

Twin Prairie 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: Looking south at Twin Prairie Unit 3, March 20th, 2023. Photo by Rolando Beorchia.

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Twin Prairie restoration: 2023 annual report

EXECUTIVE SUMMARY

The Institute for Applied Ecology (IAE) has partnered with the Bureau of Land Management (BLM) Upper Willamette Field Office, Northwest Oregon District, to restore Twin Prairie since 2013. In 2023, restoration activities focused on invasive plant removal, seeding native plants to increase community diversity and abundance, and monitoring both the remnant shaggy horkelia (*Horkelia congesta* spp. *congesta*) population and the experimental plots testing efficacy of seeding and planting Willamette Valley and mid-elevation seed sources.

During the shaggy horkelia census we counted 827 individuals. Of those, 72% were flowering, 28% were vegetative, and 24 seedlings were also recorded. There were 1,514 reproductive stems counted, with 26% of them showing signs of browsing. In the experimental plots with Willamette Valley seed, no plants were observed in the West, Central, or East plots. In the Willamette Valley plug plots there were 94, 57, and 39 plants observed in the West, Central and East plots, respectively. In the mid-elevation seed plots there were 20, 5, and 0 plants observed in the West, Central and East plots, respectively.

1. INTRODUCTION

Twin Prairie is a mid-elevation (1600-1800ft) prairie owned and managed by the Bureau of Land Management, Northwest Oregon District (BLM), and located in southern Lane County, Oregon, south of Cottage Grove (Figure 1). The meadow supports a population of the Oregon endemic, BLM Sensitive and State of Oregon Candidate (Oregon Department of Agriculture, 2017) Species shaggy horkelia (*Horkelia congesta* ssp. *congesta*). The Oregon Biodiversity Information Center (ORBIC 2016) designates shaggy horkelia as a “List 1” species that “contains taxa which are endangered or threatened throughout their range or which are presumed extinct” (ORBIC, 2016). Management that protects or bolsters shaggy horkelia is necessary to prevent the listing of this species under the Federal Endangered Species Act.

The Institute for Applied Ecology (IAE) and the BLM have partnered since 2013 to perform restoration work at Twin Prairie. This report describes restoration activities performed in 2023.

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Figure 1. Twin Prairie ACEC boundary, management units, and location within the Willamette Valley.

2. GOALS AND OBJECTIVES

The purpose of this project is to assist the BLM in maintaining and improving the regionally rare mid-elevation prairie habitat to support the native plant community and shaggy horkelia population at Twin Prairie.

There are six primary objectives of this project:

1. Increase the shaggy horkelia population through augmentation.
2. Eradicate low abundance invasive plants from within the ACEC, specifically Scotch broom and false brome.
3. Reduce the abundance of invasive grasses in open prairie by implementing regular hand pulling and herbicide applications.
4. Increase native plant abundance and diversity in the meadows by augmenting species occurring in low abundance and introducing native mid-elevation species observed at reference meadows.
5. Release Oregon white oaks (*Quercus garryana*) from conifer encroachment.
6. Create one contiguous meadow by removing conifers to form corridors.

3. 2023 RESTORATION ACTIONS

In 2023, restoration actions consisted of hand pulling invasive forbs and shrubs, and removing annual grass seed, broadcasting native seed, and monitoring shaggy horkelia (see section 0 for monitoring results). IAE, BLM, and the Lane-Metro Youth Corps (LMYC) participated in completing restoration actions.

In 2023 IAE staff, with the help of Lane-Metro Youth Corps, hand removed nonnative forbs, shrubs, and annual grass seed from Twin Prairie. Invasive plants entering the meadow from the spur road is a major concern. In June, IAE and LMYC walked the road hand pulling and digging Himalayan blackberry (*Rubus bifrons*), cutleaf blackberry (*Rubus laciniatus*), false brome (*Brachypodium sylvaticum*), St. John's wort (*Hypericum perforatum*), oxeye daisy (*Leucanthemum vulgare*), and Scotch broom (*Cytisus scoparius*). Treatments continued in units 4 and 5 with Scotch broom and Himalayan blackberry removal throughout the units (Table 1, Figure 2). Additionally, IAE and LMYC bagged and removed seed heads of rip-gut brome (*Bromus diandrus*) and bristly dog-tail (*Cynosurus echinatus*) from units 2 and 3 to reduce annual grass presence near shaggy horkelia.

In November 2023, IAE broadcast 78.1-pounds of native seed across units 3, 4, and 5 (Figure 2). The seed mix was comprised of 21 species sourced from Willamette Valley and mid-elevation locations (Table 2). Due to the low abundance of annual forbs at Twin Prairie, 31.78 pounds of annual forbs were broadcast, with 19 pounds sourced from the Willamette Valley. This mix also included eight perennial species sourced from mid-elevation BLM locations.

Table 1. 2023 management actions at Twin Prairie.

