Dalles Mountain Prairie Vegetation Monitoring – 2022 Annual Report

November 2022

Report for Washington State Parks

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Institute for Applied Ecology

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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: Dalles Mt. Prairie, IAE. *All photos by IAE*

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Dalles Mountain Prairie Vegetation Monitoring – 2022 Annual Report

EXECUTIVE SUMMARY

The primary restoration goal for the Dalles Mountain Prairie area is to increase the native vegetative diversity of grasses and forbs while reducing exotic grasses and forbs. Parts of this area was historically cultivated with SECAR and Sherman's big bluegrass, resulting in large monocultures that were intended to be controlled. To achieve these restoration goals, sustainable grazing has been implemented, with hopes that grazing will suppress non-native grasses, allowing for native plant recruitment. Here, we summarize the status of Dalles Mountain Prairie after multiple years of sustainable grazing and 7-years post wildfire activity.

We found that sustainable grazing shows promise toward reducing cultivated grass density while increasing native forbs. In areas that were not cultivated and grazed we found that native forbs exceeded exotic and cultivated grass cover, indicating some success towards meeting restoration goals. In areas that were not grazed we found that exotic cover consistently exceeding native cover. These trends were seen on both cultivated and uncultivated areas. Areas that were subjected to a wildfire in 2015 showed an initial decreasing trend in cultivated grasses. However, 7 years post-wildfire we found that levels of cultivated grasses recovered to historical levels.

Continued sustainable grazing is recommended to manage the cultivated SECAR and Sherman's big bluegrass. While we are seeing a slight increase in native perennial forbs, we have little to no changes in native annual forbs. Therefore, supplemental seeding is recommended to reach the goal of increasing native plant diversity. There has been an overall decrease in exotic grasses, but additional management should be considered to further control these grasses.

1. INTRODUCTION

Dalles Mountain Ranch was formerly a 6,000-acre cattle ranch located on the northern side of the Columbia River in southern Washington. In 1993, part of the ranch became the Columbia Hills Natural Area Preserve, administered by Washington Department of Natural Resources, and Dalles Mountain State Park, administered by Washington State Parks (WSP). In 2003 WSP combined Horsethief Lake and Dalles Mountain into the Columbia Hills State Park (Figure 1). The Park is 3,338 acres in extent.

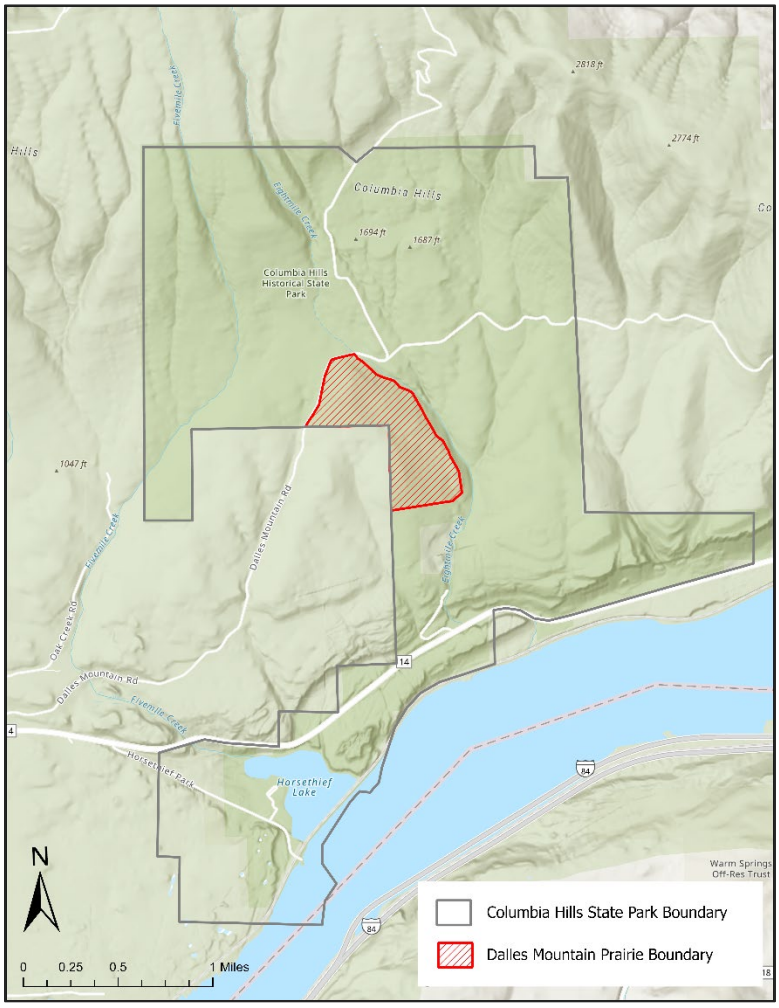

Figure 1. Location of Dalles Mountain Prairie within Columbia Hills State Park.

Natural steppe grassland habitats were degraded during the grazing era through the sowing of native cultivar grasses, such as 'SECAR' Snake River wheatgrass (*Elymus wawawaiensis*; USDA NRCS 2010; Figure 2). The 'SECAR' cultivar originates from a seed collection near Lewiston, Idaho, and naturally occupies canyons of the Snake River in Idaho, Oregon and Washington (USDA NRCS 2010). It had originally been thought that 'SECAR' was a bluebunch wheatgrass (*Pseudoroegneria spicata*; Ogle et al. 2010), but cytological examination determined it to be Snake River wheatgrass (Carlson and Barkworth 1997). SECAR is a drought tolerant cultivar, which has outcompeted local native grasses and forbs. Although Snake River wheatgrass is a native species, 'SECAR' has been regarded as an undesirable "non-native", because it was introduced as a pasture grass cultivar which was developed from non-local genetics.

While balancing the important cultural and recreational values of the park, one of the objectives of management is to identify, assess, monitor, protect, and restore plant and animal communities associated with grasslands (and other habitats) and the ecological functions they perform (Washington State Parks 2003). Grazing was chosen as a tool to help reduce the impact of 'SECAR' at the park and a rehabilitation research project has been conducted by Washington State University (WSU) at the 180-acre Dalles Mountain Prairie (Figure 1; a part of Columbia Hills State Park) since 2008, examining the response of vegetation to low intensity, rotational fall grazing (Van Vleet, in prep; Appendix 1and Appendix 2 of the 2021 report). Grazing history at the site was described each year (Table A 1).

In order to provide new input to the restoration work at Dalles Mountain Prairie, in 2016 the Institute for Applied Ecology (IAE), with support from Colombia Gorge Environmental Foundation, Washington Native Plant Society, and nearby landowner/prairie advocate Bob Hansen, established an updated vegetation monitoring framework (Moore and Bahm 2016). In 2017, IAE repeated and expanded vegetation monitoring at the site (Bahm et al. 2017), and developed a preliminary Restoration Plan, including a potential list of plant species to integrate into restoration efforts (Menke et al. 2017). The site was monitored again in the springs of 2018, 2019, and 2021(Schomaker et al. 2018, Menke and Bahm 2019, Diaz et al. 2021), with the addition of sampling reference plots in local prairie remnants in the interests of evaluating the structure (grass and forb diversity, grass to forb cover ratio) of relevant high quality grassland habitat remnants in the general area of Dalles Mountain, and to provide potential plant community context for restoration efforts at Dalles Mountain; see Appendix 4 for more information.

Figure 2. 'Secar' cultivar of Snake River Wheatgrass.

1.1 Project Area

The 180-acre Dalles Mountain Prairie project area is comprised of rolling hills, approximately 900-1,300' in elevation, with south facing slopes overlooking the Columbia River and east-facing slopes draining into the valley of Eightmile Creek (Figure 3). The site includes 5 "pastures", which are currently only temporarily fenced (electric) during times of grazing (Figure 3).

A fence runs around the perimeter of the project area and Dalles Mountain Road runs along the north-western boundary. Private farmland is adjacent to southwest boundary, and Eightmile Creek and the remainder of the Columbia Hills State Park lie to the northeast.

The majority of the area is dominated by cultivated pasture grasses, particularly the 'SECAR' cultivar of Snake River wheatgrass (Figure 2). Other cultivars in the project area include 'Sherman" Big Bluegrass (*Poa secunda*). Areas that were too steep or rocky were apparently not cultivated with 'SECAR', and some of these areas, particularly in the western edge of Pasture 3 and eastern edge of Pastures 1 and 4 show a more diverse range of native forb species and native perennial grasses, including Idaho fescue and blue bunch wheatgrass.

In September 2015, a wildfire burned through the southern 60% of the project area, including all of Pasture 5 and parts of Pasture 3 and Pasture 4.

