

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



2021

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Management, Roseburg District
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PREFACE

IAE is a non-profit organization whose mission is 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



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

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EXECUTIVE SUMMARY

The objectives of this project are to visit known occurrences of crinite mariposa lily (*Calochortus coxii*) in spring 2021, assess trends in populations, provide population estimates for a proposed pipeline area, and provide management recommendations.

- In 2021, IAE monitored five transects at the Bilger 1 site for the seventh year and six transects in an area north of Myrtle Creek named 'New Pipeline 1' for the second year.
- A major threat to crinite mariposa lily noted over the course of our study was encroachment by conifers. There has been an increase in canopy cover in 2020 and 2021. Past treatments at Bilger 1 indicated that careful canopy thinning led to an increased number of flowering individuals, though that response was short-lived and continued treatment is necessary. As seen in the 2011-2012 thinning at Bilger Ridge, canopy thinning treatments can be effective at increasing the number of flowering plants, however they must be carefully implemented to avoid spread of invasive species or impacts to crinite mariposa lily.
- Another major threat to crinite mariposa lily noted over the course of our study was invasion by exotic species. Exotic species present on transects in 2020 and 2021 declined in numbers in comparison with previous years.
- There was a notable decline of vegetative crinite mariposa lily from 2011 to 2014 in long-term monitoring transects, whereas there was an increase in vegetative plants in 2015, 2020, and 2021, which led to an overall increase in the total number of individuals. While 2020 showed the highest levels of crinite mariposa lily seen on Bilger, 2021 monitoring showed levels were similar to 2015.
- The New Pipeline 1 transects are near the route for the proposed LNG pipeline. Populations of this species are affected by changes in microclimate (canopy thinning) and non-native invasive species, therefore implementation of the LNG Pipeline in very close proximity to this population may pose a threat to the habitat and this species.
- The New Pipeline 1 transects have shown a decrease in crinite mariposa lily populations since the transects were established in 2020, with similar vegetative levels as Bilger 1, but less reproductive plants.

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EVALUATION OF POPULATION TRENDS AND POTENTIAL THREATS TO A RARE SERPENTINE ENDEMIC, *CALOCHORTUS COXII* (CRINITE MARIPOSA LILY)

REPORT TO THE BUREAU OF LAND MANAGEMENT, ROSEBURG DISTRICT

INTRODUCTION

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; ORBIC 2010-2019). This species is endemic to a ten-mile serpentine ridge system between Myrtle Creek and Riddle, Oregon (Fredricks 1992, USDI BLM and USFWS 2004). Since the species' relatively recent discovery in 1988, 24 populations have been identified (USDI BLM and USFWS 2004).



Figure 1 Crinite mariposa lily flower

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 (Fredricks 1992; Figure 1). 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. 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 (Fredricks 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*).

Threats

There are numerous threats to crinite mariposa lily. Fire exclusion over the past 90 years has resulted in encroachment of woody plant species, altering the habitat quality for this species. 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*). Additional threats include logging, grazing, mining, and road construction. The Pacific Gas Connector Gas Pipeline has 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 also support populations of crinite mariposa lily. There are concerns that the LNG pipeline will 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.

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.

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 (Fredricks 1989, Fredricks 1993). 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*). This study reports current population estimates that can be used to determine if additional measures are needed to conserve this unique endemic species.

Objectives

The objectives of this project are to:

1. Visit Bilger 1 and New Pipeline populations in spring 2021
2. Assess trends in populations
3. Provide population estimates for the proposed pipeline areas and suggest management recommendations

METHODS

Permanent monitoring transects: Bilger 1 and Bilger 4 (2011-2015, 2020-2021)

We established permanent monitoring transects at Bilger 1 and 4 to (1) characterize the habitat occupied by crinite mariposa lily, (2) measure changes in the total number of plants and ratios of vegetative to reproductive individuals over time, and (3) determine if population fluctuations differ depending on habitat characteristics. Five permanent transects were established at Bilger 1 and Bilger 4 in 2011 and were monitored each June from 2011 to 2015. We returned to monitor Bilger 1 transects in June 2020 and 2021, but were unable to monitor Bilger 4 due to time constraints. Transect locations were selected as areas with relatively high crinite mariposa lily abundance and differed by habitat (Table 1, Appendix B, Appendix C). Habitat 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. Each transect location was selected *a priori* based upon surveys conducted a few weeks prior to the first sample in 2011.

Table 1. Habitat characteristic of Bilger Ridge transect locations.

Transect	Category	Habitat Characteristics
Bilger 1		
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 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.

Transects were 25m long. Both ends were 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. We recorded azimuth of each transect from the origin to 25m, and from the origin towards the belt. Eight photopoints were taken at each transect,

capturing all cardinal directions (north, east, south, and west) at the start and end of the transect. Habitat characteristics, presence or absence of exotic species, evidence of encroachment and dominant species were documented. We counted every crinite mariposa lily individual within the 1m x 25m belt transect, tallying vegetative and reproductive plants separately. Also tallied were the number of plants with leaf herbivory by mammals or insects, and the number of plants with flower herbivory by mammals or insects.

Community data were collected on five randomly chosen 1m² plots per transect in 2011, this was repeated in the same locations each year thereafter. All vascular species and ground surface substrates were assessed for percent cover. Total plot cover was thus at least 100% and exceeded 100% if there were overlapping layers of vegetation. Substrate categories included moss/lichen, litter, rock and bare ground. When moss or lichen were growing on the ground, they were classified as “moss/lichen”, however if they were growing on a rock, they were classified as “rock”. Mean percent cover by each species or substrate was calculated for the entire transect. These data were used to calculate the proportion of total plant cover occupied by each functional group (forb, graminoid, or tree) and by provenance (native or exotic). We estimated canopy cover for each plot using a densitometer and averaged values to obtain mean % canopy cover for the entire transect.

Climate data [monthly precipitation (in), monthly minimum temperature (°F), and monthly maximum temperature (°F)] from 2011- 2015 and 2020-2021 were acquired from the PRISM Climate Group, Oregon State University. Monthly averages were combined into seasonal means (winter = December-February, spring = March-May, summer = June-August, fall = September-November) to look at trends over time.

Permanent monitoring transects: New Pipeline Transects (2020-2021)

In June 2020 we established six permanent monitoring transects along the route of the proposed LNG Pipeline about 5 miles north of Myrtle Creek, OR (Appendix D) to (1) characterize the habitat occupied by crinite mariposa lily in the area, (2) measure changes in the total number of plants and ratios of vegetative to reproductive individuals over time, and (3) improve our assessment of the limited crinite mariposa lily population in the area. Six permanent “New Pipeline” transects were established along the proposed route and were monitored. Transect locations were selected as areas with representative crinite mariposa lily habitat and abundance (Table 2, Appendix D). Habitat targeted included rocky slopes with relatively open canopy dominated by Romer’s fescue mossy slopes, and rock outcrops along the serpentine ridge. 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](#). The pipeline project was terminated in December 2021.

Table 2. Habitat characteristics of New Pipeline transect locations.

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.

Transects were 25m long. Both ends were marked with rebar topped with a yellow cap and wired with a unique numbered tag. A 1m belt was established to the north side of the tape (downslope). We recorded azimuth of each transect from the origin to 25m, and from the origin to the belt. Eight photopoints were taken at each transect, capturing all cardinal directions (north, east, south, and west) at the start and end of the transect. Habitat characteristics, absence or presence of exotic species, and other relevant observations were noted. We counted every crinite mariposa lily individual within the 1m x 25m belt transect, tallying vegetative and reproductive plants separately. Also tallied were the number of plants with leaf herbivory by mammals or insects, and the number of plants with flower herbivory by mammals or insects.

Community data were collected on five randomly chosen 1m² plots per transect in 2020 and 2021, which will be repeated in the same locations each year thereafter. All vascular species and ground surface substrates were assessed for percent cover. Total plot cover was thus at least 100% and exceeded 100% if there were overlapping layers of vegetation. Substrate categories included moss/lichen, litter, rock and bare ground. When moss or lichen was growing on the ground, they were classified as “moss/lichen”, however if they were growing on a rock, they were classified as “rock”. Mean percent cover by each species or substrate was calculated for the entire transect. These data were used to calculate the proportion of total plant cover occupied by each functional group (forb, graminoid, or tree) and by provenance (native or exotic). We estimated canopy cover for each plot using a densitometer and averaged values to obtain mean percent canopy cover for the entire transect.