Date	Unit	Activity
8-Jun	1, 2, 3	Hand pulled oxeye daisy (<i>Leucanthemum vulgare</i>) and Scotch broom (<i>Cytisus scoparius</i>). Assessed shaggy horkelia (<i>Horkelia congesta</i> ssp. <i>congesta</i>) was flowering and ready to census.
12-Jun	1, 2, 3	Monitored remnant shaggy horkelia and experimental plots with BLM staff. Hand pulled oxeye daisy.
19-Jul	5, 7	Manual weed removal with LMYC. Targeted Scotch broom in unit 5, and many non-native grass, forb, and shrub species along the access road within the ACEC.
20-Jul	3	Manual weed removal with LMYC. Hand pulled, bagged, and removed rip-gut brome (<i>Bromus diandrus</i>) and bristly dog-tail (<i>Cynosurus echinatus</i>) from unit 2 around shaggy horkelia patches.
21-Nov	3, 4, 5	Broadcast 78.1 pounds of native seed mix.
28-Nov	3	Planted 420 shaggy horkelia plugs. Created one new subplot (ME plugs) at each of the three experimental plots with 140 plugs each.

*Bureau of Land Management (BLM), Lane-Metro Youth Corps (LMYC).

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Figure 2. 2023 restoration activities at Twin Prairie.

Table 2. 2023 Twin Prairie native seed mix.

Scientific Name	Common Name	Total Seed (lb.)
<i>Amsinckia menziesii</i> var. <i>intermedia</i>	Menzies' fiddleneck	2.51
<i>Clarkia amoena</i> ssp. <i>lindleyi</i>	farewell-to-spring	6.19
<i>Clarkia purpurea</i>	winecup clarkia	5.65
<i>Collinsia grandiflora</i>	large-flowered blue-eyed Mary	2.23
<i>Collomia grandiflora</i>	large-flowered collomia	6.18
<i>Danthonia californica</i>	California oatgrass	10.00
<i>Epilobium densiflorum</i>	denseflower willowherb	0.44
<i>Eriophyllum lanatum</i>	woolly sunflower	8.30
<i>Festuca roemerii</i>	Roemer's fescue	5.71
<i>Gilia capitata</i>	bluehead gilia	1.71
<i>Iris tenax</i>	toughleaf iris	0.05
<i>Koeleria macrantha</i>	prairie Junegrass	10.00
<i>Lomatium dissectum</i>	fern-leaved biscuitroot	0.10
<i>Madia citriodora</i>	lemon-scented tarweed	0.06
<i>Madia elegans</i>	showy tarweed	1.05
<i>Madia gracilis</i>	grassy tarweed	0.68
<i>Phacelia nemoralis</i> var. <i>oregonensis</i>	Oregon phacelia	1.01
<i>Plagiobothrys figuratus</i>	fragrant popcornflower	1.07
<i>Plectritis congesta</i>	shortspur seablush	3.00
<i>Prunella vulgaris</i> var. <i>lanceolata</i>	common selfheal	6.10
<i>Wyethia angustifolia</i>	narrow-leaved mule's ear	6.00
Totals (lb.)		78.10

4. SHAGGY HORKELIA (*HORKELIA CONGESTA* SSP. *CONGESTA*) MONITORING.

Remnant population

In June 2023, we monitored the naturally occurring shaggy horkelia population and the experimental augmentation plots. We counted 827 individuals in the naturally occurring population, with 72% flowering and 28% vegetative; we also recorded 24 seedlings. There were 1,514 reproductive stems counted, with 26% of them showing signs of browsing. Monitoring protocols can be found in Appendix B and census data is available in Appendix E. The count of individuals at Twin Prairie in 2023 was the lowest to date. This marks a 2% decrease from 2022 (846) and is 18% lower than the ten-year average of 1,009 (Figure 3). Despite a slight decrease since 2022, the population has been relatively stable over the last five years.