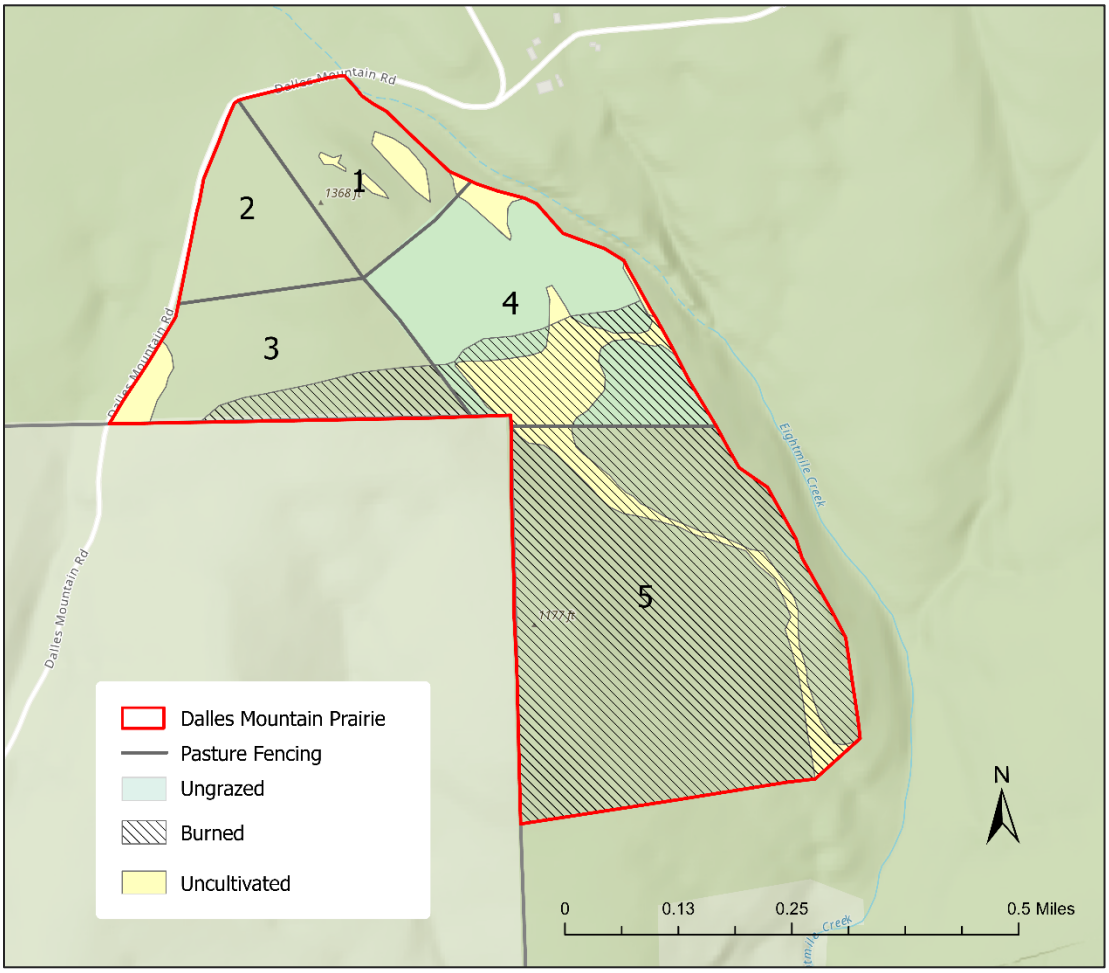

Figure 3. Pasture divisions used at Dalles Mountain Prairie from 2009 – 2022.

1.2 Grazing Management

A rehabilitation/research project has been conducted by Steve Van Vleet (WSU) at Dalles Mountain Prairie since 2008 (Appendix 1). The primary goal of the project was to increase the biological diversity of the prairie using cattle grazing, with secondary goals of preserving the historical landscape and reducing fuel for wildfires. The project at the prairie was part of a larger project, funded by the Western Sustainable Agriculture Research and Education Program, to study sustainable alternatives to the Conservation Reserve Program (Nelson and Van Vleet 2013).

The grazing history of Dalles Mountain Prairie since 2008 is summarized in Appendix 3. Light rotational fall grazing has occurred in 2009-2014, and 2016, 2018, 2019 and 2020 on four fenced pastures (Figure 3) (Pasture 1-3 and Pasture 5), while one pasture (Pasture 4) remained ungrazed. When grazing occurs, it is typically for a short (1-2 weeks) period in the fall. One rotation of spring grazing took place in 2012. No pastures were grazed in 2015 to allow for post-wildfire grassland recovery, and in 2021 to rest the pastures.

Grazing was adaptively managed and monitored for the effect on vegetation, and to minimize the trampling of areas around water troughs (S. Van Vleet, pers. comm., 2016). Water supply was a key

problem to be addressed – initially water was supplied by truck to troughs at fence lines along Dalles Mountain Road, which meant that cattle in Pasture 5 needed a fenced pathway to the northern property boundary. Later this was improved by piping water to troughs in each pasture.

Supplementary seeding of native forbs and grasses occurred in some years in limited high impact areas of the grazed pastures and to rehabilitate the areas with intensive use (e.g., water troughs, supplements).

1.3 Monitoring History

WSU Extension established monitoring plots and photo points in 2009 in the five pastures to monitor vegetation changes over time and to compare grazed with ungrazed areas (Appendix 1 and 2 in the 2021 report). Observations suggested that grazing was having positive effects, promoting increases in species richness and forb cover (Appendix 2 in 2021 report).

Since 2013, Bob Hansen and WNPS volunteers have been monitoring plant species diversity, density and phenology during the forb flowering season at Dalles Mountain Prairie, and posting photographs and results on a Facebook page: https://www.facebook.com/The-Dalles-Mountain-Prairie-Restoration-346145148747802/. Bob Hansen has been instrumental in galvanizing partners and volunteers, seeking funding and providing matching funds, to work towards a new phase of restoration and management of the prairie. A species list for the site was compiled from the monitoring by WSP, Bob Hansen, and IAE (Table A 4).

2. GOALS AND OBJECTIVES

The objective of this report is to summarize the 2022 monitoring data and evaluate if restoration treatments (burning and grazing) meet restoration objectives. The restoration objectives for this project are to increase native prairie forb and grass cover and diversity while reducing exotic species cover and diversity and reduce the cover of cultivated grasses SECAR and Sherman's big bluegrass.

These objectives were completed by conducting the following actions:

1) To monitor and summarize results for 6 relevé plots that were subjected to an array of treatments;
2) Monitor and summarize the results for 5 transects that span 3 different treatments; and
3) Provide management recommendations on how to achieve restoration goals on Dalles Mountain Prairie.

3. METHODS

3.1 Plot Establishment

In May 2016, IAE established 5 transects and 5 relevé plots (Mueller-Dombois and Ellenberg 2002) to monitor baseline vegetation conditions at Dalles Mountain Prairie and to inform the development of a restoration plan for the site. An additional relevé plot was added in 2017 to provide better coverage of grazed areas. All 5 transects and 6 plots have been annually monitored by IAE since 2016, except in 2020. Data has been used to assess plant community changes over time and help inform management actions. Plot and transect locations are included in Figure 4. Sample plot photos are included in Appendix 4.

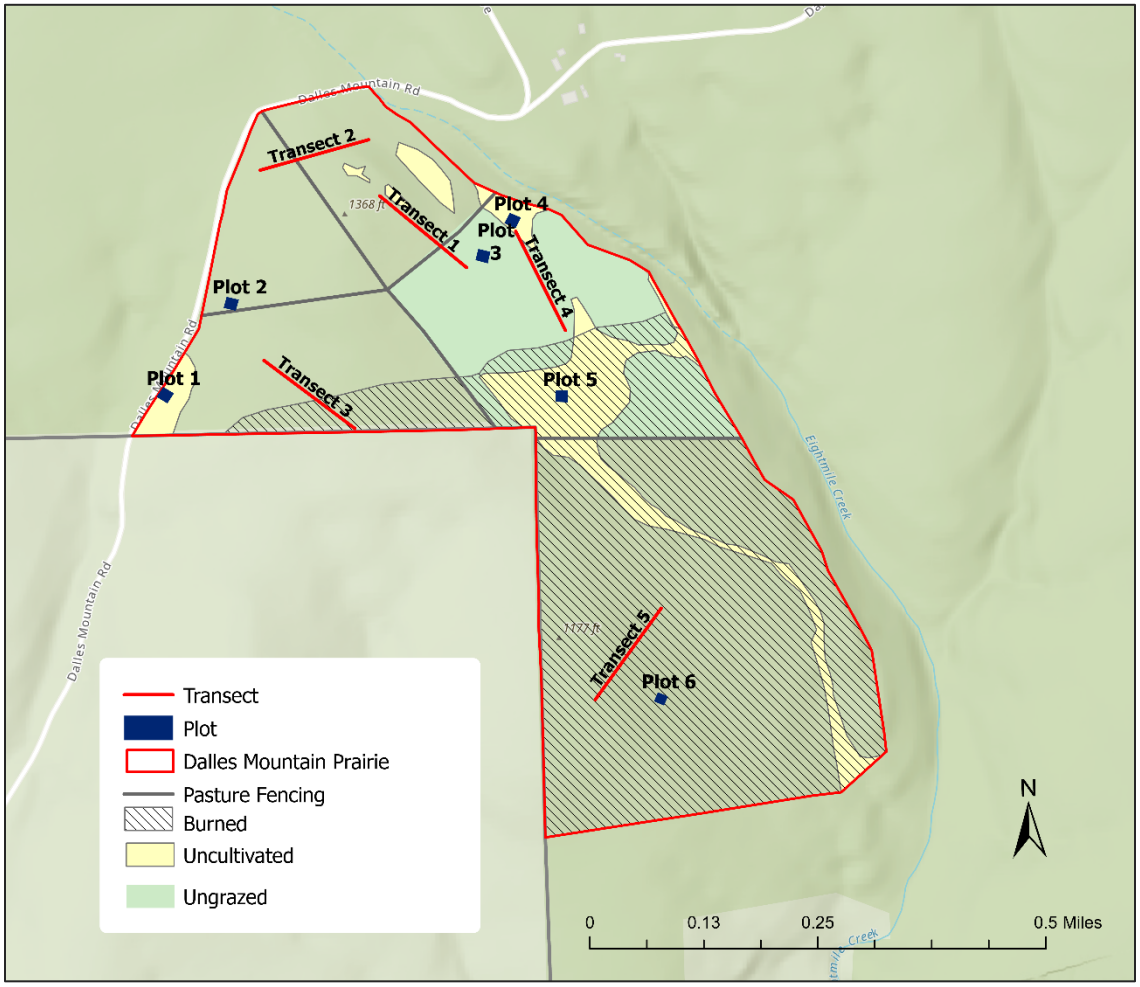

Figure 4. Relevé Plot and transect locations at Dalles Mountain Prairie for 2016-2022 vegetation monitoring.

