

Habitat restoration and monitoring for Kincaid's lupine at Fir Butte: 2024 annual report



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Report prepared by Paul Reed, Denise Giles, Andrew Esterson, and Scott Harris

Institute for Applied Ecology



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.



Questions regarding this report or IAE should be directed to:

Keith Norris, Executive Director
Institute for Applied Ecology
4950 SW Hout St.
Corvallis, OR 97333

phone: 541-753-3099
fax: 541-753-3098
email: info@appliedeco.org

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Cover photograph: Kincaid's lupine (*Lupinus oreganus*) flowering on May 20, 2024, amid non-native grasses including soft brome (*Bromus hordeaceus*), ripgut brome (*Bromus diandrus*), and tall oatgrass (*Arrhenatherum elatius*). Photo by Paul Reed.

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EXECUTIVE SUMMARY

The Institute for Applied Ecology (IAE) has conducted habitat restoration and monitoring at Fir Butte in partnership with the Bureau of Land Management (BLM) Siuslaw Field Office, Northwest Oregon District, for more than a decade. This site hosts large populations of the federally threatened Fender's blue butterfly (*Icaricia icarioides fenderi*) and its host plant, the federally threatened Kincaid's lupine (*Lupinus oreganus*). The site has approximately 13.5 acres of upland prairie habitat (where Kincaid's lupine occurs) across the northeast, southeast, and southwest management units, along with 5.5 acres of wet prairie habitat in the northwest management unit.

In 2024, IAE performed a variety of restoration activities including herbicide treatments, hand pulling, broadcasting seed, and planting native plugs, bulbs, and bare roots. IAE completed herbicide spot spray treatments targeting Himalayan blackberry and meadow knapweed across the entire site, as well as tall oatgrass, common velvetgrass, false dandelion, hedge bindweed, and orchardgrass primarily within the northeast and southeast units. IAE planted a total of 1,500 plants from five native species: California oatgrass (*Danthonia californica*), barestem biscuitroot (*Lomatium nudicaule*), Oregon geranium (*Geranium oreganum*), Oregon iris (*Iris tenax*), and narrowleaf onion (*Allium amplexans*). IAE also seeded 2 lbs of Roemer's fescue (*Festuca roemerii*).

2024 monitoring results indicate that:

- Kincaid's lupine foliar cover and raceme counts decreased in 2024 to an estimated 5,082 m² ($\pm 1,391$ m²) of foliar cover and 52,593 ($\pm 20,990$) mature racemes. Although this foliar cover estimate represents a 32% decrease compared to 2023, foliar cover remains well above historical values for the site. The raceme count in 2024 was the lowest estimate since 2006.
- Since 2018, Kincaid's lupine foliar cover has increased more in the northeast and southeast units compared to the southwest unit, aligning with the higher intensity of management treatments conducted in the northeast and southeast units.
- For the fifth consecutive year, Himalayan blackberry (*Rubus bifrons*) absolute cover remained below the 5% threshold recommended for weed species of concern in the Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington (U.S. Fish and Wildlife Service 2010), with an average of just 0.4% ($\pm 0.1\%$) absolute cover in 2024.
- The southeast management unit continues to shift toward a higher dominance of introduced species since the most recent prescribed burn in 2018. Introduced species accounted for >88% relative cover in 2024. Abundant species within this management unit in 2024 included rattail fescue, (*Vulpia myuros*), false dandelion (*Hypochaeris radicata*), and Queen Anne's lace (*Daucus carota*).

- The northeast management unit shifted toward a higher relative abundance of introduced species in 2024 (>66% relative cover), now two years removed from the most recent prescribed burn. However, introduced species cover remains below pre-burn levels and Kincaid's lupine foliar cover continued to increase within this unit.
- Introduced graminoids continued to dominate the southwest unit with 62.5% relative cover in 2024, with tall oatgrass remaining the most dominant species.

Future restoration activities will continue targeting high-priority weeds including Himalayan blackberry, tall oatgrass, and meadow knapweed, among others. Efforts will expand in 2025 to begin controlling tall oatgrass in the southwest unit, following the next prescribed burn. Weed removal treatments will continue to be complimented by native seed additions, and Fender's blue butterfly nectar resources will continue to be planted.

1. INTRODUCTION

Fir Butte is an 18-acre site owned and managed by the Bureau of Land Management (BLM) Siuslaw Field Office, Northwest Oregon District. It is located in the West Eugene Wetlands in Lane County, Oregon, at the south end of the Willamette Valley (Figure 1). Fir Butte contains upland and wet prairie habitats and is part of a network of BLM sites within the West Eugene Wetlands that provide critical habitat for a variety of rare, threatened, and endangered species. It supports large populations of both the federally threatened Kincaid's lupine (*Lupinus oregonus*) and Fender's blue butterfly (*Icaricia icarioides fenderi*) (Figure 2). Other Bureau-sensitive species, including white-topped aster (*Sericocarpus rigidus*) and three rare bryophyte species (*Bruchia flexuosa*, *Ephemerum crassinervium*, and *Ephemerum serratum*), have been observed at Fir Butte as well.

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Figure 1. Fir Butte management units (Northwest, Northeast, Southwest, and Southeast) overlaid on the Kincaid's lupine (*Lupinus oregonus*) population, most recently mapped in 2019. Inset map shows Fir Butte within the context of the Bureau of Land Management's (BLM) West Eugene Wetlands properties.

Kincaid's lupine is an herbaceous perennial plant that can be found within upland prairies of the Willamette Valley and southwestern Washington, as well as forest openings in Douglas County, Oregon. Plants form clumps of basal leaves and produce one or more flowering stems. This species primarily reproduces by seed but can also spread vegetatively (although it is unknown to what extent vegetative growth might result in the formation of physiologically distinct clones). Kincaid's lupine requires insects for successful fertilization and seed formation (Kaye 1999). Within the Willamette Valley, Kincaid's lupine serves as a larval host plant for the Fender's blue butterfly, making restoration of Kincaid's lupine habitat a high-priority objective for Fender's blue butterfly conservation.

Fender's blue butterfly is a rare species endemic to the Willamette Valley. Female adult butterflies oviposit small white eggs on the undersides of Kincaid's lupine leaves in May and June. After eggs hatch a few weeks later, larvae feed on Kincaid's lupine leaves until the plants begin to senesce in early July. After feeding, the larvae enter diapause and overwinter in the soil near the base of plants. During the following spring, larvae emerge from diapause and begin feeding on young Kincaid's lupine leaves and inflorescences before pupating for several weeks and emerging as butterflies to restart the cycle.



Figure 2. Fender's blue butterfly (*Icaricia icarioides fenderi*; left) and Kincaid's lupine (*Lupinus oregonus*; right).

In recent years, the Kincaid's lupine and Fender's blue butterfly populations at Fir Butte have been among the largest across their respective geographic ranges. As a result, this site is critical for meeting delisting goals for both species as referenced in the 2010 Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington (hereafter the "Recovery Plan") (U.S. Fish and Wildlife Service 2010).

The BLM began partnering with the Institute for Applied Ecology (IAE) in the early 2000's to monitor the Kincaid's lupine population at Fir Butte. As of 2012, IAE has also been performing habitat restoration activities at the site in support of both species. Prior to acquisition by the BLM in 1997, Fir Butte was used as a horse pasture and hay field. Overall habitat quality at the site was poor, with heavy infestations of introduced plants such as tall oatgrass (*Arrhenatherum elatius*), annual grasses, and Himalayan blackberry (*Rubus bifrons*).

Since IAE began restoration activities, the Fender's blue butterfly population has remained relatively stable or increased, with annual fluctuations (Diaz and Harris 2024), while the Kincaid's lupine population has steadily increased, also with annual fluctuations (see Section 4.2.1 below). While the site does not yet meet all habitat quality and population benchmarks for listed species as identified in the Recovery Plan (U.S. Fish and Wildlife Service 2010), conditions at this site have been moving in the right direction. Continued management actions including weed treatments, prescribed burning, native seeding, and planting will help keep recovery goals on track.

2. GOALS AND OBJECTIVES

The goal of this project is to improve habitat conditions at Fir Butte such that its populations of Kincaid's lupine and Fender's blue butterfly contribute to USFWS delisting objectives. We aim to do this by decreasing the abundance of non-native species and increasing the abundance and diversity of native species.

Specific objectives for restoration and maintenance of this sensitive habitat include:

- Maintain or increase Kincaid's lupine foliar cover.
- Reduce Himalayan blackberry to below 5% absolute cover.
- Reduce tall oatgrass to below 5% absolute cover.
- Remove all meadow knapweed (*Centaurea pratensis*) and Scotch broom (*Cytisus scoparius*).
- Increase native species relative cover to 50% or greater.

Specific monitoring goals include:

- Determine the abundance of Kincaid's lupine and summarize long term population trends.
- Summarize plant community composition to assess whether habitat quality thresholds for recovery are met.
- Obtain pre- and post-treatment data for prescribed fire and herbicide treatments.

This report summarizes the restoration and monitoring activities at Fir Butte in 2024.

3. 2024 RESTORATION ACTIONS

IAE continued key habitat restoration activities at Fir Butte in support of Kincaid's lupine and Fender's blue butterfly in 2024, including spot spraying and hand pulling priority invasive weeds, planting native nectar resources, and seeding and planting native bunchgrasses (Table 1, Figure 3). As in other recent years (Reed et al. 2024), most of our efforts were focused within the Northeast (NE) and Southeast (SE) management units and less so in the Northwest (NW) and Southwest (SW) units. See Appendix 1 for a summary of all activities completed between 2008 to 2023, Appendix 2 for a map of the site's prescribed burn history, and Appendix 4 for annual photo point images.

Table 1. 2024 activities completed by IAE at Fir Butte.

Date	Activity	Management Unit(s)	Description
1/23/2024	Site visit	All	Scouted for meadow knapweed and planned upcoming spot spray treatments.
2/6/2024	Weed treatment (spot spray)	NE, SE	Applied glyphosate (RoundUp Custom) targeting tall oatgrass, common velvetgrass, false dandelion, and hedge bindweed.
2/27/2024	Site visit	All	Assessed spot spray efficacy and monitored fall 2023 nectar plantings.
3/7/2024	Weed treatment (spot spray)	SE	Applied glyphosate (RoundUp Custom) targeting tall oatgrass and false dandelion.
3/13/2024	Planting	SE	Planted 233 California oatgrass plugs, 75 barestem biscuitroot tubers, and 100 Oregon geranium bare roots within patches of bare ground and recently sprayed vegetation.
4/1/2024	Weed treatment (spot spray)	NW, NE, SE	Applied glyphosate (RoundUp Custom) targeting tall oatgrass, orchardgrass, and meadow knapweed.
4/3/2024	Planting	SE	Planted 1000 Oregon iris seedlings.
5/20/2024	Site visit	All	Annual photo point monitoring.
7/22/2024	Weed treatment (manual)	All	Hand pulled and dug flowering meadow knapweed across site.
8/21/2024	Weed treatment (spot spray)	All	Applied triclopyr (Garlon 3A) across entire site targeting Himalayan blackberry.
10/28/2024	Site visit	All	Assessed bare ground for seeding.
11/14/2024	Planting	NW	Planted approximately 100 narrowleaf onion bulbs.
12/12/2024	Seeding	NE, SE	Hand broadcast 2 lb Roemer's fescue seed into patches of disturbed ground, covering approximately 3 acres.

