020-2022. Many of these transect locations were placed along or in close proximity to the route of the LNG Pipeline, which was visibly flagged and available to view on the State of Oregon [website](#).

Transect were established in areas with relatively high crinite mariposa lily abundance and were split between forested and dry habitat types (Table 1). Habitat characteristics that were targeted included

rocky slopes dominated by Roemer's fescue, mossy sites with rosy plectritis, forest openings with high grass cover, sites with some exotic grass cover, and areas with some conifer recruitment.

Transects were 25m long, with the start and end marked with rebar topped with a yellow cap and wired with a unique numbered tag. A 1m belt was established to the left of the origin (facing the end) and marked with 4-inch nails and washers. The azimuth of each transect from the origin to the 25m end, and from the origin towards the belt was taken during establishment.

Table 1. Habitat characteristic of Bilger Ridge and the New Pipeline transect locations.

Bilger 1		
Transect	Habitat Type	Habitat Characteristics
Transect 1	Forested	Forest meadow, partially open canopy, high moss cover, wet.
Transect 2	Forested	Forest opening, high moss and rosy plectritis cover, some recruitment of Jeffery pine and incense cedar. Presence of exotic grasses.
Transect 3	Dry	Rocky, dry, high graminoid composition (not fescue). Canopy thinning in the surrounding area occurred in winter 2011.
Transect 4	Dry	Dry area surrounded by Jeffery pine some incense cedar recruitment in the transect. Canopy thinning in the surrounding area in winter 2011.
Transect 5	Dry	High incense cedar recruitment, high moss cover. Canopy thinning occurred directly in the area and transect had to be re-established due to slash piles.
Bilger 4		
Transect	Habitat Type	Habitat Characteristics
Transect 1	Dry	Very steep with Roemer's fescue and rocky, serpentine habitat. Recruitment in the surrounding area with some incense cedar recruitment occurring in the transect.
Transect 2	Dry	Mixed open canopy, high graminoid cover. Jeffery pine recruitment present around the transect.
Transect 3	Forested	Mixed canopy forest, semi-closed canopy of incense cedar, Douglas fir, and Jeffery pine. Understory moist, some incense cedar recruitment.
Transect 4	Forested	Forested, high levels of incense cedar recruitment. High moss and rosy plectritis cover.
Transect 5	Dry	Dry site in small meadow. Rocky, with moss & rosy plectritis cover. Very little soil development.
New Pipeline		
Transect	Category	Habitat Characteristics
Transect 2	Forested	Forest opening, relatively open canopy, decaying biomass on ground, some recruitment of Jeffery pine and incense cedar
Transect 3	Forested	Relatively dense herbaceous vegetation, much moss as ground cover.
Transect 4	Dry	Rock outcrop in transect, much moss ground cover, dense herbaceous vegetation away from the outcrop, recruitment of Jeffery pine and incense cedar.
Transect 5	Dry/Forested	Rock outcrop with young pine canopy through transect and moderate herbaceous cover in open areas.
Transect 6	Dry	Open, rocky slope with large Jeffery pine and incense cedar. Large rock outcrop in transect with moderate herbaceous cover.
Transect 7	Dry	Dense crinite mariposa lily population in the area. Jeffery pine at start and end of transect. Relatively open canopy with moderate herbaceous cover.

3.2 Monitoring

Site characteristics

Upon transect set up an updated azimuth was collected. Eight photo points were taken at each transect, capturing all cardinal directions (north, east, south, and west) at the start and end of the transect. General site characteristics were noted, such as presence or absence of exotic species, evidence of encroachment, and the dominant understory and overstory species. Overstory canopy cover was recorded at 5 permanent points along the transect with a densiometer.

Crinite mariposa lily monitoring

All crinite mariposa lily were recorded within the 1 m x 25m belt transect, tallying them in the appropriate vegetative or reproductive category. A reproductive plant was considered an individual that has any reproductive structure on the plant (e.g. buds, flowers, etc.). Presence of herbivory was also recorded by tallying the number of plants with leaf herbivory by mammals or insects, and the number of plants with flower herbivory by mammals or insects.

Plant community data

Community data were collected on five 1 m² plots per transect, these permanent points are the same as the points where overstory canopy cover was collected. At each 1 m² quadrat all substrate cover and plant cover were collected, with total cover exceeding 100%. Substrate cover included moss/lichen, litter, rock, and bare ground. Plant cover was collected at species level.

3.3 Data analysis

Data was analyzed using Microsoft Excel and R (R Core Team 2022). The five monitored points of canopy overstory cover were averaged to get a mean cover for the transect. The sum of crinite mariposa lily was calculated, along with the percent of plants that were reproductive. The mean canopy cover and the percent reproductive plants were compared with a scatter plot at the transect level and over the duration of the study. Community data was divided into 6 categories based off functional group (forb, grass, or tree) and nativity (native or non-native). Each of these 6 categories had mean cover calculated for 2022 monitoring.

4. RESULTS

4.1 Permanent monitoring transects: Bilger 1 (2011-2015, 2020-2022)

Crinite mariposa lily monitoring

Monitoring occurred from June 13th – 14th, 2022 at Bilger 1. A total of 448 plants - 291 vegetative (65% from the total), 157 reproductive (35% from the total) - were found along the five transects (Figure 3). This is an increase from 2021 with 321 plants (213 vegetative, 108 reproductive). This is the highest number of plants observed throughout our years of monitoring (Figure 3, Table 3). This increase in plants was mostly influenced by transect 5, which has historically had the densest population of crinite mariposa lily (Figure 4).

Of the 157 reproductive plants, 40% had 1 flower, 47% had 2 flowers, 12% had 3 flowers, and 1% had 4 flowers (Table 3). In 2022, herbivory was conducted on all plant parts (flower and vegetative structures) proportionally by insects and mammals (Table 3, Figure 5).