The number of transects and plots were designated to provide adequate sample size and stratify by management types (grazed/ungrazed, cultivated/uncultivated and burned/unburned) while maximizing efficiency (1-2 days monitoring time). More transects and plots can be added, as necessary, to incorporate any future management actions.

3.2 Relevé Plots

Data Collection

The six 20 m x 20 m relevé plots were marked with fiberglass posts and placed to represent the grazed (Plot 2) and ungrazed (Plot 3) areas, and also to include the uncultivated areas with higher plant diversity (Plot 1 and Plot 4) or previously uncultivated shallow soil (Plot 5) (Figure 4). Plot locations differ from those used in the initial grazing study.

In each plot, each species was identified and assigned a Braun-Blanquet (1965) percent cover class (Table 1) and sociability class. Cover classes describe abundance and sociability classes measure the degree of clustering of individuals of a plant species.

Table 1. Braun-Blanquet cover classes used in Relevé plots at Dalles Mountain prairie.

Cover Class	Cover Range (%)	Midpoint
5	75 - 100	87.5
4	50 - 75	62.5
3	25 - 50	37.5
2	5 - 25	15.0
1	1 - 5	2.5
+	< 1	0.1
r	observed, rare	*

**Individuals occurring seldom or only once; cover ignored and assumed to be insignificant.*

Data Analysis

Data was analyzed using Microsoft Excel and R v. 4.1.3 (R Core Team 2022). Species richness was determined by converting species cover relevé data into presence and absence data. Species richness was summarized for the following functional groups: cultivated grass, exotic grass, native grass, exotic forb, native forb, exotic total, and native total. Relevé cover data was calculated by converting the cover classes to the midpoint value (Table 1), and then total those covers. Cover data was totaled in each of the following groups: cultivated grass, exotic grass, native grass, exotic forb, and native forb.

3.3 Transects

Data Collection

Five 100 m transects were randomly located throughout the site (Figure 4, Table 2), and were marked at each end with fiberglass poles. Transects were meant to capture grazed and ungrazed areas of the study site. Two grazed transects (part of Transect 3 and all Transect 5) were burned by wildfire in September 2015.

Along each transect 1m x 1m plots were placed every 10m, resulting in 10 plots per transect. In each plot we recorded percent cover of 'SECAR', plant functional groups (native and exotic perennial and annual grasses, native and exotic perennial, and annual forbs), bare ground, moss/soil crust, and plant litter. Subshrubs or shrubs (i.e., *Lupinus, Phlox*, *Eriogonum*) were included in the forb functional group. The cultivars 'SECAR' Snake River wheatgrass and 'Sherman' Big bluegrass were categorized separately.

Table 2. Monitoring transects at Dalles Mountain Prairie.

Status	Number of Plots	Transects
Grazed and Burned	16	T3 and T5
Grazed and Unburned	21	T1, T2, and T3
Ungrazed and Unburned	13	T1 and T4

Table 3. Vegetation monitoring dates.

Year	Survey Dates
2016	May 4
2017	April 26-27
2018	April 18-19
2019	May 2
2021	May 6-7
2022	May 11-12

Data Analysis

Data were analyzed using Microsoft Excel. The mean cover and standard error were calculated for each variable (SECAR, plant functional groups, bare ground, moss/soil crust, and a plant litter) at the treatment level (burned and grazed, unburned and grazed, unburned and ungrazed) (Table 2).

4. RESULTS

Vegetation monitoring in 2022 occurred on May 11th and 12th to capture peak bloom of perennial forbs Table 3). Timing of sampling has varied over the years, capturing varying degrees of phenology. For instance, 2017 work was pre-peak flowering period, whereas in 2016 our sampling was in the post-peak flowering period (Table 3). After a very dry spring and summer in 2021, fall precipitation in 2021 followed normal precipitation trends. December was unseasonably wet, and then dropped to an abnormally dry January and February in 2022. Spring precipitation in 2022 was consistently above normal trends (Figure 5). April and May of 2022 were somewhat cooler than normal, providing a cooler and wet spring for the 2022 monitoring season.

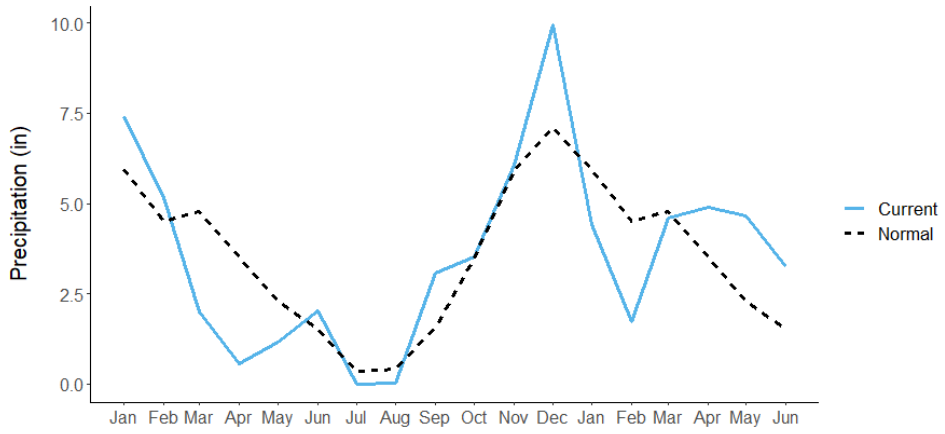

Figure 5. Total current precipitation at Dalles Mountain Prairie from January 2021- June 2022 compared to normal precipitation trends. Normal trends are mean precipitation from 1991-2020.

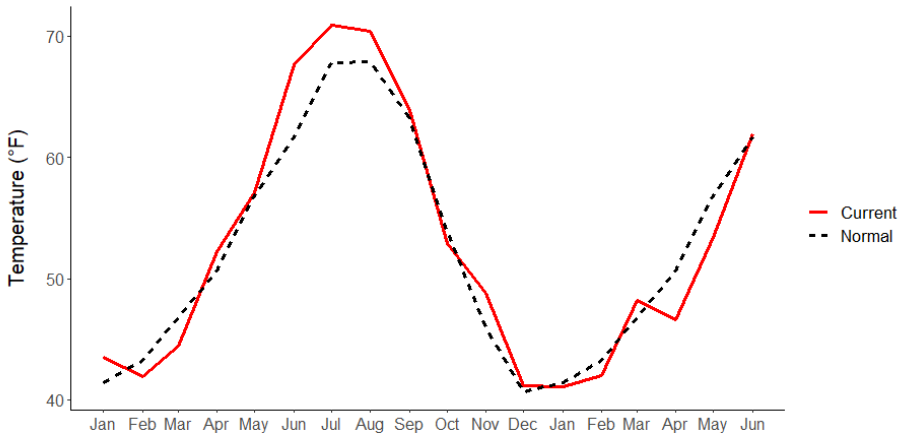

Figure 6. Mean current temperature at Dalles Mountain Prairie from January 2021- June 2022 compared to normal temperature trends. Normal trends are mean temperature from 1991-2020.

4.1 Relevé Plots

Plot 1: Grazed, Unburned, Uncultivated

Overall species richness has steadily decreased since 2018, with 34 species in 2018 and 21 species in 2022 (Table 4). This decrease is attributed to a decline in native forb richness. While native species richness has decreased, native cover is consistent with previous years and continues to be higher than exotic cover. This consistent high level of native cover is attributed to a well-established native perennial forb community, comprised of Carey's balsamroot (*Balsamorhiza careyana*), barestem biscuitroot (*Lomatium nudicaule*), and broad-leaved lupine (*Lupinus latifolius*). Exotic cover has steadily decreased in this plot since 2018, with exotic cover 174% in 2018 and 47.5% in 2022 (Figure 7). This decrease is most notably seen in exotic grasses such as bulbous bluegrass (*Poa bulbosa*), rattail fescue (*Vulpia myuros*), and soft chess (*Bromus hordeaceus*). Cultivated grasses continue to not be present on this plot.

Plot 2: Grazed, Unburned, Cultivated

Overall species richness followed consistent trends seen on this plot, with cyclic high and low years ranging between 35 and 21 species. This fluctuation tends to be attributed to native richness, which has consistently been higher than exotic richness since 2016 (Table 4). Native cover has been steadily increasing since 2016, with 0.6% cover in 2016 and 42.7% cover in 2022 (Figure 7). This increase is attributed to perennial forbs such as barestem biscuitroot. Exotic cover has been consistently higher than native cover, but exotic cover has been on a steady decline since 2016. Decline in exotic cover is largely due to the decline in exotic grasses, such as rattail fescue, soft chess, and medusa head (*Taeniatherum caput-medusae*). Cultivated grass cover was on a steady decline from 2016-2021 to trace amounts in 2021 but spiked back up in 2022 to levels seen in 2018 (62.5%, Figure 7).

Plot 3: Ungrazed, Unburned, Cultivated

Overall species richness increased to normal levels that were seen in 2019, increasing from 17 species in 2021 to 24 species in 2022. Exotic richness continues to be greater than native richness (Table 4). Native cover continues to be low on this plot (0.1%), and it is attributed to almost entirely to annual agoseris (*Agoseris heterophylla*). Exotic cover continues to be high, following previous trends (107.6%), and is entirely attributed to exotic grasses. Cultivated grass cover continued to be high, most notably of SECAR (Figure 7).

Plot 4: Ungrazed, Unburned, Uncultivated

Overall species richness has declined since 2018, from 32 species in 2018 to 20 species in 2022. This decline has been attributed to both exotic and native species, but native species have been consistently greater than exotic species richness (Table 4). Exotic cover continues to be greater than native cover, but at a small margin. Native cover (25.2%) is largely attributed to perennial forbs such as, Carey's balsamroot, arrowleaf buckwheat (*Eriogonum compositum*), barestem biscuitroot, broad-fruit lomatium (*Lomatium triternatum*), and broad-leaved lupine. Exotic cover (35.1%) is attributed to soft chess and bulbous bluegrass. Cultivated grasses have declined by a large margin from 2021 (87.5%) to 2022 (0.1%) (Figure 7).

