

Habitat restoration and monitoring for Kincaid's lupine at Fir Butte: 2022 annual report



March
2023

Report for the Bureau of Land Management, Northwest Oregon District, Agreements #L20AC00014, #L21AC10189, #L19AC00166, and #L22AC00362

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:

Thomas Kaye (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

ACKNOWLEDGEMENTS

Funding for this project was provided by the Bureau of Land Management (BLM), Assistance Agreements #L20AC00014, #L21AC10189, #L19AC00166, and #L22AC00362. We thank Sally Villegas-Moore of the BLM for her guidance and for sharing her knowledge of the site. We also thank Colin Sayre and Christine Calhoun of the BLM for their support with habitat management actions. We are grateful to Heritage Seedlings & Liners, Inc. for donating dwarf checkermallow plants in 2022 and to our many volunteers and partners for their contributions over the life of this project.

Maps in this document were created using ArcGIS® software by Esri. ArcGIS® and ArcMap™ are the intellectual property of Esri and are used herein under license. Copyright © Esri. All rights reserved. For more information about Esri® software, please visit www.esri.com.

Cover photograph: Germinating Kincaid's lupine (*Lupinus oregonus*) at Fir Butte on February 25, 2022. Photo by Julia Fields.

SUGGESTED CITATION

Reed, P., D. Giles, A. Esterson, and S. Harris. 2023. Habitat Restoration and Monitoring for Kincaid's lupine at Fir Butte: 2022 Annual Report. Prepared by the Institute for Applied Ecology for the Bureau of Land Management, Northwest Oregon District. Corvallis, Oregon.

TABLE OF CONTENTS

EXECUTIVE SUMMARY	1
1. INTRODUCTION	2
1.1. Site background	2
1.2. Species background	3
2. GOALS AND OBJECTIVES	3
3. RESTORATION ACTIVITIES	4
3.1. 2022 overview	4
3.2. Planting dwarf checkermallow	5
3.3. Invasive species control	5
3.4. Northeast corner prescribed burn and treatment plan.....	9
3.5. Southeast corner update.....	12
4. MONITORING AND HABITAT ASSESSMENT	13
4.1. Monitoring and habitat assessment methods	13
4.2. Monitoring and habitat assessment results	15
4.3. Monitoring and habitat assessment discussion	22
5. 2023 RECOMMENDED ACTIONS	22
REFERENCES	24
APPENDICES	25
Appendix 1. Fir Butte management actions (2008-2022)	25
Appendix 2. Fir Butte photopoints.....	36
Appendix 3. Nectar islands.....	40
Appendix 4. Fir Butte prescribed burns from 2008-2018.....	41
Appendix 5. Nectar island history	42
Appendix 6. Nectar island plant materials	43
Appendix 7. Kincaid's lupine monitoring results	45

Habitat restoration and monitoring for Kincaid's lupine at Fir Butte: 2022 annual report

EXECUTIVE SUMMARY

This report documents habitat restoration and monitoring work conducted in 2022 by the Institute for Applied Ecology (IAE) at Fir Butte, an 18-acre site located west of Eugene, Oregon that is owned and managed by the Bureau of Land Management, Northwest Oregon District (BLM). Fir Butte 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 oregonus*), along with other Bureau-sensitive species.

To conserve and bolster populations of critical species at Fir Butte, the BLM has partnered with IAE since 2012 to conduct habitat restoration activities. In 2022, IAE planned and implemented a variety of activities to support restoration and conservation efforts including weed control, planting nectar species, and monitoring Kincaid's lupine and the plant community across the site.

2022 monitoring results indicate that:

- Kincaid's lupine foliar cover increased across the site from 4,678m² ($\pm 1,214\text{m}^2$) in 2021 to 7,115 m² ($\pm 1,508\text{m}^2$) in 2022. The estimated number of mature racemes increased from 108,279 ($\pm 29,463$) to 191,500 ($\pm 35,387$) between the two years.
- The average Himalayan blackberry (*Rubus bifrons*) cover continued to be low with 0.7% ($\pm 0.6\%$) cover across the site in 2022. This is well under the 5% threshold recommended for species of particular concern in the Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington (U.S. Fish and Wildlife Service 2010), and the third consecutive year that cover has been below this threshold.
- In the southeast corner management unit, the percent cover of introduced graminoids increased from an average of 4% cover in 2021 to 44% cover in 2022. Introduced graminoids are now the dominant vegetation type in this treatment area.
- Introduced forb cover in the southeast corner also increased from an average of 23% cover in 2021 to 29% cover in 2022.
- Despite seeding the southeast corner with native species in fall 2021, the average cover of native species did not change substantially between 2021 to 2022. Kincaid's lupine cover increased modestly from 3% to 4%.
- The relative cover of introduced species in the southeast corner increased from 82% in 2021 to 91% in 2022.
- Percent bare ground in the southeast corner decreased from 20% in 2021 to 13% in 2022, while litter decreased from 54% cover in 2021 to 49% in 2022.

1. INTRODUCTION

1.1. Site background

Fir Butte is an 18-acre site owned and managed by the Bureau of Land Management (BLM), Northwest Oregon District, and is located in Lane County, Oregon, in the West Eugene Wetlands (WEW). Fir Butte is part of a network of sites in the Eugene West Recovery Zone within the Willamette Valley, and it supports a large population of the federally threatened Fender's blue butterfly (*Icaricia icarioides fenderi*) and the federally threatened Kincaid's lupine (*Lupinus oregonus*; Figure 1). 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. Populations of listed species at Fir Butte are critical for meeting U.S. Fish and Wildlife Service (USFWS) delisting goals 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).



Figure 1. Fender's blue butterfly (*Icaricia icarioides fenderi*; left) and Kincaid's lupine (*Lupinus oregonus*; right).

Prior to acquisition by the BLM, Fir Butte was used as a horse pasture and hay field. The site includes both upland and wetland prairie habitats. The overall habitat quality at the site was poor at the time of acquisition, with heavy infestations of introduced plants such as tall oatgrass (*Arrhenatherum elatius*) and annual grasses.

The BLM began partnering with the Institute for Applied Ecology (IAE) in the early 2000s to monitor the Kincaid's lupine population at Fir Butte. IAE then began to perform habitat restoration actions at the site in 2012. Since IAE initiated restoration activities, the Fender's blue butterfly population has remained relatively stable or increased, with annual fluctuations (Diaz and Harris 2022), while the Kincaid's lupine population has steadily increased (see Section 4.2.1 below). In general, restoration activities conducted by IAE have improved habitat conditions at Fir Butte. 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. Future management actions, including weed control, seeding, augmentation, and introduction efforts, will help keep recovery goals on track.

1.2. Species background

Kincaid's lupine, a rare member of the legume family (Fabaceae), is listed as threatened by the Oregon Department of Agriculture and USFWS. Kincaid's lupine is found in remnant prairies in the Willamette Valley and southwestern Washington, as well as forest openings in Douglas County, Oregon. In the Willamette Valley, Kincaid's lupine serves as a larval host plant for the federally threatened Fender's blue butterfly, making conservation of Kincaid's lupine a common strategy for the success of both species.

Kincaid's lupine is an herbaceous perennial that reproduces by seed. Plants form clumps of basal leaves and eventually produce one or more flowering stems. This species also spreads vegetatively, though 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).

Fender's blue butterfly oviposits 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.

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 (*Rubus bifrons*) 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 2022.

3. RESTORATION ACTIVITIES

3.1. 2022 overview

In 2022, IAE planned and implemented a variety of restoration activities at Fir Butte. Activities included weed control (via hand pulling and spot-spray herbicide application), planting dwarf checkermallow (*Sidalcea malviflora ssp. virgata*), broadcast herbicide application for future seeding, and monitoring Kincaid's lupine and the plant community. Monitoring also included Fender's blue butterfly surveys, but these results are described in a separate report (Diaz and Harris 2022). In addition to the work completed by IAE, the BLM mowed 13 acres across the site and completed a prescribed burn of an approximately five-acre unit in the northeast (NE) corner of the site. Table 1 summarizes restoration actions completed at Fir Butte in 2022. See Appendix 1 for a summary of all management actions completed from 2008 to 2022 and Appendix 2 for an annual update of photopoint images.

Table 1. Management actions completed at Fir Butte in 2022.

Date	Action	Personnel*	Description
2/25/2022	Site visit	IAE	Site visit to assess conditions.
3/4/2022	Planting	IAE, BLM	Planted approximately 1000 dwarf checkermallow plants in nectar island 8a, donated by Heritage Seedlings & Liners, Inc.
5/16/2022	Weed control	IAE	Spot sprayed meadow knapweed across entire site with glyphosate.
6/27-7/7/22	Monitoring	IAE	Monitoring of plant community, Kincaid's lupine cover, and target woody species.
7/25/2022	Site visit	IAE	Took photopoints.
	Weed control	IAE	Pulled Scotch broom from SE corner.
8/8/2022	Weed control	IAE, BLM	Pulled meadow knapweed, tansy ragwort, bull thistle, and Scotch broom from entire site.
8/31/2022	Woody species control	IAE	Spot sprayed woody species throughout northern half of site with triclopyr.
9/2/2022	Site maintenance	BLM/contractor	Mowed entire site except five acre burn unit in NE corner.
9/21/2022	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.
10/4/2022	Prescribed burn	BLM	Burned five acre unit in NE corner.
11/15/2022	Weed control	IAE/Habitat Restoration LLC	Broadcast glyphosate over five acre burn unit in NE corner.

*Institute for Applied Ecology (IAE); Bureau of Land Management (BLM).