RESULTS

Permanent monitoring transects: Bilger 1 (2011-2015, 2020-2021)

In 2021, a total of 321 plants (213 vegetative, 108 reproductive) were found along the five transects at Bilger 1 (Table 3, Figure 3, Figure 4). This is a decrease from 2020 with 351 individuals (207 vegetative, 144 reproductive). The total number of plants are comparable to 2014 (321 plants) and 2015 (313 plants) levels, but there was a shift in vegetative and reproductive proportions.

Monitoring in 2014 presented 94 vegetative plants and 227 reproductive plants and 2015 presented 161 vegetative and 152 reproductive plants. In 2021, there were similar numbers that were seen in the early years of monitoring, with the first year of monitoring (2011) having 200 vegetative plants and 108 reproductive plants. Of the 108 reproductive plants in 2021, 91.7% of those plants had one flower and the remaining 8.3% had two flowers, with no plants exceeding two flowers at Bilger 1 (Table 3).

2021 surveys were early in the phenology. Few plants were flowering, so buds were interpreted as flowers. Therefore, the total count of flowers may not be what the true phenology presented. Herbivory, which was predominantly conducted by mammals, mostly occurred to the vegetative components of the plant (Table 3).

Bilger 4 was not monitored in 2020 and 2021.

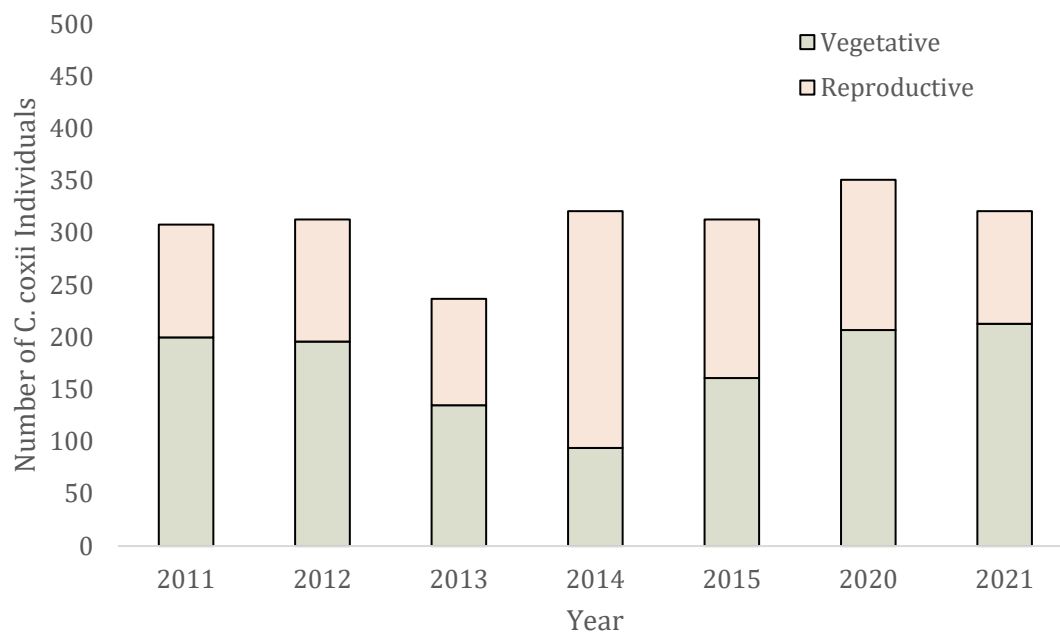


Figure 3. Combined total number of crinite mariposa lily counted in permanent monitoring transects at Bilger 1; 2011-2015 and 2020-2021.

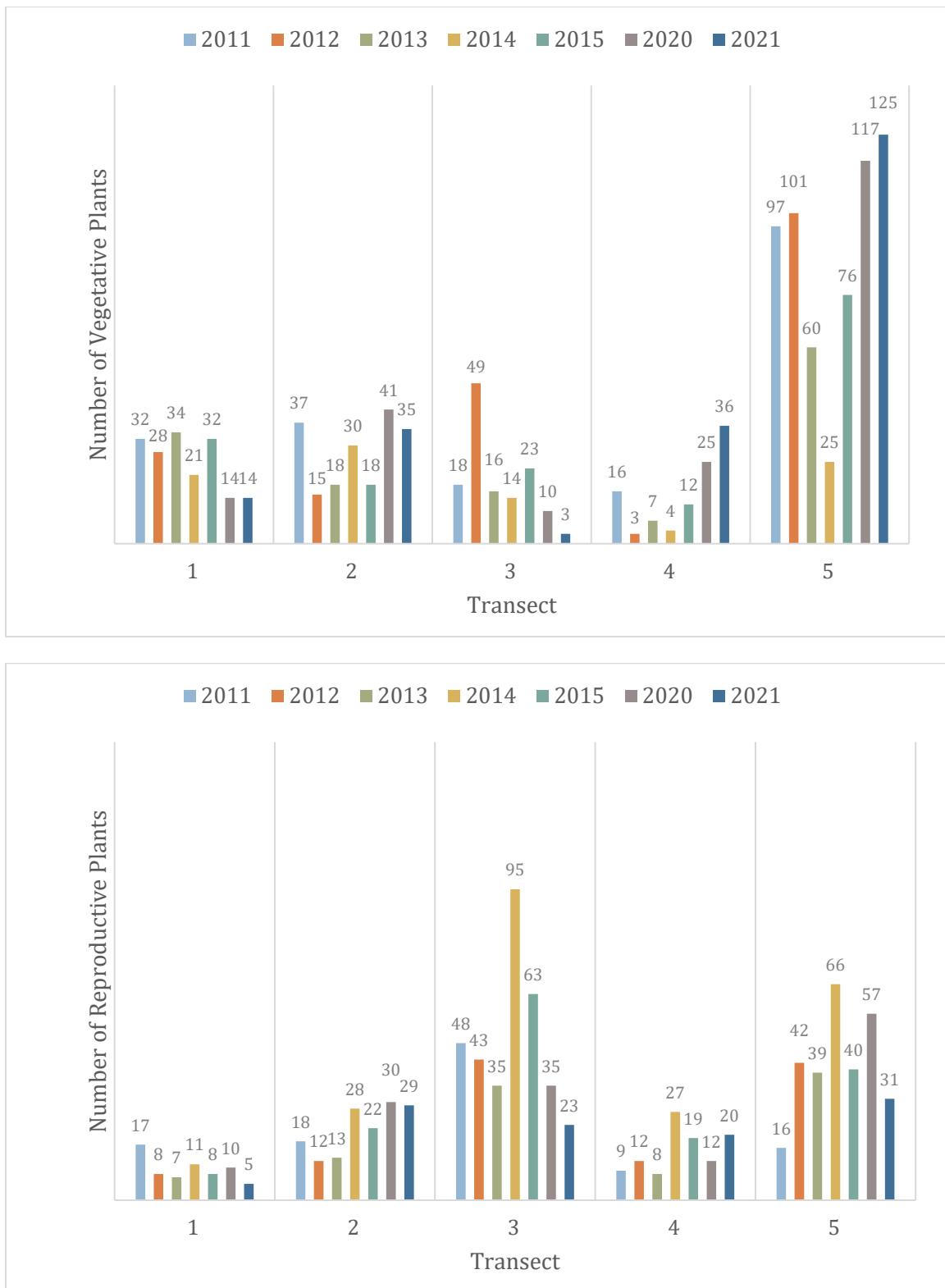


Figure 4. Total number of vegetative plants (above) and total number of reproductive plants (below) in individual transects at Bilger 1; 2011-2015 and 2020-2021.

Table 3. Crinite mariposa lily tally within 1m x 25m belt transects at Bilger 1 in 2021.

