Dalles Mountain Prairie Restoration Plan Progress Report

10/10/2016

Progress Report 2016

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Institute for Applied Ecology

Institute for Applied Ecology

PREFACE

IAE is a non-profit organization whose mission is 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: Diverse native vegetation in a previously uncultivated part of Dalles Mountain Prairie, 4 May 2016; Photo credit: Peter Moore.

SUGGESTED CITATION

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PROGRESS REPORT 2016

1. INTRODUCTION

Dalles Mountain Ranch was formerly a 6,000-acre cattle ranch located on the northern side of the Columbia River, 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 (Fig. 1). The park is 3,338 acres in extent.

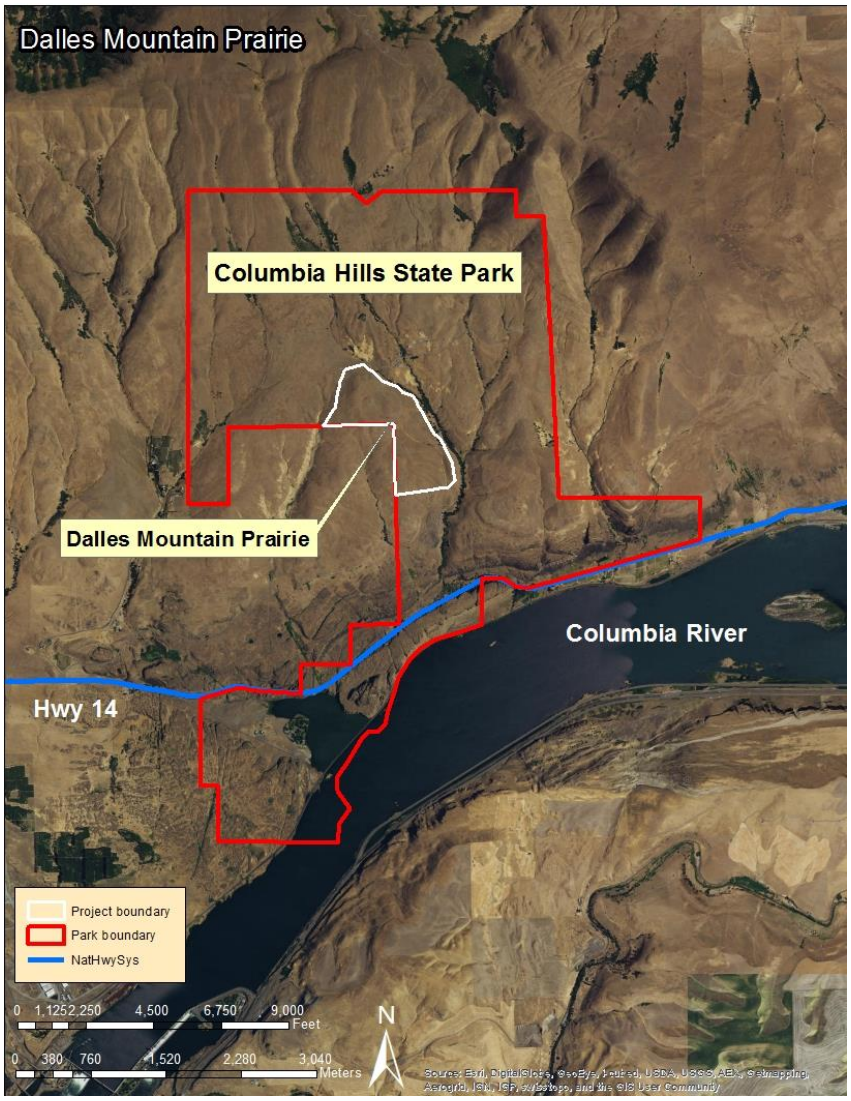

FIGURE 1. LOCATION OF DALLES MOUNTAIN PRAIRIE WITHIN COLUMBIA HILLS STATE PARK.

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). 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). It 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. 'Secar' has developed a monoculture, estimated at 80% coverage of the project area in 2008 (Appendix 1), which out-competes other native plants.