3.2. Planting dwarf checkermallow

In March 2022, Heritage Seedlings & Liners, Inc. donated approximately 1000 dwarf checkermallow to Fir Butte that they extracted from a seed production field that was set to be discontinued. The plant materials were bare roots with vegetative leaves from large reproductive adults. On March 4, IAE, BLM staff, and volunteers planted the dwarf checkermallow in nectar island 8a, which had been previously chemical fallowed in 2019 (Figure 2). Dwarf checkermallow is an excellent native nectar species for Fender's blue butterfly. This planting event substantially increased the amount of nectar available in a part of the site that has had relatively few restoration activities to date. See Appendix 3 for a map showing the location of nectar island 8a.



Figure 2. IAE, BLM staff, and volunteers planting dwarf checkermallow (*Sidalcea malviflora* ssp. *virgata*) in nectar island 8a at Fir Butte on March 4, 2022.

3.3. Invasive species control

In 2022, invasive species management primarily targeted meadow knapweed, bull thistle (*Cirsium vulgare*), tansy ragwort (*Jacobaea vulgaris*), and woody species such as Himalayan blackberry, hawthorn (*Crataegus monogyna*), Scotch broom, and rose (*Rosa* spp.). IAE conducted spot-spray herbicide treatments for meadow knapweed in May 2022 and for woody species in August 2022. We also hand-pulled meadow knapweed, bull thistle, and tansy ragwort in August 2022.

3.3.1. Tall oatgrass

Tall oatgrass is a non-native perennial grass that strongly outcompetes native vegetation. Previously, tall oatgrass was regularly mowed with a string trimmer at Fir Butte in May or June from 2013 to 2019. However, mowing was not an effective control method at this site as the population expanded during that time, especially in the NE corner (Figure 3). An alternative approach may be to broadcast spray tall oatgrass in the late fall after green-up, when Kincaid's lupine is dormant. This may be most effective after a prescribed burn or mowing to remove thatch, since it would allow more herbicide to contact actively growing plant tissue.

In 2022, the burn unit in the NE corner of Fir Butte was broadcast with glyphosate right as the tall oatgrass was greening up (described in greater detail in Section 3.4 below). Continued spot-spraying of this species will occur through early 2023 and a second broadcast application will occur in fall 2023 following a mow.

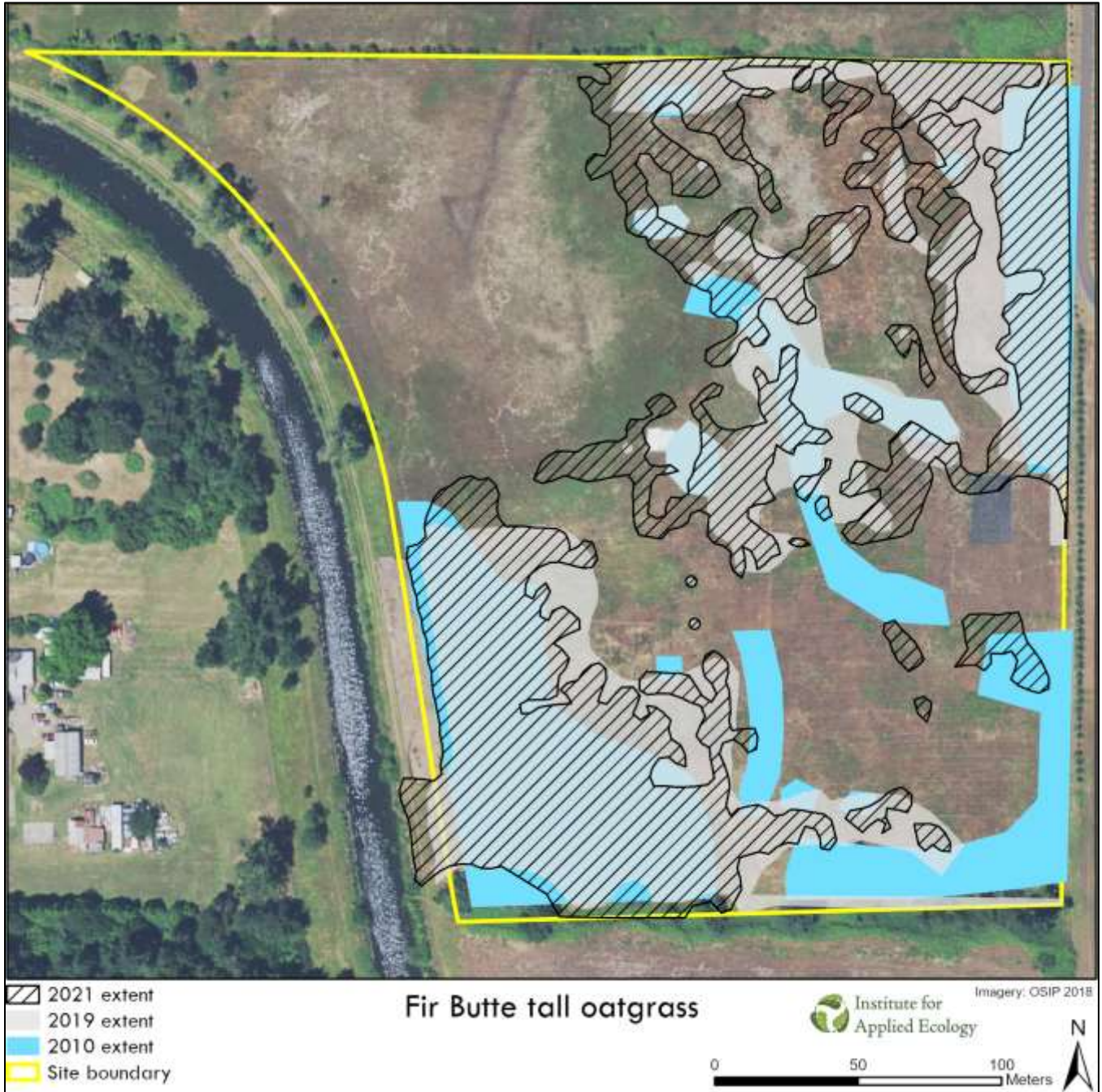


Figure 3. Tall oatgrass (*Arrhenatherum elatius*) distribution at Fir Butte in 2010, 2019, and 2021 showing expansion of the population over time.

Currently, grass-specific herbicides are only allowed for research purposes on BLM land. However, these would be an effective tool to target tall oatgrass without harming Kincaid's lupine if they were allowed to be used more broadly. Pulling tall oatgrass in the early spring or fall in areas where Kincaid's lupine is not present could also provide some control of this introduced species. Because grass specific herbicide is not currently a management tool at the site, this method could provide some additional level of control for this introduced species. Pulling or grubbing could occur in conjunction with seeding of native graminoid or forb species into the disturbed ground created during these efforts.

3.3.2. Bracken fern

Bracken fern (*Pteridium aquilinum*), although native, is a species of concern at Fir Butte. The population had been increasing for a few years and there was concern that it could outcompete Kincaid's lupine and impede access of Fender's blue butterflies to Kincaid's lupine and nectar resources. In previous years, bracken fern was mowed and hand pulled (Fields et al. 2022). However, mowing alone was not sufficient to keep pace with bracken fern as new fronds continued to grow through the summer. The West Eugene Wetlands Biological Opinion prohibits mowing Kincaid's lupine-occupied areas with a tractor during the Kincaid's lupine growing season, which limits the ability to control bracken fern in this manner (U.S. Fish and Wildlife Service 2014).

Milligan et al. (2016) found that it took six to eight years of repeated treatments (cutting via a string trimmer or herbicide applications) to eliminate bracken fern from heavily infested grassland areas. Cutting (twice or thrice a year) was equally as effective at reducing bracken fern cover and density as a one-time broadcast herbicide application followed by annual spot spraying of emerging fronds. In both cases, the greatest decline in bracken fern cover occurred after the first year of treatment. But because bracken fern is rhizomatous, achieving elimination requires a committed effort to deplete carbohydrate resources over multiple years.

In August 2021, IAE spot treated bracken fern across Fir Butte with 1.5% glyphosate. By August 2022, bracken fern cover was considerably reduced and was not retreated due to time constraints. However, the entire site was mowed on September 2, 2022 (earlier than in previous years), while most bracken fern was still green. In future years, retreatment with herbicide, early mowing, and/or cutting with string trimmers may help maintain control of this species.

3.3.3. Meadow knapweed

Meadow knapweed is located in patches throughout Fir Butte, especially along the outer perimeter of the site. Dennehy et al. (2011) recommended manual removal of meadow knapweed only when herbicides are not available and emphasized the need to remove all roots. Grubbing can be successful if the entire root system is removed, but this process can also result in substantial ground disturbance. Cutting or mowing stems to remove flowers reduces seed set but does not kill the plant and must be repeated multiple times throughout the growing season. Mowing before plants reach maturity can reduce plant vigor, but mowed plants will produce flowers lower to the ground, making them more difficult to treat in the future. Herbicide is a successful treatment method when applied at the rosette to bud stage in spring.

Prior to the BLM approving herbicide use in 2018, meadow knapweed stems were cut, bagged, and removed multiple times during the growing season to reduce seed set. IAE began spot treating meadow knapweed with 1.5% glyphosate in December 2018 and continued treatments in each spring 2019-

2022. In 2022, IAE spot-treated meadow knapweed in May and hand pulled several flowering patches in August (Figure 4).

The meadow knapweed population extends outside Fir Butte onto neighboring private properties to the north and east and City of Eugene property to the west. Control of this species will only be achieved by creating partnerships with neighboring landowners to ensure that the entire population is treated.



Figure 4. Hand pulling meadow knapweed (*Centaurea pratensis*).