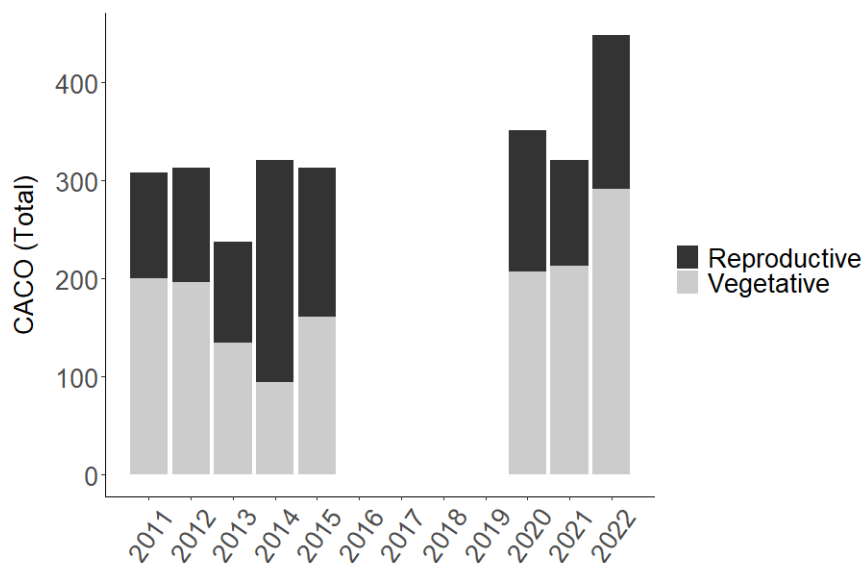


Figure 3. Combined total number of crinite mariposa lily counted in five permanent monitoring transects at Bilger 1; 2011-2015 and 2020-2022.

Table 2. Crinite mariposa lily tally within 1m x 25m belt transects at Bilger 1 in 2022.

Transect	Veg	Repro	Total	# Flowers/plant				Herbivory			
				1	2	3	4	Flower by mammal	Flower by Insect	Leaf by insect	Leaf by mammal
1	20	2	22	0	1	1	0	0	0	1	11
2	37	38	75	18	15	5	0	7	7	5	2
3	16	47	63	8	32	6	1	10	11	5	4
4	39	15	54	8	6	1	0	3	6	1	4
5	179	55	234	29	20	6	0	11	2	23	16
Mean	58	31	90	13	15	4	0	6	5	7	7
Total	291	157	448	63	74	19	1	31	26	35	37

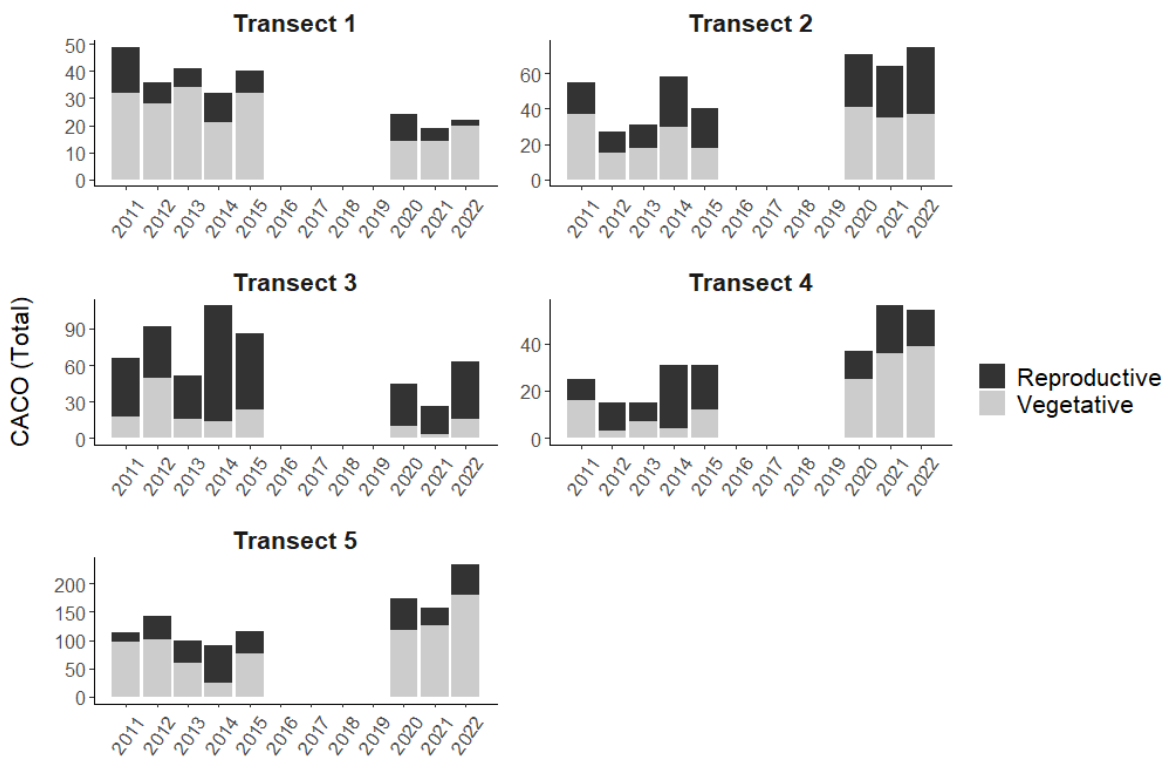


Figure 4. Total number of vegetative and reproductive plants in individual transects at Bilger 1; 2011-2015 and 2020-2022. Note the different scale on the y axis for each individual transect.

