

Upper Oak Basin Kincaid's lupine and Hitchcock's blue-eyed grass monitoring and restoration: 2023 annual report



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PREFACE

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



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Cover photographs: Kincaid's Lupine (*Lupinus oreganus*) in spring. Photo by Tyler Roberts.

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Upper Oak Basin Kincaid's lupine and Hitchcock's blue-eyed grass monitoring and restoration: 2023 annual report

EXECUTIVE SUMMARY

This report documents habitat restoration and vegetation monitoring activities conducted by the Institute for Applied Ecology (IAE) in partnership with the Bureau of Land Management's (BLM) Upper Willamette Field Office (UWFO), Northwest Oregon District, at Oak Basin ACEC (Oak Basin), a complex of upland meadows. Oak Basin is home to Kincaid's lupine (*Lupinus oreganus*), a federally threatened species, and Hitchcock's blue-eyed grass (*Sisyrinchium hitchcockii*), a federal species of concern and state-listed as endangered. Kincaid's lupine serves as the primary larval host plant for the threatened Fender's blue butterfly (*Icaricia icarioides fenderi*). The small population of Fender's blue butterfly at Oak Basin has been on the decline since 2015, and only 60 individuals were documented in 2023 at Oak Basin on BLM-administered land. All three species are endemic to western Oregon prairies.

Management treatments

Restoration activities conducted in 2023 included mowing to reduce thatch and shrub cover; removal and limbing of conifers to increase meadow connectivity and reduce woody encroachment; hand-pulling invasive plants including Scotch broom (*Cytisus scoparius*) and Italian plumeless thistle (*Carduus pycnocephalus*); chemical treatments of Himalayan (*Rubus bifrons* syn. *Rubus armeniacus*) and evergreen blackberry (*Rubus laciniatus*); installing solarization fabric in Meadow D; broadcasting native forb and grass seed to disturbed ground; planting narrow leaf mule-ears (*Wyethia angustifolia*), deltoid balsamroot (*Balsamorhiza deltoidea*), and Kincaid's lupine plugs; collecting native seed including forest scurfpea (*Rupertia physodes*), swordleaf rush (*Juncus ensifolius*), spreading rush (*Juncus patens*), common rush (*Juncus effusus*), and Hitchcock's blue-eyed grass (*Sisyrinchium hitchcockii*); and continuing seed amplification beds for dwarf checkermallow (*Sidalcea malviflora* ssp. *virgata*) and toughleaf iris (*Iris tenax*).

Kincaid's lupine

In 2023, total Kincaid's lupine foliar cover at Oak Basin was 340.8 m², continuing the generally positive trend that started in 2016 coincident with more active management of the site. The count of racemes in 2023 was 5,238. Since the initiation of more active management practices in 2016, all meadows have shown a positive trend in foliar cover and count of mature racemes.

Hitchcock's blue-eyed grass

The number of Hitchcock's blue-eyed grass individuals and reproductive stems at Oak Basin's Meadow C has generally decreased since monitoring began in 2012. In 2023, 62 total plants were observed. Of particular concern was that no plants have been observed in the small patch peripheral to the main population since 2021.

Recommendations

Activities in 2024 should include the continued control of non-native plants. We recommend treating non-native plants in the meadows and corridors using all available tools (e.g., chemical, thermal, mechanical and manual), followed by seeding and planting treated areas with a mix of native nectar species and native perennial grasses.

Habitat management in Meadow C should consider actions to improve habitat for Hitchcock's blue-eyed grass, which could include control of introduced graminoids, and/or seeding of native graminoids in and adjacent to the existing small population. Habitat maintenance in Meadow D to convert two acres of low-quality habitat to resource-rich habitat for Fenders blue butterfly is ongoing. Coordination with adjacent landowners will leverage management actions by both parties to increase connectivity between Kincaid's lupine and Fender's blue butterfly populations in the meadow complex.

Access roads to the meadows need improvement for restoration and monitoring efforts to continue effectively. The roads have degraded to the point that vehicle access is limited to only the dry season, slowing restoration efforts and constraining management methods. IAE submitted a proposal for Western Oregon Resource Advisory Council (RAC) funding to support this effort.

1. INTRODUCTION

This report documents habitat restoration and rare plant and community monitoring activities conducted by the Institute for Applied Ecology (IAE) at Oak Basin ACEC (Oak basin) in 2023. Oak Basin, managed by the Northwest Oregon BLM (Bureau of Land Management) District's Upper Willamette Field Office, is about six miles southeast of Brownsville, Oregon (Figure 1). The site includes upland prairie and oak (*Quercus garryana*), maple (*Acer macrophyllum*), and Douglas-fir (*Pseudotsuga menziesii*) woodlands. Oak Basin supports the largest known population of Kincaid's lupine (*Lupinus oreganus*; Figure 2) in the Upper Willamette Field Office's management area and is home to a population of the threatened Fender's blue butterfly (*Icaricia icarioides fenderi*; Figure 2). The Oak Basin Fender's blue butterfly population is relatively small, with an estimated population of 60 butterflies in 2023 and remains vulnerable to extirpation (Diaz and Harris 2023).

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Figure 1. The location of Oak Basin within the Willamette Valley and a close-up of the project area.

Vegetation monitoring by IAE at Oak Basin is focused on documenting the size and reproduction of the Kincaid's lupine population and assessing habitat quality. This information is used to determine the effectiveness of restoration treatments and to document long-term population trends in support of meeting recovery goals as outlined in the Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington (U.S. Fish and Wildlife Service, 2010). In addition to monitoring Kincaid's lupine, IAE monitors a small population of the rare Hitchcock's blue-eyed grass (*Sisyrinchium hitchcockii*).



Figure 2. Fender's blue butterfly (*Icaricia icarioides fenderi*) and Kincaid's lupine (*Lupinus oregonus*). Photos taken on May 5, 2021 in Meadow B.

1.1. Species status and information

Kincaid's lupine is a member of the legume family (Fabaceae). It is an herbaceous perennial that reproduces by seed. Plants form clumps of basal leaves and eventually produce one or more flowering stems. The species also spreads vegetatively, though it is unknown to what extent vegetative growth may result in the formation of physiologically distinct clones (Severns et al. 2011). Kincaid's lupine requires insects for successful fertilization and seed formation (Kaye 1999). It is found in native prairie remnants in the Willamette Valley and southwestern Washington and in forest openings in Douglas County, Oregon. Because Kincaid's lupine serves as the larval host for the federally threatened Fender's blue butterfly (Oregon Biodiversity Information Center 2016), conservation of Kincaid's lupine populations is the primary goal for the protection of both species. Kincaid's lupine is listed by the Oregon Department of Agriculture and the U.S. Fish and Wildlife Service (USFWS) as a threatened species (Oregon Biodiversity Information Center 2016)

Hitchcock's blue-eyed grass is a rhizomatous perennial forb in the Iris family (Iridaceae; Figure 3). The species reproduces by seed and by clonal vegetative growth. It is listed as a federal Species of Concern

by the U.S. Fish and Wildlife Service (Oregon Biodiversity Information Center 2016) and is a Bureau Sensitive Species for the BLM.

The site contributes to the recovery of Kincaid's lupine since the population currently meets the minimum foliar cover of 100 m² needed for the site to count towards recovery (Figure 1). Additionally, large patches of Kincaid's lupine occur on the adjacent, privately owned Oak Basin Tree Farm that is currently being restored through a cooperative agreement between private landowners, Greenbelt Land Trust, Oregon Department of Fish and Wildlife, and U.S. Fish and Wildlife's Partners for Fish and Wildlife Program.



Figure 3. Hitchcock's blue-eyed grass (*Sisyrinchium hitchcockii*): (a) long and narrow leaves with parallel veins that are mostly basal; (b) 3-chambered capsules up to 6 mm long containing black seeds; and (c) flowers with blue to bluish-purple tepals with a faint (or absent) yellow "eye" in the center.

1.2. Fender's blue butterfly life cycle

Fender's blue butterflies become mature adults in May and June at which time they fly, consume nectar, and mate. The females oviposit their eggs on the underside of Kincaid's lupine leaves. Eggs are

identifiable as small (0.5–1.0 mm) white spheres. The eggs hatch in a few weeks; hatched eggs resemble unhatched eggs except that they are burst in the center, making them look like little white “donuts.” The larvae subsequently feed on Kincaid's lupine leaves until late June or early July, at which time they crawl under nearby vegetation and plant litter and enter diapause. They remain in a dormant state until February or early March when they then begin feeding again on the newly emerging Kincaid's lupine leaves. Near the end of April, they pupate and reemerge as butterflies (Schultz and Crone 1998).

2. GOALS AND OBJECTIVES

2.1. Monitoring

The goals of the monitoring are to track the size and reproductive status of the Kincaid's lupine population at Oak Basin and examine overall Kincaid's lupine and Fender's blue butterfly habitat quality over time. Specifically, we aim to link these data with habitat restoration activities occurring on-site, conducted and facilitated by IAE, and to document population size and trends to ensure that the population remains stable or increases, with area of foliar cover being maintained at or above the minimum targets as laid out in the Recovery Plan (U.S. Fish and Wildlife Service 2010). Secondary goals are to assess the status of the Hitchcock's blue-eyed grass population and to help guide restoration activities at the site.

2.2. Habitat restoration

Habitat restoration goals are to maintain or improve prairie habitat in support of Kincaid's lupine and its associated Fender's blue butterfly populations.

This project has four primary objectives:

- 1) Maintain and improve quality prairie habitat by removing non-native invasive plants;
- 2) Prevent encroachment of woody species into the prairie;
- 3) Increase diversity and the areal extent of the native plant community; and
- 4) Improve connectivity between meadows.

3. METHODS

3.1. Monitoring methods

Habitat quality

In 2023, we continued habitat monitoring efforts that begun in 2020 and are directly applicable to the habitat quality criteria as outlined in the Recovery Plan (U.S. Fish and Wildlife Service 2010). Standard relevé plots (5m x 5m) were established in each meadow, two in Meadow A and one each in Meadows B and C. Within each plot, we estimated percent cover by species and then calculated species richness and cover by plant functional group.

Restoration experiment

In addition to the relevé plots, in 2020 a new experimental restoration project was installed to assess the efficacy of utilizing various combinations of mowing, fire, application of glyphosate, and seeding over time (one, two, and four years after treatment). Plots were first sampled in 2020 and repeated through 2023. Future sampling will occur in 2024. Two different treatment combinations, hereafter referred to as treatments, are being evaluated that include the following components: mowing (M) in the spring to prevent seed set and to reduce stored reserves of non-native perennial grasses; flame weeding (B) in the fall to reduce thatch build-up and prep the site for seeding; a post-burn spot application of 1.5% glyphosate (G) to reduce the abundance of non-native herbaceous perennials; and the application of seed (S). Mowing height will be 3-10 cm and the biomass will be left in place. In addition to the experimental treatments, a “no treatment” regime was included as a control.

A total of 10 experimental plots (10m x 30 m) were established in occupied Kincaid's lupine habitat in three BLM meadows: four in Meadow A and three in each of meadows B and C (Figure 4). Plots were divided into three 100m² (10m x 10m) subplots: control, GBGS, and MBGS. The control subplot was further subdivided into two 10m x 5m plots, one that will be seeded using the same mix as the treated subplots and one that will be left unseeded (Figure 5).

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Figure 4. Experimental plot and Kincaid's lupine (*Lupinus oreganus*) patch locations at Oak Basin.

Data are collected from four 1 m² quadrats randomly placed within each of the subplots in June. Percent cover is visually estimated to the nearest 1% for all vascular species. Ground cover classes will be divided into the following: basal vegetation, bare ground, rock, moss, and thatch (defined as non-living vegetative matter). Photos of each subplot are taken from the south-central edge of the plot before sampling the quadrats.