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 (WSP 2003). Grazing was chosen as a tool to help reduce the impact of 'Secar' at the park and a rehabilitation project has been conducted by Washington State University (WSU) at the 180-acre Dalles Mountain Prairie (Fig. 1) since 2008.

One of the primary goals of restoration at Columbia Hills Historic State Park is to develop and maintain diverse, native-dominated, steppe habitats. WSP are utilizing low-intensity grazing to achieve this goal in areas that are degraded and/or dominated by 'Secar' Snake River wheatgrass or rhizomatous wheatgrasses. A secondary goal is to demonstrate elements of a working, cattle-grazing ranch.

WSP aims to:

- minimize recruitment and expansion of non-native species;
- reduce the risk of wildfire spread through reduction of fuel loads;
- require limited long-term management intervention;
- demonstrate exemplary stewardship of Parks' land; and
- provide a model for park visitors and neighbors and for use elsewhere in the park.

Partners involved with Dalles Mountain Prairie, including WSP, WSU and WNPS, are interested in beginning a new phase of restoration, with monitoring in place that can demonstrate the efficacy of utilizing grazing as a tool.

In order to provide new input to the restoration work at Dalles Mountain Prairie, in 2015, the Institute for Applied Ecology (IAE) was asked to submit a four-year proposal for the development of a restoration plan. In 2016, the Columbia River Foundation provided initial funding ($4,000), with matching funds from Bob Hansen (volunteer collaborator; $1,000), to create a base restoration plan. The Washington Native Plant Society (WNPS) provided additional funding ($759) to create a list of potential species available for seeding at the prairie. This progress report aims to bring partners and funders up to date with the project's progress.

2. PROJECT GOALS AND OBJECTIVES

Primary goals of IAE's project at Dalles Mountain Prairie include:

- Establish baseline vegetation conditions in previously grazed and ungrazed areas, and monitor change in 2016-2019.
- Establish whether grazing is shifting the vegetation community away from a 'Secar' dominated prairie to a more diverse native composition.
- Create a new restoration plan that when enacted would lead to an increase in the diversity and cover of native plant species.

Objectives for 2016 included:

1) Meet partners and gather background information;
2) Establish baseline vegetation conditions in previously grazed and ungrazed areas;
3) Create a base restoration plan for management of the prairie; and
4) Identify sources of seed for augmentation and enhancement of native vegetation.

3. PARTNER MEETING

A project kick-off meeting was held at Columbia Hills Historic State Park on 2/18/16. Staff from IAE (Rebecca Currin and Peter Moore), WSP (Rob Fimbel, Andy Kellinen, Lem Pratt and Andrew Fielding), WSU (Steve Van Vleet) and Bob Hansen attended. Discussion covered the goals of restoration at the park, previous work conducted and IAE's role in developing a restoration plan. A site visit was conducted at the end of the meeting.

4. PROJECT AREA

4.1 Overview

The 180-acre Dalles Mountain Prairie project area is comprised of rolling hills, approximately 900-1300' in elevation, with south facing slopes overlooking the Columbia River and east-facing slopes draining into the valley of Eightmile Creek (Fig. 1).

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 (Appendix 1: Figs A1.1-1.4). Other cultivars in the project area include 'Sherman" Sandberg 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 P3 and eastern edge of P1 and P4, show a more diverse range of native forb species (Fig. 2, Appendix 1: Figs A1.5-1.8).

In September 2015, a wildfire burned through the southern 60% of the project area, including all of pasture P5 and part of P3 and P4 (Fig. 2, Appendix 1: Figs. A1.9-1.11).

4.2 Recent Management

A rehabilitation/research project has been conducted by Steve Van Vleet (WSU) at Dalles Mountain Prairie since 2008 (Appendix 2: Grazing Study Plan). The primary goal of the project was to increase the biological diversity through the use of 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, to study sustainable alternatives to the Conservation Reserve Program (Nelson & Van Vleet 2013).