Plot 5: Ungrazed, Burned, Uncultivated

Overall species richness increased to normal levels that were seen in 2017-2019, increasing from 14 species in 2021 to 19 species in 2022. Native richness continues to be greater than exotic richness (Table 4). There was a large margin between exotic cover (85%) and native cover (7.8%) in 2022, with exotic cover almost entirely comprised of grasses and native cover was entirely consist of forbs. Exotic cover was largely due to bulbous bluegrass and soft chess, while native cover was largely impacted by perennial forbs. Cultivated grasses declined back to historical levels, from 15% in 2021 to trace amounts in 2022 (Figure 7).

Plot 6: Grazed, Burned, Cultivated

Overall species richness followed consistent trends seen on this plot, with exotic richness higher than native richness (Table 4). Exotic cover continued to be greater than native cover, consisted of exotic grasses, most notably soft chess and bulbous bluegrass. The aggressive exotic grass, cheatgrass (*Bromus tectorum*), spiked in 2022 to levels that were not historically seen on this plot. Native cover was almost entirely comprised of an annual forb, Menzies' fiddleneck (Amsinckia menziesii), and minimal perennial cover. Cultivated grasses have increased throughout the project and reached the highest levels in 2022 (15%) (Figure 7).

Table 4. Species richness of six relevé plots at Dalles Mountain Ranch from 2019, 2021and 2022, monitoring did not occur in 2020. Previous years data from 2016-2018 can be found in previous reports.

	Plot 1			Plot 2			Plot 3			Plot 4			Plot 5			Plot 6		
Grazing Status	Grazed			Grazed			Ungrazed			Ungrazed			Ungrazed			Grazed		
Burn Status	Unburned			Unburned			Unburned			Unburned			Burned			Burned		
Cultivation Status	Uncultivated			Cultivated			Cultivated			Uncultivated			Uncultivated			Cultivated		
Year (20__)	**19**	**21**	**22**	**19**	**21**	**22**	**19**	**21**	**22**	**19**	**21**	**22**	**19**	**21**	**22**	**19**	**21**	**22**
Cultivated Grass	0	0	0	1	0	1	2	1	1	1	1	1	2	1	2	2	2	2
Exotic Grass*	5	6	4	5	7	5	5	3	6	4	6	6	6	5	7	5	5	5
Exotic Forbs	8	2	4	5	5	5	3	5	7	7	3	2	2	1	1	5	5	5
Native Grass	1	1	1	1	1	1	1	0	0	0	1	0	2	1	1	2	0	1
Native Forb	19	15	12	11	14	13	9	6	9	18	13	12	10	7	10	7	7	7
Exotic Total*	13	8	8	10	12	10	8	8	13	11	9	8	8	6	8	10	10	10
Native Total	20	16	13	12	15	14	9	6	9	18	14	12	11	8	11	8	7	8
Overall Richness	**28**	**24**	**21**	**21**	**27**	**24**	**26**	**14**	**22**	**28**	**23**	**20**	**21**	**14**	**19**	**21**	**17**	**18**

* Includes cultivated grasses (Sherman's big bluegrass and SECAR)

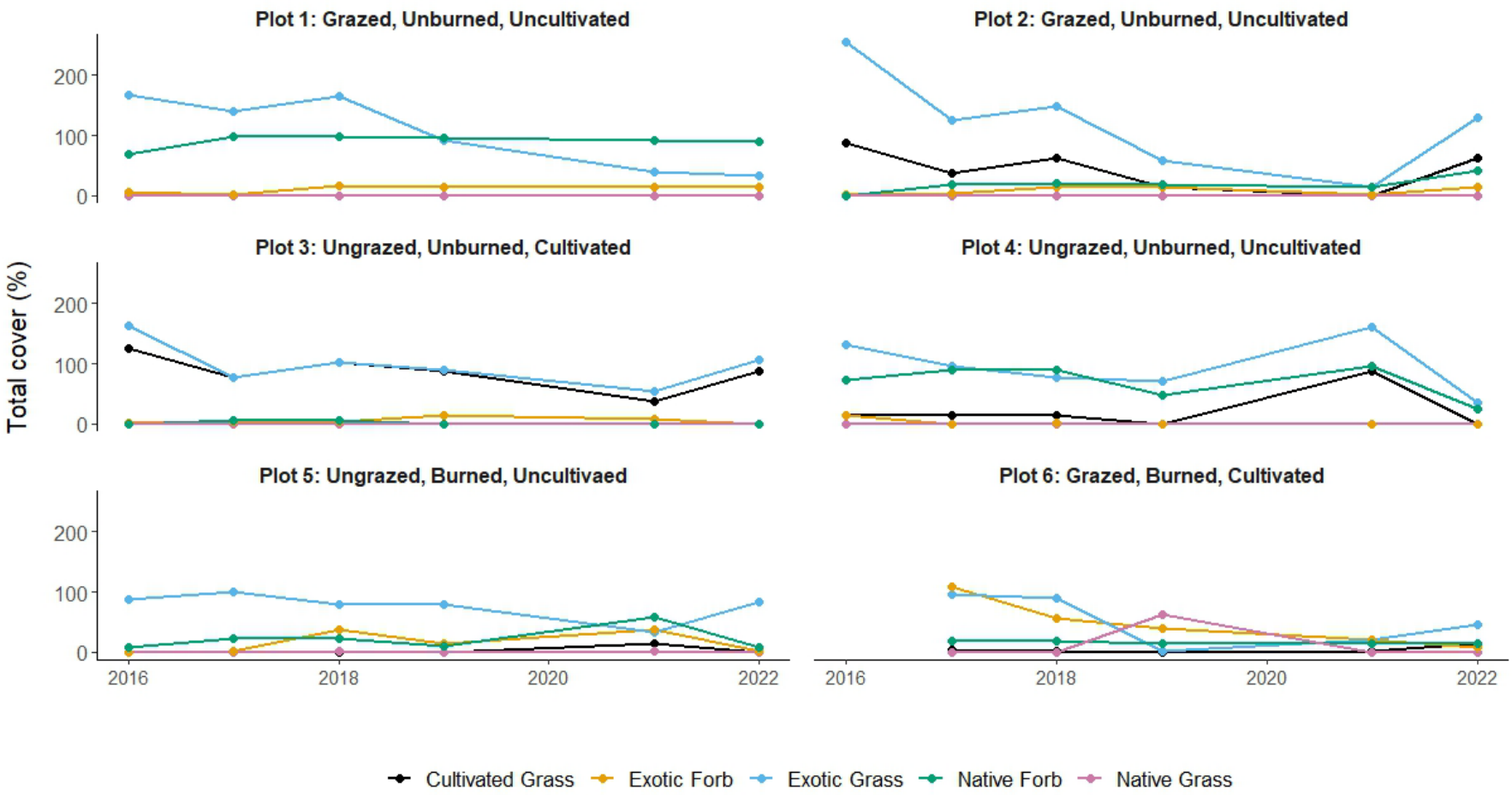

Figure 7. Total percent cover of 5 functional groups on 6 relevé plots at Dalles Mountain Prairie from 2016 – 2022. Cultivated grass is a part of the exotic grass cover.

4.2 Transects

Grazed and Burned

Sixteen-meter square plots were monitored in 2022. SECAR cover spiked in 2022 from 2.0% ± 0.9% mean cover in 2021 to 9.2% ± 4.0% mean cover in 2022, the largest mean cover seen on the grazed and burned area over the term of this project. Exotic perennial grass cover in 2022 (4.9% ± 1.7%) increased to similar values seen in 2017 (6.2% ± 2.3%). Exotic annual grasses increased in 2022 (37.7% ± 5.7%) back to values seen in 2019 (36.9% ± 6.0%), resulting in the highest cover compared to the other treatments. Exotic perennial forb cover had little change in 2022 (3.9% ± 2.8%) compared to 2021 (10.5% ± 5.5%). Exotic annual forbs cover for 2022 (14.7% ± 4.7%) has maintained similar cover to 2019 (11% ± 3.4%) and 2021(14.6% ± 2.9%). Native perennial grass cover in 2022 has maintained low cover (1.1% ± 0.6%), with no year exceeding 2.2% cover. Native annual grass cover had a spike in 2022 (6.6% ± 19.0%) after 4 years of having no cover presence, and exceeding values seen in 2016 (0.03% ± 0.03%). Native perennial forbs steadily increased in 2022 reaching the highest cover seen on this treatment (6.9% ± 1.8, Figure 8).

Grazed and Unburned

Twenty-one-meter square plots were monitored in 2022. Mean SECAR cover increased from 2021 (6.8% ± 1.5%) to 2022 (12.1% ± 4.3%), reaching levels that were seen in 2019 (13.2% ± 3.4%). Exotic perennial grass cover in 2022 increased (8% ± 1.4%), showing signs of reaching levels seen in 2017 (15% ± 3.2%). This increase was seen across all 3 treatments, meaning that this increase in exotic perennial grasses could be due to the wet spring, providing ideal conditions for growth. Exotic annual grasses have maintained similar levels seen in 2021 and is the treatment with the lowest cover. This treatment also showed an overall consistent decrease in exotic annual grasses, dropping from 50% ± 5.0% cover in 2016 to 9.4% ± 2.0% cover in 2022. Exotic perennial and annual forbs were consistent to previous years, never exceeding 10% cover. Native perennial grasses continue to be low, not exceeding 1.3% since 2017. Native annual grass cover had a spike in 2022 (5.5% ± 2.9%) after 4 years of having no cover presence, and exceeding values seen in 2016 (0.2% ± 0.1%). Native perennial forbs continue to be the highest in this treatment across all 3 treatments. Mean perennial forb cover in 2022 (36.8% ± 5.5%) was higher than exotic grass cover (17.8%) Native annual forb cover has stayed at consistent levels seen throughout this project and continues to be similar to the other treatments (Figure 8).