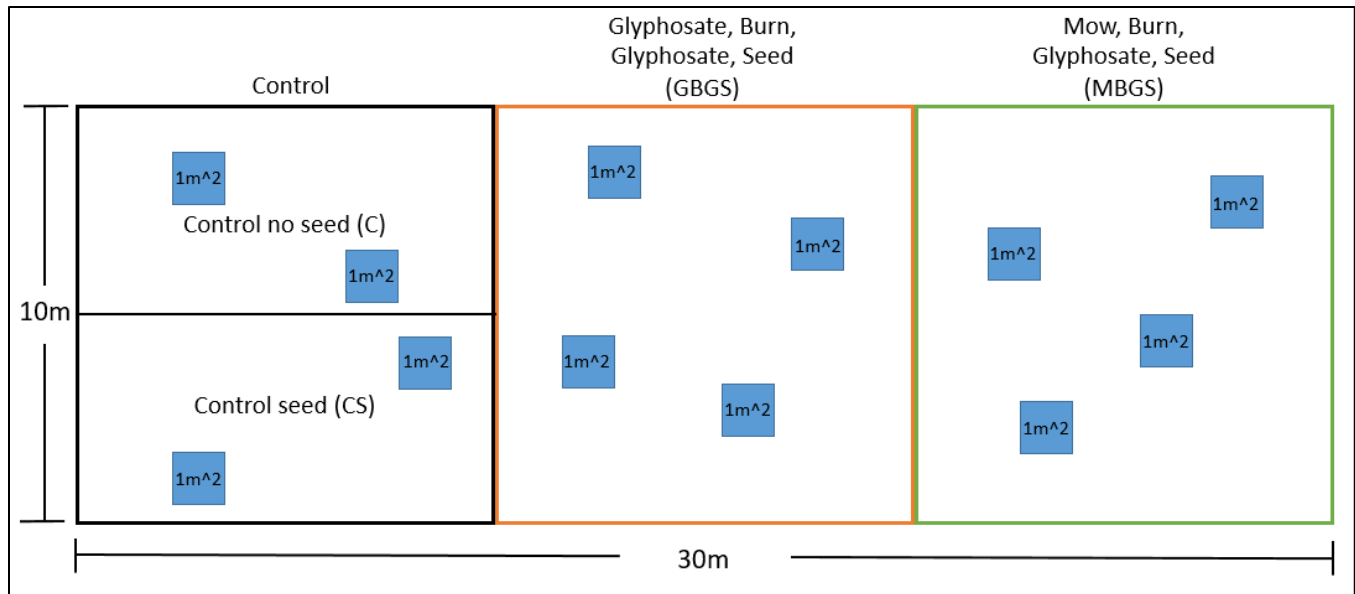


Figure 5. Diagram of oak basin experimental design. One plot is 10m x 30m. Plots are divided into three subplots (10m x 10m). Treatments for each subplot include (1) control, (2) GBGS (glyphosate-flame weed-glyphosate-seed), and (3) MBGS (mow-flame weed-glyphosate-seed). The control is divided further into two subplots: one seeded, one left unseeded. Each subplot was sampled by visually estimating species and ground cover types in four 1m² quadrats.

Kincaid's lupine

Monitoring Kincaid's lupine at Oak Basin is considered to be a complete census of the population. In 2006, Meadows A, B, and C were surveyed for the presence of Kincaid's lupine. Plots were then installed around Kincaid's lupine patches. Additional plots have been added as new patches have been located, and all plots are sampled annually. Larger plots are rectangular and marked with fiberglass posts, rebar, or conduit at all four corners. Smaller patches are monitored in either circle or belt transects. Circular plots were marked in the center and all plants were included by setting an appropriate radius. Belt transects were marked on opposite ends, a tape was stretched between the posts, and all the Kincaid's lupine on either side of the tape were recorded. Each plot origin was tagged with a pre-numbered aluminum tag. Plot notes can be found on the plot maps in Appendix F. When plants are found outside of existing plots, plot boundaries are either modified or new plots added to accommodate these plants in the census.

Kincaid's lupine is monitored by measuring the area of foliar cover (m²) and counting mature and aborted racemes in each plot. Specifically, Kincaid's lupine foliar cover is measured by taking the approximate length (cm) and width (cm) of area occupied by Kincaid's lupine using standard rulers and meter poles.

Foliar cover of Kincaid's lupine (as opposed to counting 'individual' plants of this rhizomatous species) is the standard metric for Kincaid's lupine monitoring in the Recovery Plan (U.S. Fish and Wildlife Service 2010). The percentage of aborted racemes is calculated by dividing the number of aborted racemes by the sum of all mature and aborted racemes and multiplying by 100.

In 2023 we also mapped Kincaid's lupine patches on the adjacent private property (Appendix F). These maps will be utilized in 2024 to include monitoring using similar protocols on the adjacent private property. In 2023 we also visited "Doghead Meadow" (Figure 1), at Lower Oak Basin to assess potential habitat actions and check for the presence of Kincaid's lupine that had been seeded as part of a project which evaluated the effects of microclimate and seed source on Kincaid's lupine establishment (Gray and Bahm 2017). In 2023, Kincaid's lupine plants were observed in each of the three macroplots at the site; the total cover of these plants was less than 1m².

Hitchcock's blue-eyed grass

Two permanent plots were established in 2012 to monitor the small population of Hitchcock's blue-eyed grass in Meadow C at Oak Basin. These same plots were monitored in 2023. The first is a 15m long x 8m wide belt transect with rebar marking both ends. The plot was monitored in 1m sections on the east and west sides of the tape. The origin of the transect is on the south end, tagged with an aluminum tag with #185 stamped on it. The second plot is a 2m radius circular plot with the rebar placed in the center and tagged with #186; plants in this plot are measured in four quadrants. There is a small patch of Kincaid's lupine in this same area, and the circular plot #186 serves as a marker for both the Kincaid's lupine and the Hitchcock's blue-eyed grass. Western blue-eyed grass (*Sisyrinchium bellum*) is also present in the area; for this reason, monitoring occurs at the time of flowering (late June/early July) to ensure proper identification of each species.

Due to the rhizomatous growth of Hitchcock's blue-eyed grass, plants greater than 20cm apart were counted as distinct individuals unless there was clear evidence otherwise (e.g., exposed rhizomes; Groberg et al. 2013). Plants were noted to be either vegetative (V) or reproductive (R). Those that were reproductive were also given a number to represent the number of flowering stems of each plant (e.g., R1 has one flowering stem; R2 has two flowering stems, etc.); individual stems may have more than one flower. In addition, a reproductive plant is likely to have multiple vegetative stems as well.

4. HABITAT RESTORATION ACTIONS

In 2023, IAE completed and subcontracted restoration work on both BLM and private land to achieve the habitat restoration goals outlined in Section 2.2. Restoration activities included manual treatments, mowing, solarization, spot spray herbicide applications to Himalayan blackberry (*Rubus bifrons* syn. *Rubus armeniacus*), tree removal, planting, and seed broadcasting. Through collaboration with IAE and the BLM, the adjacent private landowner dedicated time and resources to habitat restoration for Kincaid's lupine and Fender's blue butterfly on their property, which is not detailed in this report. In 2023, We received RAC funding to begin restoration at Doghead Meadow, a meadow at Lower Oak Basin. However, restoration has been delayed until relevé plots are first established in spring 2024. See Appendix A for a summary of restoration actions completed at Oak Basin over the past decade.

Table 1. Habitat restoration actions completed in 2023.

Date	Personnel	Tasks	Where
4-Jan	IAE	Planted 172 narrow leaf mule-ears plugs.	Meadow A, Meadow B, A-B Corridor
7-Feb	IAE	Mowed experimental plots.	All Meadows
24-Apr	IAE, Subcontractor	Assessed and planned treatments with Walama.	Meadow D
26-Apr	IAE	Established pre-solarization relevé plots and collected data.	Meadow D
1-May	IAE, Subcontractor	Established site wide photo points. Walama installed solarization fabric.	All Meadows
4-May	IAE	Planted 216 Kincaid's lupine plugs. Pulled Italian thistle and Scotch broom.	Meadow A
11-May	IAE, USFWS, BLM, Jim and Anna Merzenich	Discussed restoration, research, and Fender's blue butterfly augmentation at Oak Basin.	All Meadows
24-May	IAE	Pulled Italian Thistle. Planning and monitoring visit to Lower Oak Basin.	Meadow A and B, Lower Oak Basin
7-Jul	IAE	Assessed and planned treatments.	Meadow D, Meadow A and B
4-Aug	IAE	Spot sprayed Himalayan blackberry with Garlon 3A.	Meadow D
7-Aug	IAE	Spot sprayed Himalayan blackberry with Garlon 3A.	Meadow A-B Corridor
10-Aug	IAE	Spot sprayed Himalayan blackberry with Garlon 3A.	Meadow B
6-Sep	IAE, Jim and Anna Merzenich	Assessed and planned treatments.	All Meadows
19-Sep	IAE	Mowed Himalayan blackberry canes. Limbed perimeter trees and felled one Douglas-fir tree for oak release. Repaired and reinforced solarization fabric.	Meadow D
2-Oct	IAE	Mowed Himalayan blackberry canes to prepare for seeding.	Meadow D, A-B Corridor
20-Oct	IAE, Subcontractor	Walama repaired and reinforced solarization tarp following significant damage. Felled a Douglas-fir tree to expand meadow and make rounds used to reinforce fabric. <u>Seeding</u> Broadcast FBB nectar mix and a Grass mix in Meadow B and the A-B corridor. Broadcast native grass mix to bare ground disturbed by habitat restoration actions in Meadow D.	Meadow D, Meadow B, A-B corridor
30-Oct	IAE	Spot sprayed Himalayan blackberry with Garlon 3A. Broadcast FBB nectar mix, grass mix, and Roemer's fescue seed.	Meadow D
1-Dec	IAE	Planted 72 Deltoid balsamroot. Repaired and reinforced solarization fabric. Planned and mapped trees to be felled and girdled.	Meadow D, Meadow C

Date	Personnel	Tasks	Where
12-Dec	IAE, AmeriCorps	Felled three Douglas-fir trees. Repaired and reinforced solarization fabric with wood rounds from felled trees. Consolidated debris from downed trees into habitat piles in the forest.	Meadow D
13-Dec	IAE, AmeriCorps	Felled seven Douglas-fir trees and girdled one. Cleaned downed debris. Limbed along C-D corridor edge. Distributed additional wood rounds to solarization tarp.	Meadow D, C-D corridor

Walama Restoration Project (Walama)

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Figure 6. Restoration actions completed at Oak Basin in 2023.

4.1. Invasive plant treatments

Manual treatments

Manual treatments included hand pulling Italian plumeless thistle (*Carduus pycnocephalus*), mowing to reduce thatch and speed up decomposition, and removing woody debris from meadow habitat (Figure 7). Significantly less Italian plumeless thistle was observed in 2023, indicating that annual hand pulling is effectively reducing populations. Experimental plots and dead Himalayan blackberry canes were

mowed. Felling and limbing trees creates large amounts of woody debris that need to be removed from meadow habitat. IAE staff and an AmeriCorps team consolidated branches into decomposition piles in the forest and distributed tree rounds across the solarization fabric to reinforce nails and add weight. IAE mowed experimental plots except for the control treatments, and dead Himalayan blackberry canes to increase decomposition and accessibility for future treatment and seeding.



Figure 7. Manual treatments at Oak Basin in 2023. **A.** Pulling Italian plumeless thistle (*Carduus pycnocephalus*), **B.** Himalayan blackberry (*Rubus bifrons*) canes after mowing, **C.** Mowing experimental plots, **D.** AmeriCorps team members dragging woody debris out of meadow habitat.

Solarization

Walama Restoration Project (Walama), installed approximately one acre of solarization fabric in Meadow D using 10-12 inch nails to affix 17.5' by 309' rolls of geotextile fabric (AFC300 woven) to the ground in the spring. Throughout the year, the fabric required routine maintenance as it would stretch, loosen, and pull free from the ground especially during high winds and rainy weather in the latter half of the year. During a storm in October, most of the fabric had come loose and lifted free from the ground. Walama returned to troubleshoot and repair the fabric, determining that additional heavy weights were needed for reinforcement of the fabric. To prevent damage to the access roads caused by transporting heavy loads of material, IAE cut rounds from nearby felled trees to use as weights on the fabric. With

assistance from an AmeriCorps team, IAE distributed these rounds along the seams and loose sections of the fabric to reinforce it (Figure 8).



Figure 8. Installation and maintenance of solarization fabric. **A.** Materials used for solarization, **B.** Walama installing fabric in Meadow D, **C.** Fabric pulled free of the ground after a storm, **D.** AmeriCorps

team helping to repair fabric, **E.** Moving cut rounds to add weight to the fabric, **F.** Wood rounds distributed along the seams of the fabric.

Herbicide

IAE spot sprayed patches of Himalayan blackberry using Garlon 3A (Figure 9). The focus was on treating patches in Meadow D that need to be reduced before solarization fabric can be installed in 2025. Additionally, the private landowner at Oak Basin Tree Farm contributed time and resources to treating invasive grasses and other weedy species in their portion of Meadow D. During a post-spray efficacy check the landowner discovered a previously unknown patch of Kincaid's lupine growing vigorously in Meadow D, likely in response to the sudden decrease in competition.



Figure 9. Effective herbicide treatment of Himalayan blackberry (*Rubus bifrons*) in Meadow D using Garlon 3A (triclopyr).

Tree removal

IAE felled a total of ten Douglas-fir trees and girdled one to release Oregon white oaks from competition, expand meadow habitat, and increase connectivity between meadows (Figure 10). Some large Douglas-fir trees surrounding the meadow were limbed to increase the effective meadow size

without felling. IAE girdled a Douglas-fir tree to reduce competition with an Oregon white oak and minimize the risk of it damaging the oak or surrounding solarization fabric. AmeriCorps consolidated branches and woody debris into decomposition piles under the forest canopy and out of meadow habitat. Larger tree trunks were cut into rounds and distributed across the solarization fabric. Continuing corridor creation efforts started in 2022, private landowners removed woody debris by burning piles on their land and seeding native prairie species into burned patches (Figure 11).