Transect	Total Veg	Total Repr	Total All	# Flowers/plant (Tally)					Herbivory			
				1	2	3	4	Total	Flower by mammal	Flower by Insect	Leaf by insect	Leaf by mammal
1	14	5	19	5	0	0	0	5	0	0	1	1
2	35	29	64	28	1	0	0	29	3	3	4	11
3	3	23	26	15	8	0	0	23	3	1	0	0
4	36	20	56	20	0	0	0	20	5	2	2	2
5	125	31	156	31	0	0	0	31	5	0	7	19
Mean	42.6	21.6	64.2	19.8	1.8	0	0	21.6	3.2	1.2	2.8	6.6
Total	213	108	321	99	9	0	0	108	16	6	14	33

The percentage of reproductive plants (reproductive/total) and canopy cover were negatively correlated in 2021 (Figure 5). This was also the case in 2015 and 2020. We observed more vegetative plants in areas that were shaded by dense canopies and more reproductive plants in open habitat. This trend was seen most predominantly on Transect 3 with 18% canopy cover and 88% reproductive plants, this was also the only area that had flowering plants and not just buds. 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 (Table 4). From 2014-2015 and 2020-2021 canopy cover bounded on these transects, suggesting that continued canopy reduction treatments should be implemented to encourage reproductive plants.

Table 4. Mean percent canopy cover at Bilger 1 from 2011-2015, 2020-2021.

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

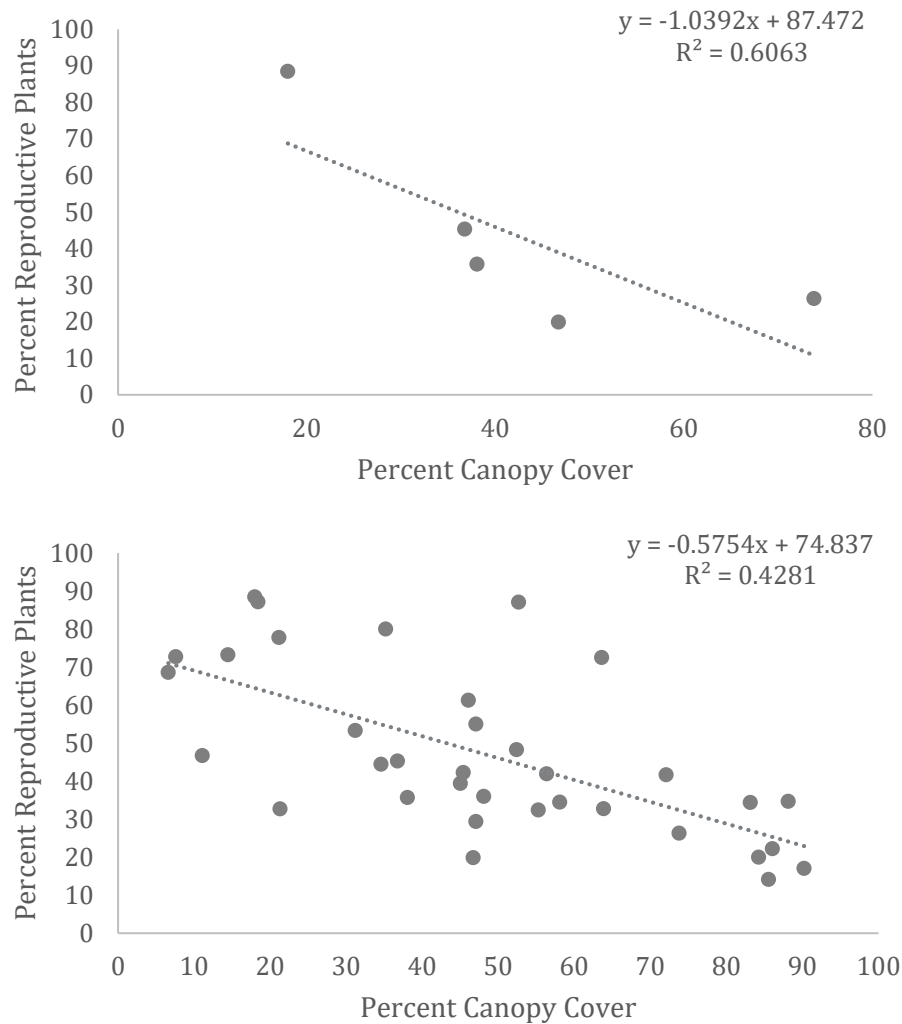


Figure 5. Relationship between mean percent canopy cover and mean percent reproductive plants at each transect at Bilger 1 in 2021 (top, n = 5) and from all combined surveys for 2011-2015 and 2020-2021 (bottom, n = 35).

Previous years showed a greater proportion of vegetative plants in forested habitat, and a higher proportion of reproductive plants in dry habitats. In 2021, we did not observe these trends (Figure 6). The dry habitat had more mean vegetative plants (80.5) than the forested habitat (17.3). The dry habitat also had more reproductive plants (25.5) than the forested habitat (19.0), but not by a large margin. One thing to note is that there were more plants in the dry habitat, suggesting that *crinite mariposa lily* prefers a more open canopy than a forested habitat. Herbivory seems to be mostly occurring in the dry habitat, largely due to mammals and insects grazing leaves (Figure 6).

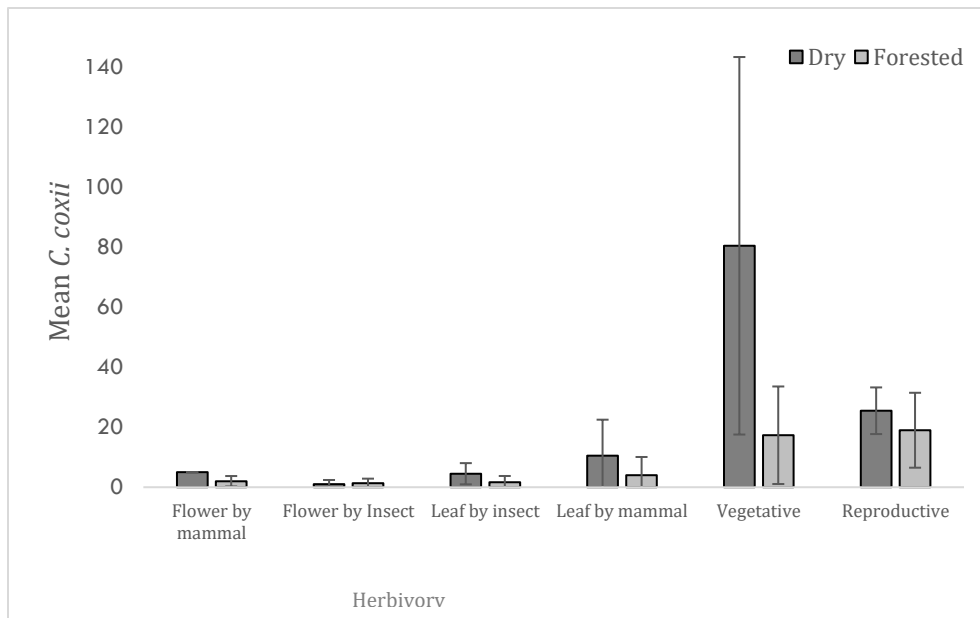


Figure 6. Mean number (+/- 1 SD) of *crinite mariposa lily* per transect in dry and forested habitats at Bilger 1, including those that exhibited herbivory; 2021.

Across the five transects at Bilger 1 in 2021, 37 species were recorded, consisting of 34 native species and 3 exotic species. This is a decrease in exotic richness since 2020 which had 5 exotic species recorded. Species richness ranged from 12 to 18 species per transect. Native species cover was 97.8% while exotic cover was 2.2% (Figure 7). Native graminoids had the highest level of cover (53.6%), consisting of Roemer's fescue, Lemon's needle grass (*Achnatherum lemmonii*), and Geyer's oniongrass (*Melica geyeri*) (Figure 7, Appendix A). Native forbs (36.9%) consisted predominately of Indian's dream and western sword fern (*Polystichum munitum*) with the highest mean cover, another notable species is western buttercup (*Ranunculus occidentalis*) which was present on all 5 transects. Native trees (7.4%) were largely due to incense cedar, which was found on 4 of the 5 transects in Bilger 1 (Appendix A). Exotic cover (2.2%) was completely comprised of exotic graminoids, predominately due to field wood-rush (*Luzula campestris*), which was found on all five transects. Other exotic grasses were soft chess (*Bromus hordeaceus*) and silver hairgrass (*Aira caryophyllea*) (Appendix A).