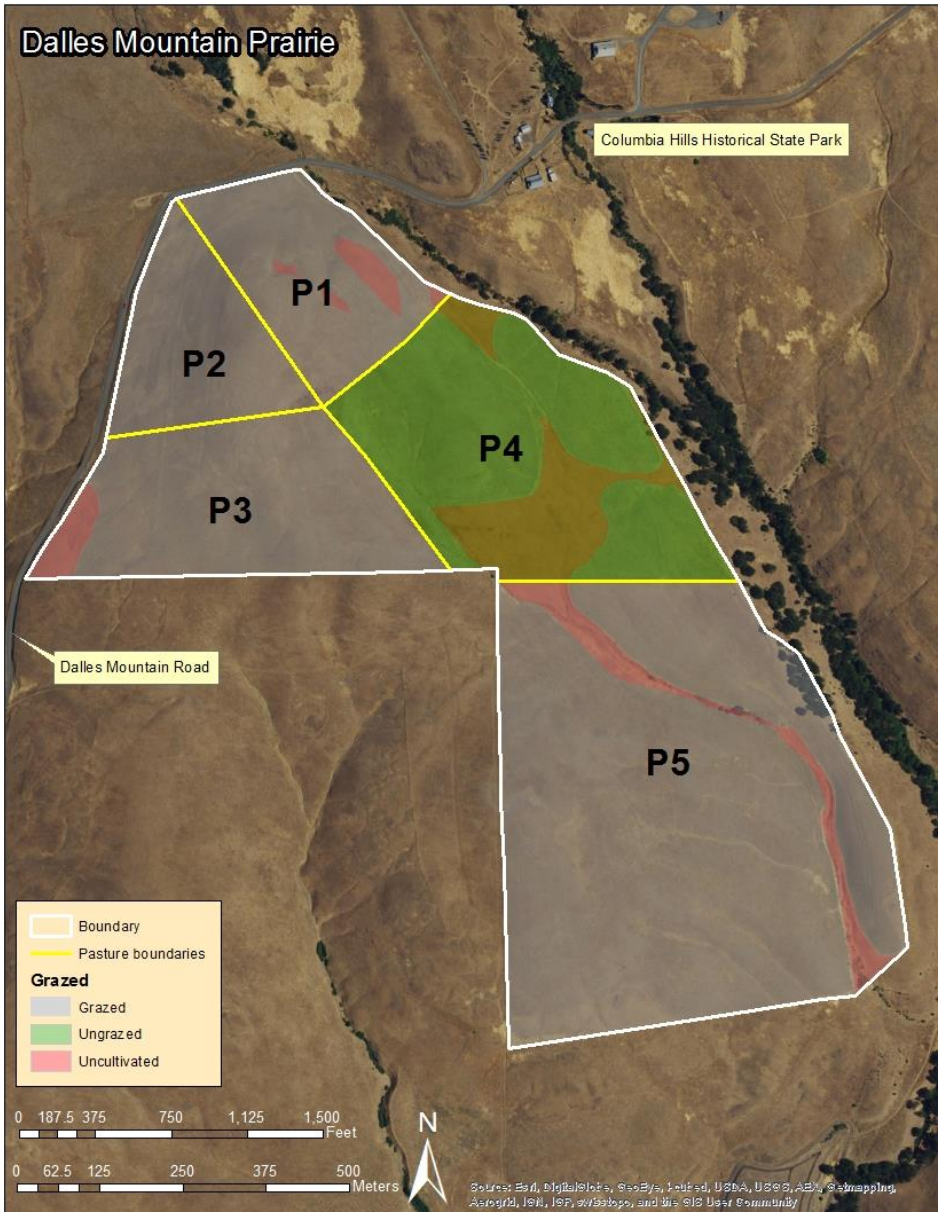

Figure 2. Pasture divisions used during the grazing study (2009-2014) at Dalles Mountain Prairie). Also shown are areas that were not originally sowed with 'Secar' Snake River wheatgrass.