Figure 10. Tree removal and maintenance in Meadow D. **A.** IAE felled trees on the north side of meadow D increasing meadow habitat, **B.** IAE girdled a Douglas-fir tree (*Pseudotsuga menziesii*) encroaching an Oregon white oak (*Quercus garryana*) above the solarization fabric, **C.** and **D.** Before and after opening a corridor from Meadow D to Meadow C.



Figure 11. Private landowner and daughter, Jim and Anna Merzenich, burning slash piles from woody debris in meadow corridor.

4.2. Revegetation actions

IAE planted and broadcast native seed including important Fender's blue butterfly nectar species, Kincaid's lupine, and native restoration species in areas disturbed by restoration actions (Figure 6). IAE planted 172 narrow leaf mule-ears (*Wyethia angustifolia*) plugs, 72 deltoid balsamroot (*Balsamorhiza deltoidea*) plugs, and 216 Kincaid's lupine plugs in patches. All seed broadcast at Oak Basin in 2023 was purchased from seed producers and sourced from the Willamette Valley due to a limited supply of mid-elevation seed and to meet the increasing need for revegetation at Oak Basin. In 2023, IAE collected native seed from Oak Basin including forest scurfpea (*Rupertia physodes*), swordleaf rush (*Juncus ensifolius*), spreading rush (*Juncus patens*), common rush (*Juncus effusus*), and Hitchcock's blue-eyed grass (*Sisyrinchium hitchcockii*)

IAE developed a Fender's blue butterfly seed mix and a grass seed mix that were broadcast to areas disturbed by restoration actions (Table 2, Table 3). The Fender's blue butterfly nectar seed mix was broadcast to Meadow B, A-B corridor, and Meadow D. The grass seed mix was broadcast to A-B corridor and Meadow D. Additionally, maintenance of the solarization fabric throughout the year led to

a slight decrease in the total fabric coverage and Roemer's fescue (*Festuca roemerii*) was broadcast around the edges of the solarization fabric where bare ground was exposed.

Table 2. Fender's blue butterfly nectar seed mix.

Species/Variety	Common Name	Meadow B & A-B corridor	Meadow D
<i>Achillea millefolium</i>	common yarrow	0.71	2.17
<i>Aquilegia formosa</i>	red columbine	0.03	0.10
<i>Brodiaea coronaria</i>	crown brodiaea	0.02	0.06
<i>Bromus vulgaris</i>	Columbia brome	0.82	2.50
<i>Carex tumulicola</i>	splitawn sedge	0.35	1.07
<i>Clarkia amoena</i> ssp. <i>lindleyi</i>	farewell-to-spring	0.16	0.48
<i>Collinsia grandiflora</i>	large-flowered blue-eyed Mary	0.11	0.33
<i>Collomia grandiflora</i>	large-flowered collomia	0.49	1.50
<i>Danthonia californica</i>	California oatgrass	1.09	3.33
<i>Elymus glaucus</i>	blue wildrye	0.48	1.46
<i>Eriophyllum lanatum</i>	woolly sunflower	0.08	0.25
<i>Festuca roemerii</i>	Roemer's fescue	0.30	0.90
<i>Gilia capitata</i>	bluehead gilia	0.74	2.25
<i>Koeleria macrantha</i>	prairie Junegrass	0.04	0.13
<i>Madia gracilis</i>	grassy tarweed	0.21	0.63
<i>Plectritis congesta</i>	shortspur seablush	0.15	0.45
<i>Prunella vulgaris</i> var. <i>lanceolata</i>	common selfheal	0.24	0.73
<i>Sidalcea malviflora</i> ssp. <i>virgata</i>	dwarf checkermallow	0.58	1.75
Total:		6.60	20.05
rate (lbs/acre):		13.19	13.37

Table 3. Grass seed mix.

Species/Variety	Common Name	Meadow B & A-B corridor	Meadow D
<i>Achillea millefolium</i>	common yarrow	0.16	0.16
<i>Bromus vulgaris</i>	Columbia brome	2.00	2.00
<i>Carex tumulicola</i>	splitawn sedge	0.55	0.55
<i>Danthonia californica</i>	California oatgrass	1.26	1.26
<i>Elymus glaucus</i>	blue wildrye	0.88	0.88
<i>Festuca roemerii</i>	Roemer's fescue	0.49	0.49
<i>Koeleria macrantha</i>	prairie Junegrass	0.06	0.06
<i>Lupinus bicolor</i>	bi-colored lupine	0.37	0.37
<i>Madia gracilis</i>	grassy tarweed	0.25	0.25
Total:		6.02	6.02
rate (lbs/acre):		12.03	12.03

5. RESULTS

5.1. Habitat quality

In each meadow, a 25 m² relevé plot was permanently installed in 2020 and surveyed for species richness. Observations are summarized in Table 4. A full list of observed species is provided in Appendix H. Plots are scheduled to be monitored on a three-year cycle to assess changes in plant community.

Table 4. Number of species observed within a 5 x 5 m plot in each meadow in 2020 and 2023, summarized by plant functional group and nativity. Plots will be monitored on 3 year cycle.

Meadow		A (plot #696)		B (plot #691)		C (plot #690)		Average	
Year		2020	2023	2020	2023	2020	2023	2020	2023
Forbs	Native	9	10	8	7	10	5	9	7
	Non-native	13	8	14	8	14	6	14	7
Graminoids	Native	6	6	4	3	6	6	6	4
	Non-native	8	3	9	3	9	3	9	4
Tree/Shrubs	Native	0	0	2	2	0	0	1	1
	Non-native	0	0	0	0	0	0	0	0
Total	Native	15	16	14	12	16	7	15	12
	Non-native	21	11	23	11	23	12	23	11

5.2. Experimental treatment plots

When plots were established, cover of each plant functional group was similar (Table 5). In the second-year post-treatment (2022), introduced graminoids were significantly lower in the treated plots compared to the controls ($p < 0.01$), however, in 2023, the third year post-treatment, there were not significant differences between the treatment plots with respect to the cover of introduced graminoids.

In 2023, the remaining functional groups including native and introduced forbs, and native graminoids remained similar to the control plots (Table 5, Figure 12, Figure 13). Bareground increased in the first-year post-treatment compared to the controls with the flame-weeded plots having higher bareground than control or mow plots (Figure 14). This trend continued in 2023, with the flame (GBGS) treatment continuing to have more bareground than the controls and more than the mow treatment (MBGS) (Table 5). Photo points of all 10 experimental plots from 2022 can be found in the 2022 report.

Table 5. Mean plant functional group cover (%) by treatment in 2020 (pre-treatment), 2021- 2023. Each experimental plot contains 3 treatments, and twelve 1x1m subplots in which percent cover was visually estimated for all species and ground cover classes. Results are reported here as an average for each treatment by year.

	2020 – Pre-treatment			2021			2022			2023		
	Control	GBGS	MBGS	Control	GBGS	MBGS	Control	GBGS	MBGS	Control	GBGS	MBGS
Native Forbs	15.4 (3.3)	16.3 (5.3)	14.0 (4.6)	9.1 (2.8)	10.7 (6.0)	13.3 (5.5)	12.6 (3.6)	17.0 (7.2)	15.5 (4.0)	16.8 (5.1)	10.9 (3.0)	12.8 (3.7)
Native Graminoids	1.5 (0.5)	1.6 (0.5)	3.3 (1.6)	1.9 (0.7)	0.9 (0.5)	4.5 (3.0)	2.3 (0.6)	0.8 (0.5)	3.1 (1.5)	6.0 (2.5)	1.2 (0.7)	2.5 (1.2)
Introduced Forbs	18.8 (4.3)	17.5 (4.8)	12.4 (3.9)	7.3 (2.2)	14.5 (4.7)	2.6 (0.9)	13.7 (3.2)	18.8 (4.5)	11.7 (3.0)	5.3 (1.3)	7.9 (2.0)	7.5 (2.1)
Introduced Graminoids	42.6 (7.4)	49.3 (8.3)	52.5 (7.0)	45.8 (6.8)	11.0 (3.6)	32.9 (6.9)	54.5 (6.9)	19.1 (5.3)	20.4 (6.0)	24.1 (6.4)	22.4 (4.9)	25.3 (5.1)
Bare Ground	1.4 (0.7)	0.6 (0.4)	0.6 (0.4)	0.7 (0.5)	10.5 (4.0)	6.0 (3.6)	0.7 (0.6)	10.6 (4.6)	2.6 (1.7)	0.8 (0.6)	5.9 (3.7)	3.0 (1.3)
Litter	62.2 (3.1)	56.2 (6.1)	65.2 (2.9)	61.5 (5.5)	58.2 (7.7)	60.2 (6.5)	52.7 (5.3)	58.8 (5.2)	67.1 (3.8)	63.9 (6.0)	62.0 (5.8)	56.9 (5.7)
Moss	1.4 (0.8)	10.2 (7.5)	1.6 (0.6)	1.4 (1.6)	6.3 (5.6)	1.7 (2.0)	2.2 (1.7)	6.2 (4.1)	2.1 (1.4)	0.8 (0.9)	2.4 (1.7)	1.3 (0.8)
Rock	0.2 (0.2)	0.2 (0.2)	0.6 (0.4)	0.5 (0.4)	2.7 (3.8)	0.6 (0.4)	0.3 (0.4)	1.5 (1.5)	1.8 (1.8)	1.4 (1.4)	3.2 (3.4)	4.5 (4.1)
Basal Vegetation	35.0 (2.9)	33.0 (3.5)	32.7 (3.1)	36.0 (5.2)	25.0 (4.6)	31.6 (5.1)	44.1 (5.9)	22.7 (4.4)	26.5 (3.9)	33.0 (6.2)	27.1 (4.1)	35.0 (4.9)

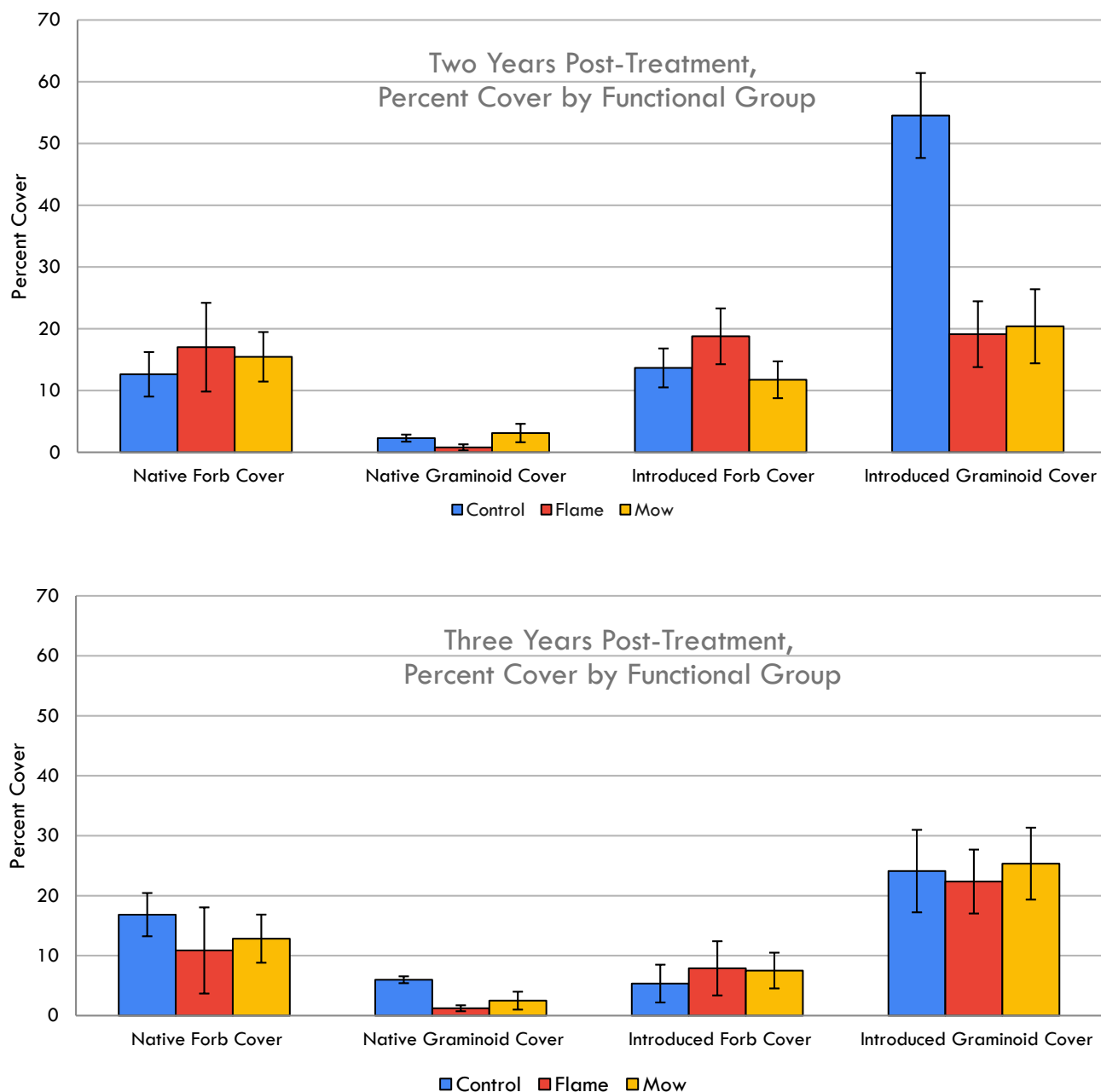


Figure 12. Percent cover by functional group in the second (2022, top) and third (2023, bottom) years post-treatment by treatment.