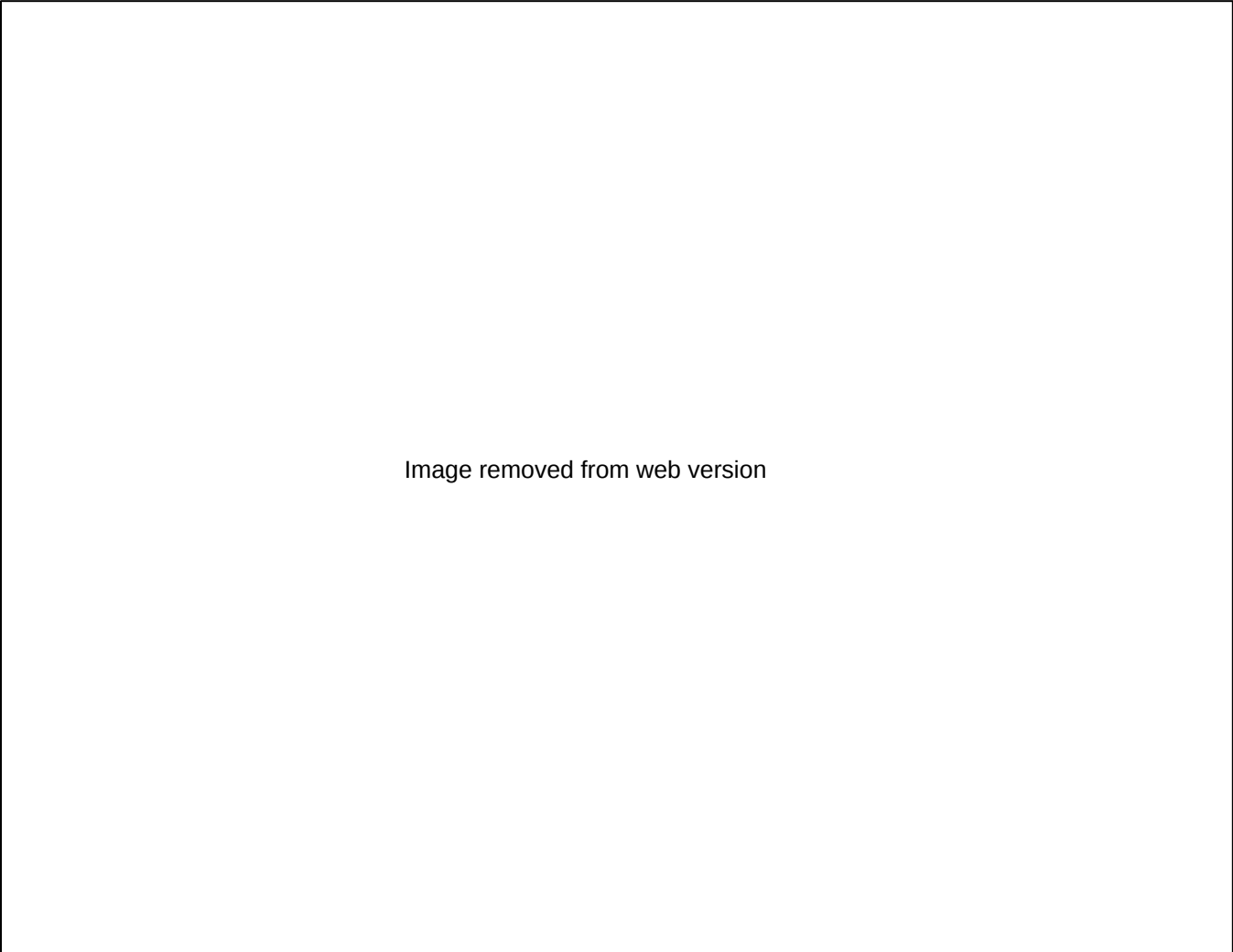


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Figure 3. 2024 herbicide, manual removal, planting, and seeding treatments at Fir Butte by IAE. Red points identify meadow knapweed (*Centaurea pratensis*) targeted via spot spray and hand pulling.

3.1. Weed treatments

Although conditions have improved substantially for Kincaid's lupine and Fender's blue butterfly at Fir Butte through the years, several weed species continue to pose a threat to their habitat. For example, invasive woody species including Himalayan blackberry and Scotch broom remain present at the site (albeit in low abundances) and threaten to create shrubby conditions. Non-native perennial grasses including tall oatgrass, common velvetgrass (*Holcus lanatus*), colonial bentgrass (*Agrostis capillaris*), and orchardgrass (*Dactylis glomerata*) are widespread at the site and create tall, dense vegetation that outcompetes Kincaid's lupine and obstructs butterfly nectar resources. Non-native annual grasses including rattail fescue (*Vulpia myuros*), Ripgut brome (*Bromus diandrus*), and soft brome (*Bromus hordeaceus*) tend to emerge early in the season and cover ground before native prairie seeds can germinate. They also quickly use up limited soil water resources in the spring. Two widespread non-native forbs at Fir Butte are false dandelion (*Hypochaeris radicata*) and Queen Anne's lace (*Daucus carota*), which also occupy a lot of ground space and are prolific seed producers. Meadow knapweed is an aggressive invasive weed

present in low abundance at Fir Butte, but with great potential to spread due to its high seed proliferation and resilience to treatments. Finally, even some native species found at the site such as bracken fern (*Pteridium aquilinum*) and hedge bindweed (*Calystegia sepium*) are a concern given their abilities to overtake native herbaceous species and dominate an area.

In 2024, IAE performed multiple treatments at Fir Butte targeting high priority weeds to reduce their abundances (Table 1, Figure 3). In February, we treated patches of tall oatgrass, common velvetgrass, false dandelion, and hedge bindweed with RoundUp Custom (glyphosate), primarily within the NE and SE units. We repeated a similar treatment in March within a smaller section of the SE unit, focusing particularly on tall oatgrass and false dandelion, and again in April, this time along the northern and eastern edges of the site and including orchardgrass and meadow knapweed as targets. In July, IAE dug up all flowering meadow knapweed that could be found across the site and disposed of the biomass. We used shovels and other hand tools to remove as much of the root mass as possible to prevent this aggressive invader from reemerging. Finally, IAE spot sprayed Himalayan blackberry across the entire site in August using Garlon 3A (triclopyr). We also targeted any meadow knapweed encountered during that treatment.



Figure 4. Dead tall oatgrass (*Arrhenatherum elatius*) on April 1, 2024, after being spot sprayed in March, with newly emerging Kincaid's lupine (*Lupinus oreganus*) around the base. Another spot spray occurred on April 1 (see blue sprayed grass in background), using plant shields to protect the Kincaid's lupine.

3.2. Planting and seeding

While Fir Butte does contain a diverse assemblage of native prairie species already, continuing to add native plant materials is necessary for the site to contribute toward delisting goals for Kincaid's lupine and Fender's blue butterfly. Non-native cover still far exceeds native cover and some native functional groups like perennial bunchgrasses are especially uncommon. Fender's blue butterfly could also benefit from having a wider array of nectar resources available throughout the flight season, given that most nectar flowers at the site are Kincaid's lupine and rose checkermallow (*Sidalcea malviflora* ssp. *virgata*). Planting and seeding natives following weed treatments and other disturbances (such as prescribed fire) is a great way to prevent non-native recolonization, bolster native cover, and diversify nectar resources.

In 2024, IAE continued to make planting and seeding native species a priority at Fir Butte (Table 1, Figure 3). In March and April, we planted 233 California oatgrass (*Danthonia californica*) plugs, 75 barestem biscuitroot (*Lomatium nudicaule*) tubers, 100 Oregon geranium (*Geranium oreganum*) bare roots, and 1,000 Oregon iris (*Iris tenax*) seedlings into recently sprayed patches and bare ground in the NE and SE units. In November within the NW unit, we scalped a small patch of non-native grass with a shovel and buried approximately 100 narrowleaf onion (*Allium amplexans*) bulbs. This was a technique we implemented in fall 2023 to great effect, as it resulted in dense "allium bomb" clusters in spring 2024 that attracted Fender's blue butterfly (Figure 5). Lastly, we broadcast 2 lbs of Roemer's fescue (*Festuca roemerii*) seed into patches of disturbed ground across the NE and SE units in December.



Figure 5. Left: A dense flowering patch of narrowleaf onion (*Allium amplexans*) in spring 2024, resulting from a scalp-and-bury planting technique implemented in fall 2023. Right: Fender's blue butterfly nectaring in narrowleaf onion clusters on May 20, 2024.

4. 2024 MONITORING AND HABITAT ASSESSMENT

In 2024, IAE monitored the Kincaid's lupine population as well as the entire upland prairie plant community at Fir Butte using the methods described below.

4.1. Methods

4.1.1. Kincaid's lupine monitoring

ORIGINAL PLOT DESIGN

In 1998, a 216m x 288m macroplot was established covering the entire area occupied by Kincaid's lupine at Fir Butte. This macroplot was further divided into 18 subplots, each 24m x 108m with the long axis running west to east (Figure 6). Within each of the 18 subplots were two nested 100m belt transects ($n = 36$) surrounded by a 2m wide buffer on each of the long sides and a 4m wide buffer on each of the narrow sides. Transects were marked on both ends with concrete markers. Corners of the macroplots were marked with t-posts or concrete markers. Each fence post or marker was labeled with a pre-numbered aluminum tag. Additional information regarding initial plot establishment can be found in Thorpe (2011).

Currently, IAE continues to monitor the site using these transects. From 1998-2010, both the north and south sides of each transect were monitored for Kincaid's lupine foliar cover and target weed species. Since 2011, only the north side of the transects are being monitored.

2024 MONITORING METHODS

In 2024, IAE estimated the Kincaid's lupine foliar cover by measuring the approximate rectangular area occupied by a cluster of plants in centimeters. Population estimates for Kincaid's lupine were made by averaging the data across all monitored transects ($n = 36$) and multiplying by the total number of possible 100m belt-transects at the site ($n = 460$). Each 100m transect was divided into 5m sections. The foliar cover and count of mature and aborted racemes were recorded for each 5m section. Additionally, staff noted the presence of Kincaid's lupine seedlings observed in the monitoring transects.



Figure 6. Plot layout for Kincaid's lupine (*Lupinus oreganus*) monitoring at Fir Butte. The entire occupied portion of the site is divided into 18 subplots. Two 100m belt-transects are monitored in each subplot in 1m x 5m sections.

4.1.2. Vegetation community monitoring

Vegetation community monitoring activities were guided by management actions, the need to address habitat quality standards as described in the Recovery Plan, management thresholds set forth by BLM, and funding availability. In 2024, habitat monitoring focused on evaluating target weed species presence and absolute cover along Kincaid's lupine monitoring transects and absolute cover to species level in a randomly selected location along each monitoring transect. Monitoring the plant community along each of the transects allows for an assessment of changes in response to management treatment by species or functional groups and provides pre-treatment data for portions of the site which are scheduled to receive management treatments soon.

PRIORITY WEEDS

In conjunction with Kincaid's lupine monitoring, we recorded the absolute cover of four high-priority invasive weeds (Himalayan blackberry, tall oatgrass, bracken fern, and hedge bindweed) and recorded the presence/absence of meadow knapweed within the same 5m transect sections used to monitor Kincaid's lupine. We calculated confidence intervals for the absolute cover estimates by considering the average absolute cover for each species in each transect. These measurements allow us to quantify changes in weed species cover and assess management effects in conjunction with changes in Kincaid's lupine foliar cover.

PERCENT COVER BY MANAGEMENT UNIT

In 2024 we monitored 1m² quadrats to the species level in two randomly selected locations along each monitoring transect. Random numbers were generated between 0-99, and the quadrat was placed on the north side of the tape at the meter mark of the randomly generated number. We assessed the absolute cover of all vascular plants and relative cover of five ground-cover types. Ground-cover classes are equal to 100% and include bare soil, litter, rock, moss, and basal vegetation. We visually estimated absolute cover to the nearest 1%; for species occurring at <1% cover, we estimated cover to 0.1% or 0.5%. We then aggregated data to the functional group level (Introduced Forbs, Native Forbs, Introduced Graminoids, Native Graminoids, Fern, Tree/shrub, Bareground, and Litter) for each of the three management units (NE, SE, and SW units) and also calculated relative cover. Species names and supplementary information including nativity and duration (annual, biennial or perennial) followed the USDA Plants Database (plants.usda.gov/home) and local floras.

4.2. Results

4.2.1. Kincaid's lupine monitoring

Kincaid's lupine foliar cover at Fir Butte has generally trended upward since monitoring began in 1998. However, the estimated Kincaid's lupine foliar cover in 2024 was 5,082 m² ($\pm 1,391$ m²), representing a 32% decrease from 2023 (Figure 7, Appendix 3). Raceme count has also followed a similar upward trend, but the 2024 raceme count was the lowest observed since 2006 with an estimate of only 52,593 ($\pm 20,990$) mature racemes (Figure 8, Appendix 3).

Between 2018-2024, the more intensively managed NE and SE units continued to show a greater increase in Kincaid's lupine foliar cover since 2018 compared to the less intensively managed SW unit (Figure 9). Raceme counts, on the other hand, increased but then fluctuated in the first and second years post-burn for the NE and SE units, while remaining stable in the SW unit (Figure 10). Raceme counts

dropped in 2024 in all units, possibly due to a site-wide phenomenon unrelated to treatment activities (such as weather conditions).