3.3.4. Woody species

The most abundant and problematic woody species at Fir Butte is Himalayan blackberry. Hawthorn, rose, and Scotch broom are less abundant but also critical to control as they can spread quickly and reduce the quality of prairie habitat for Kincaid's lupine and Fender's blue butterfly. Woody encroachment is a constant threat in Willamette Valley prairies and is typically controlled through a combination of prescribed burning, mowing, and herbicide application.

Historically, Himalayan blackberry cover was extremely high across Fir Butte and was controlled through the early 2000's and 2010's by cutting, mowing, and masticating. In 2019, IAE began contracting spot-spray herbicide applications for blackberry and other woody species, which effectively reduced Himalayan blackberry cover to <5% for the first time since monitoring began in 1998 (Fields et al. 2022), achieving one of the specific restoration goals for the site. As of 2022, woody cover remains below the <5% target threshold (see Section 4.2.2 below).

On August 31, 2022, IAE completed a spot spray herbicide treatment of woody vegetation across approximately 40% of the site using 1.5% triclopyr (Figure 5). The goal was to spot spray the entire site at least three weeks before it was mowed. However, the BLM's contractor mowed the site earlier than expected (on September 2), before IAE had an opportunity to spray the remainder of the site. Fortunately, the majority of what was sprayed was within the five acre NE corner burn unit, which was

unmowed and was not burned until October 4, giving the herbicide time to take effect and kill much of the Himalayan blackberry in that area.



Figure 5. Approximately 40% of the site was spot sprayed with 1.5% triclopyr to control woody vegetation on August 31, 2022. The site was subsequently mowed on September 2, 2022 (except for the northeast corner burn unit), before IAE had an opportunity to spray the remainder of the site.

3.4. Northeast corner prescribed burn and treatment plan

The BLM conducted a prescribed burn at Fir Butte on approximately five acres in the northeast (NE) corner of the site on October 4, 2022 (Figure 6). Prescribed burns are an important habitat management tool at native prairie sites throughout the region as they remove thatch build up that hinders native species establishment. Portions of Fir Butte were also previously burned in 2008, 2009, 2012, 2014, 2016, 2017, and 2018 (Appendix 4). All burns complied with guidelines from the Biological Opinion ((U.S. Fish and Wildlife Service 2014); standards 9 and 36). Standard 36 limits burning to no more than one third Fender's blue butterfly habitat in a given year if more than 100 Fender's blue butterflies occupy the site.



Figure 6. The northeast corner prescribed burn unit at Fir Butte, burned on October 4, 2022.

The 2022 burn achieved visible thatch removal (Figure 7). Following the burn, a lack of rain for several weeks prevented green up of any vegetation until November. Once rain returned, non-native grasses (such as tall oatgrass), Queen Anne's lace (*Daucus carota*), and false dandelion (*Hypochaeris radicata*) were among the first species to begin growing. IAE subcontracted Habitat Restoration, LLC., to complete a broadcast application of glyphosate across the burn unit to control these weedy species. The subcontractor completed the application using an ATV-mounted boom sprayer on November 15, 2022 (Figure 8).

Following the burn and broadcast herbicide application, IAE and the BLM held a virtual meeting to discuss the continued restoration plan for the NE corner. The BLM and IAE agreed to complete at least one additional broadcast application in the burn unit to reduce the cover of non-native species prior to seeding any native species. This second broadcast application will need to occur in fall 2023, given that weather conditions are unsuitable for a second application between December 2022 to February 2023, and after that point, the Kincaid's lupine will begin growing and Fender's blue butterfly will start to emerge. In spring and summer 2023, carefully applied spot spray treatments of herbicide will be necessary to maintain control over weeds until the second broadcast application occurs. Additionally, a mow in late summer 2023 will help make the fall broadcast treatment effective by allowing more

herbicide to contact actively growing plant tissue. That treatment should occur once non-native vegetation begins greening up for the season (typically early-mid October). Following the second broadcast treatment, the NE corner should be seeded with Kincaid's lupine and other native species, including Fender's blue butterfly nectar sources. Seeding should not be delayed past fall 2023; doing so runs the risk of giving non-native species too much time to establish and outcompete native seedlings.



Figure 7. The burn unit at Fir Butte from an airplane on October 11, 2022 (top), and conditions on the ground on October 21, 2022 (bottom).



Figure 8. Subcontractor from Habitat Restoration, LLC., using an ATV-mounted boom sprayer to broadcast glyphosate across the northeast corner burn unit at Fir Butte on November 15, 2022.

3.5. Southeast corner update

In October 2021, IAE and BLM seeded approximately 3.5 acres of the southeast (SE) corner of the site, following several years of spot spray applications around Kincaid's lupine patches after a prescribed burn in 2018 (Appendix 5). The unit was seeded using a Dew Drop Drill at approximately 16 lbs/acre with a diverse mix of 26 native grass and forb species including Kincaid's lupine (Fields et al. 2022). See Appendix 6 for a list of species in the seed mix.

In summer 2022, several native annual forbs, including winecup clarkia (*Clarkia purpurea* ssp. *quadrivulnera*) and showy tarweed (*Madia elegans*), were widespread and abundant across the unit. Unfortunately, there was also a large flush of non-native annual grasses (e.g., *Vulpia* sp.; see Section 4.3.2) that created dense thatch layers in some patches (Figure 9). This area was mowed in September 2022, but these annual grasses will need to be treated in 2023 in order to allow second year native seedlings (especially the perennials) to establish.



Figure 9. Annual grass thatch in the southeast corner of Fir Butte on July 25, 2022.

4. MONITORING AND HABITAT ASSESSMENT

In 2022, 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. Monitoring and habitat assessment methods

4.1.1. Kincaid's lupine monitoring methods

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 redacted to protect sensitive species data.

Figure 10). 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).

Today, IAE continues to monitor the site using the aforementioned transects. From 1998-2010, both the north and south sides of each transect were monitored for Kincaid's lupine cover and target weedy

species. Since 2011, only the north side of the transects are being monitored.

2022 MONITORING METHODS

In 2022, 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.



Figure redacted to protect sensitive species data.

Figure 10. 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 methods

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 2022, habitat monitoring focused on evaluating target weedy species presence and percent cover along Kincaid's lupine monitoring transects and species/plant functional group cover in the SE corner. We focused specifically on the SE corner because of the recent management activities that took place in that unit between 2018-2021.

PERCENT COVER OF TARGET WEEDY SPECIES IN KINCAID'S LUPINE TRANSECTS

In conjunction with Kincaid's lupine monitoring in 2022, we recorded the percent cover of Himalayan blackberry and bracken fern, and the presence/absence of meadow knapweed, in the same 5m sections used to monitor Kincaid's lupine. For hedge bindweed (*Calystegia sepium*), we estimated percent cover within each subplot. We calculated confidence intervals for the percent cover estimates by considering the average cover for each species in each transect. These measurements allow us to quantify changes in weedy species cover and assess management effects in conjunction with changes in Kincaid's lupine cover.

PERCENT COVER BY SPECIES IN THE SOUTHEAST CORNER

In 2020-2022, 30 randomly placed 1m² plots (15 with Kincaid's lupine and 15 without Kincaid's lupine) were monitored within the southeast portion of the site (roughly equivalent to Kincaid's lupine subplots 1-4;

Figure redacted to protect sensitive species data.

Figure 10). We assessed the percent cover of all vascular plants and five ground cover types (bare soil, litter, rock, moss, and basal vegetation). We visually estimated percent cover to the nearest 1%; for species occurring at <1% cover, we estimated cover to 0.1% or 0.5%. Species names and supplementary information followed the USDA Plants Database (<http://plants.usda.gov/java/>) and local floras.

4.2. Monitoring and habitat assessment results

4.2.1. Kincaid's lupine

Between 2021 and 2022, the total Kincaid's lupine foliar cover and raceme counts increased (Figure 11, Figure 12). The number of mature racemes increased from 108,279 ($\pm 29,643$) in 2021 to $191,500 \pm 37,746$ in 2022 (Appendix 7). Kincaid's lupine foliar cover increased from $4,678 \text{ m}^2$ ($\pm 1,214 \text{ m}^2$) in 2021 to $7,115 \text{ m}^2$ ($\pm 1,508 \text{ m}^2$) in 2022 (Appendix 7).

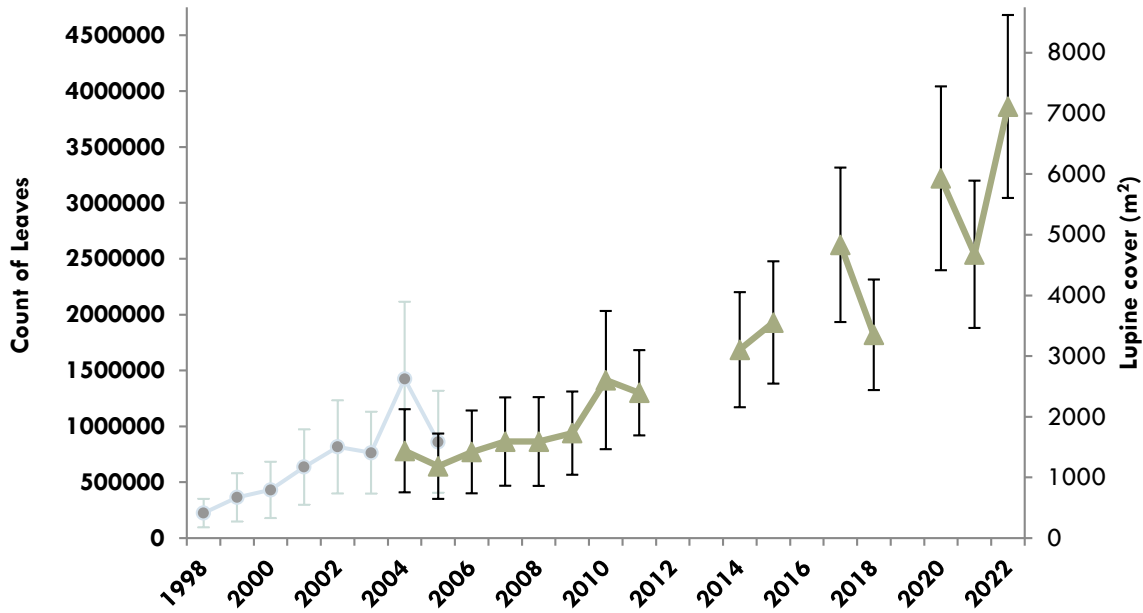


Figure 11. Kincaid's lupine (*Lupinus oreganus*) foliar cover (green lines; triangles) and leaf counts (grey lines; circles) at Fir Butte from 1998 to present. Error bars represent 95% confidence intervals. Data was not recorded every year.