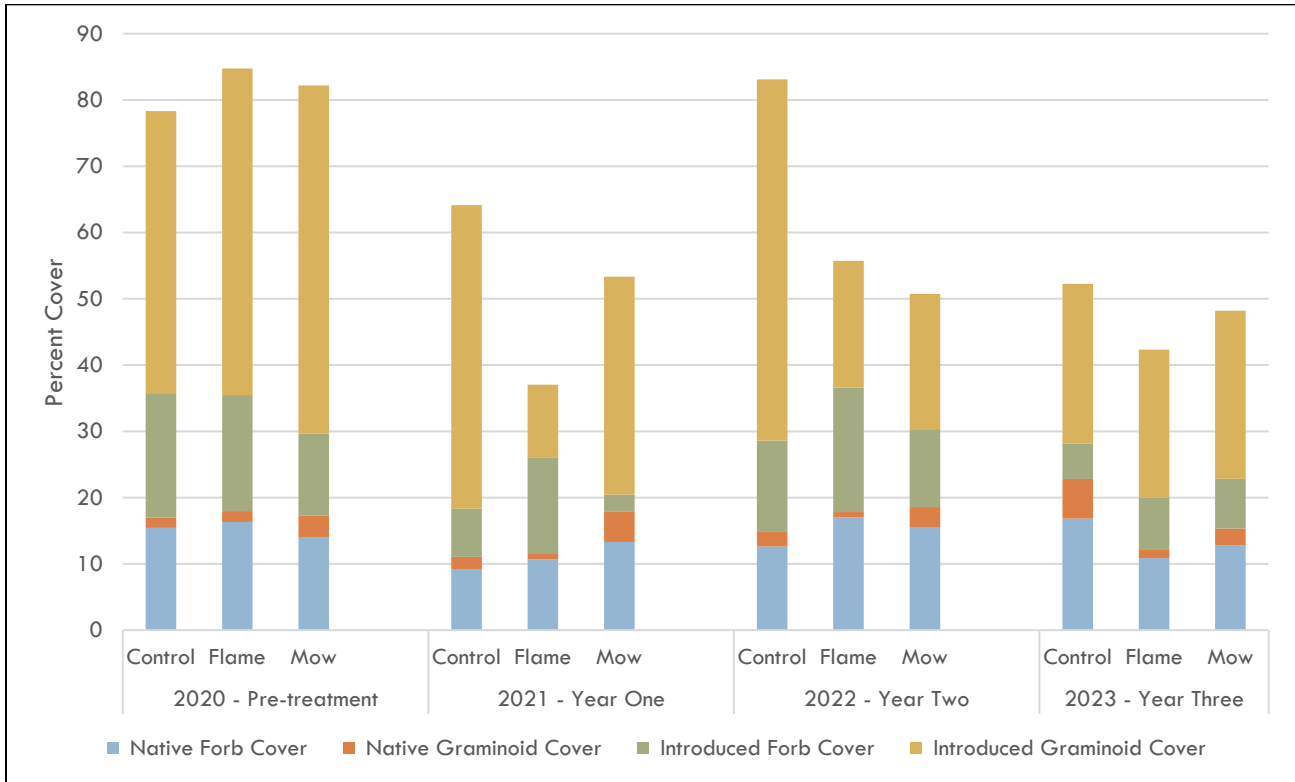


Figure 13. Average percent cover by functional group from 2020-2023 in all treatment plots in all meadows.

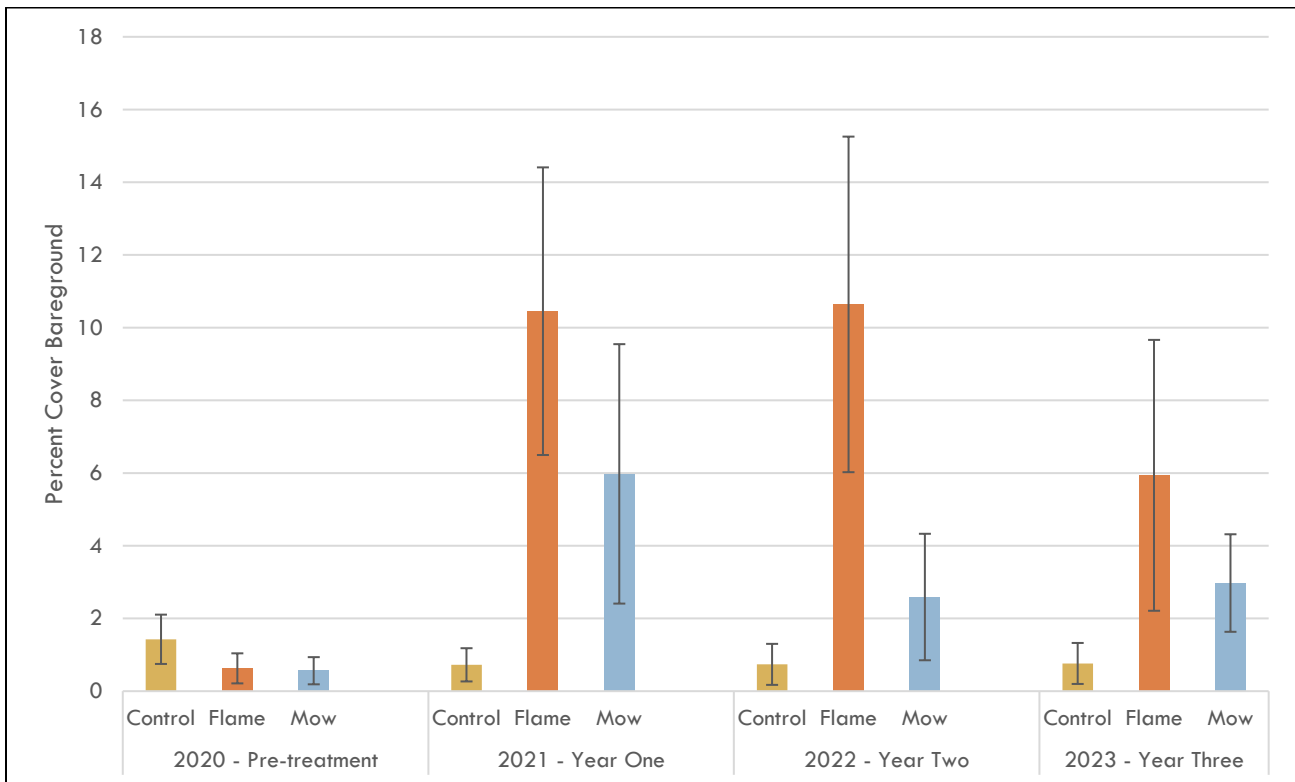


Figure 14. Percent cover bareground in treatment plots from 2020 to 2023. Error bars represent 95 % confidence intervals.

5.3. Kincaid's lupine

Kincaid's lupine cover and raceme count increased in 2023 in Meadow A and C (with the highest values ever recorded for these meadows) and remained stable in Meadow B. Total Kincaid's lupine foliar cover was 340.8 m² across all meadows (Table C-2). There were 5,238 mature racemes and 1,530 aborted racemes (22.3%) (Figure 15, Table D- 1).

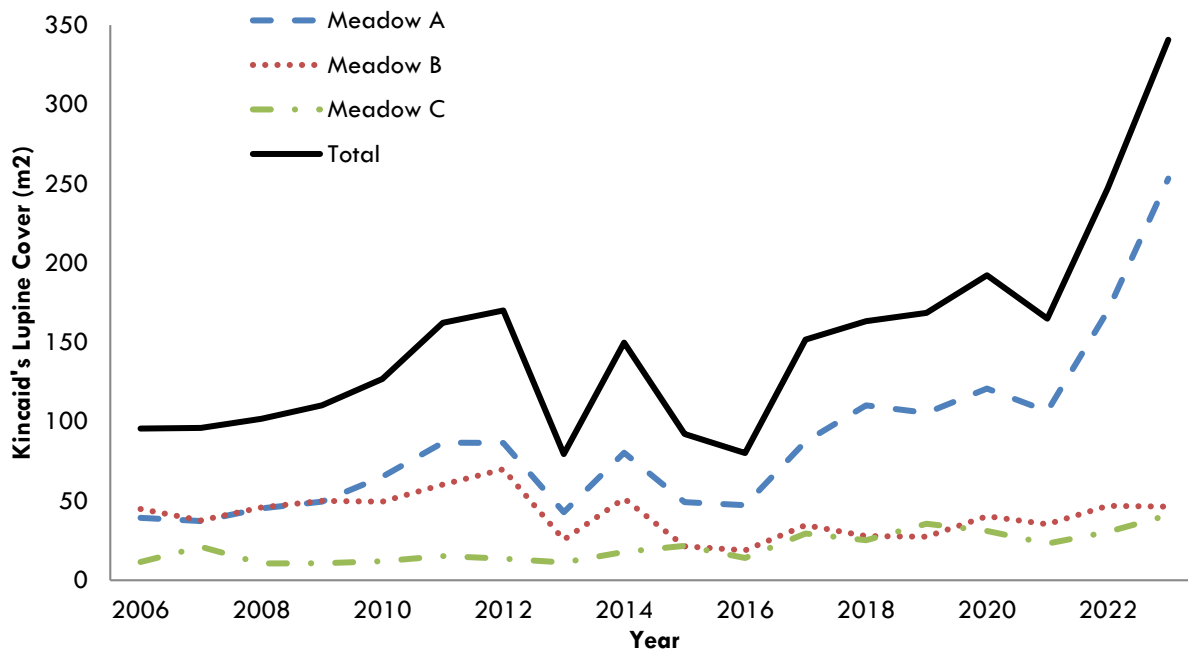


Figure 15. Foliar cover of Kincaid's lupine (*Lupinus oreganus*) from 2006-2023 at Oak Basin in Meadows A, B, C, and all meadows combined.

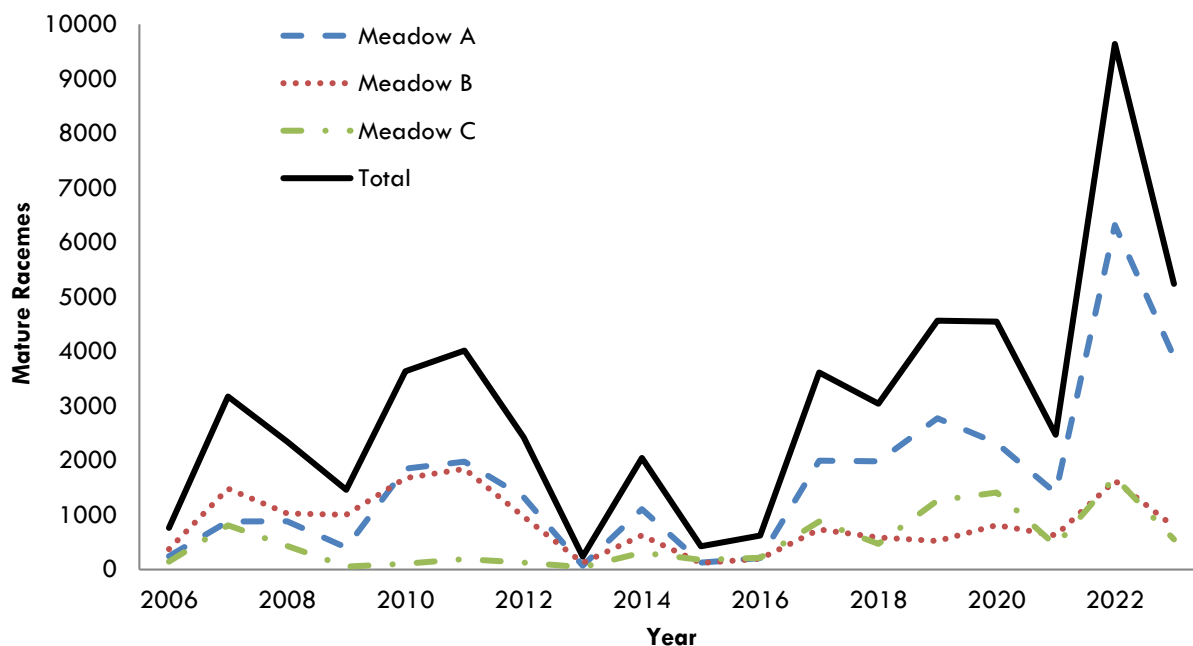


Figure 16. Count of mature Kincaid's lupine (*Lupinus oreganus*) racemes from 2006-2023 at Oak Basin in Meadows A, B, C, and all meadows combined.