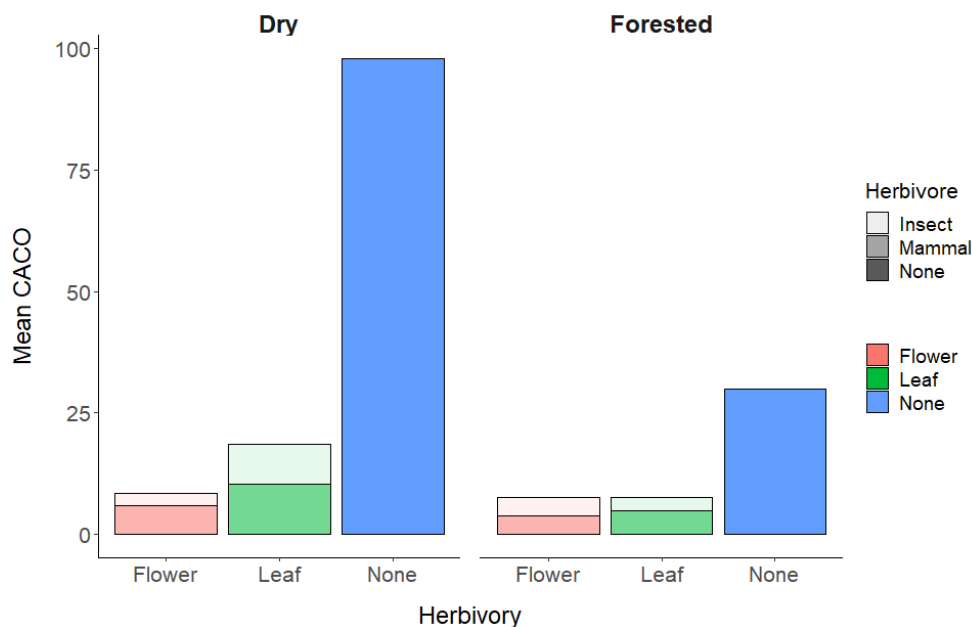


Figure 5. Mean number crinite mariposa lily (CACO) per transect in dry and forested habitats at Bilger 1, including those that exhibited herbivory; 2022. The grey scale indicates the degree of shading.

Canopy cover and habitat

The percentage of reproductive plants and percent canopy cover area have a negative linear relationship at Bilger 1 throughout this project, but with a low association ($R^2 = 0.47$, Figure 6). In 2022, we continued to observe proportionally more reproductive plants in open canopy habitat. This trend continues to be seen on Transect 2 and 3 with 13%, 37% canopy cover and 75%, 51% reproductive plants respectively in 2022 (Figure 4, Table 3). Thinning occurred around Transects 3, 4 and 5 between 2011 and 2012, which resulted in a short-term decrease in canopy cover from 2012-2013 (Figure 3).

Table 3. Mean percent canopy cover at Bilger 1 from 2011-2015, 2020-2022.

Transect	Mean Percent Canopy Cover							
	2011	2012	2013	2014	2015	2020	2021	2022
1	88	86	90	83	84	72	74	81
2	21	35	56	52	47	45	37	37
3	8	11	7	18	14	21	18	13
4	48	35	31	53	46	55	38	60
5	86	47	45	64	58	64	47	65

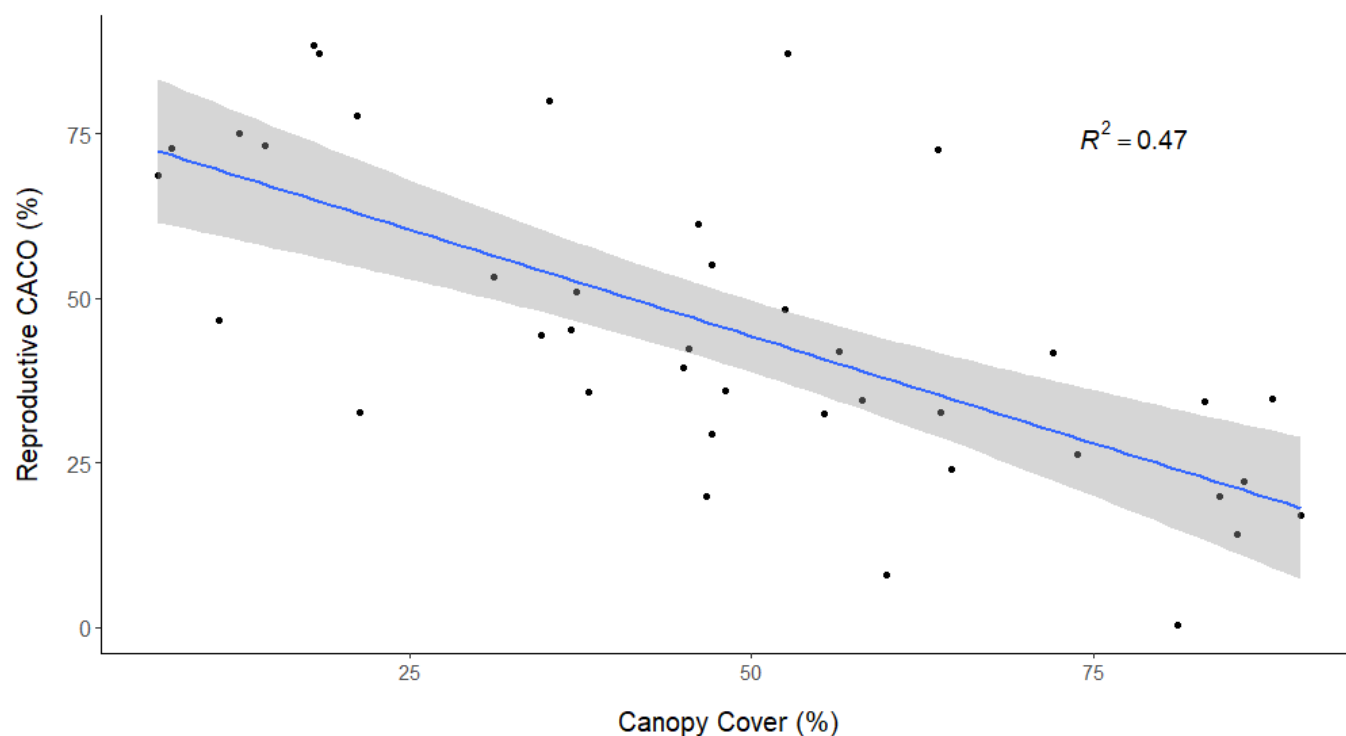


Figure 6. Linear relationship between mean percent canopy cover and percent reproductive plants at Bilger 1 from 2011-2015 and 2020-2022 ($n = 40$).

Plant community

Across the five transects at Bilger 1 in 2022, 40 species were recorded, consisting of 34 native species and 6 introduced species. This is an increase in species richness from 2021 (37), and entirely attributed to an increase in introduced species. Native species cover was 42.8% while introduced cover was 1.5% (Figure 7). Native graminoids had the highest level of cover (23.7%), consisting of Roemer’s fescue (*Festuca roemerii*, 17.2%) (Figure 7, Appendix A). Native forbs (19%) consisted predominately of Indian’s dream (*Aspidotis densa*, 5.08%) and western sword fern (*Polystichum munitum*, 3.68%) with the highest mean cover. Native trees (4.1%) were largely due to incense cedar (*Calocedrus decurrens*, 4.06%), which was found on 4 of the 5 transects in Bilger 1 (Appendix A). Exotic cover was almost entirely comprised of introduced graminoids (1.3%), predominately due to field wood-rush (*Luzula campestris*), which was found on all five transects. Other notable introduced grasses were soft chess (*Bromus hordeaceus*) and silver hairgrass (*Aira caryophyllea*) (Appendix A).