Estimated Number of Kincaid's Lupine Racemes

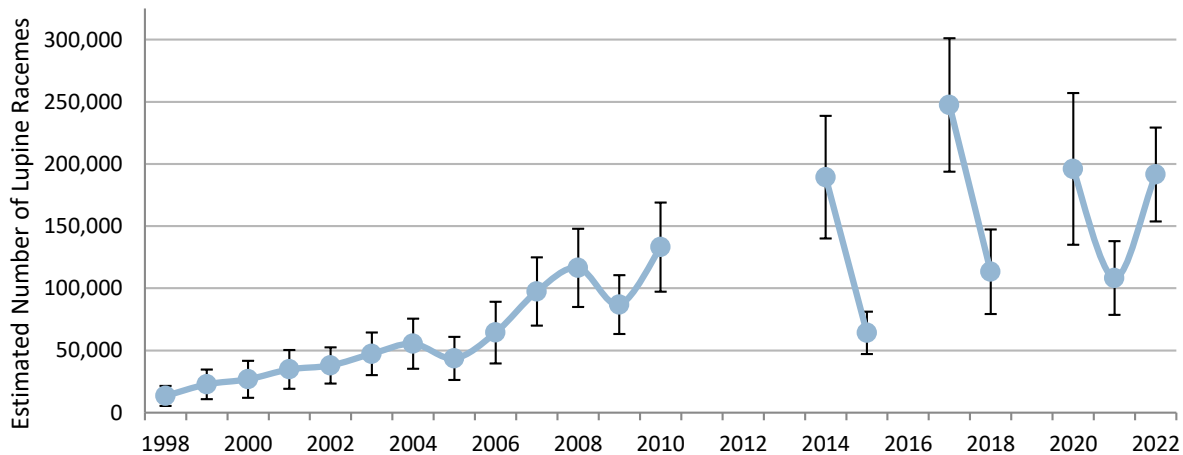


Figure 12. Estimated number of mature Kincaid's lupine (*Lupinus oreganus*) racemes at Fir Butte from 1998-2022. Data was not recorded in every year. Error bars represent 95% confidence intervals.

4.2.2. Community composition

PERCENT COVER OF TARGET WEEDY SPECIES IN KINCAID'S LUPINE TRANSECTS

The average Himalayan blackberry percent cover in Kincaid's lupine transects in 2022 was 0.7% ($\pm 0.2\%$). In 2020, Himalayan blackberry percent cover was 4.3% ($\pm 1.1\%$), a decrease from 9.9% ($\pm 1.5\%$) in 2018 (Figure 13; Table 2). In 2020-2022, Himalayan blackberry percent cover was below the 5% threshold for meeting recovery requirements as defined in the Habitat Recovery Plan (U.S. Fish and Wildlife Service 2010).

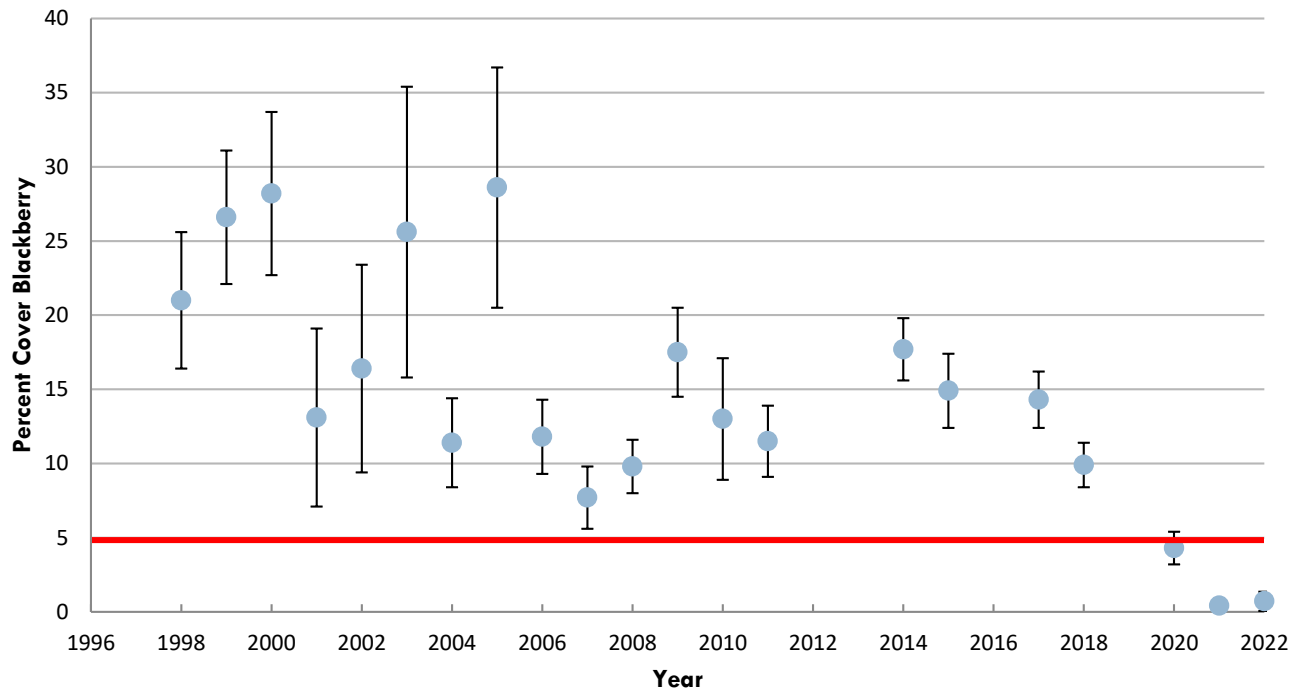


Figure 13. Himalayan blackberry (*Rubus bifrons*) percent cover at Fir Butte from 1998 to 2022. The red line represents the 5% cover management threshold. Data was not collected every year. Error bars represent 95% confidence interval; error bars in 2021 are 0.1% and are not visible at this scale.

Bracken fern cover decreased from 1.1% ($\pm 0.6\%$) in 2021 to 0.2% ($\pm 0.2\%$) in 2022 (Table 2). Between 2011-2021, meadow knapweed was observed in a least one transect every year that it was monitored. In 2022, meadow knapweed was not observed in any of the subplots (Table 2). However, a handful of plants were noted outside of transect monitoring areas. Due to continued removal efforts, most of the remaining meadow knapweed at the site is found outside areas occupied by Kincaid's lupine.

For hedge bindweed, the average cover across all transects increased from 0.9% ($\pm 1.0\%$) in 2021 to 1.7% ($\pm 1.9\%$) in 2022 (Table 2). This species continues to only be observed in patches within the western portion of the Kincaid's lupine habitat, with some subplots having cover as high as 80%.

Table 2. Himalayan blackberry (*Rubus bifrons*), tall oatgrass (*Arrhenatherum elatius*), bracken fern (*Pteridium aquilinum*), and hedge bindweed (*Calystegia sepium*) 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

* 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 SPECIES IN THE SOUTHEAST CORNER

The following results from 2018 and 2020-2022 are reported in three groups for the southeast (SE) unit: 1) patches within the SE corner where Kincaid's lupine is present that were only treated with herbicide when Kincaid's lupine was dormant (referred to as untreated areas), 2) portions of the SE corner not occupied by Kincaid's lupine that were been treated with herbicide during the growing season (referred to as treated areas), and 3) an average for both groups combined. Table 3 provides percent cover estimates at the plant functional group level while Table 4 provides estimates for individual species.

Following a period of decline between 2018-2021, introduced graminoid cover rebounded strongly in the SE unit in 2022 (average cover of 44.1% ($\pm 11.1\%$) in 2022, up from 4.3% ($\pm 1.4\%$) in 2021; Table 3). Its cover was greater in the treated areas (without Kincaid's lupine) than in the untreated areas (with lupine). Among this functional group, *Vulpia* sp. exhibited the greatest rise, from 0.8% ($\pm 0.6\%$) in 2021 to 14.6% ($\pm 6.3\%$) in 2022 (Table 4). Colonial bentgrass (*Agrostis capillaris*), which had been the dominant graminoid species in this area prior to treatment initiation in 2018, also rose, with its average cover increasing from 1.5% ($\pm 0.8\%$) in 2021 to 6.7% ($\pm 7.1\%$) in 2022. Tall oatgrass did not change much, increasing slightly from 0.1% ($\pm 0.1\%$) in 2021 to 0.3% ($\pm 0.7\%$) in 2022.

Introduced forb cover has been increasing steadily across the SE unit since 2018, rising from 22.6% ($\pm 5.6\%$) in 2021 to 28.9% ($\pm 10.6\%$) in 2022 (Table 3). Unlike the introduced graminoids, introduced forb cover was higher in the untreated areas (with Kincaid's lupine) than in the treated areas (without Kincaid's lupine). Queen Anne's lace and false dandelion both increased substantially between 2021 to 2022 (Table 4).