Ungrazed and Unburned

Thirteen-meter square plots were monitored in 2022. Mean SECAR cover continued to be high in 2022 (29.4% ± 5.9%), consistent with trend seen on this treatment. Exotic perennial grass cover has stayed at consistent levels in 2022 (3.3% ± 1.9%), since 2016 exotic perennial grass cover has ranged between 1-3.3% cover. Exotic annual grass cover has continued to be high in 2022 (20.5% ± 5.1%) but has shown a decline since 2016 (45% ± 7.9%). Exotic forbs have continued to be low, not exceeding 11% throughout this study. Native perennial grasses have continued to be low in 2022 (0.4% ± 0.4%), not exceeding 1% throughout the study. Native annual grass cover had a spike in 2022 (1.2% ± 0.8%) after 4 years of having no cover presence, and exceeding values seen in 2016 (0.8% ± 0.7%). Native perennial forb cover has increased in 2022 (6.5% ± 2.6%), reaching the highest cover seen in this study. Native annual forb cover has continued to be low but has increased to values seen in 2017 (3.4% ± 1.6%) (Figure 8).

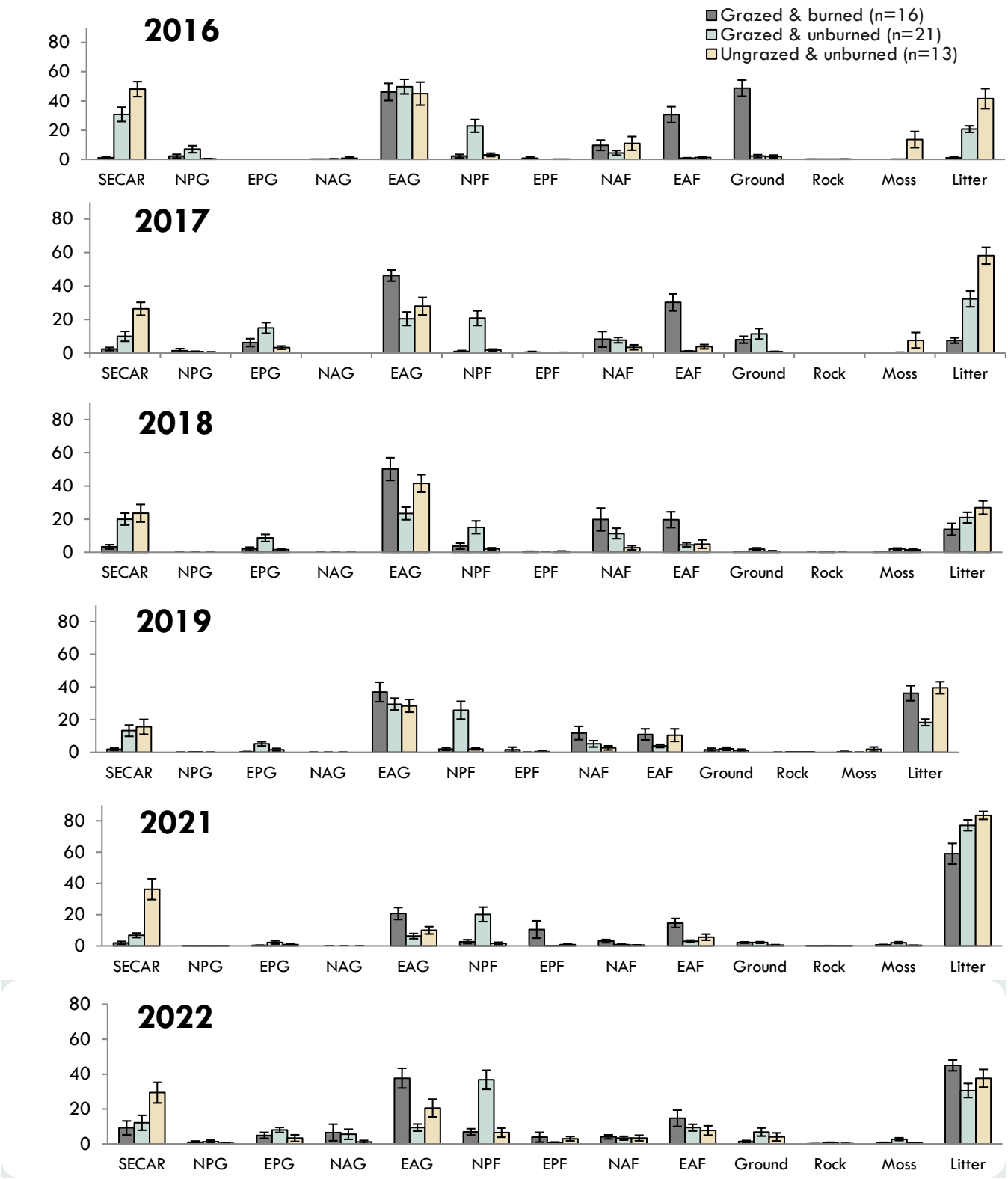

Figure 8. Average % cover (+/- standard error) of vegetation categories from 2016-2022 in transect plots that were grazed and burned, grazed and unburned, or ungrazed. Key: SECAR= Snake River wheatgrass; N= native; E= exotic; P= perennial; A= annual; F= forb;

5. DISCUSSION

5.1 Restoration Goals

The primary restoration goal for the Dalles Mountain Prairie area is to increase the native vegetative diversity of grasses and forbs while reducing exotic grasses and forbs. Parts of this area was historically cultivated with SECAR and Sherman's big bluegrass, resulting in large monocultures that are intended to be controlled. To achieve these restoration goals, sustainable grazing has been implemented, with hopes that grazing will provide control non-native grasses and allow for native plant recruitment. Sustainable grazing is meant to push back grasses like SECAR and Sherman's big bunchgrass in addition to reducing litter cover and providing bare ground for native seed germination and establishment. This form of management is ultimately meant to replace other management techniques such as prescribed fire and tillage.

In 2015, Dalles Mountain Prairie had a wildfire go through part of the prairie. This natural event provided the opportunity to assess if grazing was more effective at achieving restoration goals than fire. While we are lacking sufficient replicates to create statistically significant insight, these results can provide us with some preliminary understanding on the effectiveness of these treatments (grazing and fire) on cultivated and uncultivated prairie.

5.2 Relevé Plots

Plot 1: Grazed, Unburned, Uncultivated

Grazing on uncultivated land has presented a stage for managers to meet restoration objectives. This plot has shown a steady increase in native plant diversity and cover, most notably by well-established perennial forbs. While this plot was not located on the historically cultivated sections of Dalles Mountain Prairie, there are still common exotic invasive annual grasses (rattail fescue, soft chess, and bulbous bluegrass) present that are of management concern. These exotic annual grasses have slowly declined to levels that are lower than native cover. With fall grazing there has been a negative pressure on these exotic annual grasses, while simultaneously preventing any damage to critical native forbs such as Carey's balsamroot. This treatment has shown the most promise toward restoration objectives compared to the other plots. Continued sustainable fall grazing is recommended to maintain this habitat.

Plot 2: Grazed, Unburned, Cultivated

Grazing on cultivated land has shown promise toward meeting restoration goals. Exotic cover has continued to be higher than native cover, but the margin between exotic and native cover has decreased due to a steady increase in native cover. Grazing has shown to gradually push back cultivated grasses and annual exotic grasses over the years, but with no grazing in 2021 and with favorable weather conditions we saw a spike in cultivated and exotic grasses in 2022. This treatment has shown the most promise amongst the cultivated plots. Continued sustainable grazing on these cultivated sections of the prairie should maintain the trajectory of exotic grass decrease and native forb increase.

Plot 3: Ungrazed, Unburned, Cultivated

Neither fire nor grazing on cultivated land met restoration objectives. Exotic cover and richness continue to be higher than native cover and richness by a large margin. Native presence has shown to be pushed

back by aggressive exotic annual grasses and cultivated grasses, specifically SECAR. This is a prime example of what could happen if a previously cultivated prairie reverts to no management. This treatment has shown the least promise toward prairie restoration compared to the other treatments.

Plot 4: Ungrazed, Unburned, Uncultivated

The no-fire and no-graze on uncultivated land has presented similar trends throughout this study, with exotic cover being greater than native cover but by a small margin. This lack of change suggests that no management will give provide similar results year to year. If management could be implemented in this plot there might be a chance that restoration objectives could be met. With sustainable grazing pressure on exotic and cultivated grasses this could open the habitat for native perennial forbs to expand and for native annual forbs to establish.

Plot 5: Ungrazed, Burned, Cultivated

Only burning on cultivated land has presented minimal progress toward restoration objectives, with exotic cover continuing to be exceed native cover. This exotic cover continues to be the result of annual grasses (bulbous bluegrass and soft chess) and cultivated grasses. Native forbs have maintained similar levels over the years indicating that management has not been providing growth or new establishment. This treatment has shown that 7 years post-wildfire, restoration goals are elusive on cultivated land.

Plot 6: Grazed, Burned, Cultivated

Burning and grazing on cultivated land has provided a decrease in all exotic and native plant cover, but exotic grasses continue to have higher cover than natives. This is largely attributed to native cover being almost entirely comprised of annual forbs. These annual forbs may be receiving similar grazing pressure as grasses, therefore preventing cover to increase. In addition, these annual forbs tend to be outcompeted during germination by exotic annual grasses. Additional replication would help to understand the effect grazing has on cultivated land for both annual and perennial forbs. Without the establishment of native perennial forbs, we will continue to see exotic grasses outcompeting native annual forbs. This plot also saw a spike in the invasive cheatgrass, this should be closely monitored.