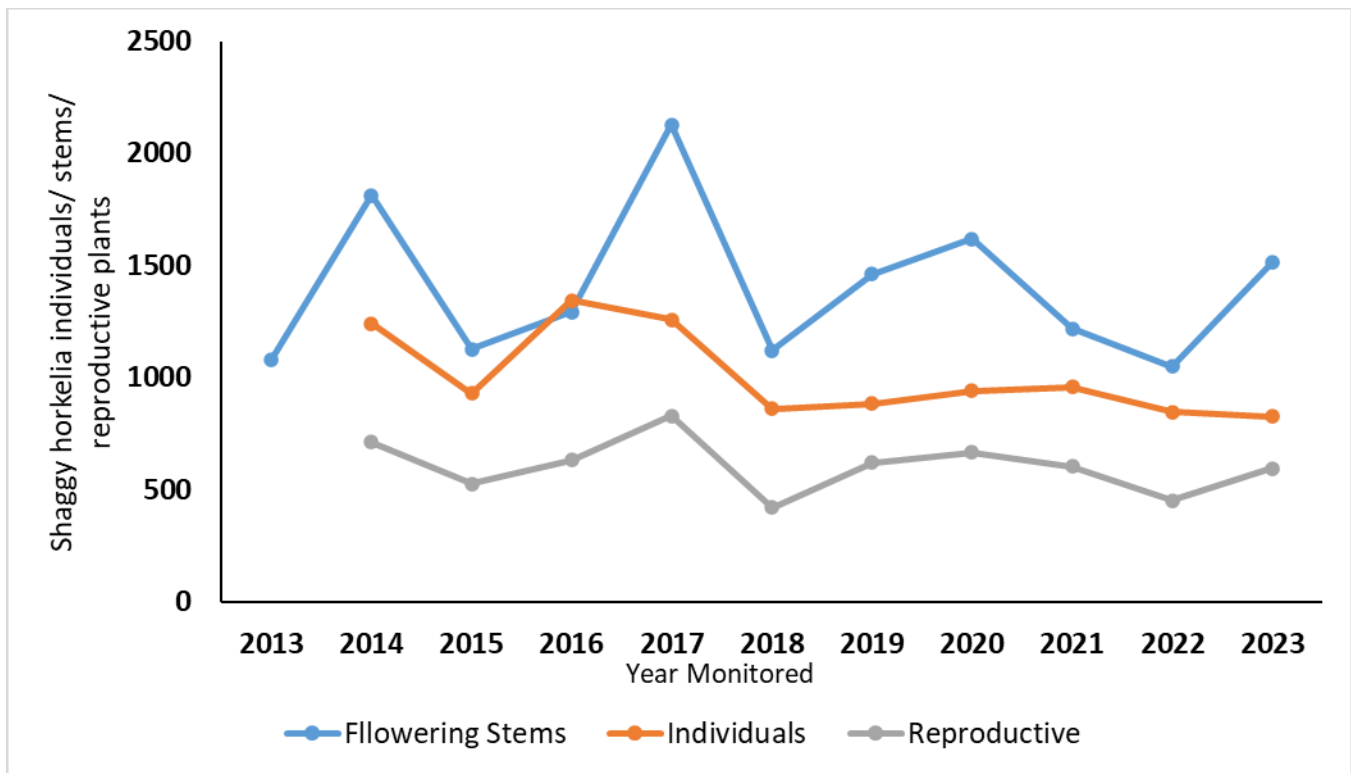


Figure 3. Shaggy horkelia (*Horkelia congesta* ssp. *congesta*) individuals, stems, and reproductive plants (2013-2023)

Seed source survivorship experiment

As described in the 2020 annual report (Celis et al. 2021), three experimental plots were established at Twin Prairie to test the efficacy of planting shaggy horkelia plugs versus sowing seeds and to determine if seed origin (Willamette Valley and mid-elevation meadow) affects survival (Celis et al. 2021). Experimental plots are referenced as east, central, and west based on their geographic location across the meadow. Each plot has concrete monuments with reference tag numbers (Appendix D). Plots are divided into subplots based on the seed source, Willamette Valley (WV) or mid-elevation (ME), and also the type of plant material used (seed or plugs). The subplot names have been updated from the original naming system (Celis et al. 2021) as follows: west subplot and east subplot have now become WV plug and WV seed, respectively. In 2020, the WV seed subplots were each seeded with 113.4g or about 110,111 seeds (971seeds/gram). In 2021, the WV plug subplots were each planted with 212 plugs and the ME seed subplots were each seeded with 8.65g or about 8,399 seeds (971 seeds/gram). To prepare the subplots for seeding, each ME seed subplot was thermally treated before hand-dispersed seeding of shaggy horkelia. In fall 2023, ME plug subplots were established and planted with approximately 120 shaggy horkelia plugs using the same wild collected mid-elevation seed.

In 2023, the experimental plots were monitored. The three subplots with WV seed had zero plants observed this year, a decrease from two mature plants and 25 seedlings as seen in 2022. The three WV plug subplots had a total of 190 plants, a 50% decrease from 2022 (381). However, eight plants were observed flowering with a total of eleven flowering stems, none of which were browsed. The ME seed subplots had a total of 25 plants, 22 of which were mature and 3 were seedlings. Data for this experiment can be found in Appendix E.

Monitoring data suggests that ME sourced seed has a slightly higher establishment rate than WV sourced seed, and planting WV plugs is more favorable than seeding WV seed. A higher percentage of ME seed germinated and survived to the second year (8.7%) than WV seed (0.008%). Furthermore, 30% of ME plugs survived to their second year and 4% of those flowered during that year. Data collected in 2024 will help determine if planting ME plugs is more favorable than ME seeding and WV plug planting. Surveyors in 2024 will also be searching for seedlings within the ME plug plots to assess if flowering plants produced viable seed.