Overall, woody cover was extremely low across the SE unit in 2022 (0.3% ($\pm 0.4\%$); Table 3). Himalayan blackberry and bracken fern continue to decline: Himalayan blackberry decreased from 1.9% ($\pm 1.5\%$) in 2021 to 0.3% ($\pm 0.4\%$) in 2022, while brackenfern decreased from 1.5% ($\pm 1.7\%$) in 2021 to 0.3% ($\pm 0.4\%$) in 2022 (Table 4).

Despite seeding the SE unit in fall 2021, the average cover of native forbs did not change substantially between 2021 (6.1% ($\pm 2.8\%$)) and 2022 (6.3% ($\pm 4.3\%$); Table 3). Kincaid's lupine did increase somewhat, from 3.2% ($\pm 2.2\%$) in 2021 to 4% ($\pm 4.2\%$) in 2022 (Table 4). Native graminoids maintained 0% cover between 2021 and 2022 (Table 3).

Lastly, the average cover of bare ground decreased from 20% ($\pm 9.3\%$) in 2021 to 12.8% ($\pm 7.3\%$) in 2022, while the average cover of litter decreased from 54.1% ($\pm 10.2\%$) in 2021 to 48.9% ($\pm 7.6\%$) in 2022 (Table 3).

Table 3. Average absolute percent cover by functional group in the southeast corner at Fir Butte in 2018 and 2020-2022.

	2018 – pre-treatment			2020			2021			2022		
	no lupine (treated)	yes lupine (untreated)	Average	no lupine (treated)	yes lupine (untreated)	Average	no lupine (treated)	yes lupine (untreated)	Average	no lupine (treated)	yes lupine (untreated)	Average
Bare ground	1.3 (1.4)	0.4 (0.7)	1.0 (1.0)	29.1 (12.8)	1.5 (2.6)	14.8 (8.0)	37.9 (13.3)	2.1 (2.1)	20.0 (9.3)	13.0 (11.8)	12.6 (9.3)	12.8 (7.3)
Litter	61.9 (7.9)	70.6 (5.0)	64.7 (5.7)	34.7 (10.2)	33.7 (10.8)	34.2 (7.3)	32.8 (10.2)	75.3 (8.7)	54.1 (10.2)	47.3 (12.1)	50.5 (9.7)	48.9 (7.6)
Intro. Graminoids	18.3 (6.0)	23.2 (7.8)	19.8 (4.8)	2.4 (1.7)	32.1 (14.6)	17.8 (9.3)	4.9 (1.7)	3.7 (2.1)	4.3 (1.4)	48.4 (16.3)	39.7 (15.3)	44.1 (11.1)
Introduced Forbs	11.9 (5.1)	5.4 (2.3)	9.8 (3.7)	21.4 (10.2)	10.2 (4.7)	15.6 (5.8)	17.6 (8.5)	27.6 (6.8)	22.6 (5.6)	22.9 (14.4)	35.0 (15.3)	28.9 (10.6)
Woody	4.5 (3.4)	2.1 (1.8)	3.7 (2.4)	1.5 (2.1)	16.0 (15.2)	9.0 (8.3)	0.3 (0.4)	3.6 (2.8)	1.9 (1.5)	0.1 (0.2)	0.4 (0.8)	0.3 (0.4)
Native Graminoids	0	0	0	0.4 (0.6)	0.3 (0.7)	0.4 (0.4)	0	0	0	0	0	0
Native Forbs	3.3 (1.6)	10.5 (7.4)	5.6 (2.8)	3.9 (3.5)	11.8 (8.5)	8.0 (4.8)	1.7 (0.8)	10.5 (4.7)	6.1 (2.8)	2.1 (1.8)	10.6 (7.8)	6.3 (4.3)

Table 4. Dominant species recorded in all 1m² quadrats in the southeast corner at Fir Butte in 2018 and 2020-2022. Values in parentheses represent 95% confidence intervals. FG = functional group; IG = introduced graminoid; IF = introduced forb; Frn = fern; Shr = shrub; NF = native forb.

Species	FG	2018: Pretreatment			2020			2021			2022		
		Average	no lupine	lupine	Average	no lupine (treated)	lupine (untreated)	Average	no lupine (treated)	lupine (untreated)	Average	no lupine (treated)	lupine (untreated)
<i>Agrostis capillaris</i>	IG	13.1(4.7)	11(5.1)	17.6(9.8)	12.1(8.2)	2.3(1.7)	21.3(14.4)	1.5(0.8)	1.4(1.4)	1.6(0.9)	6.2 (7.1)	8.9 (12.7)	3.6 (6.5)
<i>Anthoxanthum odoratum</i>	IG	0.9(1)	1.1(1.5)	0.4(0.5)	1.2(1.2)	0(0)	2.3(2.1)	0.3(0.5)	0(0)	0.7(1.1)	3.2 (4)	3.1 ()	3.4 ()
<i>Arrhenatherum elatius*</i>	IG	0.5(0.4)	0.6(0.5)	0.5(0.5)	3.4(2.9)	0(0)	6.5(5.1)	0.1(0.1)	0(0)	0.2(0.2)	0.3 (0.7)	0 (0)	0.7 (1.3)
<i>Dactylis glomerata</i>	IG	0.5(0.5)	0.5(0.6)	0.6(1.1)	0.2(0.4)	0(0)	0.5(0.8)	0(0)	0(0)	0(0)	0 (0)	0 (0)	0 (0)
<i>Festuca arundinacea</i>	IG	1.2(1.4)	1.7(2)	0.1(0.2)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0 (0)	0 (0)	0 (0)
<i>Vulpia sp.</i>	IG	2.8(2.1)	2.7(2)	3.1(5.4)	0.1(0.2)	0(0)	0.2(0.4)	0.8(0.6)	0.6(0.4)	1(1.1)	14.6 (6.3)	17.7 (10.4)	11.6 (7.3)
<i>Crepis capillaris</i>	IF	3.7(2.6)	4.8(3.7)	1.2(0.6)	3.6(2.1)	1.6(1.4)	5.3(3.7)	8(3.7)	3.6(2.7)	12.3(6.3)	2.5 (1.3)	2.4 (2.3)	2.5 (1.2)
<i>Daucus carota</i>	IF	0.4(0.3)	0.5(0.4)	0.2(0.2)	2.1(1.6)	2.5(3.2)	1.7(1.2)	2.9(2.7)	2.6(4.5)	3.3(3.2)	10.3 (8.3)	5.6 (8.1)	14.9 (14.5)
<i>Hypochaeris radicata</i>	IF	1.6(0.7)	1.7(1)	1.2(0.9)	0.6(0.5)	0.8(0.7)	0.4(0.8)	2(1.8)	0.8(0.7)	3.2(3.4)	10.3 (6.9)	11.6 (11.0)	9 (8.9)
<i>Galium parisiense</i>	IF	0.4(0.3)	0.6(0.5)	0.1(0.2)	1.2(0.7)	1.5(1)	0.9(1)	6.7(3.7)	6.9(6.2)	6.4(4.3)	3 (1.7)	1.6 (1.0)	4.4 (3.1)
<i>Pteridium aquilinum</i>	Frn	3.1(2.5)	1.7(1.2)	6.2(7.4)	2.3(3.1)	0.1(0.1)	4.3(5.9)	1.5(1.7)	0(0)	3.1(3.3)	0.3 (0.4)	0 (0)	0.5 (0.8)
<i>Rubus bifrons</i>	Shr	3.7(2.4)	4.4(3.4)	2.1(1.8)	9(8.3)	1.5(2.1)	16(15.2)	1.9(1.5)	0.2(0.4)	3.6(2.8)	0.3 (0.4)	0.1 (0.2)	0.4 (0.8)
<i>Lupinus oreganus</i>	NF	0.7(0.6)	0(0)	2.2(1.5)	3.6(3.9)	0(0)	7(7.2)	3.2(2.2)	0(0)	6.3(3.8)	4 (4.2)	0 (0)	8.1 (7.9)

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

4.3. Monitoring and habitat assessment discussion

4.3.1. Kincaid's lupine

The foliar cover and count of Kincaid's lupine racemes increased at the site from 2021 to 2022. Ongoing efforts to control introduced species and increase native plant cover and diversity have contributed to expanding and enhancing the Kincaid's lupine population at Fir Butte. Continued management of introduced graminoids and shrubs is recommended to maintain these positive trajectories, particularly in the southeast treated corner, where introduced graminoids and forbs have increased in the last year.

4.3.2. Vegetation community composition

SOUTHEAST CORNER (2018 BURN UNIT)

In 2018, prior to a prescribed burn and post-burn treatments, introduced grasses and bracken fern were the most abundant species in the SE corner. In 2021, introduced forbs were the dominant species with an average cover of 22.6% ($\pm 5.6\%$). In 2022, introduced graminoids were once again the dominant functional group, with an average cover of 44.1% ($\pm 11.1\%$) (Table 3).

The relative cover of introduced species in the SE corner remains far above the recovery goal of <50% and has been increasing. One of the primary reasons why habitat conditions have not been improving in the SE corner could be that three years passed between the last prescribed burn (2018) and the time the unit was seeded (2021). During that time, most of the herbicide treatments were spot sprays around the existing Kincaid's lupine patches, which allowed some weeds (particularly introduced forbs) to build strength within those untreated patches. Meanwhile, the treated areas were opportunistically colonized by introduced annual grasses (e.g., *Vulpia* sp.) that did not face much competition because native seed was not put on the ground early enough. Additionally, many of the herbicide treatments occurred during the winter months, when temperatures are too low for treatments to be very efficacious.