Light rotational grazing occurred in 2009-2014 (see Appendix 3: Grazing Study Plan) on four temporarily fenced pastures, with a fifth pasture (Pasture P4, Fig. 2) acting as an ungazed control.

Generally, grazing did not occur every year, and when it did occur it was typically for a short (1-2 weeks) period in the fall, and also in one spring period in 2012 (Appendix 3). No pastures were grazed in 2015 because of a wildfire. Because of its larger size, P5 received net lighter grazing pressure than pastures P1, P2, and P3 (Appendix 3).

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 fencelines along Dalles Mountain Road, which meant that cattle in pasture P5 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 around water troughs.

4.3 Recent Monitoring

Monitoring plots and photo points were set up in the five pastures to monitor vegetation changes over time and to compare grazed with ungrazed areas (Appendix 2). Methods considered not useful for detecting change were abandoned (S. Van Vleet, pers. comm., 2016). Observations suggested that grazing was having positive effect, promoting increases in species richness and forb cover (Appendix 4: Grazing Study Poster).

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 (Appendix 5: Dalles Mountain Prairie Compiled Species List).

5. 2016 GRAZING STUDY

5.1. Monitoring Methods

On 4-5 May 2016, IAE established five transects and five relevé plots to monitor baseline conditions to support restoration and management plan development at Dalles Mountain Prairie. Relevé plots were established using protocols in Mueller-Dombois and Ellenberg (2002) and cover was assigned using classes developed by Braun-Blanquet (1965). These can be monitored over time to examine changes in species diversity in relation to grazing and other management. This number of transects and plots were designated to provide adequate sample size, while mazimizing efficiency (1-2 days monitoring time). More transects and plots can be added, as necessary, to incorporate any future management actions.

6.1.2 Relevé Plots

The five 20 m x 20 m plots were marked with fiberglass posts and placed to represent the grazed (Plot 2) and ungrazed (Plot 3) areas (as of May 2015) and also to include the uncultivated areas with higher

plant diversity (Plot 1 and Plot 4) or previously uncultivated shallow soil (Plot 5) (**Error! Reference source not found.**). Plot locations differ from those used in the initial grazing study.

In each plot we recorded all species present and assigned each to a Braun-Blanquet percent cover class (Table 1) and sociability class (Table 2). Cover classes describe abundance and the sociability class measure of the degree of clustering of individuals of a plant species.