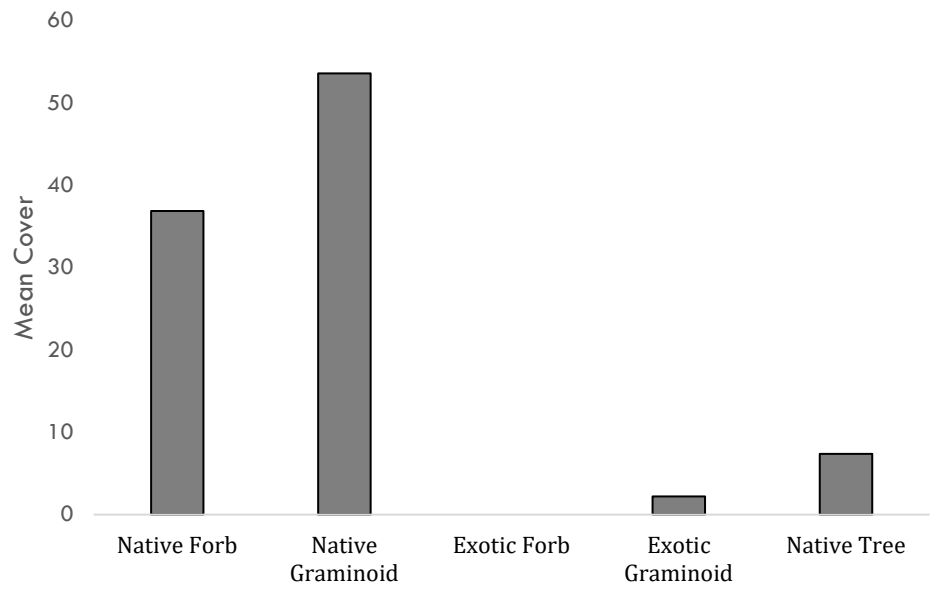


Figure 7. Mean cover of total plant cover at Bilger 1 grouped by functional group in 2021.

Permanent monitoring transects: New Pipeline, Myrtle Creek (2020-2021)

In 2021, a total of 123 plants (94 vegetative, 29 reproductive) were found along the six transects on the New Pipeline 1 (Figure 8, Table 5). This is a large decrease from the 435 plants (174 vegetative, 261 reproductive) that were found during the 2020 monitoring year. These numbers continue to follow 2021 trends that were seen at Bilger 1, with more vegetative plants than reproductive plants. This does not follow the trends that were seen in 2020 where 60% of the plants were reproductive. Of these reproductive plants in 2021, 27 of the plants had one flower and 2 had two flowers (Table 5). This may be due to monitoring occurring early in the phenology.

In 2021, 31% of the plants at New Pipeline 1 had signs of herbivory. Across all six transects, 11% of them had flower herbivory by mammals, 18% had leaf herbivory by mammals, and less than 1% herbivory was observed by insects (Table 5). This is more herbivory than we observed in 2020.

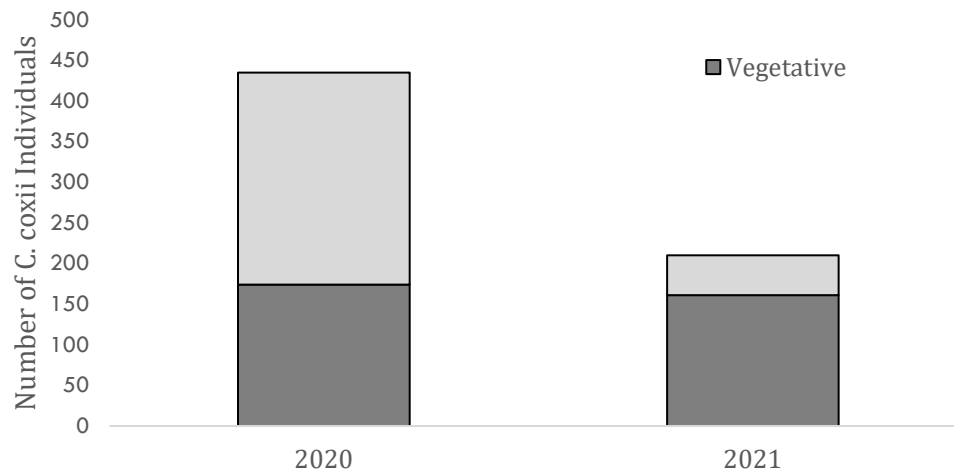


Figure 8. Total number of *crinite mariposa lily* counted across six monitored transects at New Pipeline, 2020-2021.

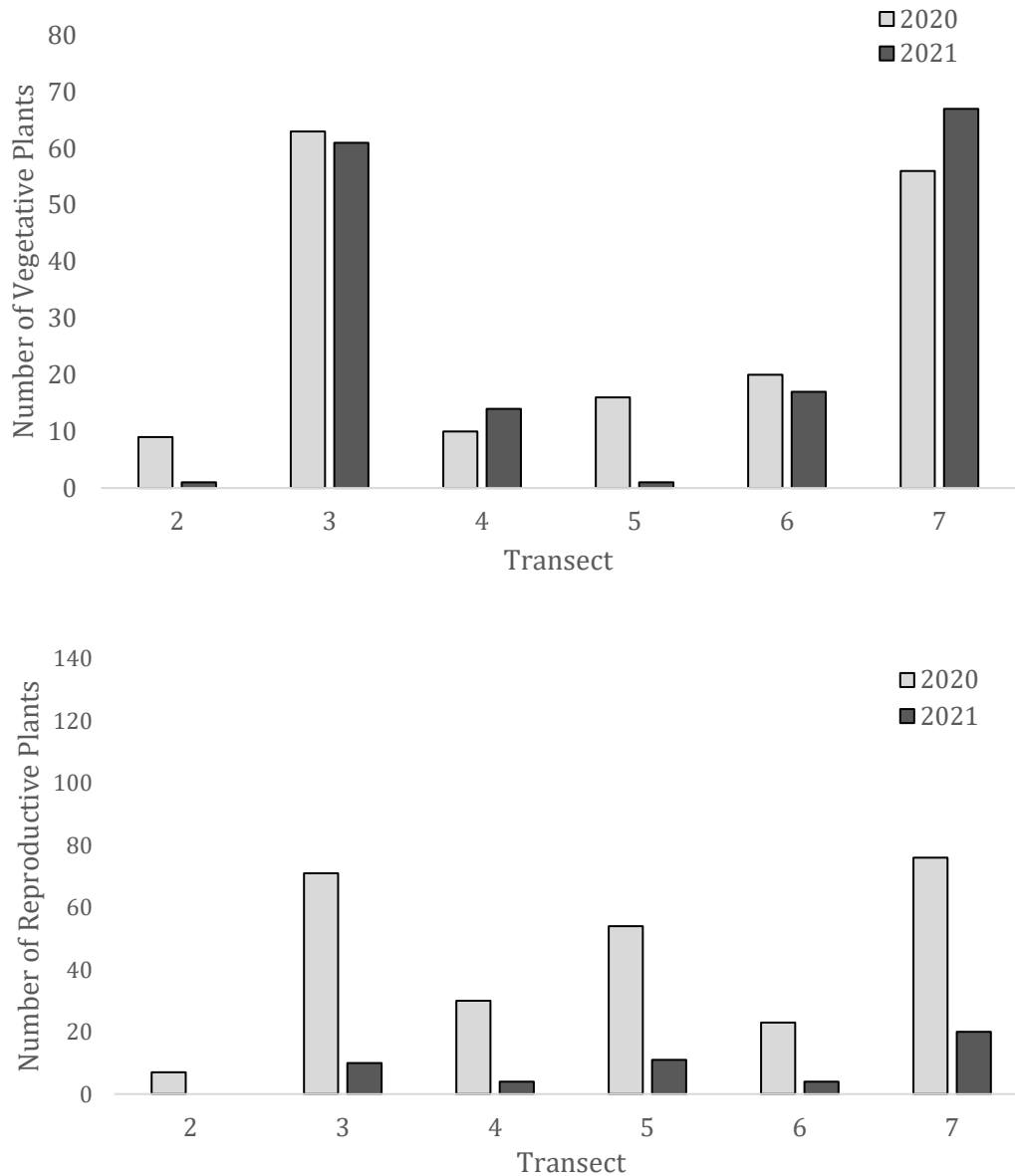


Figure 9. Total number of vegetative plants (above) and total number of reproductive plants (below) in transects at New Pipeline in 2020-2021. (Note: transects are numbered 2-7 because transect 1 fell in unsuitable habitat and was omitted)

Table 5. Crinite mariposa lily tally within 1m x 25m belt transects at New Pipeline 1 in 2021.