5. MANAGEMENT RECOMMENDATIONS

The overarching goal of this project is to maintain and improve the regionally rare mid-elevation prairie habitat and shaggy horkelia at Twin Prairie. The following restoration actions are recommended for 2024 and beyond:

- Pull and/or apply herbicide to treat false brome and Himalayan blackberry along ACEC access road and Scotch broom within unit 5.
- Monitor shaggy horkelia when in flower, likely between June 10th and 20th.
- Seed native species throughout the meadow complex. Emphasize increasing annual forb abundance and perennial forb and graminoid diversity. Consider adding fruiting shrubs to the south meadow edge to increase abundance of wildlife forage.
- Hand pull or apply herbicide to treat non-native grasses (sponge dauber or spot spray).
- Buck and pile logs for natural decay within unit 2 corridor.
- Remove live conifers in units 4 and 5 to create meadow continuity, releasing Oregon white oak and leaving snags for wildlife. Girdle trees in the summer to create snags and reduce workload.
- Plant 500 shaggy horkelia plugs annually for six years to augment and expand remnant population. If 30% of plugs survive and establish as we saw in the recent experiment, the population will more than double with this six-year planting strategy. Planting should occur around remnant patch perimeters and in radiating clumps to promote expansion.
 - 2025: 500 plugs: `166 to patches F, G (extend), J
 - 2026: 500 plugs: `166 to patches C, E, I
 - 2027: 500 plugs: `166 to patches A, D, between G and F
 - 2028: 500 plugs: `166 to new patches: West of E, in center corridor of unit 2, East of F
 - 2029: 500 plugs: `166 to new patches in unit 5
 - 2030: 500 plugs: `166 to new patches in unit 4

To make lasting change in the abundance of shaggy horkelia at Twin Prairie, augmentation of the population will be critical for successful recovery. Results from the ongoing shaggy horkelia establishment experiment should be used to guide future decisions. Augmentation efforts should begin implementing the most effective strategies identified from the experiment.

6. REFERENCES

- Celis, J., A. Esterson, and R. Currin. 2021. Habitat restoration and monitoring of shaggy horkelia at Twin Prairie: 2020 annual report. Unpublished report prepared for the Bureau of Land Management, Northwest Oregon District. Institute for Applied Ecology, Corvallis, Oregon.
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APPENDIX A. COMPLETED AND PROPOSED MANAGEMENT ACTIONS: 2013-2025

2013

- Seeds of Success collection: common yarrow (*Achillea millefolium*), winecup (*Clarkia purpurea*), American wild carrot (*Daucus pusilis*), Roemer's fescue (*Festuca roemerii*), prairie June grass (*Koeleria macrantha*), nineleaf biscuitroot (*Lomatium triternatum*), showy tarweed (*Madia elegans*), grassy tarweed (*Madia gracilis*), woodland tarweed (*Madia madioides*), and short spurred seablush (*Plectritis congesta*).
- Mapped shaggy horkelia (*Horkelia congesta* ssp. *congesta*), Himalayan blackberry (*Rubus bifrons*) and Scotch broom (*Cytisus scoparius*).
- Removed ~1.17 acres of Himalayan blackberry and ~0.4 acres of Scotch broom
- Monitored shaggy horkelia (only stems counted).

2014

- Mapped shaggy horkelia, Himalayan blackberry and Scotch broom populations.
- Removed ~1.2 acres of Himalayan blackberry, and ~0.5 acres of Scotch broom.
- Broadcast native seed mix on disturbed areas: common selfheal (*Prunella vulgaris*), blue wildrye (*Elymus glaucus*), Roemer's fescue and California oatgrass (*Danthonia californica*).
- Monitored shaggy horkelia (vegetative and reproductive individuals, browsed and unbrowsed stems).

2015

- Removed Scotch broom
- Limbed or felled shrubs and trees around shaggy horkelia populations.
- Girdled large trees near shaggy horkelia plots.
- Monitored shaggy horkelia (vegetative and reproductive individuals, browsed and unbrowsed stems).
- Planted 220 shaggy horkelia plugs in two locations (110 plugs in each).

2016

- Mapped shaggy horkelia population.
- Removed Himalayan blackberry and Scotch broom.
- Limbed or felled shrubs and trees around shaggy horkelia populations.
- Girdled large trees near shaggy horkelia plots.
- Monitored shaggy horkelia (vegetative and reproductive individuals, browsed and unbrowsed stems).
- Monitored augmented shaggy horkelia population.
- Broadcast native seed mix on disturbed areas: blue wildrye, Roemer's fescue, woolly sunflower (*Eriophyllum lanatum*), and California oatgrass.

2017

- Removed Scotch broom.
- Monitored shaggy horkelia (vegetative and reproductive individuals, browsed and unbrowsed stems).
- Limbed or felled shrubs and trees around shaggy horkelia populations.