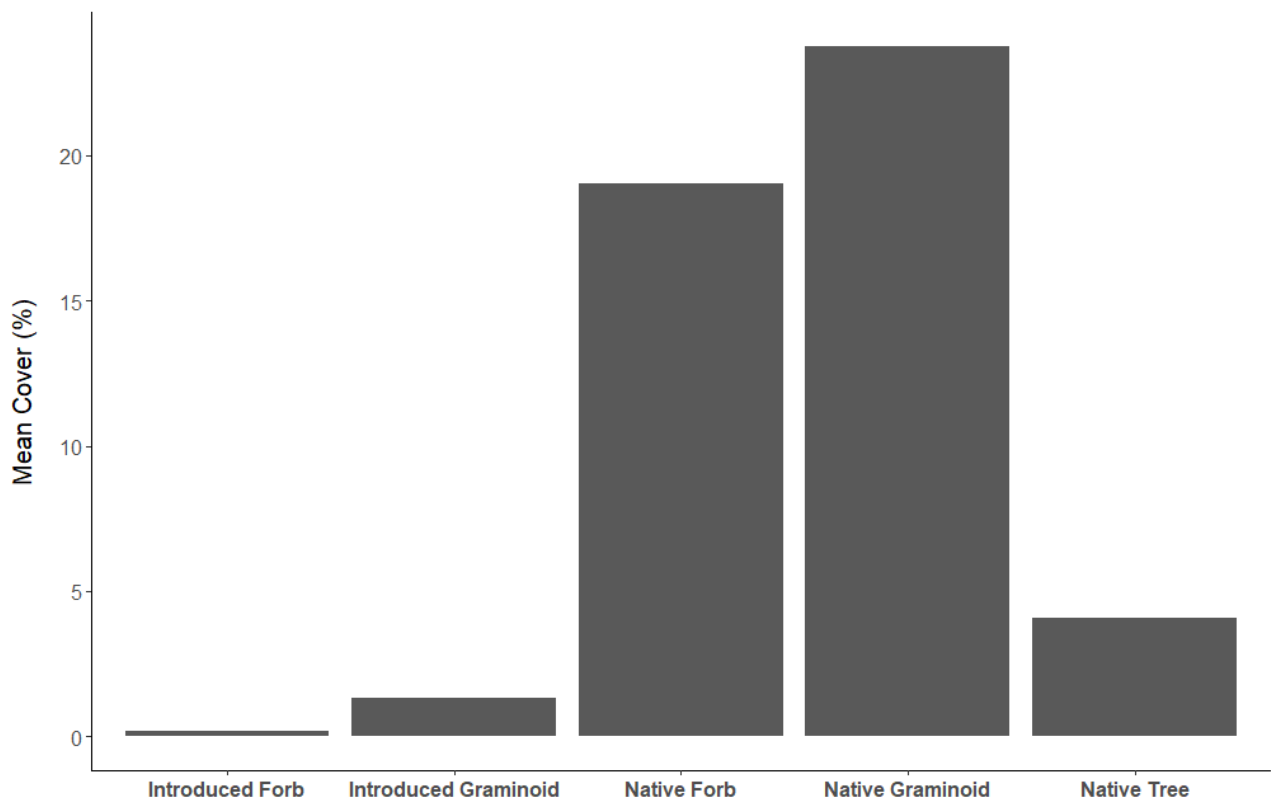


Figure 7. Mean cover of total plant cover at Bilger 1 grouped by functional group in 2022.

4.2 Permanent monitoring transects: New Pipeline (2020-2022)

Crinite mariposa lily monitoring

Monitoring occurred from June 15th – 16th, 2022 at New Pipeline. A total of 373 plants (184 vegetative, 189 reproductive) were observed along the six transects. This is an increase from the 210 plants in 2021 (161 vegetative, 49 reproductive), and a decrease from the original 435 plants observed in 2020 (174 vegetative, 261 reproductive, Figure 8). There was an increase all 6 transects, most notably in the number of reproductive plants, attributing to the overall increase seen at the site (Figure 9).

Of the 373 plants, 49% were reproductive and 51% were vegetative. Of the 189 reproductive plants, 39% had 1 flower, 32% had 2 flowers, 5% had 3 flowers, and 1% had 4 flowers (Table 4). In 2022, herbivory was conducted on all plant parts (flower and vegetative structures) by insects and mammals. Herbivory occurred more in forested areas opposed to open habitat (Table 4, Figure 10).

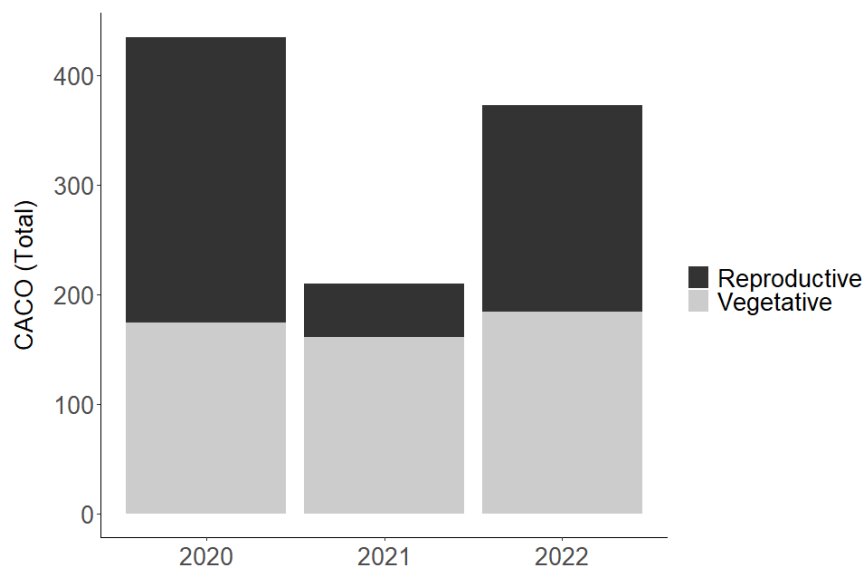


Figure 8. Total number of crinite mariposa lily (CACO) counted across six monitored transects at New Pipeline, 2020-2022.