5.3 Transects

Grazed and Burned

A grazed and burned treatment presented less than ideal conditions, similar to what was seen in relevé plot 6, with exotic cover continuing at high levels and native cover showing little to no increase. Exotic annual grass and forb cover is the highest on this treatment compared to the other treatments, indicating that exposed bared ground from the 2015 fire could have allowed for exotic annual grasses, cultivated grasses, and exotic annual forbs to invade. Exotic annual grass and forbs cover has continued to be the highest on this treatment since 2016.

Grazed and Unburned

A grazed and unburned treatment has presented relatively ideal conditions for prairie restoration goals, similar to what was seen in relevé plot 2. This treatment has shown a steady decline in exotic annual grasses, reaching levels that are below native cover. Native perennial cover has been a well-established perennial forb population on this treatment since 2016. SECAR levels have shown signs of increasing back to historical levels; this should be monitored and managed to continue progress toward restoration goals.

Both increases in perennial forbs and cultivated grasses may be attributed to the ideal weather conditions seen in spring of 2022.

Ungrazed and Unburned

An ungrazed and unburned treatment has presented less than ideal conditions for prairie restoration goals, with exotic cover continuing to be higher than native cover, similar to what was seen in relevé plot 3. There are signs of a decrease in exotic annual grasses, which could provide an opportunity for native forbs to establish. SECAR levels have continued at similar levels seen throughout the study, suggesting that a hands-off approach might not be the answer to decreasing the presence of this species.

6. CONCLUSIONS

The observations gathered from six years of monitoring the Dalles Mountain Prairie suggest the following:

- Grazing on uncultivated land was the only treatment that had native cover exceed exotic cover consistently since 2018, indicating that restoration goals were met.
- Grazing on cultivated land increases native cover while also decreasing exotic cover, suggesting that restoration goals can be met with continued management.
- Grazing on cultivated land that received a wildfire in 2015 continues to have higher exotic cover and low native cover, indicating that restoration goals are not being met.
- No grazing on cultivated land continues to have high exotic cover and low native cover, indicating that restoration goals are not being met.
- No grazing on uncultivated land has maintained similar levels of native and exotic cover throughout this study, indicating that restoration goals are not being met.
- Cultivated land that received a wildfire in 2015 and no grazing continues to have high levels of exotic grasses and low cover of natives, indicating that restoration goals were not met.
- In 2022, the grazed and burned site on cultivated land had a spike in cheatgrass (*Bromus tectorum*), which should be of management concern.
- The 2015 fire appears to have reduced SECAR and litter levels, while increasing bare ground cover. As of 2022, 7 years post-fire, bare ground has been occupied by vegetation, and litter levels have increased.
- Native annual forbs do not show signs of increasing in any of the treatments, additional management should be considered to restore these species.
- Exotic annual grasses such as soft brome, cheatgrass, medusahead, and annual fescue are still present and, even though there are fluctuations from year to year, their overall cover is slightly decreasing.

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APPENDIX 1. CATTLE GRAZING SUMMARY

Table A 1. Summary of cattle grazing on Dalles Mountain Prairie from 2009 – 2021. Grazing did not occur in 2015, 2017, and 2021.

	2009				
Pasture	**Acres**	**Number of Cattle**	**Days**	**Timing**	**Cattle Days per Acre**
1	16	122	7	November	53.4
2	16	122	7	November	53.4
3	16	122	5	November	22.6
5					
	2010				
Pasture	**Acres**	**Number of Cattle**	**Days**	**Timing**	**Cattle Days per Acre**
1					
2					
3					
5	75	112	8	November	11.9
	2011				
Pasture	**Acres**	**Number of Cattle**	**Days**	**Timing**	**Cattle Days per Acre**
1	16	134	9	November	75.4
2	16	134	7	November	58.6
3	27	134	7	Nov - Dec	34.7
5	38	134	8	November	28.2
	2012				
Pasture	**Acres**	**Number of Cattle**	**Days**	**Timing**	**Cattle Days per Acre**
1					
2	16	118	8	November	59.0
3	27	118	11	Nov - Dec	48.1
5	86	115	16	Apr - May	21.4
	2013				
Pasture	**Acres**	**Number of Cattle**	**Days**	**Timing**	**Cattle Days per Acre**
1					
2					
3					
5	86	82	28	Nov - Dec	26.7
	2014				
Pasture	**Acres**	**Number of Cattle**	**Days**	**Timing**	**Cattle Days per Acre**
1*	60.5	172	15	Nov - Dec	42.6
2*	60.5	172	15	Nov - Dec	42.6
3*	60.5	172	15	Nov - Dec	42.6
5	86	172	10	December	20.0
	2016				
Pasture	**Acres**	**Number of Cattle**	**Days**	**Timing**	**Cattle Days per Acre**
1	17.6	132	7	November	52.5
2*	42.9	178	8	November	33.2
3*	42.9	178	8	November	33.2
5					

	2018				
Pasture	**Acres**	**Number of Cattle**	**Days**	**Timing**	**Cattle Days per Acre**
1*	60.5	243	7	November	30.2
2*	60.5	243	7	November	30.2
3*	60.5	243	7	November	30.2
5	86	245	15	November	44.0
	2019				
Pasture	**Acres**	**Number of Cattle**	**Days**	**Timing**	**Cattle Days per Acre**
1*	60.5	195	5	December	16.1
2*	60.5	195	5	December	16.1
3*	60.5	195	5	December	16.1
5	86	160	13	Nov - Dec	24.1
	2020				
Pasture	**Acres**	**Number of Cattle**	**Days**	**Timing**	**Cattle Days per Acre**
1	60.5	170	10	December	28.1
2	60.5	170	10	December	28.1
3	60.5	170	10	December	28.1
5	86	170	13	November	25.7

* Cattle were grazed on the pastures at the same time; no fencing between pastures during grazing

APPENDIX 2. REFERENCE PLOTS SUMMARY – 2018

Excerpt from Schomaker et al. 2018.

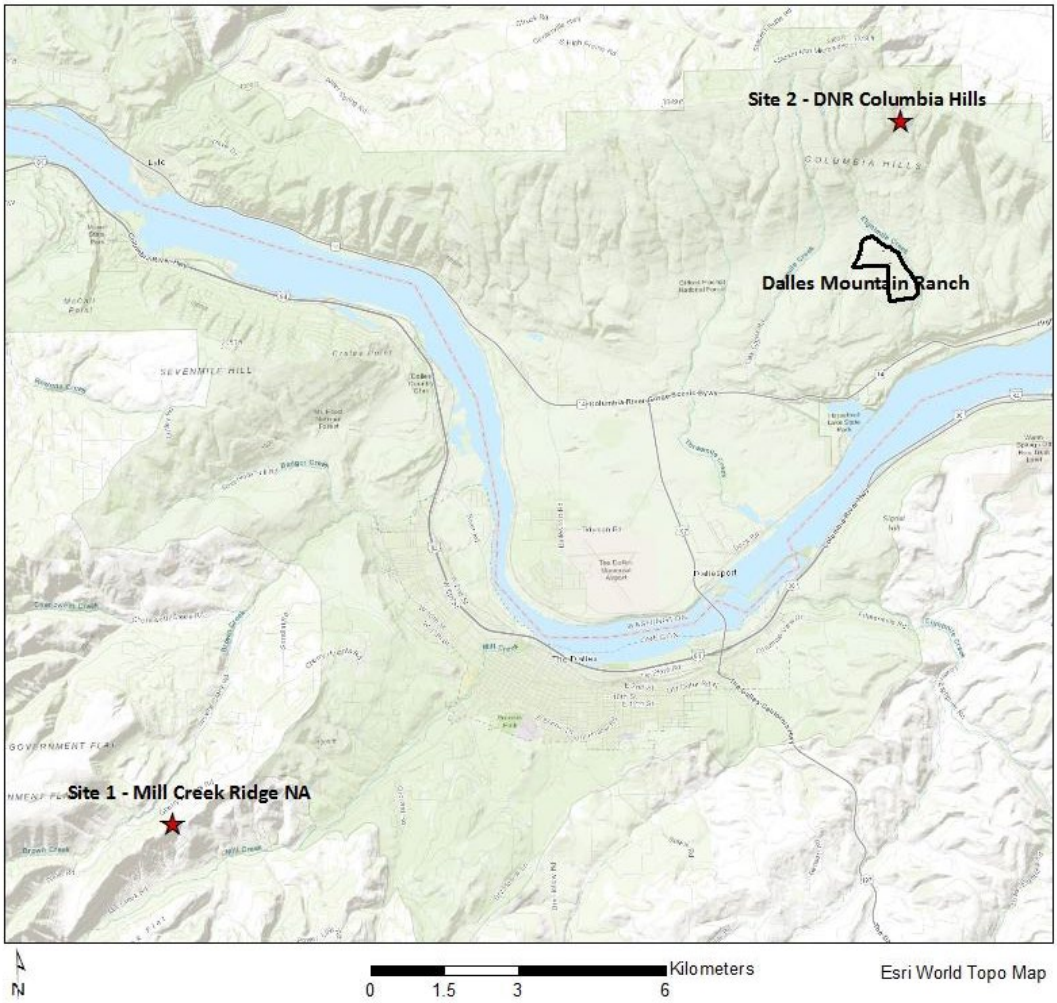


Figure A 1. Sites evaluated for potential prairie reference conditions in 2018. Including the Columbia Land Trust's Mill Creek Ridge Natural Area and the WA DNR Columbia Hills lands.

Methods/Background

In 2018, in the interests of evaluating the structure (grass and forb diversity, grass to forb cover ratio) of relevant high quality grassland habitat remnants in the general area of Dalles Mountain, and to provide potential plant community context for restoration efforts at Dalles Mountain, we visited two sites and completed relevé plots. We used the same methods as those employed at for the Relevé plots at Dalles Mountain (described above). Sites for plot placement were selected based on proximity/topography, local expert opinion, and accessibility, and are mapped in Figure 5. One is upslope of Dalles Mountain Prairie, on Washington Department of Natural Resources lands, and the other is on the south side of the Gorge, on Columbia Land Trust's Mill Creek Ridge Natural Area. Additional sites may be visited in the future.