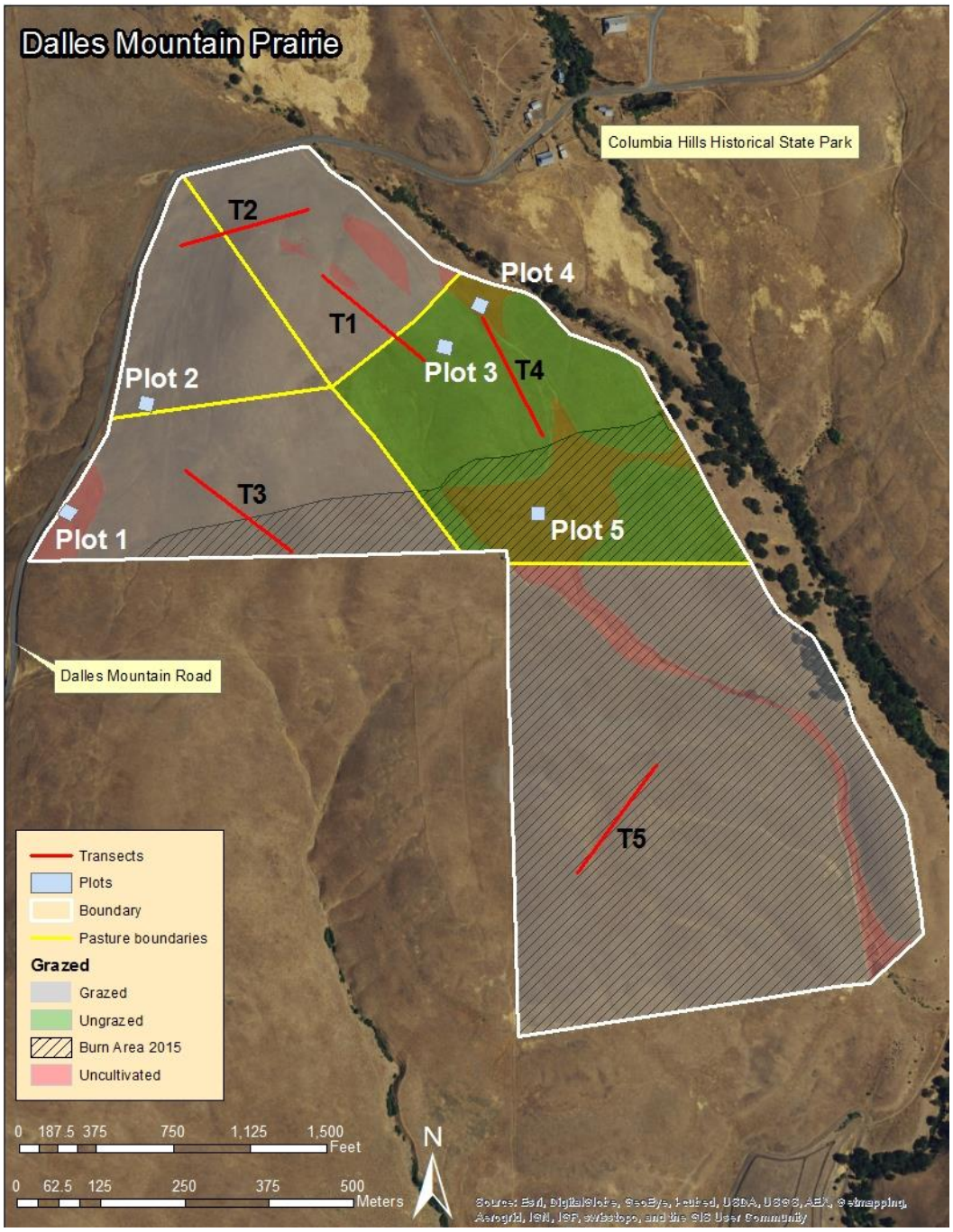

FIGURE 3. PLOT AND TRANSECT LOCATIONS AT DALLES MOUNTAIN PRAIRIE, MAY 2016.

TABLE 1. BRAUN-BLANQUET COVER CLASSES USED IN RELEVÉ PLOTS AT DALLES MOUNTAIN PRAIRIE IN 2016

Cover Class	Range of Cover (%)	Mean
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.

TABLE 2. SOCIABILITY CLASS DESCRIPTIONS USED FOR RELEVÉ PLOTS AT DALLES MOUNTAIN PRAIRIE

Sociability Class	Description/Criteria
1	Occurring in large, nearly pure stands
2	Occurring in large aggregates, coppice or in carpets
3	Occurring in small aggregates, clusters, or cushions
4	Occurring in clumps or bunches
5	Occurring singly

TABLE 3. LOCATION OF TRANSECT PLOTS AT DALLES MOUNTAIN PRAIRIE

Grazing & burned status	Transect	Number of plots
Grazed & burned	T3, T5	16
Grazed & unburned	T1, T2, T3	21
Total grazed	T1, T2, T3, T5	37
Ungrazed	T1, T4	13

6.1.2 Transect Plots

Five 100 m transects were randomly located throughout the site (**Error! Reference source not found.**, Table 3) to assess conditions in grazed and ungrazed areas as of May 2015, and were marked at each end with fiberglass poles. Two grazed transects (part of Transect 3 and all of Transect 5) were impacted by wildfire in September 2015.

1 m x 1 m plots were placed every 10 m along each transect (10 total points). 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' Sandberg bluegrass were categorized as native species. Transect data will be used to assess plant community changes over time and help inform management actions.

5.2. Results

6.2.1 Relevé Plots

Data from the relevé plots are summarized in Table 4 and included in Appendix 6: 2016 Plot Data.