Table 4. Crinite mariposa lily tally within 1m x 25m belt transects at New Pipeline 1 in 2022.

Transect	Veg	Repro	Total	# Flowers/plant				Herbivory			
				1	2	3	4	Flower by mammal	Flower by Insect	Leaf by insect	Leaf by mammal
2	9	6	15	1	3	2	0	0	1	4	1
3	55	60	115	31	23	5	1	14	38	27	9
4	6	20	26	9	8	2	1	12	1	2	0
5	13	44	57	23	20	1	0	21	1	0	1
6	34	17	51	10	7	0	0	8	2	0	7
7	67	42	109	18	24	0	0	22	9	9	15
Mean	31	32	62	15	14	2	0	13	9	7	6
Total	184	189	373	74	61	10	2	55	43	33	18

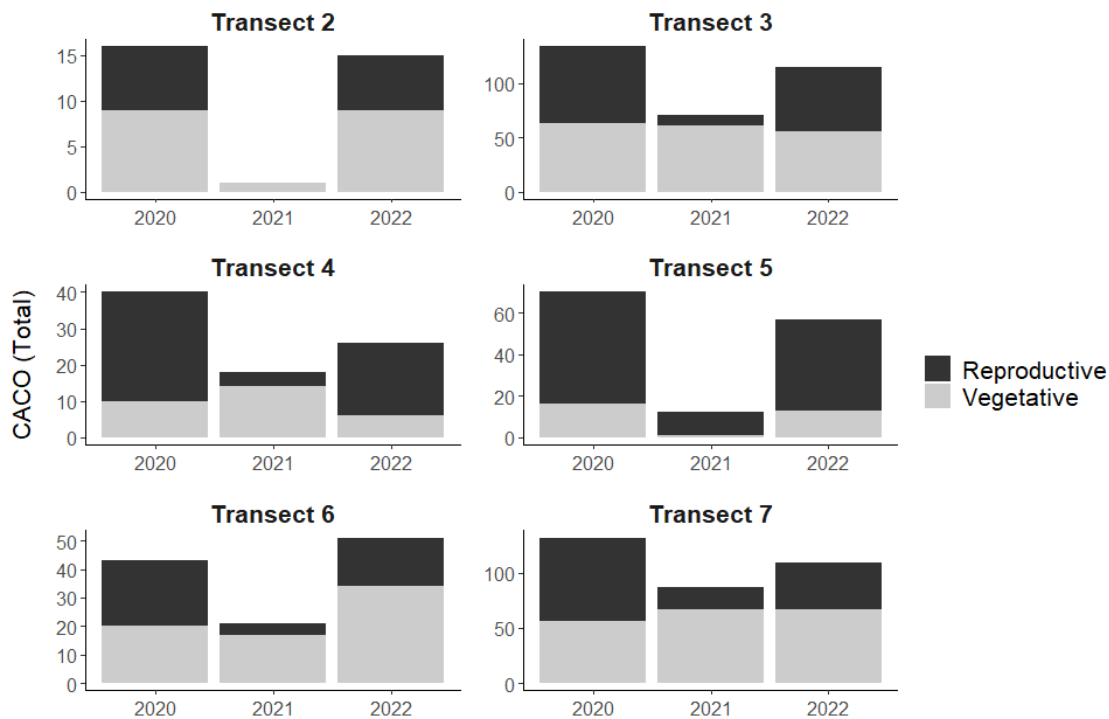


Figure 9. Total number of vegetative and reproductive plants in individual transects at New Pipeline; 2011-2015 and 2020-2022.

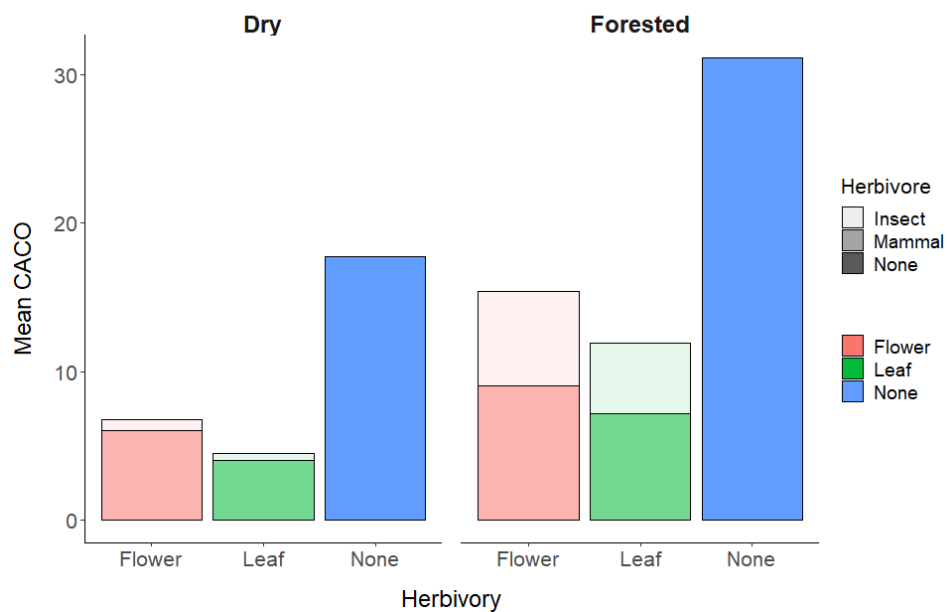


Figure 10. Mean number crinite mariposa lily (CACO) per transect in dry and forested habitats at Bilger 1, including those that exhibited herbivory; 2022. The grey scale indicates the degree of shading.

Canopy cover

From 2020 - 2022 there is no association between percent reproductive plants and percent canopy cover at New Pipeline ($R^2 = 0.01$, Figure 11). At the beginning of this project in 2020 there was a negative linear relationship ($R^2 = 0.5$), suggesting that less canopy results in more reproductive plants. As we continue to collect data, we are finding this association has no trends. Canopy cover in 2022 ranges between 30% to 70%, which is a higher range than seen in previous years (Table 5).