5.4. Hitchcock's blue-eyed grass

In 2023, a total of 62 Hitchcock's blue-eyed grass plants were observed, with a total of 40 reproductive stems (Figure 17, Appendix E). As in previous years, most plants observed in the four-meter-wide belt transect were found within two meters of the transect tape. Plants have not been observed in the smaller plot 186 since 2021 when only four plants were noted. This population has been in apparent decline since monitoring began in 2012 (Figure 17).

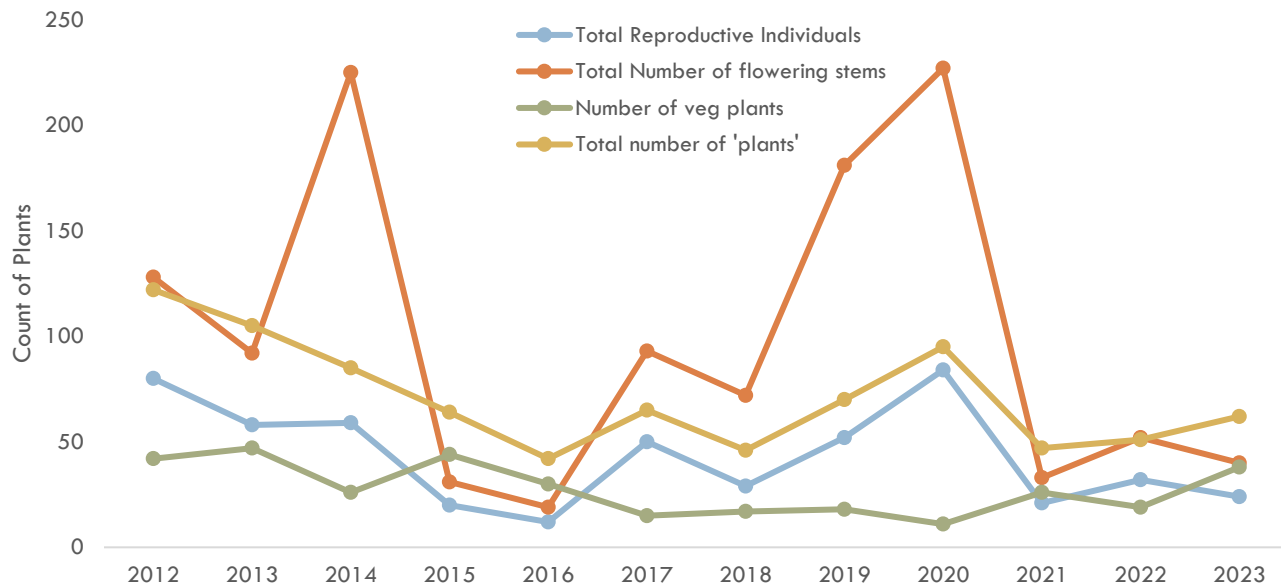


Figure 17. Count of Hitchcock's blue-eyed grass (*Sisyrinchium hitchcockii*) from 2012 - 2023 at Oak Basin, Meadow C.

6. DISCUSSION

6.1. Monitoring trends

Kincaid's lupine

Foliar cover of Kincaid's lupine has increased in Meadows A and C in recent years, likely in part due to response to increased management activities at the site (including introduced species management and corridor creation.) Continued work at the site including seeding of native forb and graminoid species as well as outplanting of plugs and seeds of Kincaid's lupine is recommended to continue this positive trend.

While mature and aborted raceme counts are more variable from year to year, and the mature racemes in all meadows have shown a positive trend (Figure 16).

Hitchcock's blue-eyed grass

The general decline in the total count of plants (and the already small size of the population) combined with the apparent extirpation of Hitchcock's blue-eyed grass plants in the smaller plot 186 is cause for

alarm. Augmentation or habitat maintenance is recommended to maintain this population of this state-listed plant.

Experimental treatment plots

Cover of introduced graminoids were decreased in the flame treatment plots into the second-year post-treatment as compared to the controls and mow plots, however by the third year post treatment, the cover of introduced graminoids was the same in control vs. treatment plots. Bareground continues to be highest in the flame plots. Considering the lower cover of introduced graminoids and higher bareground cover, this flame- treatment is recommended to enhance other habitat at the site. In order to take advantage of these treatment effects, it is recommended that seeding take place within the first two years post-management. These plots were only seeded once immediately after treatment; however, the treatment plots may have benefited from continued seeding to take advantage of the bareground and lower introduced graminoid cover initially observed in these plots- which could have contributed to greater increases in the cover of native forbs and graminoid species at the site improving habitat quality and nectar availability.

6.2. Synthesis

To reach recovery goals for Kincaid's lupine, continued monitoring of both this species and its associated plant community will be vital. Annual fluctuations in raceme count and foliar cover of Kincaid's lupine highlight the need for ongoing monitoring of extant populations in order to assess the status and overall trend of these populations to meet recovery goals (USFWS 2010), and to assess habitat improvements as a result of ongoing management. To assess the progress that has been made towards the Kincaid's lupine recovery goals, we have summarized data for 2023 to compare current conditions to the habitat-quality targets listed in the Recovery Plan (Table 6; USFWS 2010). The continued increase in cover of Kincaid's lupine, particularly in Meadows A and C, highlights the success of management actions at the site.

The prevalence of introduced grasses in the plant community continues to pose a challenge for the restoration of both Kincaid's lupine and Hitchcock's blue-eyed grass. Results from the habitat management plots show that two years post-treatment cover of introduced graminoids remained lower in the flame treatment plots with higher bareground, however by year three, the cover of introduced graminoids was not significantly different in treated vs. control plots. This treatment could be implemented in other portions of the habitat combined with seeding and outplanting efforts over a 2-year post-treatment period to increase native cover and nectar availability.

The alarming decline in the newly state-listed Hitchcock's blue-eyed grass points towards a potentially new area of focus for habitat management in Meadow C.

Table 6. Summary of current Oak Basin prairie habitat quality compared to recovery goals. Trends summarize 14 years (2006-2023) of population and community monitoring data.

Prairie Quality and Diversity Summary*			
Criteria	Oak Basin	Recovery Plan threshold*	Meets Recovery Plan objectives?
Fender's blue butterfly population size**	BLM-administered land: 60;	Minimum population size of 200 individuals over 10 years	No
Trend of Kincaid's lupine population size (foliar cover, m ²)	Generally increasing since 2006	Increasing (+ slope) or stable (0 slope) over 15 years	Yes
Target foliar cover for Kincaid's lupine downlisting	Total: 340.8 m ² Meadow A: 253.3 m ² Meadow B: 46.4 m ² Meadow C: 41.1 m ²	5,000 m ² in Eugene East Recovery Zone; minimum of 100m ² in each meadow to count towards recovery	Mixed
Evidence of Kincaid's lupine reproduction	7.18 g seed collected on BLM-administered land only in 2022	Seedset or presence of seedlings	Mixed – no seed set in some meadows, seedlings not directly observed
Native herbaceous species relative cover	15%	50% min	No
Woody species cover	5%	15% max	Yes
Do any woody species of management concern exceed 5% cover?	No	5% max	Yes
Prairie diversity: Native forb richness	7	7	Yes
Prairie diversity: Native bunchgrass richness	1	1	Yes
Prairie diversity: Total native herbaceous species richness	12	>10	Yes
Sufficient abundance of nectar species***	2 Native, 5 Non-native	5 native species	No

*From the *Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington* (USFWS 2010).

** Data from (Diaz and Harris 2023)

*** Nectar species abundance will be measured in 2024 from other (non-BLM) funding sources.

8. CONCLUSIONS AND MANAGEMENT RECOMMENDATIONS

Annual monitoring data show that recent restoration efforts at Oak Basin have put the site on the right trajectory with regard to increased Kincaid's lupine foliar cover and evidence of reproduction. However, Oak Basin is still falling short of meeting several aspects of the criteria outlined in the Recovery Plan, including the overall population size of Fender's blue butterfly, Kincaid's lupine foliar cover, and several

measures of habitat quality. These data highlight where to focus future restoration efforts at Oak Basin and also guide future monitoring methods.

Prescribed fire followed by broadcast herbicide application could provide more targeted control of tall fescue and other non-native plants. These treated areas would need to be subsequently seeded and planted with native graminoids and forbs, including Kincaid's lupine and others that serve as nectar species for Fender's blue butterfly. It will still be important to use an integrated management approach at the site and to continue to hand-pull small, isolated populations of non-native invasive plants such as Scotch broom, Himalayan blackberry, and Italian plumeless thistle.

Additionally, conifer recruitment should be addressed by cutting saplings rather than allowing trees to grow larger. To address the problem of low Fender's blue butterfly abundance, a large number of trees have been removed, girdled, or limbed since 2015 to increase connectivity between meadows; and treatments to control introduced graminoids are being implemented and tested. Once corridors are opened, follow-up treatments are necessary to prevent non-native shrubs from colonizing the site.

The following habitat management and monitoring activities are recommended at Oak Basin in 2024 and beyond:

- Monitor Kincaid's lupine populations on BLM land and at Oak Basin Tree Farm, including outplantings.
- Monitor Fender's blue butterfly nectar availability at least once every three years. (Scheduled for 2024 with non-BLM funding).
- Initiate active restoration of Hitchcock's blue-eyed grass habitat and augment population in Meadow C by putting this species into production (collecting seed in the wild and growing plugs and/or increasing seed).
- Continue to monitor and assess efficacy of management treatments to reduce abundance of non-native species through appropriate weed-control measures.
- Continue to treat non-native species using all available methods, including spot-spraying non-native perennial species with herbicide.
 - Continue treatment of non-native species between meadows, particularly in newly created corridors
 - Hand-pull all populations of Italian plumeless thistle annually.
 - Spot-spray Himalayan blackberry in all meadows.
- Continue to remove conifers to reduce encroachment on meadows, reduce competition with Oregon white oak, and to increase meadow connectivity.
- Pending authorization of the use of prescribed fire, initiate fire treatments in 2024-2025 in Meadow A.
- Continue to increase nectar availability for Fender's blue butterfly and native species cover and diversity by augmenting native forb resource plants through seeding and/or outplanting of plugs.
 - Seed/plant nectar and host plant species in experimental plots.
 - Maintain Eugene East Recovery Zone seed-production beds for Kincaid's lupine.
 - Maintain mid-elevation seed-production beds (funded through a separate agreement).
 - Augment the Kincaid's lupine population with plugs or seed from appropriate seed sources which now include Eugene West and Salem West recovery zones as approved by USFWS.

9. REFERENCES

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APPENDIX A. SUMMARY OF RESTORATION ACTIONS AT OAK BASIN (2014-2023)

For management actions occurring before 2014, see the relevant years annual report.

2023 Management Actions

- Felled 11 trees, girdled one and limbed along north border of Meadow D.
- Installed approximately one acre of solarization fabric in Meadow D.
- Swamped limbs and created decomposition piles.
- Hand-pulled *Carduus pycnocephalus* from Meadows A and B.
- Mowed all experimental plots.
- Mowed *Rubus bifrons* in meadows A and D.
- Spot-sprayed *Rubus bifrons* and *Rubus laciniatus* with Triclopyr (Garlon 3A) in meadows A, B, C, and D.
- Collected wild seed for *Elymus glaucus*, *Bromus vulgaris*, *Eriophyllum lanatum*, *Luzula comosa*, *Lupinus oreganus*.
- Established seed-production beds for *Sidalcea malviflora* ssp. *virgata* and *Iris tenax*.
- Continued Eugene East Recovery Zone seed-production beds for *Lupinus oreganus*.
- Monitored *Lupinus oreganus* and *Sisyrinchium hitchcockii*.
- Established photo points across Oak Basin project area.
- Monitored outplanting of *Lupinus oreganus* plugs at Oak Basin Tree Farm.
- Collected wild seed from *Rupertia physodes*, *Juncus ensifolius*, *Juncus patens*, *Juncus effusus*, and *Sisyrinchium hitchcockii*.