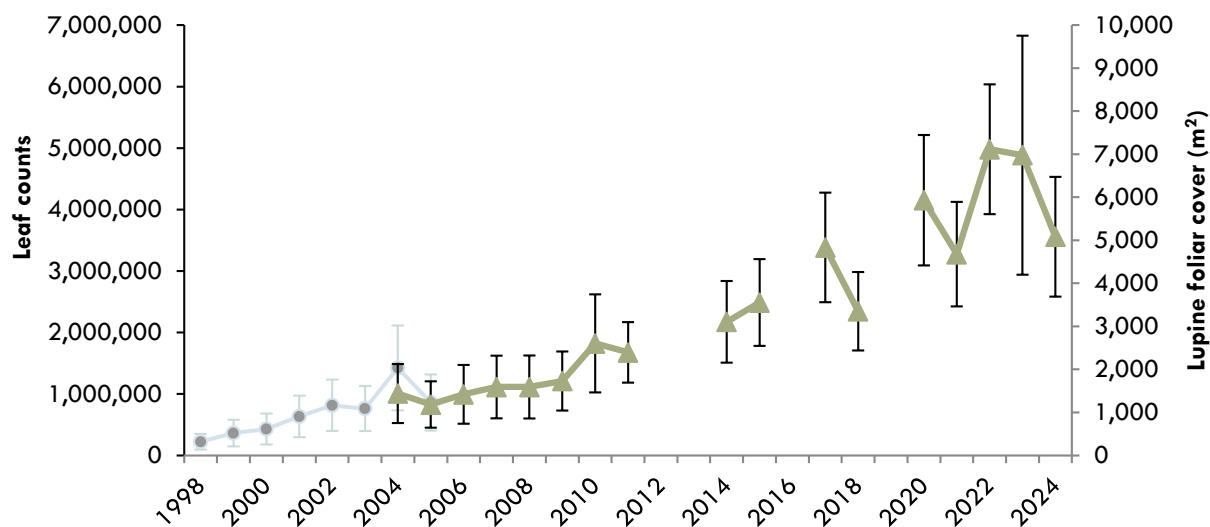


Figure 7. Kincaid's lupine (*Lupinus oreganus*) foliar cover (green lines with triangles; right Y-axis) and leaf counts (grey lines with circles; left Y-axis) at Fir Butte from 1998-2024. Error bars represent 95% confidence intervals. Data was not recorded every year. From 1998-2003 lupine was measured using leaf counts, in 2004 and 2005 data collection included both leaf count and foliar cover, and in 2006 data collection transitioned to foliar cover.

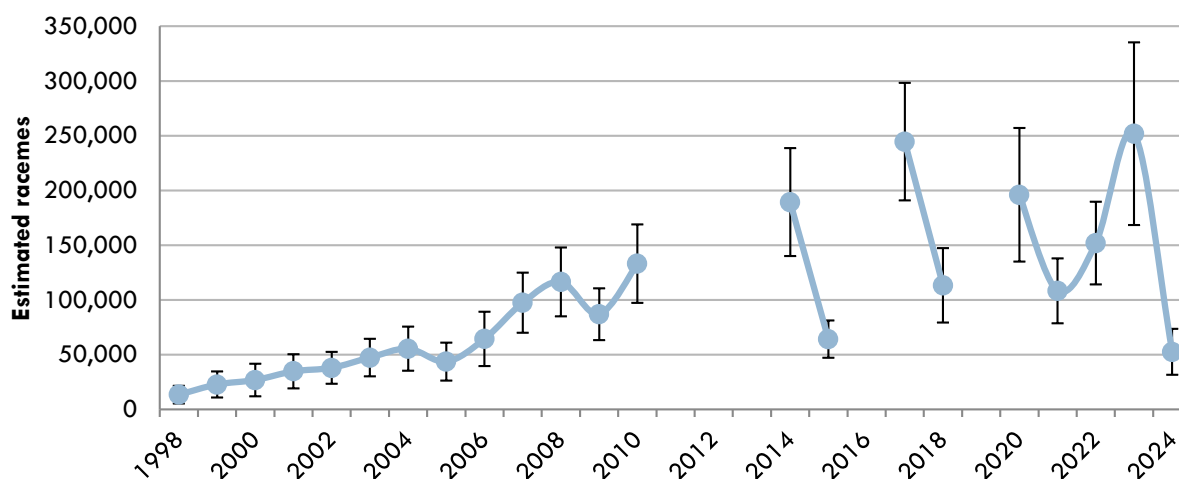


Figure 8. Estimated number of mature Kincaid's lupine (*Lupinus oreganus*) racemes at Fir Butte from 1998-2024. Data was not recorded every year. Error bars represent 95% confidence intervals.

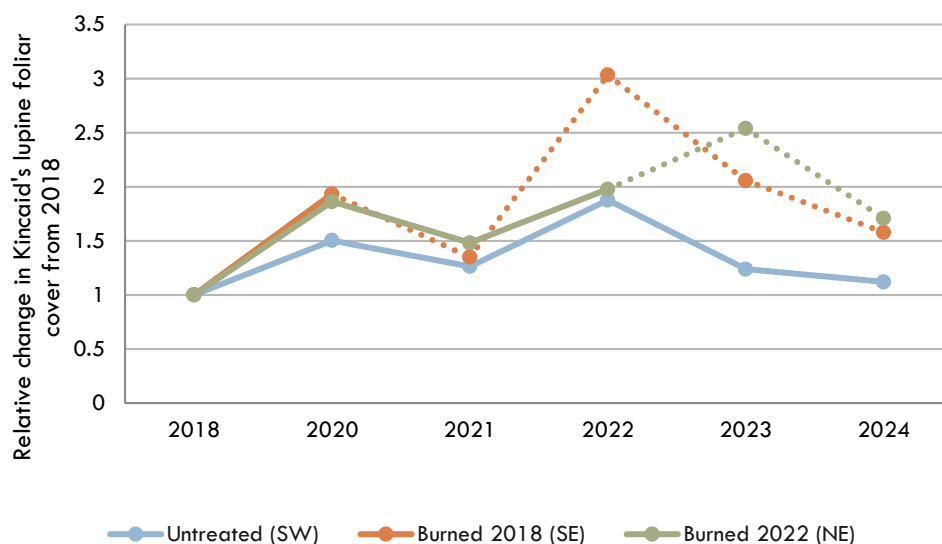


Figure 9. Relative change in Kincaid's lupine (*Lupinus oreganus*) foliar cover in the burned (SE and NE) and unburned (SW) units from 2018 to present. Dotted lines indicate years following the most recent prescribed burn. The SW unit has not burned since 2008.

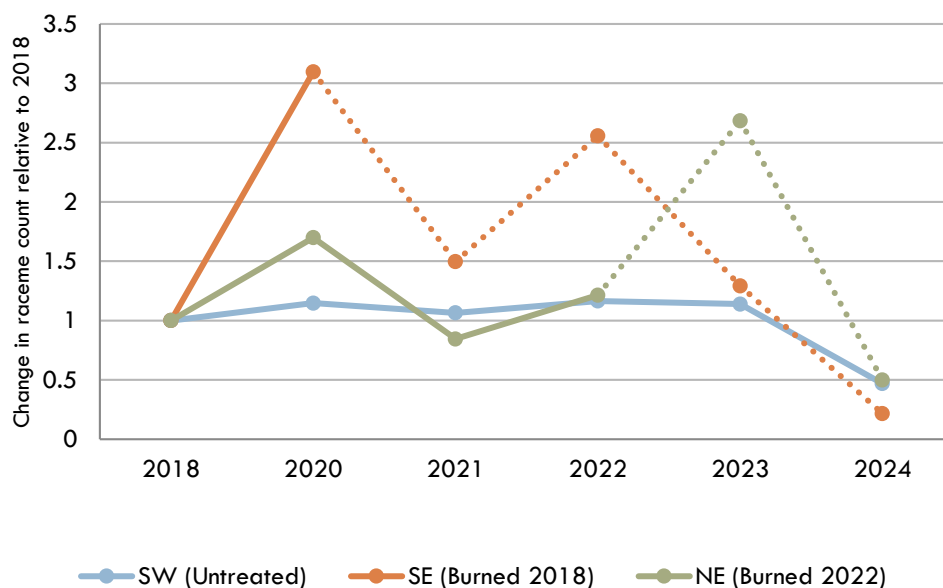


Figure 10. Relative change in raceme count of Kincaid's lupine (*Lupinus oreganus*) in the burned (SE and NE) and unburned (SW) units from 2018 to present. Dotted lines indicate years following the most recent prescribed burn. The SW unit has not burned since 2008.

4.2.2. Vegetation community monitoring

PRIORITY WEEDS

All five priority weed species monitored within the Kincaid's lupine transects declined in 2024 compared to 2023 (Table 2). In 2024, the average Himalayan blackberry absolute cover was 0.4% ($\pm 0.1\%$)

(Figure 11), remaining far below the 5% threshold for meeting recovery requirements as defined in the Habitat Recovery Plan (U.S. Fish and Wildlife Service 2010). Tall oatgrass remained above the 5% threshold in 2024 at 11.0% ($\pm 5.7\%$) but declined substantially relative to 2023 (Table 2). Both bracken fern and hedge bindweed remain low in 2024 at 0.5% ($\pm 0.3\%$) and 0.5% ($\pm 1.0\%$), respectively (Table 2). Hedge bindweed continues to only be observed in sporadic patches within the western portion of the Kincaid's lupine habitat, but some monitoring plots do have hedge bindweed cover as high as 80%. Meadow knapweed was only observed within one subplot in 2024, representing a substantial decline compared to 2023 (Table 2).

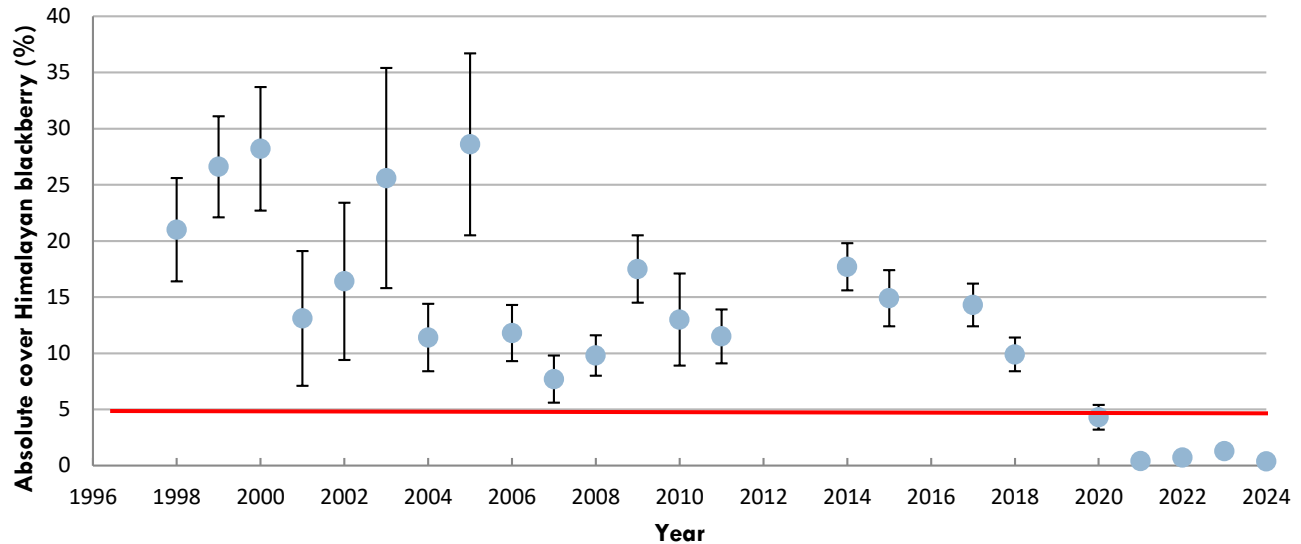


Figure 11. Himalayan blackberry (*Rubus bifrons*) absolute percent cover at Fir Butte from 1998 to 2024. The red line represents the 5% cover management threshold. Data was not collected every year. Error bars represent 95% confidence interval; error bars in 2021-24 are small and thus not visible at the scale of this graph (Table 2).

Table 2. Himalayan blackberry (*Rubus bifrons*), tall oatgrass (*Arrhenatherum elatius*), bracken fern (*Pteridium aquilinum*), and hedge bindweed (*Calystegia sepium*) absolute percent cover, and quantity of plots (out of 720 in total) with meadow knapweed (*Centaurea pratensis*) present, at Fir Butte along 100m x 1m transects monitored from 1998 to present. “-” indicates data was not collected that year.