Table 5. Mean percent canopy cover at New Pipeline 1 from 2020 – 2022.

Transect	Mean Percent Canopy Cover		
	2020	2021	2022
2	61	47	58
3	66	60	70
4	47	21	30
5	54	43	64
6	59	44	49
7	51	43	35

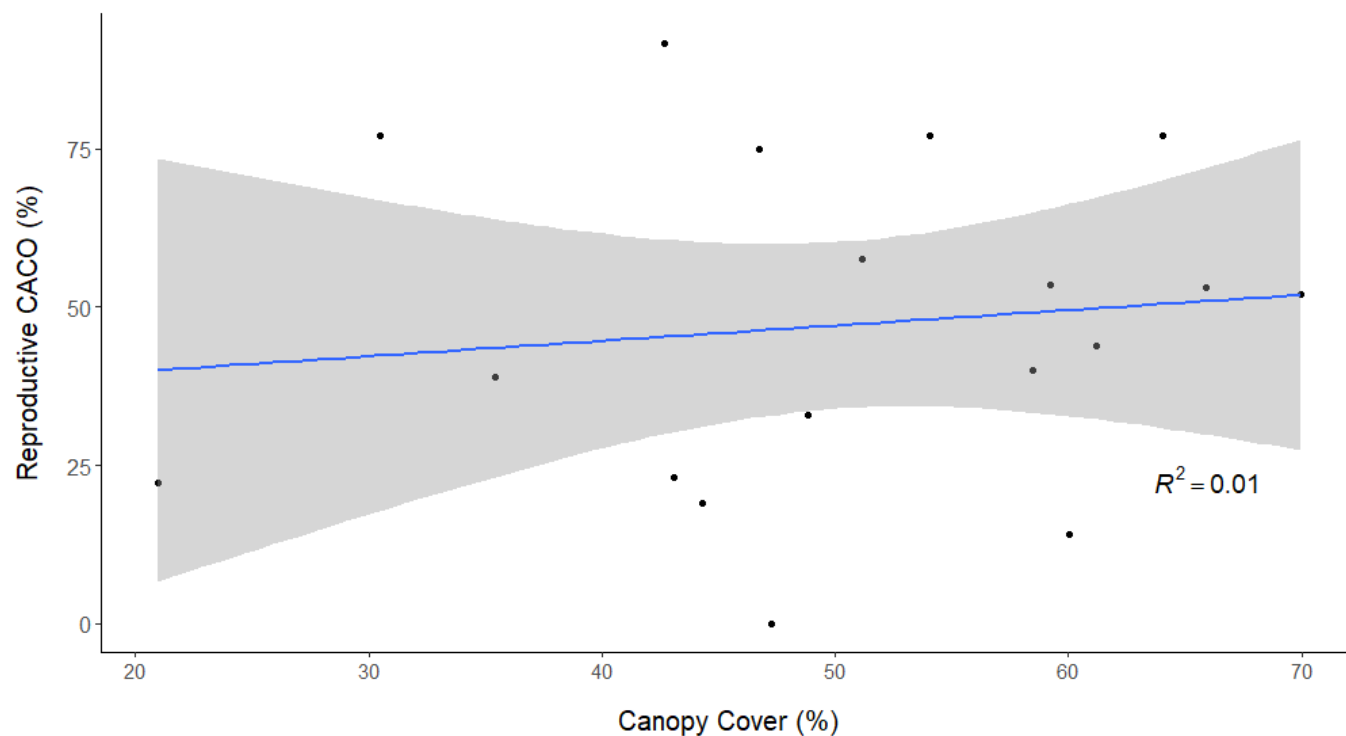


Figure 11 Linear relationship between mean percent canopy cover and mean percent reproductive plants at New Pipeline from 2020-2022 ($n = 18$).

Plant community

Across the five transects at New Pipeline in 2021, 37 species were recorded, consisting of 35 native species and 2 exotic species. Native graminoids were the most abundant (26.6%), consisting of predominately of Roemer’s fescue (22.27%), while all other native graminoids had less than 1% mean cover (Figure 12, Appendix A). Native forbs (12.9%) comprised of species ranging between 2% to 0.01% mean cover. Native tree cover (3.9%) was largely comprised of incense cedar and Jeffrey pine (*Pinus jeffreyi*) (Appendix A). Exotic cover (1.8%) was entirely comprised of introduced graminoids, which was largely due to field wood-rush (*Luzula campestris*, 1.33%). Introduced forbs (0%) were not recorded at the New Pipeline in 2022. These results are consistent with trends seen in 2020 and 2021, with higher native cover compared to introduced cover.