2022 Management and Monitoring Actions

- Limbed 17 large conifers and felled one.
- Swamped limbs and created burn piles.
- Hand-pulled *Carduus pycnocephalus* from Meadows A and B; cut *Rubus bifrons* from Meadows A and D
- Mowed *Lupinus oreganus* plots in meadow C and perimeter of plots in meadow A.
- Mowed *Rubus bifrons* in meadows A and D.
- Spot-sprayed *Rubus bifrons* and *Rubus laciniatus* with Triclopyr (Garlon 3A) in meadows A, B, and D.
- Collected wild seed from *Elymus glaucus*, *Bromus vulgaris*, *Eriophyllum lanatum*, *Luzula comosa*, *Lupinus oreganus*.
- Established seed-production beds for *Sidalcea malviflora* ssp. *virgata* and *Iris tenax*.
- Continued Eugene East Recovery Zone seed-production beds for *Lupinus oreganus*.
- Monitored *Lupinus oreganus* and *Sisyrinchium hitchcockii*.
- Took photo points in experimental plots.
- Monitored outplanting of *Lupinus oreganus* plugs at Oak Basin Tree Farm.

2021 Management Actions

- Site inspection and partner coordination.
- Tree removal over four acres of meadow between Meadows A and B and between Meadow A and the Oak Basin Tree Farm.
- Limbed 18 large conifers.
- Piled limbs into brush piles for burning.
- Hand-pulled *Carduus pycnocephalus* and *Cirsium vulgare* from Meadows B and C; cut *Rubus bifrons* from Meadows B and D.
- Collected *Lupinus oreganus* seed.
- Mowed *Lupinus oreganus* plots in Meadows A, B, and C.
- Spot-sprayed non-native species in all experimental plots with glyphosate.
- Took photo points in experimental plots.
- Broadcast seed in experimental plots.
- Continued Eugene East Recovery Zone seed-production beds for *Lupinus oreganus*.
- Monitored *Lupinus oreganus* and *Sisyrinchium hitchcockii*.
- Planted 495 plugs at the top of Meadow A.

2020 Management Actions

- Site inspection and partner coordination.
- Tree removal between Meadows B and C.
- Hand-pulled *Carduus pycnocephalus* from Meadow B, *Cytisus scoparius* from Meadow A, and grubbed *Rubus bifrons* from Meadow C.
- Installed restoration experimental plots.
- Collected *Lupinus oreganus* seed.
- Mowed *Lupinus oreganus* plots in Meadows A, B, and C, the furthest east subplot of all 10 experimental plots and a six-foot-wide path between Meadows A and B using a weed trimmer.
- Spot-sprayed non-native species in all experimental plots with Glyphosate.
- Removed a large tree in corridor between Meadows A and B.
- Flame-weeded two patches of annual grasses (A5 and A6) and all experimental plots in Meadow A. Activity approved by BLM fire duty officer Sean Sheldon.
- Took photo points.
- Broadcast a seed mix in flame-weeded patches A5 and A6.
- Cut down approximately 35 conifers along the forest/meadow edge in Meadow C.
- Established Eugene East Recovery Zone seed-production beds for *Lupinus oreganus*.
- Monitored *Lupinus oreganus* and *Sisyrinchium hitchcockii*.

2019 Management Actions

- Site inspection and partner coordination.
- Monitored 50 outplanted plugs of *Lupinus oreganus* on neighboring private land (Oak Basin Tree Farm); 18 survived.
- Cut seedlings and saplings from edges of Meadow A and between Meadows A and B.

- Grubbed *Rubus bifrons* in Meadows B and C.
- Pulled *Cytisus scoparius* and *Carduus pycnocephalus* in Meadows A and B.
- Flame-weeded patches for non-native annual and perennial graminoid control in all meadows, including three new flame-weeded patches and the *Sisyrinchium hitchcockii* population.
- Subcontracted the cutting of 60 trees between and along the edges of Meadows A and B ranging in size from 10 to 20 inches in diameter.
- Led an AmeriCorps Blue Five Team in the piling and moving of downed trees from the meadows and meadow corridor.
- Seeded areas disturbed by tree removal with a native forb and grass mix: *Danthonia californica* (0.87 lbs.), *Elymus glaucus* (1.10 lbs.), *Festuca roemerii* (0.34 lbs.), and *Wyethia angustifolium* (2.20 lbs.).

2018 Management Actions

- Site inspection and partner coordination.
- Monitored 38 outplanted plugs of *Lupinus oreganus* on neighboring private land (Oak Basin Tree Farm); 18 survived.
- Flame-weeded patches for *Taeniatherum caput-medusae* control and site preparation for seeding in Meadows A and B.
- Grubbed *Rubus bifrons*.
- Pulled *Cytisus scoparius*, *Carduus pycnocephalus*, and *Geranium lucidum* (geranium pulled near lupine patch 460 in Meadow A only).
- Cut seedlings and saplings from edges of all meadows. They were particularly concentrated in Meadow C.
- Mowed approximately one-third of *Lupinus oreganus* patches after senescence.
- Seeded flame-weeded areas (~0.67 acres) with a native forb and grass mix: *Danthonia californica* (1.87 lbs.), *Elymus glaucus* (1.45 lbs.), *Eriophyllum lanatum* (0.28 lbs.), *Koeleria micrantha* (0.09 lbs.), *Plectritis congesta* (0.46 lbs.), *Prunella vulgaris* (0.38 lbs.), and *Wyethia angustifolium* (3.27 lbs.).

2017 Management Actions

- Site inspection and partner coordination.
- Outplanted 68 plugs of *Lupinus oreganus* on neighboring private land (Oak Basin Tree Farm)
- Flame-weeded patches for *Taeniatherum caput-medusae* control and site preparation for seeding.
- Grubbed *Rubus bifrons*.
- Seeded *Danthonia californica* 2.37 lbs, *Elymus trachycaulis* 2.0 lbs, *Eriophyllum lanatum* 1.28 lbs, *Festuca roemerii* 3.41lbs, *Plectritis congesta* 1.18 lbs, *Prunella vulgaris* var. *lanceolata* 0.75 lbs, and *Sidalcea malviflora* spp. *virgata* 1.0 lbs.
- Mowed approximately one-third of *Lupinus oreganus* patches after senescence.
- Hand-mowed flame-weeded plots A3, A4, B3, and B4 in Meadows A and B.

2016 Management Actions

- Site inspection and partner coordination.
- Flame-weeded *Taeniatherum caput-medusae* control and site preparation for planting/seeding.

- Grubbed *Rubus bifrons*.
- Removed small-diameter conifers around perimeter of meadows.
- Hand-weeded *Cytisus scoparius*.
- Mowed 1/3 of all *Lupinus oreganus* patches.
- Planted plugs: 40 *Danthonia californica*, 50 *Iris tenax*, and 400 *Sidalcea malviflora* ssp. *virgata*.

2015 Management Actions

- Site inspection and partner coordination.
- Grubbed *Rubus bifrons*.
- Removed small-diameter conifers around perimeter of meadows.
- Removed, limbed, or girdled trees around edges of meadows and in corridors between meadows. Similar work also done on adjacent Merzenich property.
- Flame-weeded patches for *Taeniatherum caput-medusae* control and site preparation for planting/seeding.
- Planted native plugs: 280 *Danthonia californica*, 100 *Elymus trachycaulis*, 150 *Festuca californica*, 200 *Festuca roemerii*, 1200 *Geranium oreganum*, 2000 *Iris tenax*, 120 *Lomatium dissectum*, and 5600 *Sidalcea malviflora* ssp. *virgata*.
- Seeded 3.15 lbs *Danthonia californica*, 1.5 lbs. *Eriophyllum lanatum*, 9.40 lbs. *Festuca californica*, 6.0 *Festuca roemerii*, 3.0 lbs. *Prunella vulgaris* var. *lanceolata*, and 3.0 lbs. *Sidalcea malviflora* ssp. *virgata*.
- Mowed 1/3 of all *Lupinus oreganus* patches.

2014 Management Actions

- Site inspection and partner coordination.
- Flame-weeded patches for *Taeniatherum caput-medusae* control and site preparation for planting/seeding.
- Planted 882 bulbs plus 2 15"x15" trays of *Allium amplexans*, 784 rhizomes of *Iris tenax*, 670 plugs of *Eriophyllum lanatum*, and 8 *Balsamorhiza deltoidea* plants.
- Seeded 7.14 lbs. *Bromus carinatus*, 4.83 lbs. *Elymus glaucus*, 1.27 lbs. *Elymus trachycaulis*, 0.50 lbs. *Eriophyllum lanatum*, 1.50 lbs. *Festuca roemerii*, 0.70 lbs. *Plectritis congesta*, 1.14 lbs. *Prunella vulgaris* var. *lanceolata*, and 1.71 lbs. *Sidalcea malviflora* ssp. *virgata*.
- Nectar plant availability assessment.
- Hand-weeded *Cirsium vulgare* and *Cytisus scoparius*.
- Mowed 1/3 of all *Lupinus oreganus* patches and some *Rubus bifrons* patches.
- Grubbed *Rubus bifrons*.

APPENDIX B. PHOTO POINTS

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Upper Oak Basin – Meadow D: photo point 01

May 01, 2023



Upper Oak Basin – Meadow D: photo point 02

May 01, 2023



Upper Oak Basin – Meadow C: photo point 03

May 01, 2023



Upper Oak Basin – Meadow C: photo point 04

May 01, 2023



Upper Oak Basin – BC Corridor: photo point 05

May 01, 2023



Upper Oak Basin – Meadow B: photo point 06

May 01, 2023



Upper Oak Basin – Meadow B: photo point 07

May 01, 2023



Upper Oak Basin – Meadow B: photo point 08

May 01, 2023



Upper Oak Basin – Meadow B: photo point 09

May 01, 2023



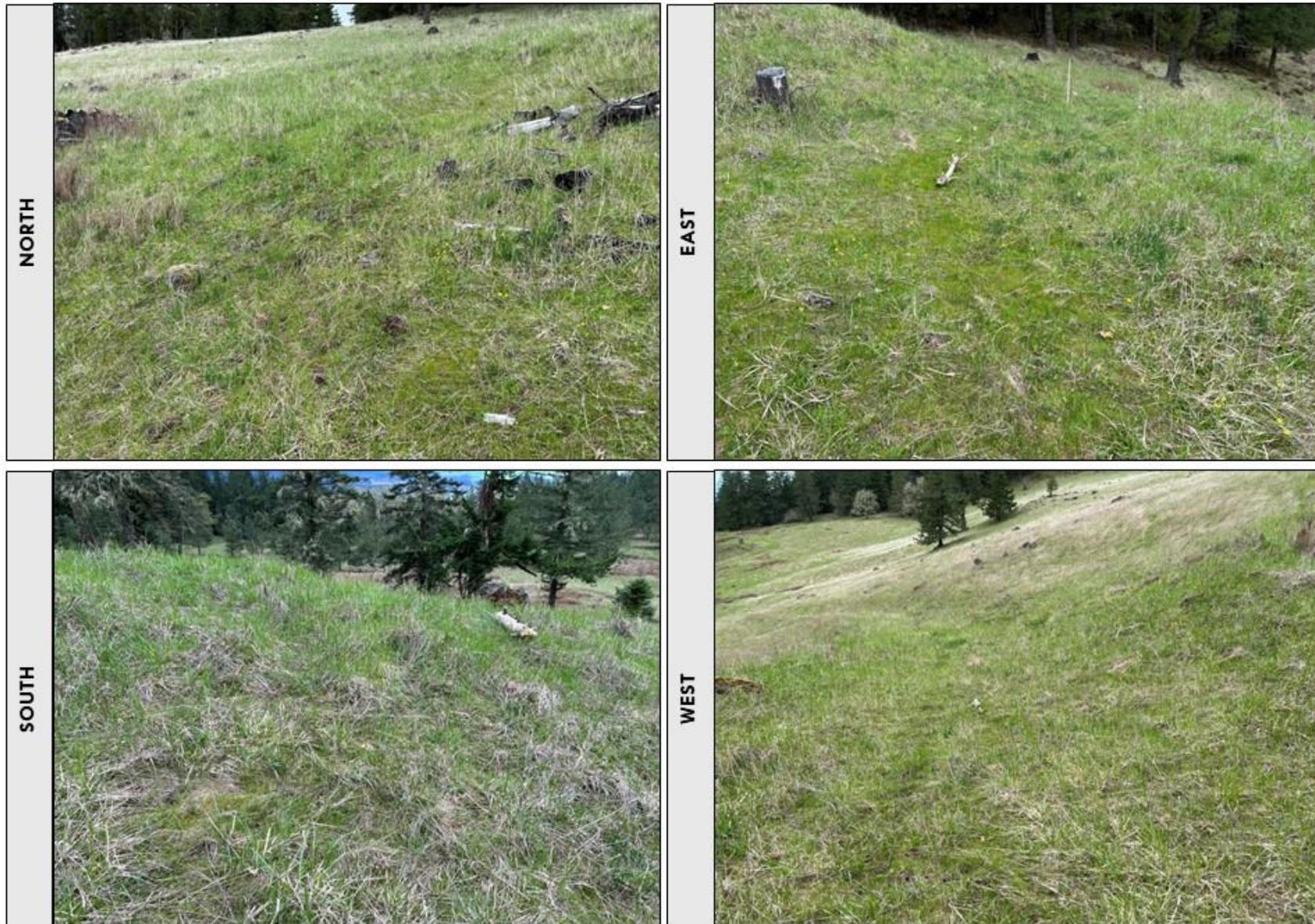
Upper Oak Basin – AB Corridor: photo point 10