Year	Average % cover								# 5m x 1m plots with meadow knapweed present
	Himalayan blackberry		Tall oatgrass*		Bracken fern		Hedge bindweed		
	Average cover	95% CI	Average cover	95% CI	Average cover	95% CI	Average cover	95% CI	
1998	21.0	±4.6	-	-	-	-	-	-	-
1999	26.6	±4.5	-	-	-	-	-	-	-
2000	28.2	±5.5	-	-	-	-	-	-	-
2001	13.1	±6.0	-	-	-	-	-	-	-
2002	16.4	±7.0	-	-	-	-	-	-	-
2003	25.6	±9.8	-	-	-	-	-	-	-
2004	11.4	±3.0	-	-	-	-	-	-	-
2005	28.6	±8.1	-	-	-	-	-	-	-
2006	11.8	±2.5	-	-	-	-	-	-	-
2007	7.7	±2.1	-	-	-	-	-	-	-
2008	9.8	±1.8	-	-	-	-	-	-	-
2009	17.5	±3.0	-	-	-	-	-	-	-
2010	13.0	±4.1	-	-	-	-	-	-	-
2011	11.5	±2.4	-	-	1.7	±0.7	-	-	5
2012	-	-	-	-	-	-	-	-	-
2013	-	-	-	-	-	-	-	-	-
2014	17.7	±2.1	-	-	4.2	±2.1	-	-	2
2015	14.9	±2.5	-	-	3.6	±1.5	-	-	3
2016	-	-	-	-	-	-	-	-	-
2017	14.3	±1.9	14.6	±4.9	4.9	±2.3	-	-	4
2018**	9.9	±1.5	9.0	±4.6	3.4	±1.7	2.1	±2.0	2
2019	-	-	-	-	-	-	-	-	-
2020	4.3	±1.1	16.2	±6.2	2.6	±1.1	2.3	±2.1	3
2021	0.4	±0.1	12.2	±5.5	1.1	±0.6	0.9	±1.0	3
2022	0.7	±0.2	-	-	0.2	±0.2	1.7	±1.9	0
2023	1.3	±0.5	18.8	±8.8	0.9	±0.6	0.9	±1	33
2024	0.4	±0.1	11.0	±5.7	0.5	±0.3	0.5	±1.0	1

* Prior to 2017, only presence/absence of tall oatgrass was recorded in the 5m sections for 100m transects.

** In 2018, the site was mowed with a string trimmer prior to monitoring.

PERCENT COVER BY MANAGEMENT UNIT

Plant community data is presented here separately by management units within Kincaid's lupine habitat: the SE unit (burned in fall 2018), NE unit (burned in fall 2022), and the SW unit (not burned since 2008). Data is reported as absolute cover by functional group (Table 3), relative cover by functional group (Table 4), and absolute cover of select species (Table 5).

Southeast unit:

In the SE unit in 2024, introduced forbs and introduced graminoids remained the dominant functional groups, collectively accounting for over 88% of relative cover (Table 4). Introduced forbs now make up nearly half of the entire plant community (49.7%), with false dandelion (*Hypochaeris radicata*) and Queen Anne's lace (*Daucus carota*) as the most abundant representatives (Table 5). Since the 2018 prescribed burn, the graminoid composition has shifted towards a higher proportion of annual grasses compared to perennials (Table 5). Dominant grasses in 2024 included the non-native annuals rattail fescue (*Vulpia myuros*, 41% $\pm$ 14% absolute cover) and soft brome (*Bromus hordeaceus*, 10% $\pm$ 9% absolute cover), as well as the non-native perennial colonial bentgrass (*Agrostis capillaris*, 11% $\pm$ 9% absolute cover) (Table 5). Native forbs and native grasses both increased slightly in 2024 relative to 2023 in terms of absolute cover (Table 3), but still represent a small proportion of the total plant community in terms of relative cover (Table 4).

Northeast unit:

In the NE unit in 2024, both introduced forbs and introduced graminoids increased in absolute and relative cover compared to 2023 (Table 3, Table 4). Together, they now comprise over 66% of the entire plant community by relative cover, whereas in 2023 they represented <45%. By contrast, native forbs and native graminoids decreased in absolute and relative cover over the same period (Table 3, Table 4). Despite these shifts, introduced forbs and introduced graminoids remain below their pre-burn (2017) levels, while native forbs and native graminoids continue to exceed their pre-burn levels. Among native species, Kincaid's lupine and rose checkermallow continue to increase in cover, with Kincaid's lupine remaining the most abundant species overall (Table 5).

Southwest unit:

In the SW unit in 2024, introduced graminoids remained the dominant functional group with 63% ($\pm$ 11%) relative cover (Table 4). Introduced forbs and native forbs now have approximately equal abundance at ~17% relative cover, after native forbs more than doubled between 2023 to 2024 (Table 4). Tall oatgrass is by far the most abundant species with 42.2% ($\pm$ 15.8%) absolute cover, followed by soft brome at 9.4% ($\pm$ 4.4%) and then Kincaid's lupine at 8.5% ($\pm$ 4.6%) (Table 5).

Table 3. Average absolute cover by functional group and ground cover class in the southeast (SE), northeast (NE), and southwest (SW) management units. Values in parentheses represent 95% confidence intervals. Values to the left of the dashed line represent 'pre-burn' data for the SE and NE units.

	SE unit (burned fall 2018)						NE unit (burned fall 2022)			SW unit (unburned)	
	2018	2020	2021	2022	2023	2024	2017	2023	2024	2023	2024
Introduced Forbs	9.8 (3.7)	15.6 (5.8)	22.6 (5.6)	28.9 (10.6)	20.6 (8.8)	27.3 (8.1)	43.9 (18.8)	12.7 (4.1)	25.5 (4.1)	9.9 (5.2)	11.2 (3.8)
Native Forbs	2.5 (1.3)	5.7 (4.0)	4.5 (2.2)	6.1 (4.2)	4.9 (2.8)	5.6 (2.4)	10.4 (9.3)	20.6 (7.3)	18.4 (6.3)	5.6 (5.4)	12.3 (5.3)
Introduced Graminoids	15.3 (4.6)	17.8 (9.3)	3.5 (1.2)	29.4 (9.4)	19.7 (8.5)	26.0 (11.7)	58.5 (15.4)	8.0 (4.1)	14.5 (4.9)	53.3 (10.8)	58.1 (14.0)
Native Graminoids	1.7 (1.4)	0.2 (0.4)	0.0 (0.0)	0.0 (0.0)	0.2 (0.2)	0.8 (0.6)	0.6 (0.6)	6.0 (1.8)	3.4 (1.3)	1.0 (1.0)	1.2 (0.9)
Fern	3.1 (2.5)	2.3 (3.1)	1.5 (1.7)	0.3 (0.4)	1.2 (1.6)	0.0 (0.0)	6.7 (9.4)	0.7 (1.4)	0.1 (0.1)	0.2 (0.2)	0.7 (0.8)
Tree/shrub	3.7 (2.4)	9.0 (8.3)	1.9 (1.5)	0.3 (0.4)	0.6 (0.7)	0.2 (0.3)	15.3 (10.1)	1.5 (1.0)	0.5 (0.4)	1.0 (0.8)	0.3 (0.4)
Bareground	1.0 (1.0)	14.8 (8.0)	20.0 (9.3)	12.8 (7.3)	9.2 (5.5)	6.8 (5.0)	4.6 (4.6)	39.6 (8.5)	9.4 (5.7)	4.9 (4.5)	6.1 (5.9)
Litter	64.7 (5.7)	34.2 (7.3)	54.1 (10.2)	48.9 (7.6)	50.4 (12.1)	68.6 (12.0)	90.0 (6.8)	19.1 (6.7)	62.3 (8.4)	46.3 (9.4)	73.1 (7.9)

Table 4. Relative percent cover by functional group in the southeast (SE), northeast (NE), and southwest (SW) management units. Values in parentheses represent 95% confidence intervals. Values to the left of the dashed line represent pre-burn values.

	SE unit (burned fall 2018)						NE unit (burned fall 2022)			SW unit (unburned)	
	2018	2020	2021	2022	2023	2024	2017	2023	2024	2023	2024
Introduced Forbs	27.4 (8.9)	43.0 (12.6)	63.2 (7.5)	43.0 (12.0)	45.6 (11.3)	49.7 (10.9)	32.6 (14.2)	27.9 (7.3)	42.8 (7.3)	15.0 (7.8)	17.2 (6.8)
Native Forbs	7.7 (4.1)	11.6 (5.3)	13.3 (4.8)	7.8 (4.6)	11.1 (5.7)	10.4 (4.4)	6.8 (6.2)	36.9 (10.3)	27.1 (7.6)	8.8 (8.0)	17.8 (8.2)
Introduced Graminoids	41.8 (9.8)	30.2 (11.0)	16.7 (6.9)	48.3 (13.0)	39.3 (10.8)	38.3 (10.8)	45.5 (11.7)	16.7 (7.6)	24.1 (8.1)	72.3 (10.3)	62.5 (10.9)
Native Graminoids	4.3 (3.5)	0.9 (1.7)	0.0 (0.0)	0.0 (0.0)	0.5 (0.7)	1.4 (1.1)	0.4 (0.4)	13.7 (4.5)	5.3 (1.9)	1.9 (1.9)	1.6 (1.2)
Fern	9.6 (5.8)	3.8 (4.3)	3.0 (3.4)	0.3 (0.5)	2.7 (3.7)	0.0 (0.0)	4.6 (6.3)	1.0 (1.9)	0.1 (0.1)	0.3 (0.3)	0.6 (0.7)
Tree/shrub	9.2 (4.9)	10.4 (7.5)	3.8 (2.5)	0.5 (0.6)	0.8 (0.9)	0.2 (0.3)	10.1 (5.8)	3.8 (2.5)	0.7 (0.6)	1.8 (1.6)	0.2 (0.3)
Meeting Recovery Criteria? (Introduced cover <50% relative cover)	No	No	No	No	No	No	No	No	No	No	No
Tree/Shrub cover <5%	No	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes

Table 5. Native and introduced richness (averaged per plot) along with select species absolute cover recorded in each of the randomly selected 1m² quadrats across the southeast (SE), northeast (NE), and southwest (SW) management units. Values in parentheses for percent cover represent 95% confidence intervals. Values to the left of the dashed line represent pre-burn values.

	SE unit (burned fall 2018)						NE unit (burned fall 2022)			SW unit (unburned)	
	2018	2020	2021	2022	2023	2024	2017	2023	2024	2023	2024
Average Native Richness per plot	3	2	2	3	1	2	1	1	3	1	2
Average Introduced Richness per plot	11	8	8	10	7	9	12	7	10	5	7
<u>FERNS</u>											
<i>Pteridium aquilinum</i>	3.1 (2.5)	2.3 (3.1)	1.5 (1.7)	0.3 (0.4)	1.2 (1.6)	0.0 (0.0)	6.7 (9.4)	0.1 (0.1)	1.7 (1.5)	0.2 (0.2)	0.7 (0.8)
<u>FORBS</u>											
<i>Daucus carota</i>	0.4 (0.3)	2.1 (1.6)	2.9 (2.7)	10.3 (8.3)	6.5 (3.9)	7.8 (4.6)	22.5 (16.7)	5.5 (2.3)	6.2 (2.8)	4.9 (2.9)	3.9 (2.0)
<i>Hypochaeris radicata</i>	1.6 (0.7)	0.6 (0.5)	2.0 (1.8)	10.3 (6.9)	9.9 (7.1)	8.4 (3.3)	1.3 (1.3)	0.6 (0.5)	1.1 (0.7)	0.0 (0.0)	0.4 (0.4)
<i>Lupinus oreganus</i>	0.7 (0.6)	3.6 (3.9)	3.2 (2.2)	4.0 (4.2)	4.5 (2.8)	3.0 (2.1)	9.9 (9.3)	12.9 (6.2)	14.2 (3.4)	5.3 (5.4)	8.5 (4.6)
<i>Sidalcea virgata</i>	0.9 (0.7)	0.1 (0.1)	0.2 (0.4)	0.3 (0.3)	0.0 (0.0)	0.5 (0.4)	0.1 (0.3)	1.0 (0.9)	1.2(0/7)	0.1 (0.2)	1.0 (1.1)
<u>GRAMINOIDS</u>											
<i>Agrostis capillaris</i>	13.1 (4.7)	12.1 (8.2)	1.5 (0.8)	6.2 (7.1)	12.6 (7.8)	10.6 (9.1)	38.2 (11.2)	3.1 (1.9)	2.6 (2.1)	18.8 (9.5)	2.6 (1.7)
<i>Anthoxanthum odoratum</i>	0.9 (1.0)	1.2 (1.2)	0.3 (0.5)	3.2 (4.2)	0.2 (0.3)	1.4 (1.5)	4.4 (4.4)	4.2 (3.6)	2.0 (1.1)	0.0 (0.0)	2.8 (2.4)
<i>Arrhenatherum elatius*</i>	0.5 (0.4)	3.4 (2.9)	0.1 (0.1)	0.3 (0.7)	5.2 (5.4)	0.6 (0.5)	6.4 (8.5)	0.3 (0.2)	2.3 (1.5)	32.3 (11.5)	42.2 (15.8)
<i>Bromus rigidus</i>	0.3 (0.4)	0.2 (0.2)	0.1 (0.1)	0.0 (0.0)	0.2 (0.2)	0.2 (0.3)	1.3 (1.3)	2.5 (1.2)	2.2 (0.7)	0.4 (0.4)	0.8 (0.6)
<i>Dactylis glomerata</i>	0.5 (0.5)	0.2 (0.4)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.5 (0.6)	0.1 (0.2)	0.2 (0.3)	0.6 (0.9)	0.5 (0.7)
<i>Festuca arundinacea</i>	1.2 (1.4)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.1 (0.1)	0.0 (0.0)	0.0 (0.0)	0.6 (0.9)	0.0 (0.0)	0.0 (0.0)
<i>Vulpia myuros</i>	2.8 (2.1)	0.1 (0.2)	0.8 (0.6)	14.6 (6.3)	9.8 (6.1)	40.8 (14.0)	2.0 (3.3)	22.2 (11.4)	7.1 (3.2)	14.7 (7.4)	4.3 (2.4)
<i>Bromus hordeaceus</i>	0.2 (0.2)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.1 (0.1)	10.2 (8.6)	6.1 (4.1)	0.0 (0.0)	6.5 (2.5)	1.7 (2.4)	9.4 (4.4)
<u>SHRUBS</u>											
<i>Rubus bifrons</i>	3.7 (2.4)	9.0 (8.3)	1.9 (1.5)	0.3 (0.4)	0.3 (0.5)	0.0 (0.0)	15.0 (10.2)	0.5 (0.4)	8.7 (2.8)	0.8 (0.7)	0.3 (0.4)