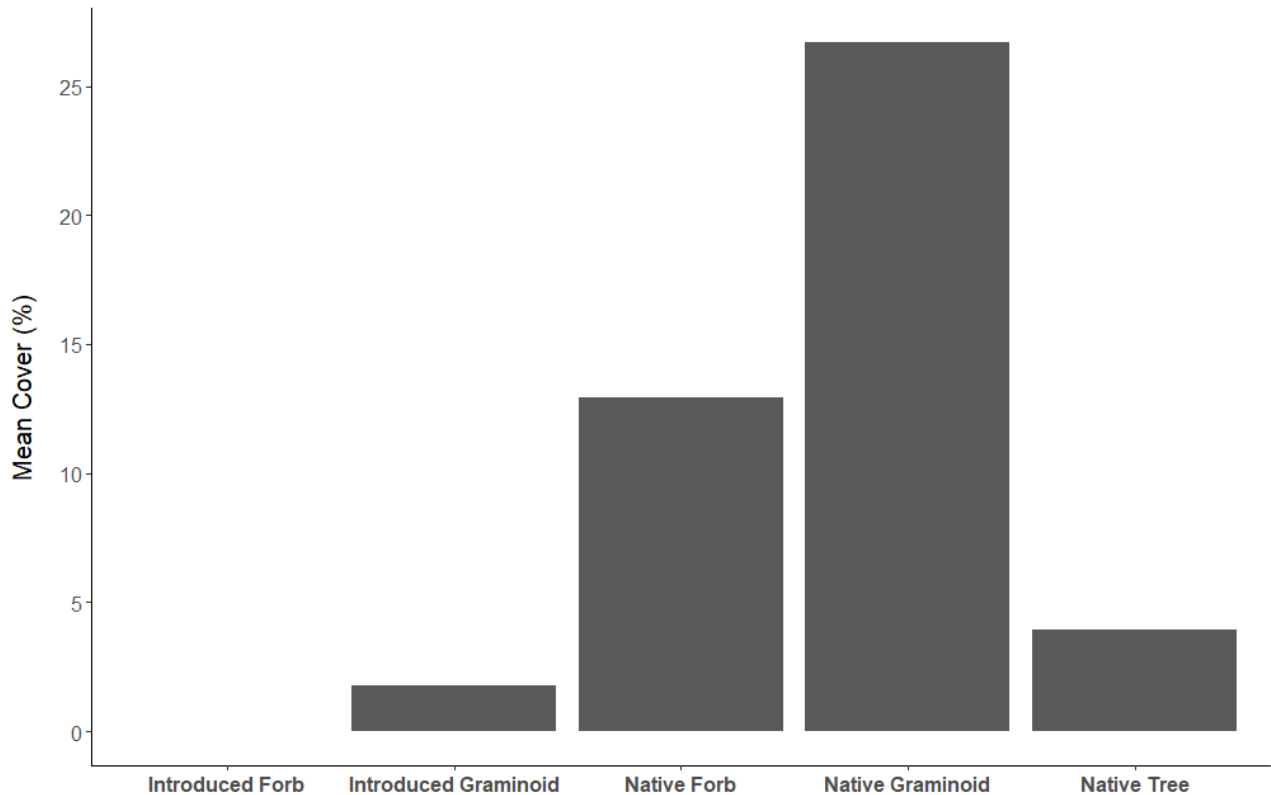


Figure 12. Mean percent plant cover at New Pipeline 1 in 2022 by functional group.

5. DISCUSSION

Crinite mariposa lily requires a habitat on serpentine-derived soils in meadows to open woodlands and the ecotone between forest and meadow habitat, often with rocky substrate and a native plant community. There are several threats to this endemic species, the most notable threats to the populations at Bilger Ridge and the New Pipeline include the following (in order of importance):

1. Shrub and tree encroachment, shifting the habitat from meadow/open woodland to dense woodland.
2. Understory composition changing from native to a non-native dominant habitat.
3. Herbivory of reproductive crinite mariposa lily

Since the beginning of this project, the Bilger 1 crinite mariposa lily population has reached the highest numbers in 2022. At New Pipeline the crinite mariposa lily population is at similar levels seen in 2020, recovering from the low numbers in 2021 (due to low reproductive numbers). This shift may be attributed to natural fluctuations in the species. Due to the inherent characteristics of endemic species with a restricted distribution, proactive measures should be taken to prevent decline in these populations. While the Bilger Ridge and New pipeline populations seem to be stable, management should also be considered to increase the population.

The primary threat to these populations continues to be encroachment by shrubs and trees at the understory and overstory level. Crinite mariposa lily evolved in an area with high fire frequency, and with fire suppression since the early 20th Century, sites that were once open have experienced encroachment by shrubs and conifer species. From 2020-2022 it has been noted that there is an abundance of incense cedar saplings on Bilger 1 transects (Figure 15). The New Pipeline population also has similar levels of incense cedar and Jeffrey pine saplings encroaching the understory of the site. Considering understory thinning mechanically would be recommended until we can determine the impacts that prescribed fire might have on these populations.

We found evidence that canopy cover and reproductive plants may be negatively correlated, indicating that high canopy cover might suppress crinite mariposa lily from flowering. Canopy thinning occurred at the Bilger 1 transects in the winter of 2011-2012. In the years following the canopy thinning, we observed a short-term slight increase of flowering crinite mariposa lily, with a shift back to a reponderance of nonflowering plants afterwards. These results indicate that careful thinning does not disturb patches of crinite mariposa lily and opening potential habitat can be an effective way to stimulate flowering and reproduction in the species. New Pipeline has not had any overstory thinning or removal, but considering observations from Bilger Ridge, overstory and understory thinning could be beneficial to the New Pipeline population. While the serpentine habitat of this species tends to be more resistant to invasion, management activities that disturb and open the landscape, such as controlled burns or selective logging, should be considered with caution.

A large threat to crinite mariposa lily habitat is high non-native invasion. While in low numbers, soft chess (*Bromus hordeaceus*), field wood-rush (*Luzula campestris*), and silver hairgrass (*Aira caryophyllea*) are the most abundant exotic grasses in areas surrounding high crinite mariposa lily abundance in Bilger 1 and New Pipeline. Soft chess is known to invade areas with low fertility and is a common threat to rare plants

in serpentine soils. While exotic graminoid abundance has continued to be low in these areas, we should take caution when managing these landscapes to prevent possible invasion.

Herbivory on crinite mariposa lily leaves and flowers may have a negative effect on reproduction, growth, and survival. Herbivory was present across all transects at Bilger 1 and New Pipeline. Historically in this study, herbivory was most abundant in dry habitats with the most occurring on flowers by mammals or insects. In dry habitats, herbivory on flowers by mammals was more abundant than in forested habitats, however this is likely due to the lack of abundance of flowers in forested habitats. Leaf herbivory was more common in forested habitats. Though effects of native mammal and insect herbivory are unknown, herbivory is likely to negatively affect seed production and proliferation of this species (Kagan 1993). The removal of leaf tissue may deplete carbohydrate reserves and slow recovery for this slow-growing species, and grazing has been observed to nearly eliminate all capsules from some sites (USDI BLM and USDI FWS 2004). Herbivory by small mammals and ungulates was found to negatively impact Greene's mariposa lily (*Calochortus greenei*), a similar species in Oregon (Menke et al. 2013). Previous studies have indicated that cattle grazing may negatively affect crinite mariposa lily, especially at unprotected sites (Fredericks 1992, USDI BLM and USDI FWS 2004). In past years at Myrtle Creek 4, we observed a healthy population of crinite mariposa lily on public land, however its distribution ended at the public/private property boundary where heavy cattle grazing was evident on unprotected land. Similar observations have been noted in previous studies (Kagan 1993).