Data Summary

The area we sampled at the Mill Creek Ridge Natural Area was selected because it was an example of forb diverse native prairie. The site was west northwest facing, just below the ridge, on an approximately 15-20% slope, at approximately 1370' in elevation, similar to Dalles Mountain Prairie (elevation 1370'-1100'). Soils are in the Wamic-Skyline complex, which are well drained, with moderately slow permeability and depths of 40-60 inches to bedrock (for comparison to Dalles Mountain Prairie Soils, see Table 5). This site has patchy oak woodland cover that opens up at the ridge. This remnant prairie area was located outside the dripline of tree/shrub vegetation, in the area of the slope just below the ridge. A total of 24 native forb species (5 annual, 19 perennial) were present in the plot, and two native (and perennial) grasses. The perennial native grasses (fescue, wheatgrass) were the most abundant species, but each had less than 25% cover. No single forb species had greater than 5% cover. A species list for this plot, and the Columbia Hills DNR plot are included in Appendix 3.

The area sampled within the larger Columbia Hills DNR lands was selected due to its proximity to Dalles Mountain Prairie, and because it was an area of high (relative to surrounding landscape) native prairie species diversity. The site was west-southwest facing, on a 10-15 % slope, at just over 2400' in elevation (higher than Dalles Mountain Prairie). Identifying sites in this area with predominantly native plant community was challenging. Soils in the sample area were mapped as Horseflat Cobbly silt loams (also well drained soils) with adjacent Stacker-Horseflat complex soils, which are present at lower elevations on Dalles Mountain Prairie. The Horseflat soils are shallower than most soils at Dalles Mountain Prairie, with depths up to 12-14 inches (Fisherhill soils at Dalles Mountain Prairie mostly at least 60 inches deep; Table 5). In the area sampled, a total of 18 native forbs (four annual, 14 perennial), and two native perennial grasses present. Though native forb diversity was high, the site still had over 50% cover of exotic grasses, including bulbous blue grass, cheatgrass and annual fescue (*Vulpia*). Similar to the Mill Creek site, no single forb species had greater than 5% cover.

Table A 2. Soils at the Dalles Mountain Prarie and at the grassland reference sites sampled in 2018.

Location	Soil	Slope	Depth	Drainage	Available Water
DMP	Fisherhill silt loam	15 to 30 %	60 inches	Well drained	High (about 11.4 inches)
		10 to 15 %			
		5 to 10 %			
DMP	Stacker silt loam	15 to 30 %	20 to 40 inches to lithic bedrock		Low (about 5.4 inches)
		5 to 10 %			
DMP	Stacker-Horseflat complex	16 to 30 %			
		2 to 15 %			
		30 to 65 %	12 to 20 inches to lithic bedrock		Very low (about 1.8 inches)
Mill Creek Ridge NA	Wamic Skyline Complex	2-20 %	40- 60 inches	Well drained	6.5 – 11.4 inches
Columbia Hills DNR Lands	Horseflat Cobbly Silt Loam	15-30 %	12-20 inches to lithic bedrock	Well Drained	Very low (about 1.8 inches)

Reference Plot Data

Table A 3. Data from 2 relevé reference plots on Mill Creek and Columbia Hill in 2018. Key presented at the end of the table.

Species	Common name	Form	Life Cycle	Status	2018 MC Cover	2018 MC Sociability	2018 CH Cover	2018 CH Sociability
Achillea millefolium	common yarrow	f	p	n	+	5	r	5
Agoseris grandiflora		f	p	n	+	5	r	5
Amsinckia menziesii	Menzies' fiddleneck	f	a	n			1	4
Antennaria dimorpha	low pussytoes	f/s	p	n	r	3		
Astragalus sp.		f	p	n			r	5
Balsamorhiza careyana	Carey's balsamroot	f	p	n	1	5	1	4
Calochortus macrocarpus	green-banded Mariposa lily	f	p	n	+	5		
Castilleja sp.	paintbrush sp.	f	p	n	+	3		
Claytonia lanceolata		f	a	n	+	5		
Claytonia perfoliata	miner's lettuce	f	p	n			+	5
Collinsia parviflora		f	a	n	1	2	+	5
Delphinium nuttallianum	twolobe larkspur	f	p	n	+	5	+	5
Dodecatheon conjugens	Desert Shooting Star	f	p	n	+	3		
Draba verna		f	a		+	5	r	5
Eriogonum compositum	arrowleaf buckwheat	f	p	n	+	5	+	4
Erodium cicutarium	redstem stork's bill	f	a	e			+	4
Galium aparine	stickywilly	f	a	n	r	5		
Hieracium scouleri* var. *cynoglossoidae	scouler's hawkweed	f	p	n	+	3	1	4
Holosteum umbellatum		f	a	e			r	5
***Lithodora* sp.**		f	p	n	+	4		
Lithophragma bulbiferum		f	p	n			+	5
Lithospermum ruderale	western stoneseed	f	p	n	+	3		
Lomatium triternatum	nineleaf biscuitroot	f	p	n	+	5	r	5
Lupinus latifolius	broadleaf lupine	f	p	n	+	5	+	5
Microsteris gracilis	slender phlox	f	a	n	r	5		
Nothocalais troximoides	sagebrush false dandelion	f	p	n	r	5	r	5
Perideridia sp.		f		n	+	5		
Phlox diffusa		f	p	n			r	5
Plagiobothrys sp.		f	a	n			+	4
Saxifraga integrifolia	wholeleaf saxifrage	f	p	n	+	3		
Senecio integerrimus	lambstongue ragwort	f	p	n	r	5		

Species	Common name	Form	Life Cycle	Status	2018 MC Cover	2018 MC Sociability	2018 CH Cover	2018 CH Sociability
Triteleia grandiflora var. howellii	Howell's triteleia	f	p	n	r	5	r	5
Vicia sp.	vetch	f			+	5		
Bromus hordeaceus	soft brome	g	a	e	+	5		
Bromus tectorum	cheatgrass	g	a	e			2	2
Festuca idahoensis	Idaho fescue	g	p	n	1	5	1	4
Poa bulbosa	bulbous bluegrass	g	p	e	1	5	3	1
Poa sp. unknown (pratensis?)		g	p	e	r	5		
Pseudoroegnaria spicata	bluebunch wheatgrass	g	p	n	2	5	2	4
Vulpia myuros	annual fescue	g	a	e	2	5	2	2

Site
Mc Mill Creek
CH Columbia Hills

Form
f forb or herb/subshrub
g grass

Life Cycle
a annual
b biennal
p perennial

Status
e exotic
n native

Sociability
1 occurring in large, nearly pure stands
2 large aggregations, coppice or carpets
3 small aggregations, clusters or cushions
4 clumps or bunches
5 occurring single

Cover Classes
5 75-100%
4 50-75%
3 25-50%
2 5-25%
1 1-5%
+ 0.5-.09%
r rare

APPENDIX 3. DALLES MOUNTAIN PRAIRIE COMPILED SPECIES LIST

Table A 4. A compiled species list of all species observed on the Dalles Mountain Prairie. Key presented at the end of the list.

Scientific name	Common name	Form	Growth	Native	Source
Achillea millefolium	common yarrow	f	p	n	1,2
Agoseris grandiflora	bigflower agoseris	f	p	n	2
Agoseris heterophylla	annual agoseris	f	a	n	1
Allium acuminatum	tapertip onion	f	p	n	1,2
Amsinckia menziesii	Menzies' fiddleneck	f	a	n	1,2
Antennaria dimorpha	low pussytoes	f	p	n	2
Anthriscus caucalis	bur chervil	f	a	e	1
Asclepias fascicularis	arrowleaf milkweed	f	p	n	2
Balsamorhiza careyana	Carey's balsamroot	f	p	n	1,2
Bromus diandrus	ripgut brome	g	a	e	2
Bromus hordeaceus	soft brome	g	a	e	1
Bromus tectorum	cheatgrass	g	a	e	1
Calochortus macrocarpus	green-banded Mariposa lily	f	p	n	1,2
Carex sp.	sedge species	g	p	n	2
Castilleja attenuata	narrowleaf paintbrush	f	a	n	1,2
Centaurea solstitialis	yellow starthistle	f	a	e	2
Chondrilla juncea	rush skeletonweed	f	p	e	1,2
Cichorium intybus	chicory	f	p	e	1,2
Cirsium arvense	Canada thistle	f	p	e	1
Cirsium undulatum	wavyleaf thistle	f	p	n	2
Clarkia gracilis	slender clarkia	f	a	n	2
Claytonia perfoliata	miner's lettuce	f	a	n	1,2
Collinsia parviflora	maiden blue eyed Mary	f	a	n	2
Collomia grandiflora	large flowered collomia	f	a	n	1,2
Convolvulus arvensis	field bindweed	f	p	e	2
Crepis occidentalis	Western hawksbeard	f	p	n	1,2
Croton setigerus	dove weed	f	a	n	2
Cuscuta sp.	dodder	f	a	n	2
Delphinium nuttallianum	upland larkspur	f	p	n	2
Dodecatheon conjugens	Bonneville shootingstar	f	p	n	1,2
Draba verna	spring draba	f	a	e	2,3
Elymus elymoides	bottlebrush squirreltail	g	p	n	1,2
Elymus repens	quackgrass	g	p	e	1
*Elymus wawawaiensis**	Snake River wheatgrass*	g	p	n	1
Epilobium brachycarpum	tall annual willowherb	f	a	n	2
Epilobium densiflorum	denseflower willowherb	f	a	n	2