Transect	Total Veg	Total Repr	Total All	# Flowers/plant (Tally)					Herbivory			
				1	2	3	4	Total	Flower by mammal	Flower by Insect	Leaf by insect	Leaf by mammal
2	1	0	1	0	0	0	0	0	0	0	0	1
3	61	10	71	9	1	0	0	10	1	2	1	11
4	14	4	18	3	1	0	0	4	3	0	0	6
5	1	11	12	11	0	0	0	11	9	0	0	1
6	17	4	21	4	0	0	0	4	1	0	0	3
7	67	20	87	20	0	0	0	20	5	0	0	18
Mean	26.8	8.2	24.6	7.8	0.3	0	0	5.8	2.8	0.4	0.2	6.7
Total	94	29	123	27	2	0	0	29	14	2	1	22

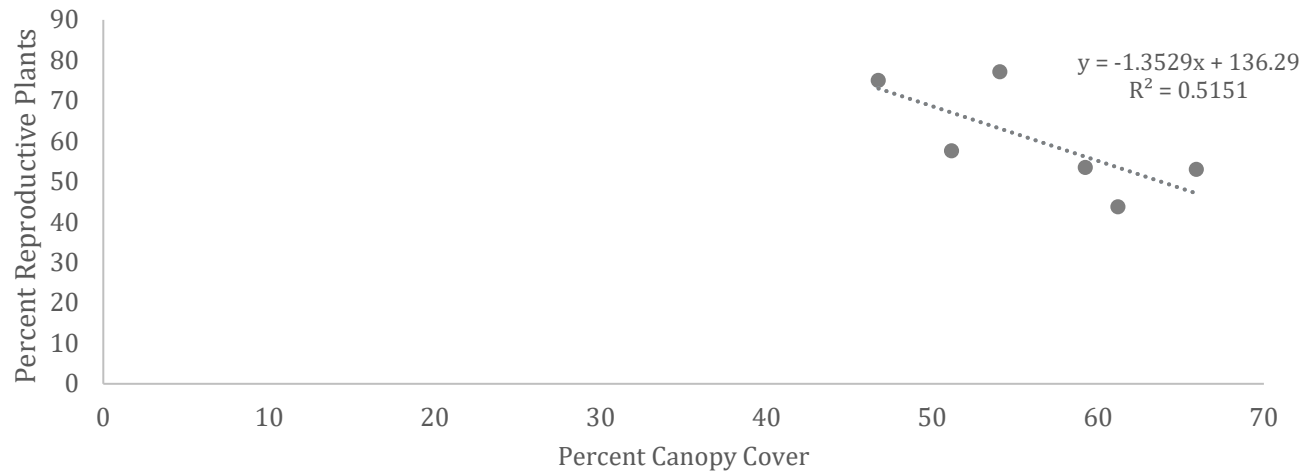
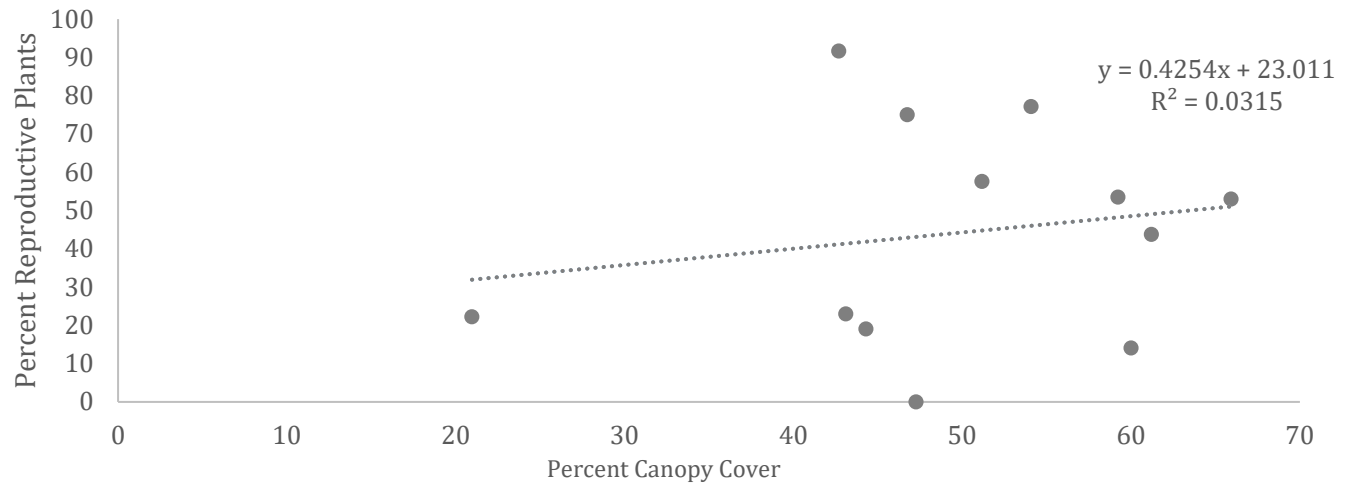


Figure 10. Relationship between mean percent canopy cover and mean percent reproductive plants composing each transect at New Pipeline 1 in 2021(top), n = 7, and from 2020 surveys (bottom), n = 7.

There is no correlation between percent reproductive plants and percent canopy cover at the New Pipeline 1 ($r^2 = 0.003$, Figure 10). This is largely due to the low percentage of reproductive plants found at the New Pipeline 1 in 2021. There was a negative correlation found in 2020 ($r^2 = 0.5$), suggesting that canopy thinning could encourage more reproductive plants. Further monitoring will help to address if canopy cover influences the number of reproductive plants. Canopy cover varied across transects at New Pipeline 1, ranging from 21% to 60%, which is a lower range than 2020 (Table 6).

Table 6. Mean percent canopy cover at New Pipeline 1 from 2020 – 2021.

Transect	Mean Percent Canopy Cover	
	2020	2021
2	61	47
3	66	60
4	47	21
5	54	43
6	59	44
7	51	43

Unlike the Bilger transects, we did not distinguish transects by dry and forested characteristics, as they all contained a mixture of conifer growth, rock outcrops, moss growth, and native grasses.

Across the five transects at Bilger 1 in 2021, 39 species were recorded, consisting of 34 native species and 5 exotic species. This is an increase in exotic richness since 2020 which had 3 exotic species recorded. Species richness ranged from 16 to 24 species per transect. Native species cover comprised of 98.7% while exotic cover comprised of 1.3% (Figure 11). Native graminoids were the most abundant (85.6%), consisting of predominately of Roemer's fescue. Blue wild rye (*Elymus glaucus*) was present at all 6 transects, while all other native graminoids had less than 1% mean cover (Figure 7, Appendix A). Native forbs (11.6%) had no species with greater than 1% mean cover, but yellowleaf iris (*Iris chrysophylla*) was present on all six transects. Native tree cover (1.5%) was largely comprised of incense cedar, which was found on 4 of the 6 transects at New Pipeline (Appendix A). Exotic cover was predominantly comprised of exotic graminoids, predominately due to *field wood-rush*, which was found on all six transects. Other exotic grasses were bentgrass (*Agrostis spp.*) and silver hairgrass (Appendix A). Exotic forb cover was also present at New Pipeline 1, consisting entirely of an unknown vetch (*Vicia spp.*) (Appendix A). These results are consistent with trends seen in 2020, but with slightly higher exotic cover than what was seen in 2020 (0.4%) and more exotic richness.