*In 2018 tall oatgrass (*Arrhenatherum elatius*) had been weedwhacked prior to monitoring, making the 2018 estimate artificially low.

4.3. Discussion

4.3.1. Kincaid's lupine monitoring

Kincaid's lupine foliar cover and raceme counts both decreased sitewide in 2024 compared to 2023. The decline in cover may be partially explained by the fact that 2023 was a post-burn year, as Kincaid's lupine typically responds positively to fire. Additionally, 2024 may have been climatically less favorable for the species or particularly advantageous for competitors, such as the annual grass rattail fescue (*Vulpia myuros*), which increased substantially in the SE unit. Despite the decrease, Kincaid's lupine foliar cover in 2024 remained exceptionally high at Fir Butte compared to most other sites across its range. The 2024 cover estimate still shows a long-term growth trend since monitoring began while also reflecting natural biannual fluctuations in the population.

In contrast, the sharp decline in raceme counts raises more concerns. The 2024 count was the lowest recorded at the site since 2006. Observations of numerous aborted racemes during spring 2024 suggest potential issues, though the underlying causes are unclear. Factors such as unfavorable climatic conditions, increased competition, reduced pollinator activity, or a combination of these may be at play. Previously, our monitoring efforts at Oak Basin in the Coburg Hills suggested that the strongest predictors of aborted racemes were low spring precipitation and high temperature (Giles et al. 2017), and that raceme abortion may be associated with invasive annual grass abundance. Anecdotally, it seemed that the proportion of aborted racemes at Fir Butte in 2024 was greater in the NE and SE units (where there are more annual grasses) compared to the SW unit. Monitoring mature versus aborted racemes in future years may be crucial to determine whether this is an anomaly or part of a more concerning trend. Investigating patterns in raceme abortion—particularly in relation to the composition of the surrounding plant community—could provide valuable insights into the drivers of this decline.

4.3.2. Vegetation community monitoring

PRIORITY WEEDS

The five priority weed species monitored in recent years showed declines in 2024 compared to 2023, underscoring the success of targeted management efforts. Himalayan blackberry, tall oatgrass (in the NE and SE units), meadow knapweed, and hedge bindweed were specifically targeted during 2024 spot-spray herbicide treatments, with positive results. Himalayan blackberry cover has remained below the 5% management goal for five consecutive years, demonstrating sustained control. Tall oatgrass continues to decline across the eastern half of the site, where treatments have been focused. Meadow knapweed is now less prevalent in the central prairie but will remain a priority for eradication along the site's edges. Hedge bindweed cover remains relatively low on average (<1%) across the site, but isolated patches with cover exceeding 80% still exist, with little other vegetation present in these areas. Targeted management of these dense patches is critical to prevent further spread, particularly with planned management activities in the SW unit. Finally, while bracken fern was not directly targeted in 2024, its cover has remained below 1% for three consecutive years, likely due to the cumulative effects of prior treatments and regular mowing. These results emphasize the importance of continued management efforts to maintain control of priority weeds.

PERCENT COVER BY MANAGEMENT UNIT

Southeast unit:

The relative cover of introduced species in the SE unit remains far above the recovery goal of <50% and continues to rise. This increase has been driven by the proliferation of false dandelion, Queen Anne's lace, and non-native annual grasses, with rattail fescue standing out as particularly abundant in 2024.

A key factor behind the lack of improvement since the most recent prescribed burn in 2018 may lie in the management practices employed between 2018 and 2021. During this period, herbicide treatments were largely limited to spot spraying around existing Kincaid's lupine patches, without a post-burn broadcast herbicide application or timely seeding of native species until 2021. This piecemeal approach may have allowed fire-responsive invasive species to thrive in untreated areas, eventually spreading into patches disturbed by herbicide treatments before native seeds could establish.

Northeast unit:

In 2024, the relative cover of introduced species in the NE unit exceeded the recovery goal of <50%. This marks a negative trend compared to 2023, when introduced cover was below 50%, but it remains an improvement over pre-burn levels in 2017. This pattern reflects the typical post-burn dynamic: native species often experience a surge in the first year following a prescribed burn, followed by a gradual resurgence of introduced species as more time passes since the burn. Some natives including Kincaid's lupine still appear to be benefiting from the 2022 prescribed burn, though this advantage may diminish in coming years. These trends underscore the critical importance of maintaining regular prescribed burn intervals of 3–5 years to support native plant communities. Coupling these burns with post-burn herbicide treatments and native seeding is essential to gradually tip the balance toward sustained native dominance over invasive species.

Southwest unit:

The SW unit saw little change in 2024 compared to 2023, with tall oatgrass continuing to dominate the area. Both tall oatgrass and Kincaid's lupine showed increases in absolute cover during 2024. Notably, however, the relative abundance of these two species shifted slightly toward Kincaid's lupine, despite the lack of substantial management treatments in recent years apart from spot spraying for Himalayan blackberry. This positive trend may provide encouraging momentum to implement a more comprehensive treatment plan targeting tall oatgrass in 2025.

5. MANAGEMENT RECOMMENDATIONS

IAE and the BLM's goal at Fir Butte is to improve habitat conditions such that its populations of Kincaid's lupine and Fender's blue butterfly contribute to USFWS delisting objectives. In recent years, the NE and SE management units have been the focus of intensive restoration efforts, including prescribed burns, herbicide treatments, and seeding and planting native species. These actions have successfully reduced the prevalence of high-priority invasive species, including Himalayan blackberry and tall oatgrass, across the eastern half of the site. At the same time, Kincaid's lupine and other natives have shown modest improvement, with the potential for further gains as recent seeding and planting efforts take hold. However, some disturbances have allowed other non-native species, including annual grasses, false dandelion, and Queen Anne's lace, to opportunistically increase. Finding the right balance between these tradeoffs is key to optimizing habitat conditions for Kincaid's lupine and Fender's blue butterfly.

Rattail fescue, false dandelion, and Queen Anne's lace are growing concerns to monitor and manage because of their ability to rapidly colonize disturbed areas. These species can be difficult to control due to their seasonality and seed proliferation. Winter and early spring herbicide applications have proven moderately successful to eliminate dense troublesome patches, but treated areas should be regularly monitored for follow-up treatment needs and sown with competitive native seed to recolonize the space. Queen Anne's lace seed heads can also be collected (manually or mechanically) in late summer to reduce its spread, although this would be labor intensive given its abundance across the site.

While fall is the ideal time for seeding native species, we recommend incorporating at least some native seeding in the winter or spring immediately following significant ground disturbances, such as from spot sprays or other weed treatments. We especially advocate for doing this with native bunchgrass seed such as Roemer's fescue since it is cheap, readily available, and establishes relatively quickly. Since native bunchgrasses are scarce at Fir Butte, this approach would also help bolster this vital functional group. Additionally, seeding native bunchgrasses into areas dominated by false dandelion and Queen Anne's lace would enable us to continue treating these areas with broadleaf-specific herbicides, such as triclopyr or aminopyralid, without compromising the seed we just put down.

Looking ahead, IAE recommends focusing new restoration efforts in the SW unit, where Kincaid's lupine is currently inundated by extensive tall oatgrass. While introducing new disturbances such as fire and herbicide treatments in this area may risk increasing populations of false dandelion, Queen Anne's lace, and non-native annual grasses, these species generally pose less competition to Kincaid's lupine and have a lower impact on butterfly nectar resources compared to tall oatgrass. Therefore, we believe that implementing a targeted treatment plan to reduce tall oatgrass is a worthwhile investment, provided that steps are taken to minimize the spread of other invasive species.

Since grass-specific herbicides are still not permitted on BLM sites, the most effective strategy for addressing tall oatgrass in the southwest unit involves conducting a prescribed burn, followed by applying a broad-spectrum herbicide like glyphosate and then seeding shortly thereafter. Timing the post-burn herbicide application is crucial and depends on precipitation and vegetation green-up conditions. The optimal window typically occurs 2–4 weeks after the burn, when non-native grasses have begun to green up but before most native plants have emerged. Delaying beyond this period increases the risk of impacting too many natives, which would undermine habitat restoration efforts.

To maximize restoration success, seeding the unit within the same season as a prescribed burn, immediately following herbicide treatment, is essential. The absence of timely seeding after the 2022 burn in the NE unit and the 2018 burn in the SE unit likely contributed to the proliferation of invasive species like false dandelion, Queen Anne's lace, and annual grasses in those areas. In the NE unit, herbicide was applied a month after the 2022 burn, but seeding was delayed until fall 2023. Similarly, in the SE unit, spot spraying was conducted for three years following the 2018 burn, but seeding did not occur until fall 2021, leaving disturbed areas vulnerable to weed encroachment. To avoid similar outcomes, future burns should include a post-burn herbicide and seeding plan implemented within the same season. If weather or other constraints prevent herbicide application, seeding should still proceed to boost native cover and suppress invasive species.

The NW unit, while unsuitable for Kincaid's lupine due to its wet prairie habitat, still offers valuable nectar resources for Fender's blue butterfly. Instead of tall oatgrass, the dominant non-native grass here

is colonial bentgrass. Nevertheless, this unit would benefit from similar management strategies. If the NW unit is burned alongside the SW unit, a post-burn herbicide application followed by seeding should also be prioritized to enhance habitat quality. If this unit becomes too saturated for effective post-burn herbicide application, it could just be seeded.

Aside from these priority plans for the two western units in 2025, IAE recommends continuing spot spray and manual treatment efforts site-wide for high priority weeds including Himalayan blackberry, tall oatgrass, meadow knapweed, and Scotch broom. Himalayan blackberry has reached a manageable level throughout the prairie which can likely be maintained with a day or two of spot spraying each summer along with annual end-of-season mowing. Denser patches on the northern, eastern, and southern fencelines have also been targeted and are declining. We recommend continuing to prioritize treatments for Himalayan blackberry along the fencelines to reduce seed spread into the central prairie. Coordinating with neighbors to masticate and treat blackberry along the opposing sides of these fences should also be considered.

Likewise, tall oatgrass is declining within the NE and SE units but should still be targeted during winter and early spring spot sprays to prevent it from expanding again. Meadow knapweed continues to be present in several locations across the site and should remain a priority for several rounds of spraying and/or collecting seed heads each year. Finally, some patches of Scotch broom can be found in the southern half of the SE unit, which should be targeted for hand pulling in early spring when the ground is still wet, but the broom has had enough time to regrow after being mowed.

In 2025, IAE recommends the following tentative work plan at Fir Butte (subject to adaptive management changes):

Table 6. 2025 proposed restoration activities at Fir Butte.