Scientific name	Common name	Form	Growth	Native	Source
Epilobium sp.	willowherb	f	a		3
Ericameria nauseosa	rubber rabbitbrush	s	p	n	1,2
Eriogonum compositum	arrowleaf buckwheat	f/s	p	n	1,2
Eriogonum elatum	tall woolly buckwheat	f/s	p	n	2,3
Eriogonum strictum	Blue Mountain buckwheat	f/s	p	n	1,2
Eriophyllum lanatum	Oregon sunshine	f	p	n	2
Erodium cicutarium	redstem stork's bill	f	a	e	1,2
Festuca idahoensis	Idaho fescue	g	p	n	3
Fritillaria pudica	yellow fritillary	f	p	n	2
Gaillardia aristata	blanketflower	f	p	n	2
Galium aparine	stickywilly	f	a	n	1
Grindelia nana var. discoidea	Columbia River gumweed	f	b	n	2
Holosteum umbellatum	jagged chickweed	f	a	e	3
Idahoa scapigera	oldstem idahoa	f	a	n	2,3
Kickxia elatine	sharpleaf cancerwort	f	a	e	1
Lactuca serriola	prickly lettuce	f	a	e	2
Lagophylla ramosissima	branched lagophylla	f	a	n	1,2
Lamium amplexicaule	henbit deadnettle	f	a	e	3
Lithophragma glabrum	bulbous woodland-star	f	p	n	1
Lithophragma parviflorum	smallflower woodland-star	f	p	n	1
Lithophragma sp.	prairie woodland-star	f	p	n	2
Lithospermum ruderale	Western stoneseed	f	p	n	2
Lomatium canbyi	Canby's biscuitroot	f	p	n	1
Lomatium gormanii	Gorman's biscuitroot	f	p	n	3
Lomatium macrocarpum	bigseed biscuitroot	f	p	n	2,3
Lomatium nudicaule	barestem biscuitroot	f	p	n	1,2
Lomatium papilioniferrum	butterfly-bearing biscuitroot	f	p	n	2
Lomatium piperi	Indian biscuitroot	f	p	n	2,3
Lomatium triternatum	nineleaf biscuitroot	f	p	n	1,2
Lupinus bicolor	minature lupine	f	a	n	1,2
Lupinus latifolius	broadleaf lupine	f	p	n	1
Lupinus lepidus var. aridus	dry ground lupine	f	p	n	2
Lupinus leucophyllus	velvet lupine	f	p	n	2
Lupinus polycarpus	smallflower lupine	f	a	n	2
Lupinus sericeus	silky lupine	f	p	n	2
Madia citriodora	lemonscented madia	f	a	n	1
Madia exigua	small tarweed	f	a	n	1,2
Madia glomerata	mountain tarweed	f	a	n	1
Madia gracilis	grassy tarweed	f	a	n	2

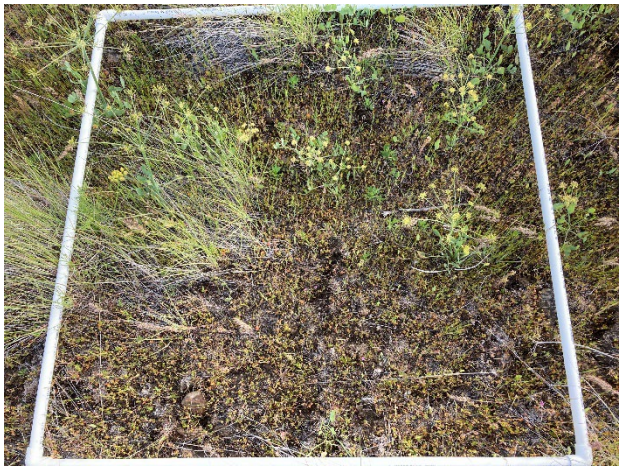
Scientific name	Common name	Form	Growth	Native	Source
Marah oregana	Oregon bigroot	f	p	n	2
Medicago lupulina	black medic	f	p	e	2
Medicago sativa	alfalfa	f	p	e	1,2
Melilotus officinalis	sweetclover	f	a/b	e	2
Micranthes integrifolia	wholeleaf saxifrage	f	p	n	1,2
Microsteris gracilis	slender phlox	f	a	n	1,2
Myosotis discolor	changing forget-me-not	f	a/p	e	3
Myosotis sp.	forget-me-not?	f	a/p	e	2
Nemophila sp.	Nemophila	f	a	n	3
Olsynium douglasii	Douglas' grasswidow	f	p	n	1,2
Pectocarya sp.	combseed	f	a	n	1
Penstemon richardsonii var. richardsonii	Richardson's penstemon	f	p	n	2
Perideridia gairdneri	Gardner's yampah	f	p	n	2
Phlox speciosa	showy phlox	f	p	n	3
Phoenicaulis cheiranthoides	wallflower phoenicaulis	f	p	n	1,2
Plagiobothrys tenellus	Pacific popcornflower	f	a	n	2
Plantago lanceolata	narrowleaf plantain	f	p	e	2
Plectritis macrocera	longhorn plectritis	f	a	n	1,3
Poa bulbosa	bulbous bluegrass	g	p	e	1,2
Poa secunda	"Sherman" bluegrass	g	p	n	1
Polygonum aviculare	prostrate knotweed	f	a	e	2
Pyrrocoma carthamoides. var. carthamoides	largeflower goldenweed	f	p	n	1,2
Rigiopappus leptocladus	wireweed	f	a	n	2
Rosa woodsii	pearhip rose	s	p	n	2
Rumex crispus	curly dock	f	p	e	2
Rumex fueginus	golden dock	f	a/b	n	2
Rumex occidentalis	Western dock	f	p	n	1
Senecio integerrimus	lambstongue ragwort	f	b/p	n	1,2
Sisymbrium altissimum	tall tumblemustard	f	a	e	2
Sonchus oleraceus	common sowthistle	f	a/b	e	1
Taeniatherum caput-medusae	medusahead	g	a	e	1
Thysanocarpus curvipes	sand fringepod	f	a	n	3
Tragopogon dubius	yellow salsify	f	a/b	e	1,2
Trifolium arvense	rabbitfoot clover	f	a	e	1,2
Triteleia grandiflora	Howell's triteleia	f	p	n	1,2
Ventenata dubia	North Africa grass	g	a	e	1
Vulpia myuros	annual fescue	g	a	e	1
Yabea microcarpa	false carrot	f	a	n	3

Key	Source
f = forb or herb s = subshrub or shrub g = grass or graminoid a = annual b = biennial p = perennial e = exotic n = native	1 = IAE monitoring 2 = Bob Hansen records 3 = WSP monitoring in 2006 *Naming convention: USDA NRCS Plants Database http://plants.usda.gov/*

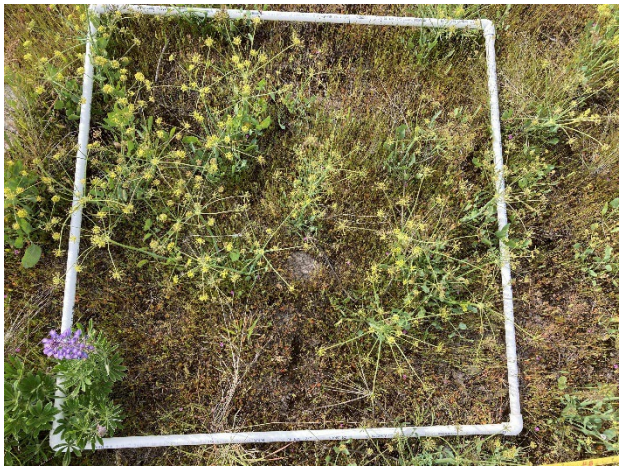
APPENDIX 4. 2022 SAMPLE PLOT PHOTOS

Transect 1: Unburned and Grazed


Transect 1: Unburned and Ungrazed

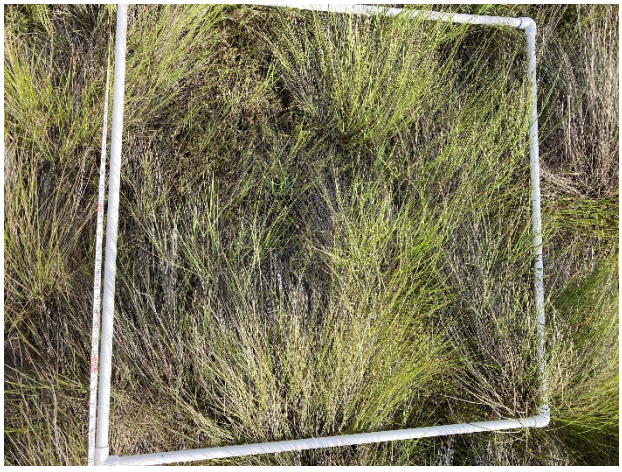
Transect 2: Unburned and Grazed

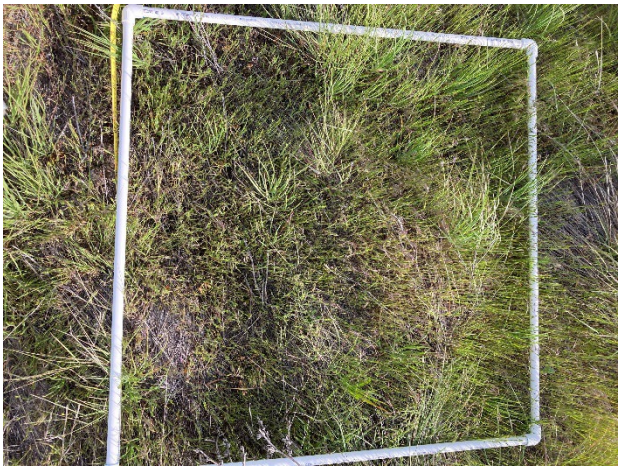



Transect 3: Unburned and Grazed

Transect 3: Burned and Grazed

Transect 4: Unburned and Ungrazed





Transect 5: Burned and Grazed