Moving forward, retreating non-native species, followed by seeding and outplanting of native species in this area, is recommended in order to reach recovery goals. As of 2022, there is still relatively high cover of ground in this unit (12.8% ($\pm 7.3\%$)), providing opportunities to continue seeding with native species. Lastly, continued monitoring will contribute to our understanding of the effects of management treatments on target weed species, Kincaid's lupine, and the overall vascular plant community.

5. 2023 RECOMMENDED ACTIONS

In 2023, IAE recommends the following habitat restoration and assessment activities:

- Follow the post-burn treatment plan for the NE corner as outlined in Section 3.4. Plan to seed that unit in fall 2023.
- Develop and implement a new treatment plan for the SE corner. Start spot-spraying patches of non-native annual grasses. After several treatments, plant native perennial bulbs and plugs of Fender's blue butterfly nectar species into these patches where bare ground occurs.
- Begin applications of grass-specific herbicides if BLM receives approval for use.

- Continue targeted herbicide applications of meadow knapweed, blackberry, bracken fern, and other non-native species (e.g., hedge bindweed) as necessary throughout the site.
- Work with BLM and the City of Eugene to coordinate treatment of meadow knapweed on neighboring properties.
- Continue hand pulling meadow knapweed, bull thistle, tansy ragwort, and Scotch broom as necessary.
- Work with property neighbors to spray, mow, and masticate blackberry along southern and eastern fence lines.
- Consider adding seed of other threatened and endangered or Bureau-sensitive species (e.g., Willamette daisy (*Erigeron decumbens*) and shaggy horkelia (*Horkelia congesta*)) to Fir Butte if conditions are appropriate for their introduction.
- Continue monitoring SE corner vegetation to evaluate efficacy of ongoing management actions.
- Monitor NE corner vegetation to evaluate efficacy of ongoing management actions following the 2022 prescribed burn.
- Monitor nectar islands and treatment areas using the Relevé method.
- Monitor Kincaid's lupine and evaluate overall site habitat quality.
- Hold biannual IAE-BLM meetings to coordinate restoration treatments at Fir Butte.
- Write annual report and update the Fir Butte habitat management plan.

REFERENCES

- Dennehy, C., E. R. Alverson, H. E. Anderson, D. R. Clements, R. Gilbert, and T. N. Kaye. 2011. Management Strategies for Invasive Plants in Pacific Northwest Prairies, Savannas, and Oak Woodlands. *Northwest Science* 85:329–351.
- Diaz, S., and S. Harris. 2022. 2022 Status of the Fender's blue butterfly. Institute for Applied Ecology, Corvallis, Oregon, USA.
- Fields, J., D. Giles, and A. Esterson. 2022. Habitat restoration and monitoring for Kincaid's lupine at Fir Butte: 2021 annual report. Institute for Applied Ecology, Corvallis, OR.
- Kaye, T. N. 1999. Obligate insect pollination of a rare plant, *Lupinus sulphureus* ssp. *kincaidii*. *Northwest Science* 73:50–52.
- Milligan, G., E. S. Cox, J. G. Alday, V. M. Santana, H. A. McAllister, R. J. Pakeman, M. G. Le Duc, and R. H. Marrs. 2016. The effectiveness of old and new strategies for the long-term control of *Pteridium aquilinum*, an 8-year test. *Weed Research* 56:247–257.
- Thorpe, A. S. 2011. Kincaid's lupine (*Lupinus oregonus*) and community monitoring at Fir Butte. Institute for Applied Ecology, Corvallis, Oregon, USA.
- U.S. Fish and Wildlife Service. 2010. Recovery plan for the prairie species of western Oregon and southwestern Washington. U.S. Fish and Wildlife Service, Portland, OR, USA.
- U.S. Fish and Wildlife Service. 2014. Biological opinion for the Resource Management Plan for the West Eugene Wetlands in Lane County, Oregon. U.S. Fish and Wildlife Service, Portland, OR, USA.

APPENDICES

Appendix 1. Fir Butte management actions (2008-2022)

Year	Date	Activity	Personnel*	Notes
2008	June-July	Weed control	Land steward	Pull tansy ragwort (<i>Senecio jacobaea</i>)
2008	June-July	Weed control	Land steward	Clip seed heads on tall oatgrass (<i>Arrhenatherum elatius</i>)
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	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	NWYC	Pull meadow knapweed in N end, S end, and around E small shade cloth patch
2008	April-June	Weed control	Land steward	Cut Himalayan blackberry (<i>Rubus bifrons</i>) along fenceline and shade cloth
2008	April-June	Weed control	Land steward	Cut bracken fern (<i>Pteridium aquilinum</i>)
2008	June-July	Woody species control	Land steward	Cut Ponderosa pine (<i>Pinus ponderosa</i>) in wetland prairie
2008	August-October	Ecological burn	BLM	Wetland and SW third of upland
2008	August-October	Seed nectar mix		Wetland and SW third of upland
2009	June-July	Weed control	Youth crew	Clip seed heads from tall oatgrass
2009		Weed control	Monitoring staff	Pull Scotch broom, tansy ragwort, tall oatgrass
2009		Weed control	Monitoring staff	Shade cloth, cut meadow knapweed and Himalayan blackberry
2009	August-October	Ecological burn	BLM	SE third of upland prairie
2009	August-October	Seed nectar species		SE third of upland prairie
2010	June-July	Weed control	Monitoring crew	Pull Scotch broom in South end
2010	April-July	Weed control	Monitoring crew	Pull bracken fern

Year	Date	Activity	Personnel*	Notes
2010	June-July	Weed control	Monitoring crew	Pull purple-anther pepper weed
2010		Weed control	Youth crew	Pull Scotch broom, tansy ragwort, tall oatgrass
2010		Weed control	Youth crew	Pull Scotch broom, tansy ragwort, tall oatgrass
2011	April-June	Shade cloth repair	LGYC	Eastern border
2011	April-June	Weed control	LGYC	Pull bracken fern
2011	June-July	Woody species control	LGYC	Cut woody species
2011	June-July	Weed control	LGYC	Pull tansy ragwort
2011	August-October	Weed control	LGYC	Pull tansy ragwort
2011	April-June	Weed control	NWYC	Pull bracken fern
2011	August-October	Woody species control	BLM contractor	Masticate Himalayan blackberry
2011	August-October	Prescribed burn	BLM	NE third of upland
2011	August-October	Seed nectar mix	BLM	NE third of upland prairie, N and S center shade cloth areas, S border
2012	April-June	Apply shade cloth and solarization	LGYC	E border of site
2012	April-June	Weed control	LGYC	Pull Scotch broom, tansy ragwort, tall oatgrass
2012	June-July	Weed control	LGYC	Pull Scotch broom, tansy ragwort, tall oatgrass
2012	June-July	Apply shade cloth	IAE/LGYC	5 8m x 10m areas dispersed throughout site
2012	October	Prescribed burn	BLM	6 acres: Wetland and NE third of upland
2012	October	Seed wetland and upland species mix	IAE	Burned area
2012	October	Plant nectar species	IAE/LGYC	Shade cloth and solarization area on E border of site
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> .
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	25-Apr	Hand removal of weeds throughout site	IAE	Digging/pulling of all weeds marked on 4/17/13
2013	29-Apr	Hand removal of weeds throughout site	IAE	Digging/pulling of all weeds marked on 4/17/13
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	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	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	14, 15, 22-May	Weed control	IAE/LGYC	Shade cloth/solarization installation.
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	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	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	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	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.

Year	Date	Activity	Personnel*	Notes
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.
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	Weed control	IAE	Clipped seed heads on meadow knapweed along north border and east of big shade cloth area.
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	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	Solarization removal	IAE	Removed shredded plastic at the remaining 2 solarization plots.
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	31-Oct	Flame weeding	IAE	Flame weeded plots 1a-5a.
2013	1-Nov	Plant delivery	IAE	Picked up plants at Eugene NPN and Heritage and delivered to Fir Butte
2013	4-Nov	Planting	IAE/ Lane Metro Youth Corps	Planted in plots 2a, 3a, 4a, and "lepidium".
2013	6-Nov	Seeding	IAE	Seeded over plots 2a, 3a, 4a, "lepidium", and Experiment A-C.
2013	20-Nov	Shade cloth removal	IAE	plot 6a
2013	20-Nov	Flame weeding	IAE	plot 6a
2014	20-Mar	Flame weeding	IAE	Flame weeded plots 1a, 5a, 6
2014	20-May	Flame weeding	IAE	Flame weeded plots 1a, 5a, 6

Year	Date	Activity	Personnel*	Notes
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	6-Jun	Monitoring	IAE	Monitored shade cloth/solarization experimental plots
2014	17, 18-Jun	Hand weeding	IAE/ 12 from NWYC	Plots 2a, 3a, 4a
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 bracken fern	IAE/ 12 from NWYC	Weeded 200 feet west of plot 2a around Kincaid's lupine
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	12-Sep	Re-mowed fire line	IAE	N edge of prescribed burn area; preparation for burn
2014	22-Sep	Fence construction	Island Fence	Fence constructed along entire east border of property
2014	29-Oct	Flame weeding	IAE	Flame weeded plots 1a, 5a. Did not reflare plot 6 because excessive weedy grasses had established.
2014	3, 5-Nov	Planting	IAE/ Lane Metro Youth Corps	Planted plugs and bulbs in plots 1a, 5a, 3b
2014	24-Nov	Planting	IAE/ AmeriCorps	Finished planting plugs and bulbs in plots 1a, 3b, 5a
2014	24-Nov	Weeding	IAE	Weeded most velvet grass out of 1a
2015	14-Jan	Seeding	IAE	Overseeded plots 1a, 3b, 5a, and burned area
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	23-Apr	Orientation visit; hand pull & dig weeds	IAE	Removed meadow knapweed rosettes, Lepidium, thistle, tansy ragwort in northern portion of site
2015	6-May	Remove weeds	IAE	Removed meadow knapweed rosettes, Lepidium, thistle, tansy ragwort throughout site
2015	12-May	Monitoring	IAE	Collected data from shade cloth/solarization test plots
2015	13-May	Removed weeds	IAE	Removed Lepidium from plot 6, weeded invasive grasses from nectar islands

Year	Date	Activity	Personnel*	Notes
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	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	5-Aug	Hand weeding	IAE	Hand weeded and bagged meadow knapweed, mainly in the NW corner
2015	7-Aug	Hand weeding	IAE	Removed blackberry from edges of nectar islands, weeded nectar islands
2015	9-Nov	Planting	IAE/ LGYC	Planted plugs and bulbs in plot 4b
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	13-Nov	Planting	IAE/ 4 volunteers	Planted plugs and bulbs in plots 1b and 2b
2015	19-Nov	Planting	IAE	Planted plugs and bulbs in plots 2b 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	8-Dec	Seeding	IAE	Over seeded plots 1a, 1b, 2b, 4b, 5a, and 5b
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
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	6-May	Survey for Fender's blue butterfly	IAE/ BLM	Distance sampling for Fender's blue butterfly
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.