Figure 13. A snail on *crinite mariposa lily*

While we have not surveyed the extent of crinite mariposa lily populations since 2011-2012, our new transects will assist in tracking the population dynamics and trends of crinite mariposa lily at both sites. For a further discussion of previous population surveys, see (Gray and Bahm 2015).

6. CONCLUSIONS

Below are several general conclusions and recommendations that can be drawn from this project:

- The crinite mariposa lily population on Bilger Ridge and the New Pipeline sites has maintained similar population size over the course of this project, but still low compared to historical projections.
- Canopy cover has maintained similar levels since the 2011-2012 thinning effort. Crinite mariposa responded minimally to this canopy opening. Opening the canopy in surrounding habitat could provide ideal conditions for natural dispersal for crinite mariposa lily.
- Understory incense cedar and Jeffrey pine recruitment continues to be patchy, but some areas are notably dense. Understory thinning should be considered to maintain ideal conditions.
- Native species continue to dominate the understory herbaceous community. Future management actions should take this into consideration, and precautions should be taken to prevent the possible invasion of non-native invasive grasses such as soft chess (*Bromus hordeaceus*).
- Areas in close proximity to these sites, such as road edges and logging landings, should be monitored as potential source areas for invasive grasses, and should be considered for management actions.
- In addition to habitat restoration, supplemental plantings or seeding should be considered for future management to bring the species back into its historical range.
- Continued monitoring of crinite mariposa lily should be conducted to document changes in population dynamics, habitat changes, and potential threats to the populations.



Figure 14. Monitoring Bilger 1, Transect 5 in 2021. Note the recruitment of incense cedar in and along the transect.

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APPENDIX A. MEAN PERCENT COVER IN 2022 FOR BILGER 1 AND NEW PIPELINE 1 TRANSECTS.

Note: "--" indicates that the species was not present at the site, and "0.00" indicates that the species was present, but mean cover was less than 0.009%

Species	Nativity	Growth Form	Bilger 1	New Pipeline
<i>Achillea millefolium</i>	native	forb	0.88	0.20
<i>Achnatherum lemmonii</i>	native	graminoid	0.84	--
<i>Acmispon parviflorus</i>	native	forb	0.08	--
<i>Agoseris heterophylla</i>	native	forb	--	0.00
<i>Agrostis</i> sp.	exotic	graminoid	0.04	--
<i>Aira caryophylla</i>	exotic	graminoid	0.04	0.43
<i>Allium acuminatum</i>	native	forb	0.00	--
<i>Aspidotis densa</i>	native	forb	5.08	1.41
<i>Bromus carinatus</i>	native	graminoid	--	--
<i>Bromus hordeaceus</i>	exotic	graminoid	0.29	--
<i>Calocedrus decurrens</i>	native	tree	4.06	0.63
<i>Calochortus coxii</i>	native	forb	0.50	0.93
<i>Calochortus tolmeii</i>	native	forb	--	0.07
<i>Camassia quamash</i>	native	forb	0.00	1.47
<i>Cerastium arvense</i>	native	forb	0.86	0.60
<i>Claytonia perfoliata</i>	native	forb	0.28	--
<i>Collinsia parviflora</i>	native	forb	--	0.00
<i>Deschampsia danthonioides</i>	native	graminoid	0.08	--
<i>Elymus glaucus</i>	native	graminoid	2.73	1.67
<i>Epilobium minutum</i>	native	forb	0.67	0.30
<i>Eriophyllum lanatum</i>	native	forb	--	0.10
<i>Erythronium oregonum</i>	native	forb	--	0.05
<i>Festuca roemerii</i>	native	graminoid	17.20	22.27
<i>Galium aparine</i>	native	forb	0.64	0.45
<i>Hieracium scouleri</i>	native	forb	0.04	0.27
<i>Iris chrysophylla</i>	native	forb	0.48	1.74
<i>Koeleria cristata</i>	native	graminoid	0.08	--
<i>Lathyrus</i> spp.	native	forb	--	0.13
<i>Lomatium nudicaule</i>	native	forb	1.12	0.10
<i>Lomatium utriculatum</i>	native	forb	0.16	--
<i>Luzula campestris</i>	exotic	graminoid	1.00	1.33
<i>Madia gracilis</i>	native	forb	0.04	0.03
<i>Melica geyeri</i>	native	graminoid	2.04	1.50
<i>Montia linaris</i>	native	forb	0.20	0.07
<i>Nemophila parviflora</i>	native	forb	0.04	--

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Species	Nativity	Growth Form	Bilger 1	New Pipeline
<i>Pinus attenuata</i>	native	tree	--	0.10
<i>Pinus jeffreyi</i>	native	tree	--	3.20
<i>Plagiobothrys</i> spp.	native	forb	0.12	0.20
<i>Plectritis congesta</i>	native	forb	1.08	--
<i>Poa secunda</i>	native	graminoid	--	0.10
<i>Polystichum munitum</i>	native	forb	3.68	2.20
<i>Ranunculus occidentalis</i>	native	forb	1.82	1.67
<i>Rumex acetosella</i>	exotic	forb	0.00	--
<i>Sedum stenopetalum</i>	native	forb	--	0.31
<i>Silene hookeri</i>	native	forb	0.12	0.10
<i>Trifolium</i> spp.	unknown	forb	0.28	--
<i>Triteleia hendersonii</i>	native	Forb	--	0.03
<i>Viola hallii</i>	native	forb	0.12	--
<i>Vulpia macrostachys</i>	native	graminoid	0.08	--
<i>Zigadenus venenosus</i>	native	forb	1.01	0.27

APPENDIX B. LOCATIONS OF PERMANENT MONITORING TRANSECTS AT BILGER 1

Image removed from web version

Map B1. Monitoring transects (yellow circles) were established in areas of high crinite mariposa lily abundance. Transects 1 and 2 are north of the road, whereas Transects 3-5 are south of the road.

APPENDIX C. LOCATION OF PERMANENT MONITORING TRANSECTS AT NEW PIPELINE

Image removed from web version

Map C1. Permanent monitoring transects (yellow circles) were established in areas of high crinite mariposa lily abundance. The red line is the proposed route for the LNG Pipeline. The yellow line is Rock Creek Road (BLM 29-5-11).