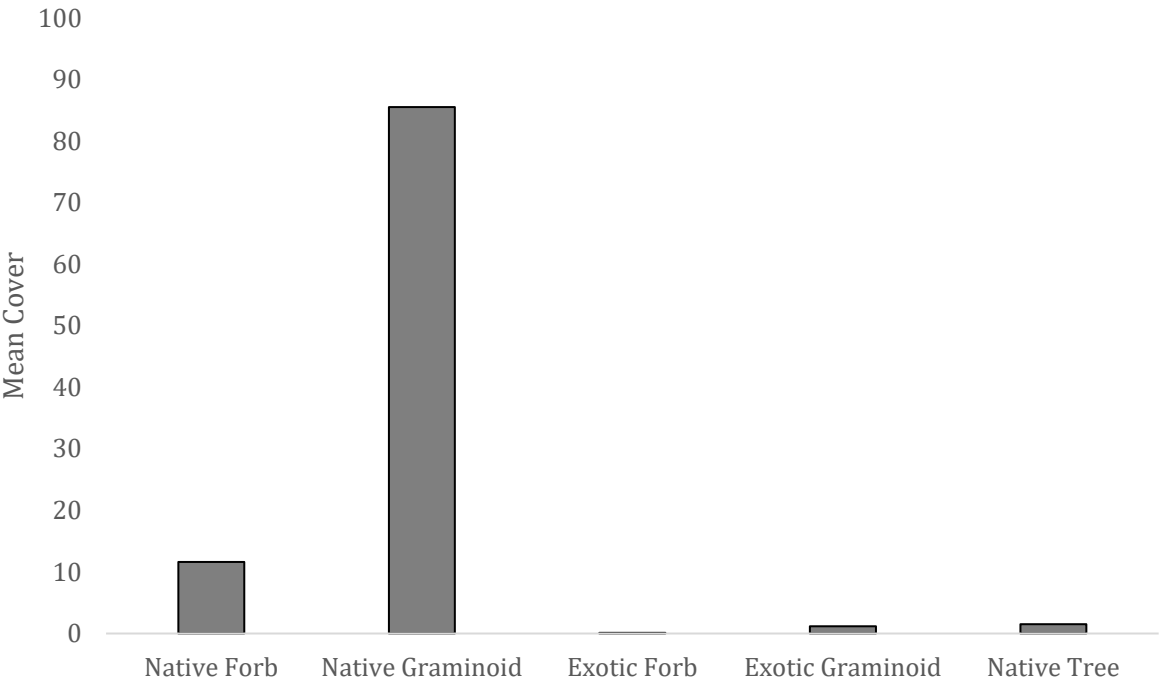


Figure 11. Mean percent plant cover at New Pipeline 1 in 2021, by functional group.

DISCUSSION

Permanent monitoring transects: Bilger 1 and Bilger 4

Crinite mariposa lily was associated with habitats dominated by native plant species, which is consistent with past observations. In turn, crinite mariposa lily tended to be negatively associated with exotic species. Crinite mariposa lily may have been extirpated from areas now characterized by high exotic abundance. soft chess, field wood-rush and silver hairgrass were the most abundant exotic grasses in areas surrounding high crinite mariposa lily abundance, and they both show high potential to invade habitat of this sensitive endemic species. While exotic graminoid abundance was very low in 2021, the increased presence of *soft chess* from 2015 to 2020 is notable and should be monitored in future years.



Figure 12. A snail on *crinite mariposa lily*

Herbivory on the leaves and flowers of crinite mariposa lily, which may have a negative effect on reproduction, growth, and survival, was present across all transects at Bilger Ridge. Historically, 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 USFWS 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 (Fredricks 1992, USDI BLM and USFWS 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).

The primary threat to these populations continues to be encroachment by shrubs and trees into occupied habitat. In 2020 and 2021 there was an abundance of *incense cedar saplings* on Bilger 1 transects. Some areas along the ridgelines within Bilger 1 may require careful thinning to prevent canopy closure and extirpation of crinite mariposa lily. 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, which could negatively affect population trends for this species. We found that canopy cover and reproductive plants

were negatively correlated, indicating that high canopy cover might suppress flowering in this lily. Canopy thinning occurred at Bilger 1 in the area of the transects in the winter of 2011-2012. In the years following the canopy thinning, we observed a short-term increase of flowering crinite mariposa lily, with a shift back to a preponderance 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. While this area experienced an original decrease in canopy cover, in 2015 and 2020-2021 canopy started to close in these areas. This suggests that the effects of canopy clearing might be short-lived and that encroachment by tree seedlings might also have potential to impact abundance of crinite mariposa lily. 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. Between 2020 and 2021 a slight increase in exotics occurred at Bilger 1, so additional monitoring of exotic cover is crucial in the years to come to prevent a threat to crinite mariposa lily habitat.

While in previous years there was an observed decline in vegetative crinite mariposa lily (2011-2014), there has since been a steady increase from 2015-2021 at Bilger 1. While vegetative plants have increased, there is still a sporadic fluctuation in the number of observed reproductive plants over the years. 2021 observed one of the lowest reproductive years, comparable to numbers seen in 2013, but with overall levels similar to levels seen in 2020. It is likely that climate could be impacting the abundance of crinite mariposa lily and the population dynamics that have been observed over the years. Variation in weather as well as microclimate associated with canopy cover could be important drivers of population dynamics.

Temperatures from 2013-2015 and 2020-2021 have been higher than long-term averages, while precipitation in these years have been lower than long-term averages (Figure 13). The warmest year across all seasons was 2015. Winter and fall temperatures vary from year to year but stay close to long-term averages. While spring and summer continue to stay warmer than normal since 2014. The winter of 2011 had one of the lowest levels of winter precipitation. Spring of 2021 was the driest spring seen throughout the all years, with 3.06" less precipitation than normal. This dry spring may be the reason we observed fewer reproductive plants. Summer precipitation has been below normal since 2013. Fall precipitation has varied over the years, with most years being below normal levels. A better understanding of dormancy patterns would help better understand the effects of weather on crinite mariposa lily.

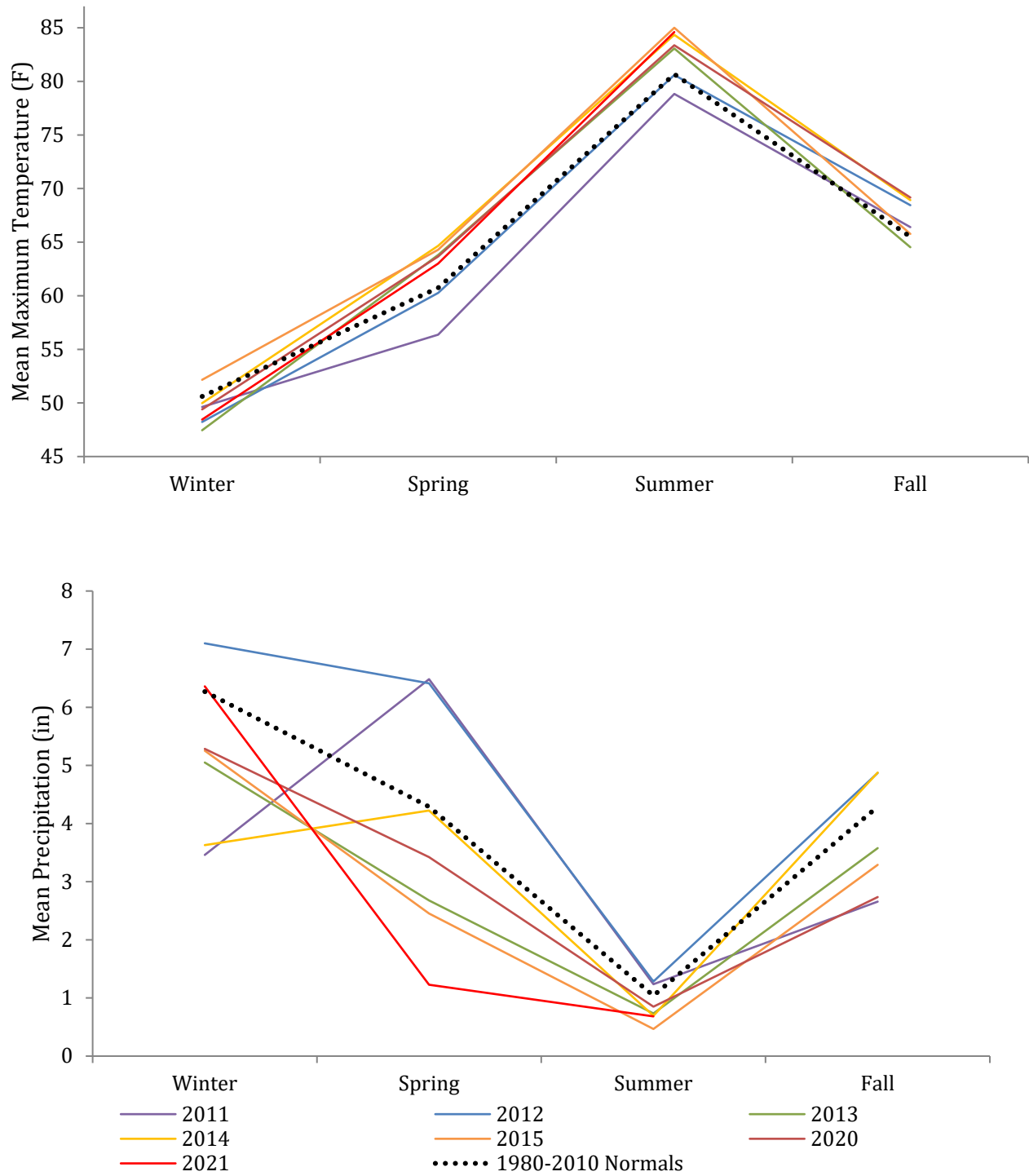


Figure 13. Average long-term temperature (top) and precipitation (bottom) normals from 1980-2010 relative to conditions experienced at Bilger Ridge (2011-2015, 2020-2021 - PRISM 2006).