May 01, 2023



Upper Oak Basin – Meadow A: photo point 11

May 01, 2023



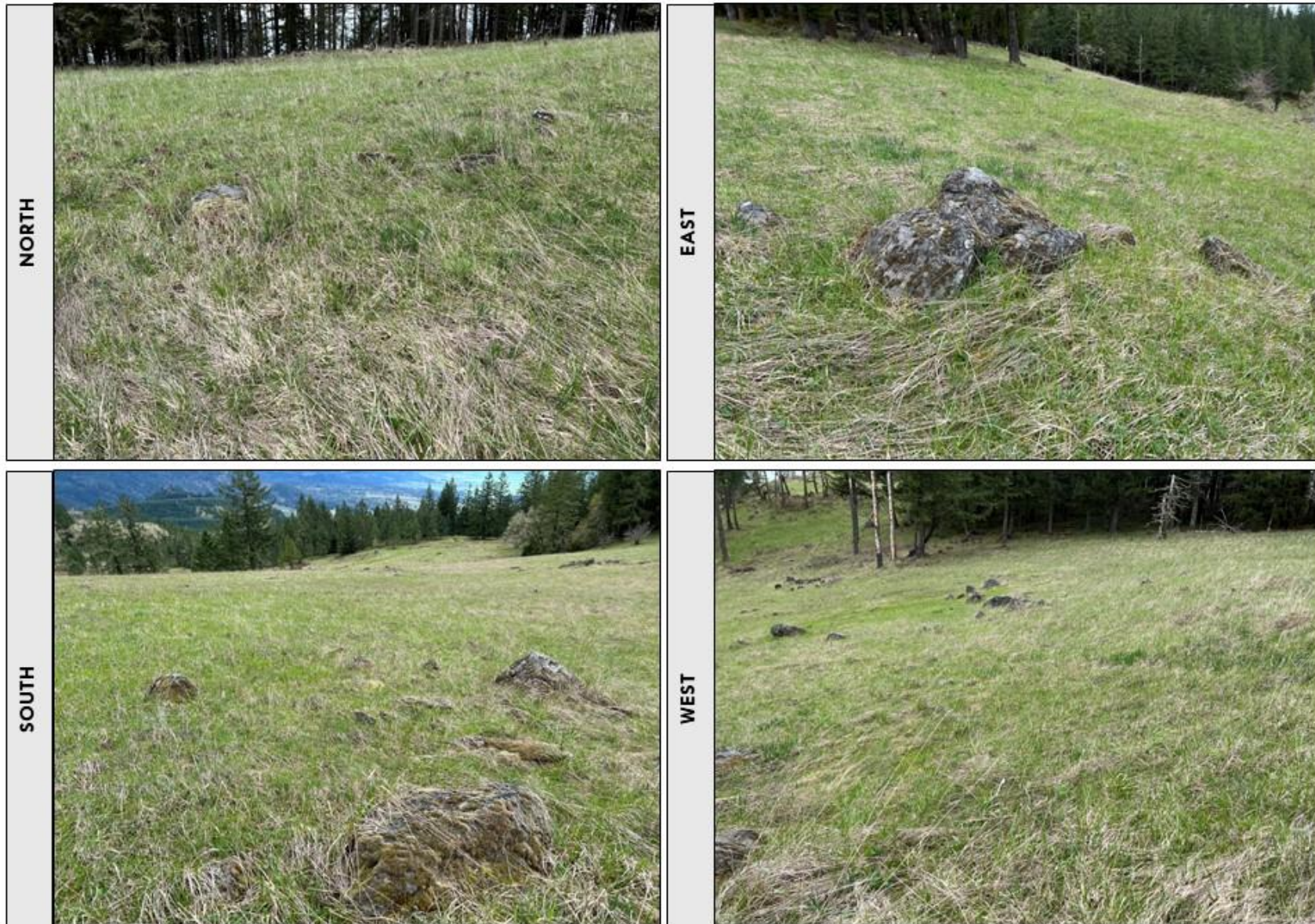
Upper Oak Basin – Meadow A: photo point 12

May 01, 2023



Upper Oak Basin – Meadow A: photo point 13

May 01, 2023



Upper Oak Basin – Meadow A: photo point 14

May 01, 2023



Upper Oak Basin – Merzenich Meadow: photo point 15 May 01, 2023



Upper Oak Basin – Merzenich Meadow: photo point 16 May 01, 2023



APPENDIX C. KINCAID'S LUPINE COVER AND RACEME COUNTS BY PLOT (2013-2023)

Table C- 1. Count of Kincaid's lupine racemes by plot from 2013-2023.

	Plot	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Meadow A	7	10	36	10	12	201	62	145	164	7	40	33
	8	3	1	-	-	4	6	9	19	-	0	0
	9	2	146	24	5	49	30	25	162	14	56	28
	10	-	18	3	-	8	3	3	29	4	0	0
	369						50	-	8	14	96	0
	406	1	-	-	2	1	-	1	12	-	6	0
	450	23	30	21	22	29	7	93	251	111	1000	481
	451	-	4	-	-	16	-	-	-	-	5	0
	452	6	93	9	-	129	34	25	116	67	433	164
	454	4	10	-	-	36	3	27	42	15	322	59
	459	6	361	9	-	1,069	669	1,142	555	517	2968	1436
	460	2	192	12	117	206	785	589	223	365	753	594
	464	4	118	2	-	126	23	90	83	12	315	79
	509	8	52	30	51	56	239	462	550	176	190	565
	510	-	14	4	-	1	8	14	43	15	51	19
	511	2	33	5	-	65	65	127	56	86	65	423
	653							23	7	-	18	16
Meadow A Total		71	1,108	129	209	1,996	1,984	2,775	2,320	1,403	6,318	3,897
Meadow B	1	20	309	31	43	441	379	198	222	175	542	262
	2	1	1	1	-	3	1	-	-	-	0	0
	3	5	21	7	13	15	5	16	49	72	131	76
	4	2	23	7	-	40	2	6	-	6	28	38
	5	2	114	50	25	19	22	67	134	184	181	137
	6	51	125	24	21	51	107	36	80	71	339	136
	399	41	34		95	167	71	200	330	119	408	138
Meadow B Total		122	627	120	197	736	587	523	815	627	1,629	787
Meadow C	184	-	-	-			1	3	7	13	4	10
	233			-		2	-	4	2	8	12	0
	400	-	1	1	3	-	-	2	7	-	222	0
	431	-	20	8	-	62	32	99	162	70	777	88
	432	42	173	86	187	408	322	741	1,010	251	596	383
	433	2	117	82	14	408	78	372	213	94	81	47
	594				13	1	38	44	12	6	4	26
Meadow C Total		44	311	177	217	881	471	1,265	1,413	442	1,692	554
Grand Total		237	2,046	426	623	3,613	3,042	4,563	4,548	2,472	9,639	5,238

Table C- 2. Count of Kincaid's lupine racemes by plot from 2013-2023.

	Plot	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Meadow A	7	1.1	2.9	1.8	1.9	2.8	1.8	2.1	4.1	0.4	2.2	2.5
	8	0.3	0.2	0.1	0.1	0.3	0.4	0.3	0.5	0	0	0.0
	9	4.7	6.4	3.2	2.2	4.7	6	4.3	7.4	1.8	7.6	8.4
	10	0.4	0.8	0.4	0.6	0.5	0.6	0.5	0.8	0.5	0.1	1.4
	369						10.9	7.8	13.8	14	21.5	21.0
	406	0.7	0.3	0	0.1	0.3	0.4	0.5	0.4	0.2	0.4	0.2
	450	10.8	11.3	7.5	3.9	6.2	7.4	15	10.5	13.5	22.4	34.7
	451	0.7	1.6	0.6	0.9	1.4	1.4	0.5	0.9	0.6	1.6	3.3
	452	3.4	10	8.5	3.8	11.1	10.4	8	8.3	12.8	20.2	34.0
	454	1.8	5.7	2.6	1.3	6.8	6.4	4.7	5.7	6.9	8.1	27.0
	459	9.7	19.3	11.9	16.8	26.3	39.3	25.1	35.2	29.9	38.2	40.4
	460	2.4	4.8	3	2.5	6.5	6.4	10.1	8.7	9.9	10.8	14.7
	464	5.3	13.8	6.4	7.9	17.4	12	14.9	9.6	7.3	20.9	36.8
	509	1	1.5	1.6	0.7	2.3	5	7.1	10.4	5.3	9.2	13.5
	510	0.3	1.4	1.3	0	0.1	0.8	1.6	2.2	1.3	3	6.9
	511	0.4	0.5	0.3	4.5	0.8	1.2	1.2	1.4	1.5	1.2	5.0
	653							2.1	0.9	0.6	2.4	3.5
Meadow A Total		42.9	80.4	49.2	47.3	87.5	110.3	105.5	120.8	106.6	169.9	253.3
Meadow B	1	8.6	31.3	11.8	8.8	23.2	12.1	13.5	16.9	18.9	21.3	18.2
	2	0.5	0.5	0.1	0	0.1	0	0	0	0.1	0	0.0
	3	2	3.2	1.6	1.5	1.3	0.5	1	3.6	2.6	2.9	7.6
	4	1.7	2.5	0.7	0.9	1.5	0.4	1.1	0.7	0.9	0.8	1.2
	5	4.3	6.2	4.3	1.7	1.6	4.5	3.8	5.9	4.8	5.8	6.4
	6	3.6	4.6	2.9	2.3	2.5	4.3	1.9	3.8	4.2	7.2	5.9
	399	4.9	3.3	0	3.7	4.6	6.1	6.1	9.4	3.9	8.9	7.1
Meadow B Total		25.5	51.6	21.4	18.9	34.7	27.9	27.4	40.3	35.3	46.9	46.4

Meadow C	184	0	0	0			0.1	0.2	0.4	0.6	0	2.0
	233			0		0.1	0	0.1	0.1	0	0.2	0.1
	400	0.1	0.1	0	0	0	0.1	0.1	0.1	0	5.9	0.0
	431	1.8	2.7	3.1	1.6	3.9	2.6	4.4	6.1	4.8	14.4	9.4
	432	5.1	10.1	9.4	7.4	12.2	12.4	20.4	16.1	8.2	7	17.0
	433	4.2	4.8	9.1	4.3	12.3	8.7	9.1	6.6	7.3	3.1	9.0
	594				0.7	0.9	1.3	1.5	1.8	2.2	0	3.7
Meadow C Total		11.2	17.8	21.7	14	29.5	25.2	35.6	31.1	23.1	30.5	41.1
Grand Total		79.6	149.8	92.3	80.2	151.7	163.4	168.6	192.3	164.9	247.3	340.8
*Values with 0.0 do not show due to rounding. Some lupine is present. Blanks indicate that the plot was not monitored or established in that year.												

APPENDIX D. TOTAL NUMBER OF MATURE RACEMES AND PERCENT RACEMES ABORTED OF KINCAID'S LUPINE (*LUPINUS OREGANUS*) AT OAK BASIN FROM 2006 TO 2023

Table D- 1. Total number of mature racemes and percent racemes aborted of Kincaid's lupine (*Lupinus oreganus*) at Oak Basin from 2006 to 2023.

	Meadow A		Meadow B		Meadow C		Grand Total	
	Mature Racemes	Percent Aborted	Mature Racemes	Percent Aborted	Mature Racemes	Percent Aborted	Mature Racemes	Percent Aborted
2006	245	13%	375	9%	145	6%	765	10%
2007	881	28%	1,482	7%	810	4%	3,173	13%
2008	891	21%	1,027	13%	432	3%	2,350	15%
2009	415	31%	1,004	17%	55	38%	1,474	23%
2010	1,860	5%	1,678	4%	108	28%	3,646	5%
2011	1,978	3%	1,845	3%	192	6%	4,015	3%
2012	1,328	3%	969	2%	127	0%	2,424	3%
2013	71	58%	122	55%	44	46%	237	55%
2014	1,108	4%	627	1%	311	0%	2,046	2%
2015	129	46%	120	35%	177	11%	426	32%
2016	209	2%	197	3%	217	37%	623	18%
2017	1,996	2%	736	3%	881	2%	3,613	2%
2018	1,984	1%	587	2%	471	1%	3,042	1%
2019	2,775	24%	523	26%	1,265	13%	4,563	24%
2020	2,320	8%	815	10%	1,413	4%	4,548	7%
2021	1,403	12%	627	13%	442	13%	2,472	12%
2022	6,318	5%	1,629	6%	1,692	6%	9,639	5%
2023	3,897	19%	787	33%	554	29%	5,238	22%

Table D- 2. Total Kincaid's lupine (*Lupinus oreganus*) cover and number of racemes per m² of Kincaid's lupine foliar cover at Oak Basin from 2006 to 2023.