2018

- Removed Scotch broom.
- Monitored shaggy horkelia (vegetative and reproductive individuals, browsed and unbrowsed stems).

2019

- Removed Scotch broom.
- Monitored shaggy horkelia (vegetative and reproductive individuals, browsed and unbrowsed stems).
- Approximately 12, 14–18-inch diameter Douglas-fir (*Pseudotsuga menziesii*) were cut to open space near shaggy horkelia.

2020

- Felled numerous Douglas-fir to release Oregon white oak (*Quercus garryana*)
- Monitored shaggy horkelia.
- Hand pulled Scotch broom in western meadow.
- Setup three experimental plots to test efficacy of seeding and planting shaggy horkelia plugs.
- Applied glyphosate to approximately one acre of non-native grasses.
- Flame weeded Willamette Valley (WV) seed and WV plugs experimental subplots.
- Seeded WV seed subplots with shaggy horkelia.

2021

- Monitored shaggy horkelia.
- Removed Douglas-fir for meadow connectivity enhancement.
- Planted 600 shaggy horkelia plugs in WV plug experimental subplots.
- Flame torch treatment of mid-elevation (ME) seed experimental subplots.
- Seeded shaggy horkelia in ME seed experimental subplots.
- Seeded native mix of mid-elevation origin to disturbed areas: winecup clarkia, blue wildrye, woolly sunflower, California fescue (*Festuca californica*), Roemer's fescue, prairie June grass, showy tarweed, grassy tarweed, woodland tarweed, short spurred seablush.

2022

- Removed Douglas-fir to improve meadow connectivity.
- Monitored shaggy horkelia.
- Seeded native mix of mid-elevation origin to disturbed areas (Appendix F).

2023

- Hand pulled oxeye daisy (*Leucanthemum vulgare*), Scotch broom in unit 5, and many non-native grass, forb, and shrub species along the access road within the ACEC, with LMYC.
- Monitored remnant shaggy Horkelia and experimental plots with BLM staff.
- Broadcast 78.1 pounds native seed mix (Appendix F).
- Planted 360 shaggy Horkelia plugs. Created one new subplot (ME plugs) at each of the three experimental plots with 120 plugs each.

2024

- May-July: Pull and/or apply herbicide to treat false brome and Himalayan blackberry along ACEC access road and Scotch broom within unit 5.
- May/June: Hand pull or apply herbicide to treat non-native grasses (sponge dauber or spot spray).
- June 5-20: Monitor shaggy horkelia when in flower, likely between June 5th and 20th.
- July/Aug: Girdle target conifer trees.
- Oct/Nov: Seed native species throughout the meadow complex. Emphasize increasing annual forb abundance and perennial forb and graminoid diversity. Consider adding fruiting shrubs to the south meadow edge to increase abundance of wildlife forage.
- Sept-Dec: Buck and pile logs for natural decay within unit 2 corridor.
- Sept-Dec: Remove live conifers in units 4 and 5 to create meadow continuity, leaving snags for wildlife.

2025-2030

- Plant shaggy horkelia plugs annually to augment and expand remnant population. Planting should occur around remnant patch perimeters and in radiating clumps to promote expansion.
 - 2025: 500 plugs: `166 to patches F, G (extend), J
 - 2026: 500 plugs: `166 to patches C, E, I
 - 2027: 500 plugs: `166 to patches A, D, between G and F
 - 2028: 500 plugs: `166 to new patches: West of E, in center corridor of unit 2, East of F
 - 2029: 500 plugs: `166 to new patches in unit 5
 - 2030: 500 plugs: `166 to new patches in unit 4

APPENDIX B. SHAGGY HORKELIA MONITORING PROTOCOL

1. Designate field crew members as either plant counter (counter) or data recorder (recorder).

Generally, there are multiple counters and only one recorder.

2. Divide each shaggy horkelia patch into sections using transect tapes.
3. Count all individual shaggy horkelia encountered within each patch.
 - a. Individual plants are defined as basal rosettes not obviously connected to a single crown, usually a minimum of 1-2 inches apart (Alverson, 2013).
 - b. In 2020, the monitoring crew defined a seedling as any plant less two inches in diameter; however, the crew encountered many plants that were much smaller than this (Figure 3).
 - c. When a counter sees a shaggy horkelia plant they will shout whether the plant is a seedling, vegetative or reproductive. If the plant is a seedling or vegetative then no other information is needed. For example, “I have three vegetative.” The recorder will then write three tally marks under the column “vegetative” in the row indicating the patch number. However, if the counter sees a plant with any number of stems, even if browsed, they will tell the recorder that they have a “reproductive” and provide the number of browsed and unbrowsed stems present on that individual. For example, “one reproductive, four unbrowsed and three browsed stems.” The recorder will then add one tally mark to the column “flowering,” four tallies to the column “unbrowsed,” and three tallies to the column “browsed.”