General time frame	Activity	Management unit(s)	Description
January – March (before Kincaid's lupine emerges)	Weed treatments (spot spray)	All (NE, SE for tall oatgrass)	Winter spot sprays for knapweed across site; tall oatgrass, false dandelion, Queen Anne's lace within NE and SE units.
January – April	Weed treatments (manual)	SE, SW	Hand pull Scotch broom across southern areas.
January – April	Seeding	All	Opportunistic seeding of native bunchgrasses into disturbed ground following treatments.
June – August	Weed treatments (spot spray)	All	Summer spot sprays for knapweed across site.
July – August	Weed treatments (manual)	All	Cut and bag knapweed seedheads that were missed during sprays.

General time frame	Activity	Management unit(s)	Description
August – September	Weed treatments (spot spray)	All	Spot spray Himalayan blackberry across site.
September	Site maintenance	NE, SE	BLM end-of-season mow.
October	Site maintenance	NW, SW	BLM prescribed burn.
October – November	Weed treatment (broadcast)	NW, SW	Hire contractor to broadcast glyphosate across burn unit.
October – November	Seeding	NW, SW	Seed burn unit following herbicide treatment (seed already purchased and in IAE cooler).
November – December	Weed treatments (mechanical)	All	Use brush cutters to mow dead blackberry canes along fence lines.

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APPENDICES

Appendix 1. Fir Butte management actions (2023-2008)

Year	Date	Activity	Personnel*	Notes
2023	15-Dec	Site visit	IAE	Checked on plantings and formulated plans for early 2024 treatments.
2023	10-Nov	Planting	IAE, volunteers	Planted thousands of Fender's blue butterfly native nectar plants across site.
2023	13-Oct	Weed control, seeding	IAE	Spot sprayed dense patches of annual grasses in NE section with glyphosate and seeded overtop with 30 lbs native prairie mix. Spot sprayed perennial grasses and meadow knapweed across site.
2023	6-Oct	Seeding	IAE	Seeded NE section (six acres) and portions of SE section (~one acre) with 77 lbs native prairie mix. Marked areas in NE section with dense annual grass patches to treat and seed heavily.
2023	3-Oct	Weed control	IAE	Spot sprayed false dandelion patch in SE section, false dandelion, non-native perennial grasses, and rattail fescue throughout NE section, and meadow knapweed across site with glyphosate.
2023	20-Sep	Site maintenance	BLM Contractor	Mowed eastern 10 acres of site. Western eight acres not mowed because it was originally on the 2023 burn plan.
2023	29-Aug	Weed control	Contractor (R. Franco Restoration)	Spot sprayed Himalayan blackberry and other woodies across entire site.
2023	26-Jul	Site visit	IAE	Site visit to assess woody spot spray needs.
2023	13-Jul	Weed control	IAE, BLM, Youth Corps	Hand pulled Queen Anne's lace from SE section. Hand pulled meadow knapweed across site.
2023	6/27-7/7/23	Monitoring	IAE	Monitoring of plant community, Kincaid's lupine cover, and target woody species.
2023	15-Jun	Weed mapping, weed control	IAE	Mapped tall oatgrass population and formulated plans for long-term control methods. Cut false dandelion heads in SE section and hand pulled dense patch of wild oat (<i>Avena fatua</i>) in NE section.
2023	9-Jun	Weed control	IAE	Hand wiped several patches of tall oatgrass with glyphosate amid Kincaid's lupine in NE section. Spot sprayed false dandelion and meadow knapweed across site with glyphosate. Hand pulled Queen Anne's lace in SE section.

Year	Date	Activity	Personnel*	Notes
2023	19-May	Photopoints	IAE	Photopoints. Kincaid's lupine reaching peak bloom.
2023	9-May	Site visit	IAE	Checked efficacy of 4/27 spot spray and weed dabbing treatments. Spot spray was effective, but weed dabber may not have coated false dandelion with enough herbicide to fully kill.
2023	27-Apr	Weed control	IAE	Spot sprayed large patches of false dandelion and rattail fescue with glyphosate in SE section. Used weed dabber to wipe false dandelion where Kincaid's lupine seedlings were nearby.
2023	29-Mar	Planting	IAE	Planted ~400 dwarf checkermallow in NE section.
2023	23-Mar	Planting	BLM, Youth Corps	Planted ~300 dwarf checkermallow in NE section.
2023	16-Mar	Weed control	IAE	Spot sprayed tall oatgrass, false dandelion, and rattail fescue across NE section with glyphosate. Used plant shields to protect Kincaid's lupine.
2023	14-Mar	Site visit	IAE, BLM	Site visit to discuss spot spray plans targeting tall oatgrass and false dandelion.
2023	5-Mar	Site visit	IAE	Site visit to assess spot spray treatment needs.
2023	11-Jan	Site visit	IAE	Site visit to assess efficacy of November 2022 post-burn broadcast herbicide treatment in NE section.
2022	15-Nov	Weed control	IAE/Habitat Restoration LLC	Broadcast glyphosate over five acre burn unit in NE corner.
2022	4-Oct	Prescribed burn	BLM	Burned five acre unit in NE corner.
2022	21-Sep	Site visit	IAE, BLM	Site visit to discuss fall 2022 plans, upcoming prescribed burn, and seed mix. Checked on mowed areas and efficacy of triclopyr treatment.
2022	2-Sep	Site maintenance	BLM/contractor	Mowed entire site except six acre burn unit in NE corner.
2022	31-Aug	Woody species control	IAE	Spot sprayed woody species throughout northern half of site with triclopyr.
2022	8-Aug	Weed control	IAE, BLM	Pulled knapweed, tansy ragwort, bull thistle, and Scotch broom from entire site.
2022	25-Jul	Weed control	IAE	Pulled Scotch broom from SE corner.
2022	16-May	Weed control	IAE	Spot sprayed meadow knapweed across entire site with glyphosate.
2022	4-Mar	Planting	IAE, BLM	Planted approximately 1000 <i>Sidalcea malviflora</i> plants in nectar island 8a, donated by Heritage Seedlings & Liners, Inc.

Year	Date	Activity	Personnel*	Notes
2022	25-Feb	Site visit	IAE	Site visit to assess conditions.
2021	14-Oct	Seeding	IAE/BLM	Seeded SE corner and nectar island 8a with dew drop drill borrowed from USACE.
2021	4-Oct	Weed control	IAE	Broadcast glyphosate to SE corner and nectar island 8a.
2021	29-Sep	Site visit	IAE/USACE	Site visit to discuss use of seed drill.
2021	14-Sep	Woody species control	IAE/Contractor (IRM)	Treated woody plants throughout meadow.
2021	18-Aug	Weed control	IAE	Spot sprayed bracken fern and hand pulled meadow knapweed.
2021	5-Aug	Mapping	IAE	Mapped tall oatgrass population.
2021	12-Jul	Site visit	IAE/BLM	Site visit to discuss treatment options and seeding.
2021	18-Jun	Weed control	IAE	Spot sprayed SE corner and nectar island 8a.
2021	26-May	Site visit	IAE	Finished flagging lupine in SE corner.
2021	13-May	Site visit	IAE	Site visit to assess herbicide treatment and take photopoints.
2021	3-May	Weed control	IAE	Spot sprayed meadow knapweed, SE corner, and nectar island 8a.
2021	14-Apr	Weed control	IAE	Spot sprayed meadow knapweed and SE corner.
2021	16-Mar	Weed control	IAE	Site visit to assess conditions. Flagged lupine in SE corner.
2021	14-Jan	Weed control	IAE	Spot sprayed SE corner with glyphosate.
2020	22-Dec	Site visit	IAE	Site visit to assess herbicide efficacy.
2020	20-Nov	Site preparation	IAE/BLM/Contractor (IRM)	Broadcast glyphosate to 3.5 ac in SE corner and nectar island 8a.
2020	1-Oct	Woody species control	IAE/BLM/Contractor (NTS)	Spot spray blackberry, hawthorn and rose.
2020	29-Sep	Site visit	IAE/BLM	Site visit, lupine senesced.
2020	August	Weed control	BLM/ LGYC	Hand pull meadow knapweed.
2020	5-Aug	Site visit	IAE/BLM	Site visit to assess conditions.

Year	Date	Activity	Personnel*	Notes
2020	24-Jul	Weed control	IAE/BLM	Complete spot spray with Rodeo/Nu-Film-IR of areas missed during 6/23 spray that was initiated on 7/10. Hand pulled tansy ragwort.
2020	22-Jul	Site visit	IAE/BLM	Site visit by Sally Villegas-Moore, Julia Fields, Rebecca Currin, and Ian Silvernail.
2020	10-Jul	Weed control	IAE/BLM	Spot spray with Rodeo/Nu-Film-IR of areas missed during 6/23 spray.
2020	23-Jun	Weed control	IAE/BLM/Contractor (IRM)	Spot-sprayed Rodeo/Nu-Film-IR with backpacks over 3 acres in SE corner and less than one acre in nectar island 8a. Target was all vegetation outside lupine patches.
2020	5-May	Site visit	IAE	Site visit by Rebecca Currin and Ian Silvernail.
2020	28-Apr	Weed control	IAE/BLM	Spot spray of meadow knapweed throughout site with Rodeo/NuFilm-IR
2020	30-Jan	Weed control	IAE/BLM/Contractor (IRM)	Spot-sprayed Rodeo/Nu-Film-IR with backpacks over 3 acres in SE corner and less than one acre in nectar island 8a. Targeted all vegetation outside lupine patches.
2019	5-Nov	Site preparation	BLM/ LGYC	Removed weed cloth from nectar island 6d
2019	12-Sep	Weed control	IAE/ Contractor (NTS)	Spot sprayed blackberry, hawthorn (<i>Crataegus monogyna</i>), and rose (<i>Rosa</i> sp.)
2019	20-Jul	Site preparation	IAE	Removed pin flags from SE corner to prepare for mowing
2019	24-Jul	Weed control	IAE	Hand pulled and spot sprayed meadow knapweed
2019	11-Jun	Weed control	IAE	Spot sprayed meadow knapweed with 1.5% solution of glyphosate
2019	24-May	Weed control	IAE/ BLM	Mowed tall oatgrass
2019	22-May	Weed control	IAE/ Contractor (IRM)	Applied glyphosate with weed wiper on bracken fern
2019	22-May	Weed control	IAE/ Contractor (IRM)	Spot sprayed bracken fern with 1.5% solution of glyphosate
2019	5/14, 5/15, 5/22	Weed control	IAE	Mowed tall oatgrass and bracken fern
2019	23-Apr	Herbicide application	IAE/ Contractor (IRM)	Spot-sprayed over additional 1.5 acres in SE corner; flagged lupine areas were not sprayed
2019	16-Apr	Herbicide application	IAE/ Contractor (IRM)	Spot-sprayed glyphosate over 1.5 acres in SE corner; flagged lupine areas were not sprayed
2019	3/26, 3/29	Site preparation	IAE	Flagged lupine in SE corner (burn area)

Year	Date	Activity	Personnel*	Notes
2018	7-Dec	Herbicide application	IAE	Applied 1.5% glyphosate solution to meadow knapweed across the site using a backpack sprayer.
2018	7-Dec	Herbicide application	Contractor	Integrated Resource Management broadcast a 1.5% glyphosate solution over the 3-acre burn unit in the SE corner and nectar island 8a.
2018	17-Oct	Seeding	IAE	Broadcast nectar island seed mix over nectar islands
2018	13-Oct	Prescribed burn	Interagency team	Burned approximately 5-acres in SE corner and all nectar islands
2018	2-Oct	Weed control	IAE/ BLM/ LGYC	Removed Scotch broom from SE corner
2018	6-Sep	Site preparation	IAE/ BLM	Removed plastic from solarization treatments
2018	27-Aug	Weed control	Contractor	Site wide mowing (except for burn unit and nectar islands)
2018	14-Aug	Site preparation	IAE	Flagged nectar islands
2018	26-Jul	Weed control	IAE	Pulled knapweed
2018	10-Jul	Weed control	IAE	Pulled knapweed
2018	26-Jun	Weed control	IAE	Pulled knapweed
2018	13-Jun	Weed control	IAE	Mowed meadow knapweed in northwest corner
2018	9-Jun	Site preparation	IAE	Covered mowed nectar island with plastic for solarization treatment
2018	8-Jun	Site preparation	IAE	Established a new 6X20m nectar island by clearing off vegetation with a string trimmer
2018	8-Jun	Weed control	IAE	Mowed tall oatgrass with string trimmer
2018	5-Jun	Weed control	IAE	Mowed tall oatgrass with string trimmer
2018	1-Jun	Weed control/site preparation	IAE	Mowed tall oatgrass with string trimmer and put plastic on nectar island
2018	30-May	Weed control	IAE	Mowed tall oatgrass with string trimmer
2018	29-May	Weed control	IAE/ BLM	Mowed tall oatgrass with string trimmer
2018	21-May	Weed control	IAE	Mowed bracken fern
2018	17-May	Site preparation	IAE/ BLM	Flame weeded a 9x8m plot for nectar island establishment and covered plot with plastic for solarization treatment