Year	Date	Activity	Personnel*	Notes
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.
2016	26-Jul	Hand weeding	BLM/ LGYC	Hand weeded meadow knapweed, mainly in the NW corner
2016	17-Aug	Hand weeding	IAE/ BLM	Removed Himalayan blackberry from edges of nectar islands, weeded nectar islands
2016	22-Aug	Burn break prep	IAE/ BLM	Mowed edges of Schultz research plots to prepare for prescribed burn.
2016	22-Aug	Shade cloth	IAE/ BLM	Replaced shade cloth on nectar island 2c.
2016	2-Sep	Fire break prep	IAE	Removed tree on the edge of fire break on Schultz research plot.
2016	16-Sep	Prescribed burn	Inter-Agency burn crew	Burned 4 acres in SE corner; burned 8 research plots in SW corner.
2016	19-Oct	Seeding	BLM	Seeded burn unit with native mix
2016	8-Nov	Planting	IAE/ BLM/ LGYC/ AmeriCorps/ volunteer	Planted bulbs and bare root lomatium in plots 1c, 2c, 4c & 5c
2016	21-Nov	Planting	IAE/ BLM/ LGYC/ AmeriCorps/ volunteer	Planted plugs and bulbs in plots 4c, 1c, 2c, and 5c
2016	29-Nov	Seeding	IAE	Over seeded plots 1a, 1b, 1c, 2a, 2b, 2c, 3a, 3b, 4a, 4b, 4c, 5a,5b, 5c
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
2017	May-July	Survey for Fender's blue butterfly	BLM	Distance sampling for Fender's blue butterfly
2017	13-Jul	Weed removal	BLM/ LGYC	Removed meadow knapweed inflorescences
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-Sep	Nectar island prep	IAE/ BLM	Cleared and prepared shade cloth for nectar species planting

Year	Date	Activity	Personnel*	Notes
2017		Fire break prep	Contractor	Mowed fire brake around burn zone
2017	13-Sep	Fire break prep	IAE/BLM	Delineated burn zone with pin flags
2017	5-Oct	Prescribed burn	Inter-Agency burn crew	Burned 4 acres in north section which contain both upland and wet prairies
2017	19, 26-Oct	Nectar island prep	IAE/ BLM	Burned 1710 holes in shade cloth and seeded with native mix
2017	24-Oct	Seeding	IAE/ BLM	Seeded wet prairie with native mix
2017	26-Oct	Seeding	IAE/ BLM	Seeded upland with native mix
2017	8-Nov	Planting	IAE/ BLM/ LGYC	Planted 400 Kincaid's lupine plugs at Hansen
2017	14-Nov	Planting	BLM/ LGYC	Planted approximately 1200 <i>Fragaria virginiana</i> runners
2017	15-Nov	Planting	IAE/ BLM/LGYC	Planted approximately 1600 <i>Triteleia hyacinthine</i> bulbs
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	20-Nov	Nectar island prep	IAE/ BLM	Burned holes in weed barrier
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
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
2018	18-Apr	Weed control	IAE	Flame weeded meadow knapweed in NW corner
2018	18-Apr	Weed control	IAE/ BLM/ LGYC	Picked bracken fern on south east side
2018	8-May	Weed control	LGYC	Picked bracken fern on south east side
2018	17-May	Site preparation	IAE/ BLM	Flame weeded a 9x8m plot for nectar island establishment and covered plot with plastic for solarization treatment
2018	21-May	Weed control	IAE	Mowed bracken fern
2018	29-May	Weed control	IAE/ BLM	Mowed tall oatgrass with string trimmer
2018	30-May	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

Year	Date	Activity	Personnel*	Notes
2018	5-Jun	Weed control	IAE	Mowed tall oatgrass with string trimmer
2018	8-Jun	Weed control	IAE	Mowed tall oatgrass with string trimmer
2018	8-Jun	Site preparation	IAE	Established a new 6X20m nectar island by clearing off vegetation with a string trimmer
2018	9-Jun	Site preparation	IAE	Covered mowed nectar island with plastic for solarization treatment
2018	13-Jun	Weed control	IAE	Mowed meadow knapweed in northwest corner
2018	26-Jun	Weed control	IAE	Pulled knapweed
2018	10-Jul	Weed control	IAE	Pulled knapweed
2018	26-Jul	Weed control	IAE	Pulled knapweed
2018	14-Aug	Site preparation	IAE	Flagged nectar islands
2018	27-Aug	Weed control	Contractor	Site wide mowing (except for burn unit and nectar islands)
2018	6-Sep	Site preparation	IAE/ BLM	Removed plastic from solarization treatments
2018	2-Oct	Weed control	IAE/ BLM/ LGYC	Removed Scotch broom from SE corner
2018	13-Oct	Prescribed burn	Interagency team	Burned approximately 5-acres in SE corner and all nectar islands
2018	17-Oct	Seeding	IAE	Broadcast nectar island seed mix over nectar islands
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	7-Dec	Herbicide application	IAE	Applied 1.5% glyphosate solution to meadow knapweed across the site using a backpack sprayer.
2019	3/26, 3/29	Site preparation	IAE	Flagged lupine in SE corner (burn area)
2019	4/16	Herbicide application	IAE/ Contractor (IRM)	Spot-sprayed glyphosate over 1.5 acres in SE corner; flagged lupine areas were not sprayed
2019	4/23	Herbicide application	IAE/ Contractor (IRM)	Spot-sprayed over additional 1.5 acres in SE corner; flagged lupine areas were not sprayed
2019	5/14, 5/15, 5/22	Weed control	IAE	Mowed tall oatgrass and bracken fern
2019	5/22	Weed control	IAE/ Contractor (IRM)	Spot sprayed bracken fern with 1.5% solution of glyphosate
2019	5/22	Weed control	IAE/ Contractor (IRM)	Applied glyphosate with weed wiper on bracken fern
2019	5/24	Weed control	IAE/ BLM	Mowed tall oatgrass

Year	Date	Activity	Personnel*	Notes
2019	6/11	Weed control	IAE	Spot sprayed meadow knapweed with 1.5% solution of glyphosate
2019	7/24	Weed control	IAE	Hand pulled and spot sprayed meadow knapweed
2019	7/20	Site preparation	IAE	Removed pin flags from SE corner to prepare for mowing
2019	9/12	Weed control	IAE/ Contractor (NTS)	Spot sprayed blackberry, hawthorn (<i>Crataegus monogyna</i>), and rose (<i>Rosa</i> sp.)
2019	11/5	Site preparation	BLM/ LGYC	Removed weed cloth from nectar island 6d
2020	1/30	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.
2020	4/28	Weed control	IAE/BLM	Spot spray of meadow knapweed throughout site with Rodeo/NuFilm-IR
2020	5/5	Site visit	IAE	Site visit by Rebecca Currin and Ian Silvernail.
2020	6/23	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	7/10	Weed control	IAE/BLM	Spot spray with Rodeo/Nu-Film-IR of areas missed during 6/23 spray.
2020	7/22	Site visit	IAE/BLM	Site visit by Sally Villegas-Moore, Julia Fields, Rebecca Currin, and Ian Silvernail.
2020	7/24	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	8/5	Site visit	IAE/BLM	Site visit to assess conditions.
2020	August	Weed control	BLM/ LGYC	Hand pull meadow knapweed.
2020	9/29	Site visit	IAE/BLM	Site visit, lupine senesced.
2020	10/1	Woody species control	IAE/BLM/Contractor (NTS)	Spot spray blackberry, hawthorn and rose.
2020	11/20	Site preparation	IAE/BLM/Contractor (IRM)	Broadcast glyphosate to 3.5 ac in SE corner and nectar island 8a.
2020	12/22	Site visit	IAE	Site visit to assess herbicide efficacy.
2021	1/14	Weed control	IAE	Spot sprayed SE corner with glyphosate.
2021	3/16	Weed control	IAE	Site visit to assess conditions. Flagged lupine in SE corner.
2021	4/14	Weed control	IAE	Spot sprayed meadow knapweed and SE corner.