	Meadow A		Meadow B		Meadow C		All Meadows	
	Cover (m ²)	Mature racemes/m ²	Cover (m ²)	Mature racemes/m ²	Cover (m ²)	Mature racemes/m ²	Cover (m ²)	Mature racemes/m ²
2006	39.3	6	44.9	8	11.5	13	95.7	8
2007	37.3	24	37.7	39	21.1	38	96.1	33
2008	45.3	20	45.9	22	10.6	41	101.8	23
2009	49.5	8	50.1	20	10.7	5	110.3	13
2010	65.3	28	49.6	34	12.0	9	126.9	29
2011	86.8	23	60.3	31	15.2	13	162.3	25
2012	86.5	15	70.0	14	13.6	9	170.1	14
2013	42.9	2	25.5	5	11.2	4	79.6	3
2014	80.4	14	51.6	12	17.8	17	149.8	14
2015	49.2	3	21.4	6	21.7	8	92.3	5
2016	47.3	4	18.9	10	14.0	15	80.2	8
2017	87.5	23	34.7	21	29.5	30	151.7	24
2018	110.3	18	27.9	21	25.2	19	163.4	19
2019	105.5	26	27.4	19	35.6	36	168.5	27
2020	120.8	19	40.0	20	31.1	45	192.3	24
2021	106.6	13	35.3	18	23.1	19	164.9	15
2022	169.9	37	46.9	35	30.5	55	247.3	39
2023	253.3	15	46.4	17	41.1	13	340.8	15

APPENDIX E. *SISYRINCHIUM HITCHCOCKII* SIZE CLASS AND REPRODUCTIVE SUMMARY**Table E- 1.** Count of number of Hitchcock's blue-eyed grass (*Sisyrinchium hitchcockii*) stems by size class in Meadow C at Oak Basin from 2012 to 2023. "R" numbers represent the number of inflorescences recorded per stem (R1, R2, R3, etc.).

Size Class	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Vegetative	42	47	26	44	30	15	17	18	11	26	19	38
R1	55	40	17	13	8	21	12	17	29	14	21	17
R2	14	10	9	5	2	20	10	9	19	22	7	3
R3	7	5	5	1	1	8	4	15	15	5	1	2
R4	1	1	7	0	1	1	1	3	8	0	1	1
R5	1	1	0	1	0	1	1	1	6	0	2	0
R6	1	0	12	0	0	0	0	0	3	0	0	0
R7	0	0	7	0	0	0	0	1	2	0	0	1
R8	0	1	0	0	0	0	0	0	0	0	0	0
R9	1	0	0	0	0	0	0	1	0	0	0	0
R10	0	0	0	0	0	0	0	1	1	0	0	0
R11	0	0	0	0	0	0	0	1	1	0	0	0
R12	0	0	1	0	0	0	0	1	0	0	0	0
R13	0	0	0	0	0	0	0	0	0	0	0	0
R14	0	0	1	0	0	0	0	1	0	0	0	0
R19	0	0	0	0	0	0	1	0	0	0	0	0
R21	0	0	0	0	0	0	0	1	0	0	0	0
Total Reproductive Individuals	80	58	59	20	12	51	29	52	84	21	32	24
Total Reproductive Stems	128	92	225	31	19	89	72	160	206	33	52	40
Total number of plants	122	105	85	64	42	66	46	70	95	47	51	62

APPENDIX F. LOCATION OF LUPINE PLOTS BY MEADOW

Meadow A

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Figure F- 1. Map of Kincaid's lupine (*Lupinus oreganus*) monitoring plots in Meadow A.

Meadow B

Image removed from web version

Figure F- 2. Map of Kincaid's lupine (*Lupinus oreganus*) monitoring plots in Meadow B.

Meadow C

Image removed from web version

Figure F- 3. Map of Kincaid's lupine(*Lupinus oreganus*) and blue-eyed grass (*Sisyrinchium hitchcockii*) monitoring plots in Meadow C.

Private Property

Image removed from web version

Figure F- 4. Map of Kincaid's lupine (*Lupinus oreganus*) patches on private property mapped in 2023.

APPENDIX G. LOCATION, DIMENSIONS, AND MONITORING NOTES FOR PLOTS AT OAK BASIN

Table G- 1. Location, dimensions, and monitoring notes for Kincaid's lupine (*Lupinus oreganus*) and Hitchcock's blue-eyed grass (*Sisyrinchium hitchcockii*; in bold) plots at Oak Basin.

Meadow	Plot Number	Dimensions	origin (Nad27)	Notes
A	7	23m x 12m	504288 E 4906986 N	Measured in 2m increments
A	8	Circular, 2m radius	504259 E 4907001 N	Measured entire plot as one. Fallen log partially on plot.
A	9	18m x 14m	504286 E 4906960 N	Measured in 2m increments
A	10	Circular, 2m radius	504312 E 4906952 N	Measured in 4 quadrats: NW, NE, SW, and SE
A	459	13m x 12m	504246 E 4906964 N	Measured in 3m increments
A	454	20m x 13m	504210 E 4906979 N	Measured in 4m increments. 3 individuals 8m and 48° from origin.
A	464	20m x 26m	504183 E 4906999 N	Measured in 2m increments
A	450	90m x 7m	504232 E 4907030 N	Measured in 5m increments (E-W)
A	451	8m x 7m	504132 E 4906987 N	Measured in 2m increments (N-S)
A	452	25m x 35m	504156 E 4907003 N	Measured in 2m increments
A	460	22m x 16m with extension	504274 E 4906955 N	Measured in 4m increments
A	406	Circular, 2m radius	504101 E 4907056 N	Measured in 4 quadrants: NW, NE, SW, and SE
A	509	Circular, 1.5m radius	504199 E ¹ 4907048N ¹	New in 2011. Measured in 4 quadrats: NW, NE, SW, and SE.
A	510	6m x 10m	503967 E ¹ 4907105 N ¹	New in 2011. Measured in 1m increments N-S; 1m segment measured from E-W.
A	511	3m radius	504702 E ¹ 4907160 N ¹	Changed plot to 4 quadrants (NW, NE, SW, and SE) in 2018
A	369	14m x 12m		New in 2018. Measured in 2m increments N-S.
A	653	16m x 11m	504136 E 4907160 N	New 2019, Measured in 2m segments N-S.

Meadow	Plot Number	Dimensions	origin (Nad27)	Notes
B	1	60m x 18m+	504420 E 4906668 N	Measured in 5m increments
B	2	Triangular adjacent to Plot 3	504503 E 4906649 N	Measured entire plot as 1
B	3	12m x 18m (20m)	504514 E 4906646 N	Measured in 2m increments
B	4	Circular, 3m radius	504545 E 4906630 N	Measured in 4 quadrats: NW, NE, SW, and SE
B	5	12m x 9m	504597 E 4906570 N	Measured in 2m increments, except the last, which was 3m
B	6	11m belt transect	504628 E 4906559 N	Measured in 2m increments to each side until last plant
B	399**	11m x 14m-16m plot	504326 E 4906806 N	Measured E-W in 2m increments
B	Plot 2 Tag 558	12m x 6.8m x 13.7m	504413 E ¹ 4906842 N ¹	New in 2014, plot is triangular, directly adjacent to Plot 3.
C	594	12m belt	See map	New in 2017. Measured in 2m increments on each side (N&S).
C	233	1m radius	See map	New in 2017. Measured entire plot as one.
C	1(185) ²	14m belt transect	504639 E ¹ 49065659N ¹	Measured in 1m increments on each side (E&W)
C	2(186) ²	2m radius	504655 E ¹ 4906555N ¹	Measured in 4 quadrats: NW, NE, SW, and SE
C	433	8m belt transect	504712 E 4906379 N	Measured in 2m increments on each side (N&S)
C	432	8m x 9m	504649 E 4906401 N	Measured in 2m increments
C	431	18m belt transect	504732 E 4906378 N	Measured in 1m increments on each side (E & W)
C	400	1m radius	504609 E ¹ 4906553 N ¹	New in 2012; along tree line in <i>Rupertia physodes</i>

¹ Coordinates are in NAD83 instead of NAD27.² Plots 1 (185) and Plot 2 (186) in Meadow C are SIHI plots.

** There is a large patch of Kincaid's lupine at the SW end of Meadow B, which is on private property. Plot 399 captures the lupine nearest the public/private boundary.

APPENDIX H. SPECIES OBSERVED IN RELEVÉ PLOTS IN 2020 AND 2023

Relevé plots were surveyed in 2020 and 2023. Values in bold were found in both years, values struck through indicate species present in 2020 not observed in 2023. “New” species noted in 2023 are noted with (2023).

	Meadow (plot #)		
	A (696)	B (691)	C (690)
Non-native forbs	Cerastium glomeratum Dianthus armeria Galium parisiense Hypericum perforatum Leucanthemum vulgare Linum bienne Myosotis discolor Plantago lanceolata Sherardia arvense Taraxacum officinale Tragopogon dubius Comandra umbellata Veronica arvensis Vicia sativa (2023)	Cerastium glomeratum Geranium dissectum Hypericum perforatum Leucanthemum vulgare Linaria grandis (2023) Linum bienne Medicago lupulina Plantago lanceolata Prunella vulgaris Rumex acetosella Sherardia arvense Torilis arvensis Tragopogon dubius Unk. forb 1 Vicia sativa	Centaureum erythraea Dianthus armeria Geranium dissectum Hypericum perforatum Hypochaeris radicata Leucanthemum vulgare Linum bienne Lotus micranthus Medicago lupulina Myosotis discolor (2023) Plantago lanceolata Sherardia arvense Torilis arvensis Veronica arvensis Vicia sativa
Native forbs	Achillea millefolium Brodiaea coronaria Calochortus tolmiei Clarkia amoena Clarkia purpurea Eriophyllum lanatum Fragaria vesca (2023) Fragaria virginiana Leptosiphon bicolor	Achillea millefolium Clarkia amoena Cynoglossum grande (2023) Dichelostemma capitatum Eriophyllum lanatum Fragaria vesca Fragaria virginiana Iris tenax	Achillea millefolium Allium sp. (2023) Balsamorhiza sagittata Brodiaea coronaria (2023) Calochortus tolmiei Clarkia amoena Eriophyllum lanatum Fragaria vesca (2023)

	<i>Madia gracilis</i>	<i>Madia</i> sp (2023) <i>Viola nuttallii</i>	<i>Fragaria virginiana</i> <i>Ligusticum apiifolium</i> (2023) <i>Madia elegans</i> <i>Polygonum</i> sp. <i>Potentilla gracilis</i> <i>Ranunculus occidentalis</i>
Non-native graminoids	<i>Agrostis capillaris</i> <i>Aira caryophyllea</i> <i>Bromus hordeaceus</i> <i>Bromus sterilis</i> <i>Cynosurus echinatus</i> <i>Dactylis glomerata</i> <i>Schedonorus arundinaceus</i> <i>Vulpia bromoides</i> <i>Taeniatherum caput-medusae</i> (2023)	<i>Agrostis capillaris</i> <i>Aira caryophyllea</i> <i>Bromus hordeaceus</i> <i>Bromus sterilis</i> <i>Cynosurus echinatus</i> <i>Dactylis glomerata</i> <i>Phleum pratense</i> <i>Schedonorus arundinaceus</i> <i>Vulpia bromoides</i>	<i>Agrostis capillaris</i> <i>Briza minor</i> <i>Bromus hordeaceus</i> <i>Cynosurus echinatus</i> <i>Dactylis glomerata</i> <i>Holcus lanatus</i> <i>Phleum pratense</i> <i>Schedonorus arundinaceus</i> <i>Taeniatherum caput-medusae</i>
Native graminoids	<i>Bromus carinatus</i> <i>Danthonia californica</i> <i>Elymus trachycaulus</i> <i>Festuca roemerii</i> <i>Koeleria macrantha</i> <i>Luzula comosa</i>	<i>Bromus carinatus</i> <i>Danthonia californica</i> <i>Elymus glaucus</i> <i>Festuca roemerii</i> (2023) <i>Luzula comosa</i>	<i>Bromus carinatus</i> <i>Carex tumulicola</i> (2023) <i>Danthonia californica</i> <i>Elymus glaucus</i> <i>Elymus trachycaulus</i> <i>Festuca roemerii</i> <i>Luzula comosa</i>
Shrub/tree		<i>Amalanchier alnifolia</i> (2023) <i>Crataegus suksdorfii</i> <i>Quercus garryana</i>	