Permanent monitoring transects: New Pipeline 1

Similar to trends seen at Bilger 1, the crinite mariposa lily population at New Pipeline 1 was associated with native species cover. New Pipeline 1 shows observations of high native species richness, and low exotic richness. Field wood-rush and silver hairgrass were the most abundant exotic grasses in areas surrounding high crinite mariposa lily abundance, and both species are known to invade habitat of this sensitive endemic species. While exotic richness continues to be low from 2020-2021, continued monitoring must be implemented to make sure exotic cover does not increase negatively impact crinite mariposa lily habitat.

Herbivory on the leaves and flowers of crinite mariposa lily, which may have a negative effect on reproduction, growth, and survival, was present across all transects at New Pipeline 1. Herbivory was predominantly conducted by mammals and targeted the vegetative components of the plant. While there were some signs of insect herbivory, the all-around impact was low compared to mammal herbivory. As discussed at Bilger 1, mammal herbivory has shown to be detrimental to *Calochortus* species due to reducing seed production, therefore this could be a management concern for crinite mariposa lily at New Pipeline 1.

New Pipeline 1 has not had any overstory thinning or removal, but considering observations from Bilger Ridge, thinning and overstory removal could be beneficial to the New Pipeline 1 population. The overstory at New Pipeline 1 is denser than Bilger 1, which may explain why there were less reproductive plants at New Pipeline 1 compared to Bilger 1. Canopy cover and percent reproductive plants have shown to have a negative correlation at Bilger 1, therefore additional overstory management at New Pipeline 1 could be helpful to increase the number of reproductive plants. Incense cedar, Douglas fir, and Jeffery pine saplings were present at New Pipeline, indicating that encroachment is still a threat to crinite mariposa lily habitat.

One of the most immediate threats to the New Pipeline 1 population is the proximity to the proposed LNG Pipeline. This pipeline is proposed to pass through this crinite mariposa lily population. Therefore, careful steps should be implemented to limit negative impacts. Most notably, pipeline construction could bring physical damage to the population and potentially introduce exotic species that could outcompete crinite mariposa lily.

From 2020 to 2021 there was a notable shift in crinite mariposa lily abundance and the proportions of reproductive and vegetative plants, with 212 less reproductive plants and 13 less vegetative plants found in 2021. This could be due to identification error, because pussy ear was noted in 2021 but not in 2020. Another possible reason for this shift could be weather, because 2021 was one of the driest springs on record, with half the amount of rainfall compared to 2020 (Figure 13).

Surveys of previously known crinite mariposa lily populations

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.

FUTURE ACTIVITIES

We recommend continued monitoring of the permanent transects at Bilger Ridge and New Pipeline 1 to assess population trends in relation to potential threats and habitat over time. Repeated surveys of historic occurrences should be conducted to document changes in population dynamics, habitat changes, and document potential threats. In 2012, we found far fewer plants on BLM lands than previously thought and continued surveys will be essential to inform future conservation actions. Demographic studies will improve our understanding of patterns of dormancy and population cycles. Population studies of this rare species will enable land managers to determine which additional actions are needed for its conservation.

One management concern is the encroachment of woody species, such as Jeffery pine and incense cedar (Figure 14). This encroachment inhibits light from reaching the understory and crinite mariposa lily. Therefore, we recommend canopy thinning and seedling removals to benefit crinite mariposa lily. Thinning occurred on the Bilger ridge in 2011-2012, and there were brief positive effects to the crinite mariposa lily population, specifically increasing reproductive plants.



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

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APPENDICES

Appendix A: Mean Percent Cover in 2021 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	0.26	0.04
<i>Achnatherum lemmonii</i>	native	graminoid	4.48	--
<i>Acmispon parviflorus</i>	native	forb	0.00	--
<i>Agoseris grandiflora</i>	native	forb	0.06	0.01
<i>Agrostis sp.</i>	exotic	graminoid	--	0.01
<i>Aira caryophylla</i>	exotic	graminoid	0.00	0.01
<i>Aspidotis densa</i>	native	forb	6.36	0.88
<i>Bromus carinatus</i>	native	graminoid	0.20	0.50
<i>Bromus hordeaceus</i>	exotic	graminoid	0.50	--
<i>Calocedrus decurrens</i>	native	tree	2.28	0.18
<i>Calochortus coxii</i>	native	forb	0.11	0.04
<i>Camassia quamash</i>	native	forb	--	0.36
<i>Cerastium arvense</i>	native	forb	0.37	0.40
<i>Claytonia perfoliata</i>	native	forb	0.00	--
<i>Collinsia parviflora</i>	native	forb	--	0.00
<i>Cryptantha intermedia</i>	native	forb	0.02	0.01
<i>Cryptantha sp.</i>	native	forb	0.00	--
<i>Danthonia californica</i>	native	graminoid	--	0.00
<i>Elymus glaucus</i>	native	graminoid	0.10	0.47
<i>Epilobium minutum</i>	native	forb	0.03	0.02
<i>Eriophyllum lanatum</i>	native	forb	--	0.03
<i>Festuca roemerii</i>	native	graminoid	9.97	24.17
<i>Galium aparine</i>	native	forb	0.15	0.06
<i>Hieracium scouleri</i>	native	forb	0.04	0.09
<i>Iris chrysophylla</i>	native	forb	0.16	0.42
<i>Lomatium nudicaule</i>	native	forb	0.33	0.04
<i>Lomatium triternatum</i>	native	forb	--	0.03
<i>Lomatium utriculatum</i>	native	forb	0.10	0.00
<i>Luzula campestris</i>	exotic	graminoid	0.20	0.33
<i>Madia gracilis</i>	native	forb	0.00	0.00
<i>Melica geyeri</i>	native	graminoid	1.38	0.18
<i>Microsteris gracilis</i>	native	forb	--	0.01
<i>Montia sp.</i>	native	forb	0.01	--
<i>Perideridia oregana</i>	native	forb	--	0.00

Species	Nativity	Growth Form	Bilger 1	New Pipeline
<i>Pinus jeffreyi</i>	native	tree	0.00	0.27
<i>Plectritis congesta</i>	native	forb	0.64	--
<i>Poa secunda</i>	native	graminoid	0.97	0.02
<i>Polystichum munitum</i>	native	forb	2.24	0.67
<i>Pseudotsuga menziesii</i>	native	tree	0.08	--
<i>Ranunculus occidentalis</i>	native	forb	0.51	0.23
<i>Sedum stenopetalum</i>	native	forb	--	0.02
<i>Silene hookeri</i>	native	forb	0.04	0.01
<i>Trisetum cernuum</i>	native	graminoid	0.03	0.02
<i>Vicia sp.</i>	exotic	forb	--	0.03
<i>Viola hallii</i>	native	forb	0.06	0.02
<i>Vulpia macrostachys</i>	native	graminoid	0.03	0.04
<i>Zigadenus venenosus</i>	native	forb	0.34	0.06

Appendix B: Locations of permanent monitoring transects at Bilger 1

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.