Year	Date	Activity	Personnel*	Notes
2018	8-May	Weed control	LGYC	Picked bracken fern on south east side
2018	18-Apr	Weed control	IAE/ BLM/ LGYC	Picked bracken fern on south east side
2018	18-Apr	Weed control	IAE	Flame weeded meadow knapweed in NW corner
2018	20-Mar	Herbicide application	Habitat Restoration LLC	Applied Fusillade herbicide to four experimental plots to test non-target impacts of using Fusillade to manage prairie harboring Fender's blue butterfly
2017	21-Nov	Planting	IAE/ BLM	Planted 200 <i>Eriophyllum lanatum</i> , 300 <i>Sidalcea malviflora</i> pots, ~300 <i>Camassia leichtlinii</i> and ~300 <i>Allium amplexans</i> bulbs and a native seed mix in the nectar island
2017	20-Nov	Nectar island prep	IAE/ BLM	Burned holes in weed barrier
2017	20-Nov	Planting	IAE	Planted 50 pots of <i>Eriophyllum lanatum</i> and <i>Sidalcea malviflora</i> , respectively in the upland area of the burn zone
2017	15-Nov	Planting	IAE/ BLM/LGYC	Planted approximately 1600 <i>Triteleia hyacinthine</i> bulbs
2017	14-Nov	Planting	BLM/ LGYC	Planted approximately 1200 <i>Fragaria virginiana</i> runners
2017	8-Nov	Planting	IAE/ BLM/ LGYC	Planted 400 Kincaid's lupine plugs at Hansen
2017	26-Oct	Seeding	IAE/ BLM	Seeded upland with native mix
2017	24-Oct	Seeding	IAE/ BLM	Seeded wet prairie with native mix
2017	19, 26-Oct	Nectar island prep	IAE/ BLM	Burned 1710 holes in shade cloth and seeded with native mix
2017	5-Oct	Prescribed burn	Inter-Agency burn crew	Burned 4 acres in north section which contain both upland and wet prairies

Year	Date	Activity	Personnel*	Notes
2017	13-Sep	Fire break prep	IAE/BLM	Delineated burn zone with pin flags
2017		Fire break prep	Contractor	Mowed fire brake around burn zone
2017	13-Sep	Nectar island prep	IAE/ BLM	Cleared and prepared shade cloth for nectar species planting
2017	6-Jun	Hand mow tall oatgrass	IA/ BLM	Hand mowed tall oatgrass at 6" throughout site. Where growing concurrently with Kincaid's lupine, mowed above top of raceme. Did not mow Cheryl Schultz's research plots in the SW corner
2017	13-Jul	Weed removal	BLM/ LGYC	Removed meadow knapweed inflorescences
2017	May-July	Survey for Fender's blue butterfly	BLM	Distance sampling for Fender's blue butterfly
2017	23-Mar	Herbicide application	Habitat Restoration LLC	Applied Fusillade herbicide to four experimental plots to test non-target impact of using Fusillade to manage prairie harboring Fender's blue butterfly
2016	29-Nov	Seeding	IAE	Over seeded plots 1a, 1b, 1c, 2a, 2b, 2c, 3a, 3b, 4a, 4b, 4c, 5a,5b, 5c
2016	21-Nov	Planting	IAE/ BLM/ LGYC/ AmeriCorps/ volunteer	Planted plugs and bulbs in plots 4c, 1c, 2c, and 5c
2016	8-Nov	Planting	IAE/ BLM/ LGYC/ AmeriCorps/ volunteer	Planted bulbs and bare root lomatium in plots 1c, 2c, 4c & 5c
2016	19-Oct	Seeding	BLM	Seeded burn unit with native mix
2016	16-Sep	Prescribed burn	Inter-Agency burn crew	Burned 4 acres in SE corner; burned 8 research plots in SW corner.
2016	2-Sep	Fire break prep	IAE	Removed tree on the edge of fire break on Schultz research plot.
2016	22-Aug	Shade cloth	IAE/ BLM	Replaced shade cloth on nectar island 2c.
2016	22-Aug	Burn break prep	IAE/ BLM	Mowed edges of Schultz research plots to prepare for prescribed burn.
2016	17-Aug	Hand weeding	IAE/ BLM	Removed Himalayan blackberry from edges of nectar islands, weeded nectar islands
2016	26-Jul	Hand weeding	BLM/ LGYC	Hand weeded meadow knapweed, mainly in the NW corner
2016	2-Jun	Hand mow tall oatgrass	IAE	Hand mowed tall oatgrass at 6" throughout site. Where growing concurrently with Kincaid's lupine, mowed above top of raceme. Did not mow Cheryl Schultz's research plots in the SW corner.

Year	Date	Activity	Personnel*	Notes
2016	27-May	Hand mow tall oatgrass	IAE	Hand mowed tall oatgrass at 6" throughout site. Where growing concurrently with Kincaid's lupine, mowed above top of raceme. Did not mow Cheryl Schultz's research plots in the SW corner.
2016	6-May	Survey for Fender's blue butterfly	IAE/ BLM	Distance sampling for Fender's blue butterfly
2016	19, 20-April	Hand weeding	IAE/LGYC	Hand-weeded meadow knapweed, purpleanther field pepper weed (<i>Lepidium heterophyllum</i>), bull thistle (<i>Cirsium vulgare</i>), tansy ragwort in northern portion of site; removed hairy cat's ear (<i>Hypochaeris</i> spp.), sheep sorrel (<i>Rumex acetosella</i>), and bentgrass (<i>Agrostis</i> spp.) from nectar islands
2016	31-Mar	Herbicide application	IAE	Applied Fusillade herbicide to four experimental plots to test non-target impact of using Fusillade to manage prairie harboring Fender's blue butterfly
2015	8-Dec	Seeding	IAE	Over seeded plots 1a, 1b, 2b, 4b, 5a, and 5b
2015	3-Dec	Planting, weeding	IAE/ AmeriCorps	Planted strawberry runners in plots 1b, 5b, and 2b weeded <i>Agrostis</i> from 1a
2015	19-Nov	Planting	IAE	Planted plugs and bulbs in plots 2b and 5b
2015	13-Nov	Planting	IAE/ 4 volunteers	Planted plugs and bulbs in plots 1b and 2b
2015	10-Nov	Planting	IAE/ LGYC/ AmeriCorps	Planted plugs, bulbs, and runners in plots 4b, 5b and 2b, moved shade cloth to plots 4c, 1c, 2c, and 5c,
2015	9-Nov	Planting	IAE/ LGYC	Planted plugs and bulbs in plot 4b
2015	7-Aug	Hand weeding	IAE	Removed blackberry from edges of nectar islands, weeded nectar islands
2015	5-Aug	Hand weeding	IAE	Hand weeded and bagged meadow knapweed, mainly in the NW corner
2015	12-Jun	Nectar island weeding	IAE	Mowed edges of all nectar islands and Experiments A, B, and C. Weeded velvetgrass out of all nectar islands (except 6, which was excessively weedy).
2015	26, 27-May	Hand mow tall oatgrass	IAE/ Walama Restoration	Hand mowed tall oatgrass at 6" throughout site. Where growing concurrently with Kincaid's lupine, mowed above top of raceme. Did not mow Cheryl Schultz's research plots in the SW corner.
2015	13-May	Removed weeds	IAE	Removed <i>Lepidium</i> from plot 6, weeded invasive grasses from nectar islands

Year	Date	Activity	Personnel*	Notes
2015	12-May	Monitoring	IAE	Collected data from shade cloth/solarization test plots
2015	6-May	Remove weeds	IAE	Removed meadow knapweed rosettes, Lepidium, thistle, tansy ragwort throughout site
2015	23-Apr	Orientation visit; hand pull & dig weeds	IAE	Removed meadow knapweed rosettes, Lepidium, thistle, tansy ragwort in northern portion of site
2015	24-Mar	Orientation visit	IAE	New IAE staff visited site for first time, observed nectar islands and got an overview of the site from Christine
2015	14-Jan	Seeding	IAE	Overseeded plots 1a, 3b, 5a, and burned area
2014	24-Nov	Weeding	IAE	Weeded most velvet grass out of 1a
2014	24-Nov	Planting	IAE/ AmeriCorps	Finished planting plugs and bulbs in plots 1a, 3b, 5a
2014	3, 5-Nov	Planting	IAE/ Lane-Metro Youth Corps	Planted plugs and bulbs in plots 1a, 5a, 3b
2014	29-Oct	Flame weeding	IAE	Flame weeded plots 1a, 5a. Did not reflare plot 6 because excessive weedy grasses had established.
2014	22-Sep	Fence construction	Island Fence	Fence constructed along entire east border of property
2014	12-Sep	Re-mowed fire line	IAE	N edge of prescribed burn area; preparation for burn
2014	12-Sep	Preparation for new fence construction	IAE	Removed E border T-posts and barbed wire; mowed 15 foot wide blackberries and grass up against fence.
2014	17, 18-Jun	Hand weeding bracken fern	IAE/ 12 from NWYC	Weeded 200 feet west of plot 2a around Kincaid's lupine
2014	17, 18-Jun	Hand mow tall oatgrass	IAE/ 12 from NWYC	Finished work started by Walama on 6/5 and 6/6
2014	17, 18-Jun	Hand weeding	IAE/ 12 from NWYC	Plots 2a, 3a, 4a
2014	6-Jun	Monitoring	IAE	Monitored shade cloth/solarization experimental plots
2014	5, 6-Jun	Weed control	IAE/ 4 people from Walama	Hand mowed tall oatgrass at 6" throughout site. Where growing concurrently with Kincaid's lupine (<i>Lupinus oreganus</i>), mowed above top of raceme. At Cheryl Schultz' request did not mow L shape patch in SW corner.
2014	20-May	Flame weeding	IAE	Flame weeded plots 1a, 5a, 6
2014	20-Mar	Flame weeding	IAE	Flame weeded plots 1a, 5a, 6
2013	20-Nov	Flame weeding	IAE	plot 6a

Year	Date	Activity	Personnel*	Notes
2013	20-Nov	Shade cloth removal	IAE	plot 6a
2013	6-Nov	Seeding	IAE	Seeded over plots 2a, 3a, 4a, "lepidium", and Experiment A-C.
2013	4-Nov	Planting	IAE/ Lane-Metro Youth Corps	Planted in plots 2a, 3a, 4a, and "lepidium".
2013	1-Nov	Plant delivery	IAE	Picked up plants at Eugene NPN and Heritage and delivered to Fir Butte
2013	31-Oct	Flame weeding	IAE	Flame weeded plots 1a-5a.
2013	30-Sep	Solarization raking, shade cloth removal, weed whacking around plots	IAE	Raked four solarization plots to refill trenches. Weed whacked around all solarization/shade cloth plots because mower will not be able to mow close to plots/stakes. Removed shade cloth on plots 1a and on small lepidium shade cloth plot. Tall oatgrass in areas that were weed whacked on 5/10 flowered more than areas mowed on 6/19.
2013	18-Sep	Solarization removal	IAE	Removed shredded plastic at the remaining 2 solarization plots.
2013	18-Sep	Large shade cloth alteration	IAE	Lifted east edge of big shade cloth and folded over so that there will be room to get mower past.
2013	18-Sep	Wooden post removal	IAE	Removed 2 wooden posts with signs along E edge and placed on nearby shade cloth plots.
2013	18-Sep	Weed control	IAE	Clipped seed heads on meadow knapweed along north border and east of big shade cloth area.
2013	18-Sep	T-post replacement, middle	IAE	Replaced T-posts in middle of property. Started at north end and replaced all green transect T-posts. Put metal scratch tag on concrete markers that says 'transect'. For red plot marker T-posts, replaced #824, 819, and 818 (transferred tags), left #826, 820 in place, and couldn't locate #825, 821-823.
2013	18-Sep	T-post replacement, East edge	IAE	Replaced all T-posts near east edge of property with orange cement markers. The only T-post that had a tag on it was the one in the far SE corner; it was transferred to new marker. T-posts appeared to be regularly spaced in southern 2/3 of property, but were sparse and irregular in northern 1/3.