Figure 4. Average size of shaggy horkelia (*Horkelia congesta* ssp. *congesta*) seedlings found during monitoring. Photo taken by Jessica Celis on June 4, 2020.

APPENDIX C. SHAGGY HORKELIA PATCH LABELING 2013 TO 2022

The shaggy horkelia (*Horkelia congesta* spp. *congesta*) population at Twin Prairie was first mapped in 2013 by BLM staff. In the original map individual patches were labeled by number. Over the past ten years new patches have been created as offshoots of the original patch (e.g., 7 and 7a), and at other times patches were merged due to low numbers and ease of monitoring. In 2022, multiple patches were combined and the need to revise the overall number system became necessary. To avoid confusion with the previous labeling system, the patch numbers have been replaced by letters A through J (Table 3, Figure 3).

Table 3. Shaggy horkelia (*Horkelia congesta* spp. *congesta*) patch mergers

Patch	Merger Notes
A	Patches 1 and 2 combined 2022.
B	Patches 3, 4, 5 combined 2015; plot 6 combined 2022.
C	Patches 7 and 7a combined 2021.
D	Patches 8 and 8a combined 2021
E	Patches 9, 10, 10a, and 11 combined 2022.
F	Patches 12, 12a, 12b combined 2022
G	Patches 13, 14, and 15 combined 2022.
H	Patch 16
I	Patch 18
J	Patches 17 and 19 combined 2022.

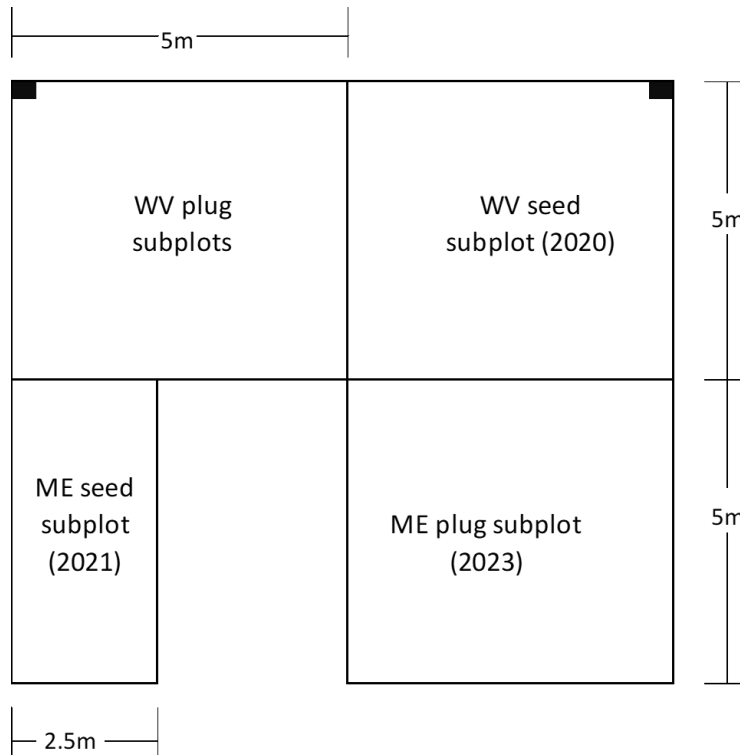
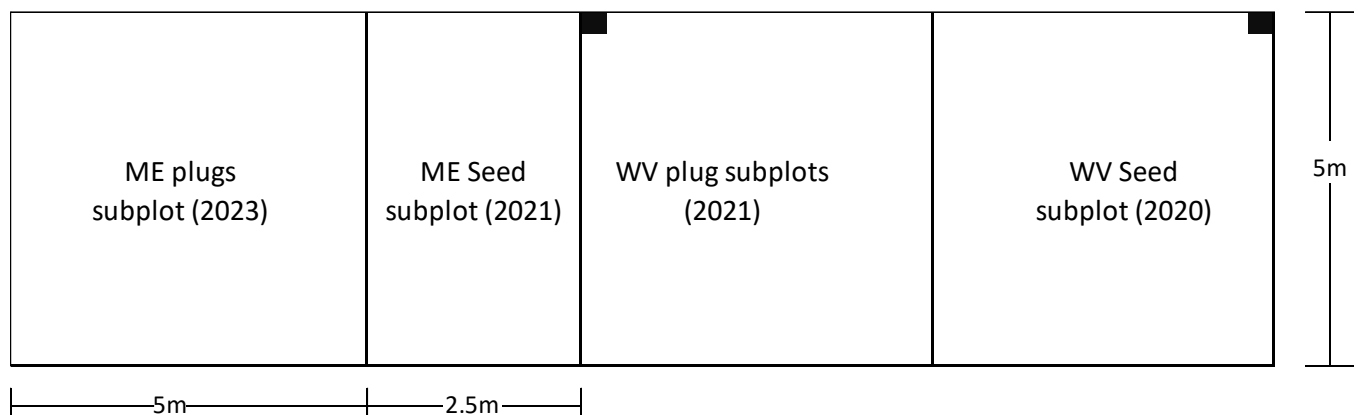


Figure 5. Twin Prairie shaggy horkelia (*Horkelia congesta* spp. *congesta*) patches with old labeling system (numbers) and new labeling system (letters).