Year	Date	Activity	Personnel*	Notes
2021	5/3	Weed control	IAE	Spot sprayed meadow knapweed, SE corner, and nectar island 8a.
2021	5/13	Site visit	IAE	Site visit to assess herbicide treatment and take photopoints.
2021	5/26	Site visit	IAE	Finished flagging lupine in SE corner.
2021	6/18	Weed control	IAE	Spot sprayed SE corner and nectar island 8a.
2021	7/12	Site visit	IAE/BLM	Site visit to discuss treatment options and seeding.
2021	8/5	Mapping	IAE	Mapped tall oatgrass population.
2021	8/18	Weed control	IAE	Spot sprayed bracken fern and hand pulled meadow knapweed.
2021	9/14	Woody species control	IAE/Contractor (IRM)	Treated woody plants throughout meadow.
2021	9/29	Site visit	IAE/USACE	Site visit to discuss use of seed drill.
2021	10/4	Weed control	IAE	Broadcast glyphosate to SE corner and nectar island 8a.
2021	10/14	Seeding	IAE/BLM	Seeded SE corner and nectar island 8a with dew drop drill borrowed from USACE.
2022	2/25	Site visit	IAE	Site visit to assess conditions.
2022	3/4	Planting	IAE, BLM	Planted approximately 1000 <i>Sidalcea malviflora</i> plants in nectar island 8a, donated by Heritage Seedlings & Liners, Inc.
2022	5/16	Weed control	IAE	Spot sprayed meadow knapweed across entire site with glyphosate.
2022	7/25	Site visit	IAE	Took photo points.
		Weed control	IAE	Pulled Scotch broom from SE corner.
2022	8/8	Weed control	IAE, BLM	Pulled knapweed, tansy ragwort, bull thistle, and Scotch broom from entire site.
2022	8/31	Woody species control	IAE	Spot sprayed woody species throughout northern half of site with triclopyr.
2022	9/2	Site maintenance	BLM/contractor	Mowed entire site except six acre burn unit in NE corner.
2022	9/21	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	10/4	Prescribed burn	BLM	Burned five acre unit in NE corner.
2022	11/15	Weed control	IAE/Habitat Restoration LLC	Broadcast glyphosate over five acre burn unit in NE corner.

* 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 photopoints

Photos taken on July 25, 2022.



Photopoint 1

North



East



South



West



Photopoint 2

North



East



South



West



Photopoint 3

North



East



South



West



Appendix 3. Nectar islands



Appendix 4. Fir Butte prescribed burns from 2008-2018



Appendix 5. Nectar island history

Plot	Size	Year established	Treatment type	Year planted
1a	8m x 10m	2012	Shade cloth	2014 (plants), 2015 (seed), 2016 (seed)
1b	8m x 10m	2014	Shade cloth	2015 (seed), 2016 (seed)
1c	8m x 10m	2015	Shade cloth	2016 (plants and seed)
2a	8m x 10m	2012	Shade cloth	2013 (plants and seed), 2016 (seed)
2b	8m x 10m	2013	Shade cloth	2015 (plants and seed) 2016 (seed)
2c	8m x 10m	2015	Shade cloth	2016 (plants and seed)
3a	8m x 10m	2012	Shade cloth	2013 (plants and seed), 2016 (seed)
3b	8m x 10m	2013	Shade cloth	2014 (plants), 2015 (seed), 2016 (seed)
4a	8m x 10m	2012	Shade cloth	2014 (plants), 2015 (seed), 2016 (seed)
4b	8m x 10m	2013	Shade cloth	2015 (plants and seed), 2016 (seed)
4c	8m x 10m	2015	Shade cloth	2016 (plants and seed)
5a	8m x 10m	2012	Shade cloth	2014 (plants and seed), 2016 (seed)
5b	8m x 10m	2014	Shade cloth	2015 (plants and seed), 2016 (seed)
5c	8m x 10m	2015	Shade cloth	2016 (plants and seed)
6d	15m x 25m	2017	Solarization, shade cloth	2017 (plants and seed)
4e (small)	9m x 8m	2018	Solarization, shade cloth	2018 (seed)
7e	6m x 20m	2018	Solarization, shade cloth	2018 (seed)
4e (big)	20m x 13m	2018	Solarization, shade cloth	2018 (seed)
8a	0.25 acres	2018	Prescribed burn and chemical fallow	2021 (seed), 2022 (plants)
SE corner	3 acres	2018	Prescribed burn and chemical fallow	2021 (seed)

Appendix 6. Nectar island plant materials

Nectar plots seeded and planted from 2014-2022.

Year	Nectar plot	
	Seeded	Planted
2014	1a, 3b, 5a	1a, 3b, 5a
2015	1b, 2b, 4b, 5b	1b, 2b, 4b, 5b
2016	1a, 1b, 1c, 2a, 2b, 2c, 3a, 3b, 4a, 4b, 4c, 5a, 5b, 5c	1c, 2c, 4c, 5c
2017	6d	6d
2018	1a, 1b, 1c, 2a, 2b, 2c, 4a, 4b, 4c, 5a, 5b, 4e (small), 7e	-
2021	8a, SE corner	-
2022	-	8a

Species planted in nectar plots from 2014-2022.

Scientific name	Common name	Form	Quantity				
			2014	2015	2016	2017	2022
<i>Allium amplexans</i>	narrowleaf onion	bulbs	1,650	700	1,500	-	-
		plugs	-	-	-	300	-
<i>Camassia leichtlinii</i>	large camas	bulbs	10 trays	-	-	-	-
		plugs	-	-	-	300	-
<i>Eriophyllum lanatum</i>	Oregon sunshine	1'x2' Flats	186	-	-	-	-
		band pots	-	60	-	-	-
<i>Eriophyllum lanatum</i>	Oregon sunshine	band pots	-	-	-	250	-
<i>Festuca roemerii</i>	Roemer's fescue	medium plugs	800	2,448	400	-	-
<i>Fragaria virginiana</i>	wild strawberry	ramets	-	1,000	-	-	-
<i>Iris tenax</i>	Oregon iris	4" pots	-	40	-	-	-
<i>Lomatium nudicaule</i>	barestem biscuitroot	bare root	699	-	2,600	-	-
<i>Luzula comosa</i>	Pacific woodrush	medium plugs	273	-	800	-	-
<i>Sidalcea malviflora ssp. virgata</i>	dwarf checkermallow	medium plugs	1,080	2,560	1,600	-	1,000
		band pots	-	-	-	350	-
<i>Sisyrinchium idahoense</i>	Idaho blue-eyed grass	4" pots	-	80	-	-	-
<i>Triteleia hyacinthina</i>	white brodiaea	bulbs	1 tray	-	-	-	-
<i>Zigadenus venenosus</i>	death camas	bulbs	800	500	-	-	-

Seed broadcast in nectar plots from 2014-2021.

Scientific name	Common name	Seed (lbs)					
		2014	2015	2016	2017	2018	2021
<i>Achillea millefolium</i>	common yarrow	0.06	0.09	0.20	0.20	0.10	0.17
<i>Allium amplexans</i>	narrowleaf onion	-	-	-	-	1.20	1.39
<i>Camassia leichtlinii</i> var. <i>suksdorfii</i>	large camas	1.31	1.61	1.59	1.59	5.01	-
<i>Camassia quamash</i>	Common camas	-	-	-	-	-	4.88
<i>Carex tumulicola</i>	Splitawn sedge	-	-	-	-	-	1.88
<i>Clarkia purpurea</i> ssp. <i>quadrivulnera</i>	farewell-to-spring	0.02	0.02	0.06	0.06	-	0.26
<i>Collomia grandiflora</i>	large-flowered collomia	-	-	-	-	-	3.01
<i>Danthonia californica</i>	California oatgrass	-	-	-	-	-	4.36
<i>Epilobium densiflorum</i>	denseflower willowherb	0.05	0.07	0.09	0.09	-	0.43
<i>Eriophyllum lanatum</i>	Oregon sunshine	0.07	0.23	0.17	0.17	0.81	0.42
<i>Festuca roemerii</i>	Roemer's fescue	0.35	0.52	0.84	0.84	-	1.22
<i>Hordeum brachyantherum</i>	meadow barley	-	-	-	-	-	3.25
<i>Iris tenax</i>	toughleaf iris	-	-	-	-	-	7.95
<i>Linanthus bicolor</i>	true babystars	0.02	0.02	0.02	0.02	-	0.15
<i>Lomatium nudicaule</i>	barestem biscuitroot	-	0.22	0.19	0.20	1.21	6.17
<i>Lupinus oreganus</i>	Kincaid's lupine	-	-	-	-	-	6.00
<i>Luzula comosa</i>	Pacific woodrush	0.09	-	-	-	0.12	0.52
<i>Madia elegans</i>	Showy tarweed	-	-	-	-	-	1.14
<i>Microseris laciniata</i>	cutleaf silverpuffs	0.10	0.12	0.17	0.17	0.29	1.54
<i>Nemophila menziesii</i> var. <i>atomaria</i>	baby blue eyes	-	0.06	0.05	0.11	-	-
<i>Perideridia oregana</i>	Oregon yampah	-	-	-	-	-	0.77
<i>Plectritis congesta</i>	shortspur seablush	0.07	0.51	0.21	0.21	0.20	0.46
<i>Potentilla gracilis</i> var. <i>gracilis</i>	slender cinquefoil	0.03	0.40	0.07	0.07	-	0.26
<i>Prunella vulgaris</i> var. <i>lanceolata</i>	self-heal	0.16	0.18	0.31	0.31	0.34	0.91
<i>Ranunculus occidentalis</i>	Western buttercup	-	-	-	-	0.44	1.83
<i>Sidalcea malviflora</i> ssp. <i>virgata</i>	dwarf checkermallow	0.49	0.83	0.83	0.83	4.00	4.59
<i>Sisyrinchium idahoense</i>	Idaho blue-eyed grass	-	-	-	-	0.22	2.01
<i>Wyethia angustifolia</i>	narrowleaf mule's ears	0.66	0.75	0.48	0.48	-	3.67
Total		3.48	5.63	5.28	5.35	13.94	59.24

Appendix 7. 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 1998-2020. 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	191,500	±37,746	27