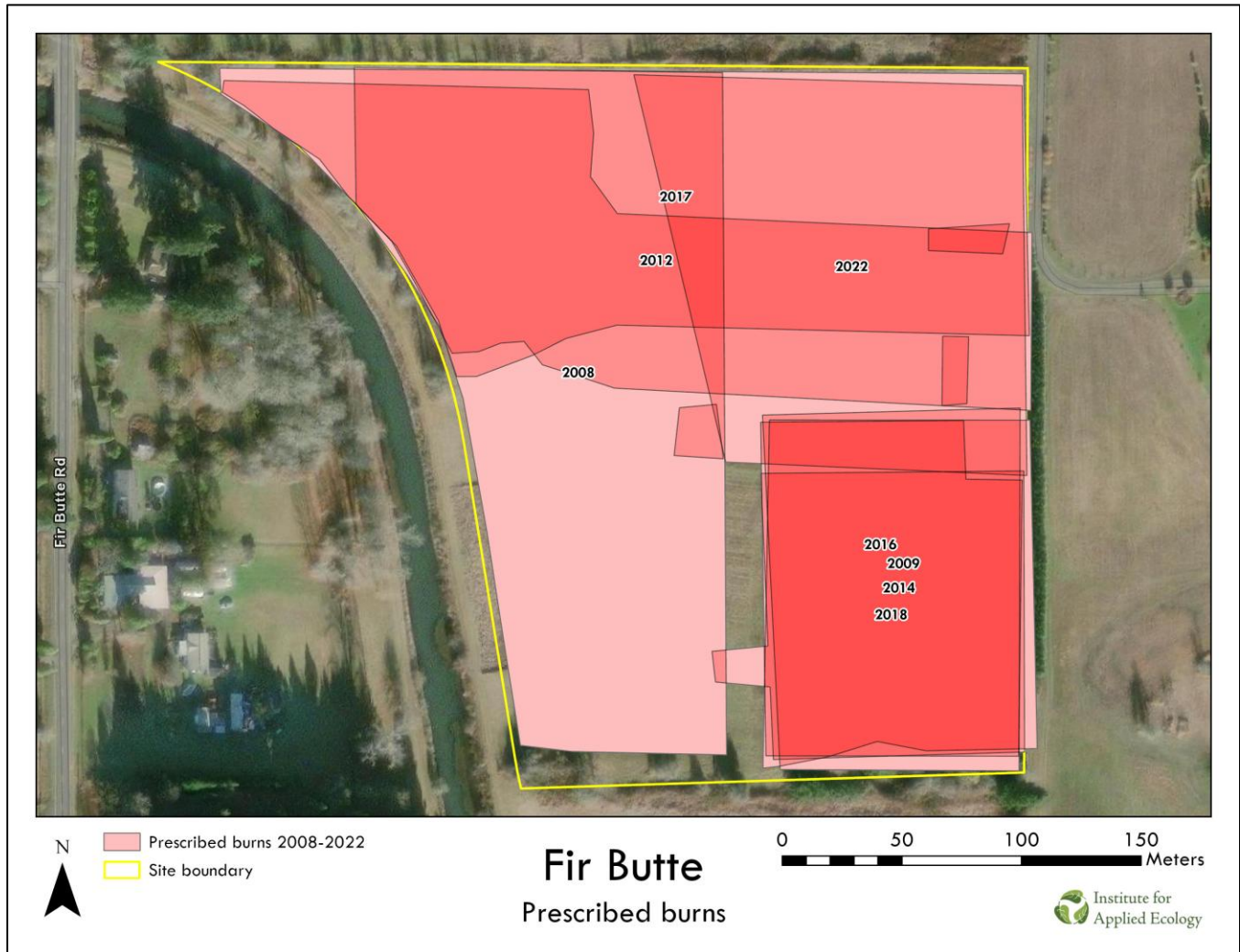
Year	Date	Activity	Personnel*	Notes
2013	16-Sep	Weed control	IAE	In large shade cloth/solarization experiment plot, dug out all visible Purple anther pepper weed (<i>Lepidium heterophyllum</i>) plants that had set seed this year. Small plants in leaf were generally not removed. Lots of dry seed on the plants.
2013	16-Sep	Solarization removal	IAE	Upon arrival, found that the plastic on all four solarization plots was shredded and the plots were no longer covered. Perhaps fault of heat or lack of UV stabilizer in plastic. Cleaned up 2 of the 4 plots.
2013	10-Jul	Weed control	IAE	Hand weeded in shade cloth/ solarization experiment area. Focused largely on removing seed heads of velvet grass and sheep sorrel. 5 contractor bags full.
2013	19-Jun	Hand weeding solarization plots	IAE/ NWYC (crew of 6)	Hand weeded starting in SW corner of shade cloth/solarization experiment area. Attempted to be thorough but impractical with this density of <i>Agrostis capillaris</i> and <i>Rumex acetosella</i> colonization.
2013	19-Jun	Weed control	IAE/ NWYC crew of 6	Mow tall oatgrass with string trimmer: Started in NE corner and moved south along east boundary to SE corner. Moved west across southern border to middle. Walked north through middle mowing small patches. Did not mow big patch in SW corner nor small patches in north-middle. Hand weeded solarization plots.
2013	14, 15, 22-May	Weed control	IAE/LGYC	Shade cloth/solarization installation.
2013	10-May	Weed control	IAE	Weed whacked all new shade cloth plots in preparation for youth crew. Weed whacked 2m wide perimeter around all shade cloth plots. Tilled 3 of the 4 plots that are to receive solarization next week.
2013	1-May	Pre-treatment data on new shade cloth areas	IAE	Took pre-treatment data on shade cloth areas to be placed with youth crew the next week
2013	1-May	Post-treatment data on shade cloth/solarization plots	IAE	Recorded species and cover information in 10 plots per treatment area, 30 plots total. Took photograph of all points.
2013	29-Apr	Hand removal of weeds throughout site	IAE	Digging/pulling of all weeds marked on 4/17/13
2013	25-Apr	Hand removal of weeds throughout site	IAE	Digging/pulling of all weeds marked on 4/17/13
2013	23-Apr	Finish marking weeds	IAE	Systematically wandered through rest of site and marked all locations of the species listed from 4/17.

Year	Date	Activity	Personnel*	Notes
2013	17-Apr	Marking of weeds site wide	IAE	Systematically marked locations of <i>Cirsium vulgare</i> , <i>Cytisus scoparius</i> , <i>Centaurea pratensis</i> , <i>Lepidium heterophyllum</i> , <i>Hypericum perforatum</i> , and <i>Senecio jacobaea</i> .
2012	October	Plant nectar species	IAE/LGYC	Shade cloth and solarization area on E border of site
2012	October	Seed wetland and upland species mix	IAE	Burned area
2012	October	Prescribed burn	BLM	6 acres: Wetland and NE third of upland
2012	June-July	Apply shade cloth	IAE/LGYC	5 8m x 10m areas dispersed throughout site
2012	June-July	Weed control	LGYC	Pull Scotch broom, tansy ragwort, tall oatgrass
2012	April-June	Weed control	LGYC	Pull Scotch broom, tansy ragwort, tall oatgrass
2012	April-June	Apply shade cloth and solarization	LGYC	E border of site
2011	August-October	Seed nectar mix	BLM	NE third of upland prairie, N and S center shade cloth areas, S border
2011	August-October	Prescribed burn	BLM	NE third of upland
2011	August-October	Woody species control	BLM contractor	Masticate Himalayan blackberry
2011	April-June	Weed control	NWYC	Pull bracken fern
2011	August-October	Weed control	LGYC	Pull tansy ragwort
2011	June-July	Weed control	LGYC	Pull tansy ragwort
2011	June-July	Woody species control	LGYC	Cut woody species
2011	April-June	Weed control	LGYC	Pull bracken fern
2011	April-June	Shade cloth repair	LGYC	Eastern border
2010		Weed control	Youth crew	Pull Scotch broom, tansy ragwort, tall oatgrass
2010		Weed control	Youth crew	Pull Scotch broom, tansy ragwort, tall oatgrass
2010	June-July	Weed control	Monitoring crew	Pull purple-anther pepper weed
2010	April-July	Weed control	Monitoring crew	Pull bracken fern
2010	June-July	Weed control	Monitoring crew	Pull Scotch broom in South end

Year	Date	Activity	Personnel*	Notes
2009	August-October	Seed nectar species		SE third of upland prairie
2009	August-October	Ecological burn	BLM	SE third of upland prairie
2009		Weed control	Monitoring staff	Shade cloth, cut meadow knapweed and Himalayan blackberry
2009		Weed control	Monitoring staff	Pull Scotch broom, tansy ragwort, tall oatgrass
2009	June-July	Weed control	Youth crew	Clip seed heads from tall oatgrass
2008	August-October	Seed nectar mix		Wetland and SW third of upland
2008	August-October	Ecological burn	BLM	Wetland and SW third of upland
2008	June-July	Woody species control	Land steward	Cut Ponderosa pine (<i>Pinus ponderosa</i>) in wetland prairie
2008	April-June	Weed control	Land steward	Cut bracken fern (<i>Pteridium aquilinum</i>)
2008	April-June	Weed control	Land steward	Cut Himalayan blackberry (<i>Rubus bifrons</i>) along fenceline and shade cloth
2008	June-July	Weed control	NWYC	Pull meadow knapweed in N end, S end, and around E small shade cloth patch
2008	June-July	Weed control	NWYC	Pull Scotch broom (<i>Cytisus scoparius</i>), tansy ragwort, and tall oatgrass
2008	June-July	Weed control	Land steward	Pull meadow knapweed in N end, S end, and around E small shade cloth patch
2008	June-July	Weed control	Land steward	Shade cloth on meadow knapweed (<i>Centaurea pratensis</i>) at N end, S end, and around E small shade cloth patch
2008	June-July	Weed control	Land steward	Clip seed heads on tall oatgrass (<i>Arrhenatherum elatius</i>)
2008	June-July	Weed control	Land steward	Pull tansy ragwort (<i>Senecio jacobaea</i>)

* BLM (Bureau of Land Management), IAE (Institute for Applied Ecology), IRM (Integrated Resource Management), LGYC (Looking Glass Youth Crew), NTS (Nick's Timber Service), NWYC (Northwest Youth Crew)

Appendix 2. Fir Butte prescribed burns from 2008-2018



Appendix 3. Kincaid's lupine monitoring results

Foliar cover, number of leaves, number of mature racemes, and racemes/m² of Kincaid's lupine at Fir Butte from 1998-present. Data was not collected every year.

Year	Estimated # of leaves		Estimated foliar cover (m ²)		Estimated # of mature racemes		Estimated # racemes/m ² lupine cover
	Value	95% CI	Value	95% CI	Value	95% CI	
1998	223,780	±124,773	-	-	13,468	±8,052	-
1999	364,506	±212,576	-	-	22,776	±11,913	-
2000	431,283	±247,315	-	-	26,821	±14,870	-
2001	635,720	±332,041	-	-	34,800	±15,599	-
2002	816,571	±409,937	-	-	37,963	±14,558	-
2003	764,355	±360,055	-	-	47,335	±17,138	-
2004	1,424,524	±678,553	1,440	±685	55,456	±20,147	39
2005	861,633	±448,592	1,185	±539	43,624	±17,324	37
2006	-	-	1,421	±683	64,377	±24,799	45
2007	-	-	1,591	±728	97,437	±27,446	61
2008	-	-	1,592	±732	116,438	±31,446	73
2009	-	-	1,730	±686	86,921	±23,654	50
2010	-	-	2,605	±1,139	133,113	±35,837	51
2011	-	-	2,396	±703	-	-	-
2012	-	-	-	-	-	-	-
2013	-	-	-	-	-	-	-
2014	-	-	3,106	±872	189,354	±49,295	61
2015	-	-	3,555	±927	64,183	±17,037	18
2016	-	-	-	-	-	-	-
2017	-	-	4,834	±1,170	247,412	±53,661	51
2018	-	-	3,352	±838	113,313	±33,995	34
2019	-	-	-	-	-	-	-
2020	-	-	5,931	±1,515	196,011	±61,004	33
2021	-	-	4,678	±1,214	108,279	±29,643	23
2022	-	-	7,115	±1,508	151,900	±37,746	27
2023	-	-	6,701	± 2,739	148,133	±60,301	22
2024	-	-	5,082	±1,391	52,593	±20,990	10

Appendix 4. Fir Butte photopoints