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Appendix C: Locations of permanent transects at Bilger 3 and 4

Permanent monitoring transects (green squares) were established in areas of high crinite mariposa lily abundance. Note that Transects 1 and 2 are between Bilger 3 and 4, and are outside of the areas indicated by the BLM shapefile (in pink).

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Appendix D: Location of permanent monitoring transects at New Pipeline

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).

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Appendix E: Transect Notes (2021)

The notes below were collected in 2021 to give indication of habitat quality, potential threats in the surrounding area, and potential management that could occur. Photos were taken along the monitoring transects in 2021.

Bilger 1 Transect 1: Lots of incense cedar recruitment in the surrounding area with mixed canopy of Douglas fir and incense cedar. Very high moss cover, *Polystichum minutum* most abundant forb.

Greatest threat: conifer recruitment

Suggested management action: Minimize conifer encroachment in opening.



Bilger 1 Transect 2: Transect runs across slope in rocky, mossy, forested opening. Increasing Jeffery pine and incense cedar recruitment in opening. Very high native cover in and around transect. Most common species: Indian's dream, Roemer's fescue, barestem biscuitroot (*Lomatium nudicaule*), Geyer's oniongrass, California brome (*Bromus carinatus*)

Greatest threat: conifer recruitment

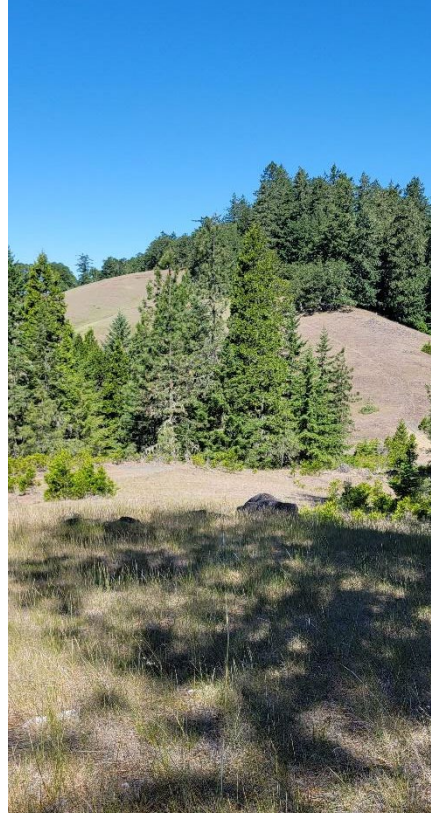
Suggested Management actions: Minimize conifer encroachment in opening.



Bilger 1 Transect 3: Some invasive grasses (soft brome & silver hairgrass) present in the transect. High abundance of moss/lichen. Evidence of cattle here including fresh cowpies, some in the transect. This was the only spot between the two sites that crinite mariposa lily was flowering. All other transects only had buds present.

Greatest threat: invasion by exotics and grazing by cattle

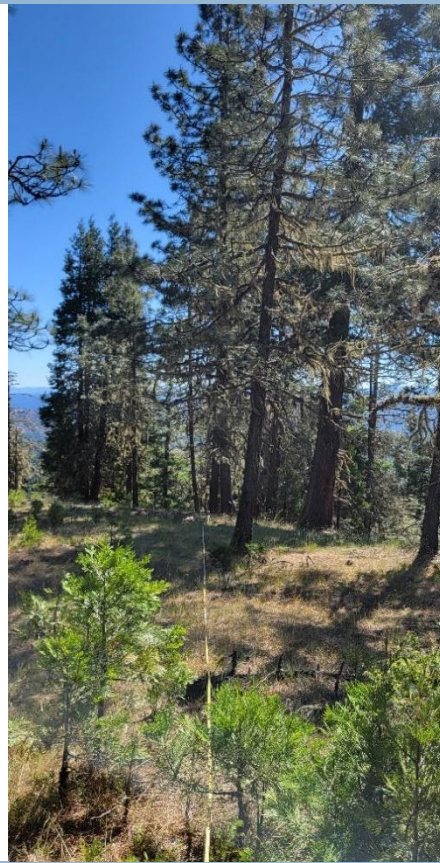
Suggested management action: Nothing at the moment but watch closely.



Bilger 1 Transect 4: Canopy thinning has occurred in the surrounding area and while thinning occurred in mature trees, seedlings are starting to creep into the area that supports crinite mariposa lily. Some incense cedar saplings present in and surrounding the transect. Overall the composition is mostly native, dominated by Roemer's fescue (over 40% cover) and various biscuitroot species.

Greatest threat: conifer encroachment

Suggested management actions: Remove *Calocedrus decurrens* seedlings in area



Bilger 1 Transect 5: High moss/lichen cover and rocky slope. Lots of incense cedar recruitment directly within areas of high crinite mariposa lily density. Some Jeffery pine present as well. Primarily native vegetation in this area.

Greatest threat: conifer encroachment

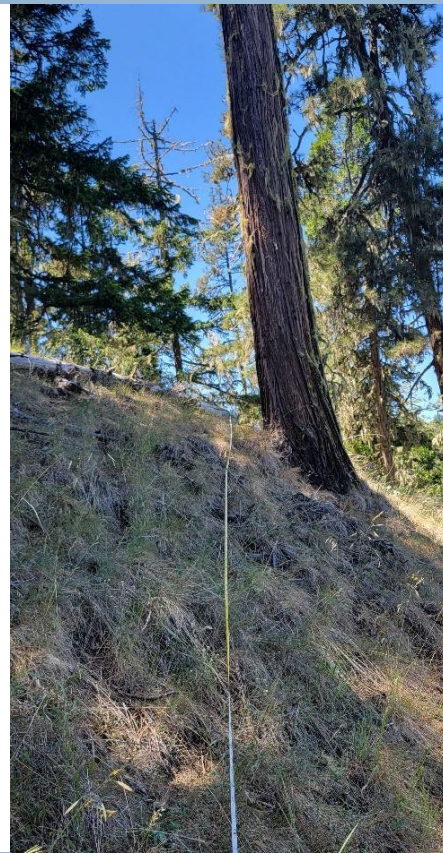
Suggested management actions: Remove incense cedar seedlings taking care not to impact crinite mariposa lily as it is very dense in this area.



New Pipeline Transect 2: Site in area of relatively open canopy and a steep slope. Decaying biomass in transect as well as a large incense cedar. Young saplings present, as well as Indian's dream, biscuitroot species, yellowleaf iris, and death camas. This transect had the lowest number of crinite mariposa lily, with only 1 individual.

Greatest threat: conifer encroachment and LNG pipeline

Suggested management actions: No immediate action necessary. Minimize conifer encroachment in opening.



New Pipeline Transect 3. Relatively dense herbaceous and moss ground cover with a large abundance of Roemer's fescue. Transect surrounded by tall incense cedar and shaded in the morning.

Greatest threat: conifer encroachment and LNG Pipeline

Suggested management actions: No immediate action necessary but maintaining open canopy and removal of saplings to prevent encroachment.



New Pipeline Transect 4. Very high abundance of Roemer's fescue on the transect, as well as moss ground cover. Small saplings and rock outcrop in transect.

Greatest threat: conifer encroachment and LNG Pipeline

Suggested management actions: No immediate action necessary but maintaining open canopy and removal of saplings to prevent encroachment.



New Pipeline Transect 5. Abundance of Roemer's fescue and Indian's dream. Rock with young pine canopy through transect – moderate herbaceous cover in open areas.

Greatest threat: conifer encroachment and LNG Pipeline

Suggested management actions: Removal of saplings and further opening the canopy



New Pipeline Transect 6. Open, rocky slope with large Jeffery pine and incense cedar. Large rock outcrop in transect with moderate herbaceous cover. Abundance of Roemer's fescue.

Greatest threat: conifer encroachment and LNG Pipeline

Suggested management actions: Removal of saplings and further opening the canopy



New Pipeline Transect 7: Dense crinite mariposa lily population in area and mixed with pussy ear. To distinguish the two species apart vegetatively, crinite mariposa lily has small hairs that run on along the central vein on the back of the leaf blade. Pine trees at start and end of transect, bordering a small opening. Relatively open canopy with moderate herbaceous cover. Abundance of Roemer's fescue.

Greatest threat: conifer encroachment and LNG Pipeline

Suggested management actions: Removal of saplings and further opening the canopy. Also connecting this small opening to neighboring openings.