APPENDIX D. EXPERIMENTAL PLOT LAYOUT

Table 4. Tag numbers for shaggy horkelia (*Horkelia congesta* ssp. *congesta*) experimental plots.

Plot Location	W.V. NE Label	W.V. NW Label
East	278	279
Central	284	291
West	289	288

**Figure 6.** Experimental East plot layout with label locations marked in black.**Figure 7.** Experimental Central and West plot layout with label locations marked in black.

APPENDIX E. SHAGGY HORKELIA MONITORING DATA 2014-2023

Shaggy horkelia abundance (total individuals) from 2014-2023.

Patch*	# of total plants (# of additional seedling plants)									
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
A	19	16	18	29 (4)	8	15	22 (1)	32 (19)	14	19
B	427	422	521	723 (124)	484 (45)	528 (27)	588 (60)	511 (261)	431 (2)	472 (9)
C	63	35	42	46	41 (15)	39	27 (1)	28 (0)	5 (0)	24
D	68	13	58	54	68 (14)	40	30 (3)	21 (9)	49 (0)	38 (2)
E	5	9	13	30	8	6	6 (0)	5 (4)	1	12
F	104	69	119 (5)	51	31	46 (1)	26 (202)	66 (101)	80 (10)	71
G	96	87	108	94	50 (1)	42	62 (76)	76 (47)	68 (5)	47
H	355	216	303 (81)	211	122 (12)	111 (3)	130 (131)	128 (114)	123 (6)	83 (13)
I	76	44	104 (60)	31	31 (7)	31	26 (79)	37 (17)	19 (1)	20
J	17	16	59 (50)	8	17 (1)	20 (3)	25 (109)	53 (42)	57 (5)	42
Total	1242	929	1345 (196)	1257 (128)	860 (95)	883 (34)	942 (661)	957 (614)	847 (29)	828 (24)

*Patch mergers notes available in Appendix C.

Shaggy horkelia abundance (reproductive individuals) from 2014-2023.

Patch	# of reproductive plants									
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
A	19	14	6	20	8	13	19	25	13	14
B	245	225	276	424	188	358	416	334	273	327
C	51	30	30	33	19	20	20	21	5	19
D	35	13	37	43	31	36	29	19	25	36
E	8	10	8	9	6	6	6	5	1	11
F	64	39	58	40	26	38	21	18	13	59
G	49	43	50	65	39	35	44	57	34	37
H	184	116	125	159	78	82	74	79	56	56
I	46	24	36	27	18	25	18	26	13	14
J	12	13	7	8	7	8	18	20	18	23
Total	713	527	633	828	420	621	665	604	451	596
Percent Flowering:	57.4%	56.7%	47.1%	65.9%	48.8%	70.3%	70.6%	63.1%	53.3%	72.1%

*Patch mergers notes available in Appendix C.

Flowering stems (browsed) of shaggy horkelia at Twin Prairie, 2013-2023

Patch	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
A	25	22 (30)	35 (3)	7 (1)	70	21	45 (3)	37 (25)	65	24 (17)	42
B	516	217 (340)	345 (168)	99 (426)	464(634)	417 (158)	530 (288)	733 (178)	306 (294)	564 (31)	615 (69)
C	77	53 (63)	51 (11)	30 (38)	84(7)	39	38	37 (3)	28 (19)	12	40
D	61	39 (54)	26	44 (39)	102(23)	62 (18)	57 (30)	69 (46)	34 (26)	42 (34)	102 (50)
E	14	17 (1)	9 (16)	4 (9)	12 (16)	17 (16)	10 (3)	13 (6)	1 (12)	3 (0)	22 (7)
F	17	113 (79)	59 (23)	39 (88)	81(23)	52(6)	109	68 (5)	45 (7)	24 (8)	157
G	29	48 (72)	55 (29)	47 (47)	98	70	52	80 (5)	81 (14)	49 (16)	62 (16)
H	229	205 (287)	111 (98)	83 (185)	239(136)	167 (9)	149 (37)	118 (93)	104 (61)	74 (50)	48 (115)
I	102	66 (68)	48 (4)	10 (85)	57(35)	40 (6)	76	29 (14)	59 (9)	24 (25)	13 (51)
J	11	10 (29)	37	3 (17)	15(14)	18 (5)	33	23 (36)	30 (23)	18 (35)	23 (82)
TOTAL	N/A	790 + (1023)	776 + (352)	359 + (935)	1222 + (907)	903 + (218)	1098 + (362)	1,207 + (411)	753 + (465)	834 +(216)	1,124 + (390)
Unbrowsed + (browsed)											
TOTAL	1081	1813	1128	1294	2129	1121	1,460	1,618	1,218	1,050	1,514
Combined											
Proportion of browsed stems	N/A	56%	31%	72%	43%	19%	25%	25%	38%	21%	26%

Table 5. Shaggy horkelia (*Horkelia congesta* ssp. *Congesta*) seed source survivorship experiment data

		# of plants (# of seedlings)		
	Plot	2021	2022	2023
WV seed	West	0 (123)	0 (0)	0 (0)
	Central	0 (33)	2 (0)	0 (0)
	East	0 (315)	0 (25)	0 (0)
ME seed	West	x	0 (115)	17 (3)
	Central	x	0 (90)	5 (0)
	East	x	0 (84)	0 (0)
WV plug	West	x	122 (0)	94 (0)
	Central	x	124 (0)	57 (0)
	East	x	135 (0)	39 (0)
ME plug	West	x	x	x
	Central	x	x	x
	East	x	x	x

Total # plants by subplot type (# of seedlings)			
	2021	2022	2023
WV Seed	0 (471)	2 (25)	0 (0)
ME Seed	x	0 (289)	22 (3)
WV plugs	x	381 (0)	190 (0)
ME plugs	x	x	x

APPENDIX F. COMPREHENSIVE PLANTING AND SEEDING RECORD 2012-2023

Scientific name	Common name	Amount seed (lb.) and number of plugs or shrubs {quantity}.						
		2023	2022	2021	2020	2016	2015	2014
<i>Achnatherum lemmonii</i> ssp. <i>lemmonii</i>	Lemon's needlegrass		0.117					
<i>Amsinckia menziesii</i> var. <i>intermedia</i>	Menzies' fiddleneck	2.51*						
<i>Clarkia amoena</i> ssp. <i>lindleyi</i>	farewell-to-spring	6.19*						
<i>Clarkia purpurea</i>	winecup clarkia	5.65*	0.121	Seed				
<i>Collinsia grandiflora</i>	large-flowered blue-eyed Mary	2.23*						
<i>Collomia grandiflora</i>	large-flowered collomia	6.18*						
<i>Danthonia californica</i>	California danthonia	10	2			2		5
<i>Elymus glaucus</i>	blue wildrye			Seed		1		7
<i>Epilobium densiflorum</i>	denseflower willowherb	0.44*						
<i>Eriophyllum lanatum</i>	Oregon sunshine	8.3	2	Seed		1		
<i>Festuca californica</i>	California fescue		0.68	Seed				
<i>Festuca roemerii</i>	Roemer's fescue	5.71	2	Seed		2		5
<i>Gilia capitata</i>	globe gilia	1.71*	0.7					
<i>Horkelia congesta</i> spp. <i>congesta</i>	shaggy horkelia	{360}		Seed {600}	0.75		{220}	
<i>Iris tenax</i>	toughleaf iris	0.047						
<i>Koeleria macrantha</i>	prairie Junegrass	10	1	Seed				
<i>Lomatium dissectum</i>	fern-leaved biscuitroot	0.165						
<i>Lomatium utriculatum</i>	spring gold		0.02	Seed				
<i>Madia citriodora</i>	lemon-scented tarweed	0.0548						
<i>Madia elegans</i>	showy tarweed	1.05*		Seed				
<i>Madia gracillis</i>	grassy tarweed	0.68*		Seed				
<i>Madia madioides</i>	woodland tarweed			Seed				
<i>Phacelia nemoralis</i> var. <i>oregonensis</i>	Oregon woods phacelia	1.01*						
<i>Plagiobothrys figuratus</i>	fragrant popcornflower	1.07*						
<i>Plectritis congesta</i>	shortspur seablush	3.003*						
<i>Poa secunda</i>	pine bluegrass			Seed				
<i>Prunella vulgaris</i> var. <i>lanceolata</i>	common selfheal	6.1	0.026					3

Scientific name	Common name	Amount seed (lb.) and number of plugs or shrubs {quantity}.						
		2023	2022	2021	2020	2016	2015	2014
<i>Sidalcea malviflora</i> spp. <i>virgata</i>	rose checkermallow		0.1					
<i>Wyethia angustifolia</i>	narrowleaf mule's ear	6.0035	2					
	Totals:	78.10 lb. 360 plugs	10.76 lb.	Unknown seed total, 600 plugs	0.75 lb.	6 lb.	220 plugs	20 lb.
	Seed source notes: Willamette Valley (WV) or mid-elevation (ME) genetic origin.	ME and WV sourced. * Annual Color Mix: WV sourced.	All ME sourced.	All ME sourced, but unknown quantities (see 2021 report). <i>H. congesta</i> from WV (Douglas).	All WV sourced.			