Of the two grazed plots, more species, particularly native forbs, were observed in the uncultivated area (Plot 1) than the cultivated area (Plot 2) (Table 4). Most of these additional species were in the rare to <5% cover class, except for Carey's balsamroot (*Balsamorhiza careyana*)(25-50%) and barestem biscuitroot (*Lomatium nudicaule*)(5-25%)(Appendix 6). Exotic forbs, such as redstem stork's bill (*Erodium cicutarium*), were rare to uncommon (<5% cover) in both plots. Exotic grasses with high cover values (25-75%) in both grazed plots included annual species, such as soft brome (*Bromus hordeaceus*) and cheatgrass (*Bromus tectorum*), and the perennial species bulbous bluegrass (*Poa bulbosa*). Other exotic grasses found in one or other of the two plots included medusahead (*Taeniatherum caput-medusae*), North Africa grass (*Ventenata dubia*) and annual fescue(s) (*Vulpia* spp.). Native grasses included 'Secar' in the cultivated area (75-100% cover) and bottlebrush squirreltail (*Elymus elymoides*), which comprised <1% cover in both plots.

Of the two cultivated plots, more species, particularly exotic grasses, were observed in the grazed (Plot 2) than the ungrazed plot (Plot 3). In the latter plot, the two exotic grass species were cheatgrass (25-50% cover) and bulbous bluegrass (rare). Native grasses were represented by the two cultivars 'Secar' (75-100% cover) and 'Sherman' (25-50%) in the ungrazed plot. Exotic forbs species, such yellow salsify (*Tragopogon dubius*) and common sowthistle (*Sonchus oleraceus*), varied in presence between the two plots but none had greater than 5% cover. Similarly the species of native forbs, nineleaf bicuitroot (*Lomatium triternatum*) and perennial lupine (*Lupinus latifolius/sericeus*), varied between plots, but none had greater than 1% cover.

The three ungrazed plots all had fewer species present than in the two grazed plots. Of the ungrazed plots, the plot in the uncultivated area with thin soils (Plot 5) yielded the fewest species. Of the exotic grasses, cheatgrass had more cover in Plots 3 and 4, but bulbous bluegrass had greater cover in the uncultivated plots, especially Plot 5 (75-100%). As expected 'Secar' was not present in the uncultivated Plot 5, however, wheatgrass was recorded in the uncultivated Plot 4, suggesting presence of the native bluebunch wheatgrass, or colonization of the 'Secar' cultivar of Snake River wheatgrass, both of which are difficult to distinguish without cytological examination. Exotic forbs were rare or less than 1% cover

in ungrazed plots except for yellow salsify in Plot 3 (1-5% cover) and alfalfa (*Medicago sativa*)(5-25%) in Plot 5. Native forbs of note were Cary's balsamroot (25-50% cover) and arrowleaf buckwheat (*Eriogonum compositum*) (5-25%) in Plot 4 and Canby's biscuitroot (*Lomatium canbyi*) and perennial lupine (all 1-5% cover) in Plot 5 (Appendix 6).

0TABLE 4. SPECIES RICHNESS IN RELEVÉ PLOTS AT DALLES MOUNTAIN RANCH, MAY 2016.

Plot	Plot 2	Plot 1	Plot 3	Plot 4	Plot 5
Grazing status	Grazed	Grazed	Ungrazed	Ungrazed	Ungrazed
Cultivated	Yes	No	Yes	No	No
Other features		Diverse native vegetation		Diverse native vegetation	Thin soils
Exotic grass	6	5	2	4	2
Native Grass	2	1	2	2	1
Exotic forb	5	4	4	3	1
Native forb	11	20	11	11	10
Native total	13	21	13	13	11
Exotic total	11	9	6	7	3
Species Richness Total	**24**	**30**	**19**	**20**	**14**

6.2.2 Transect Plots

Data from transects are provided in Appendix 7: 2016 Transect Data and summarized in Fig. 4. Photos of sample plots are included Appendix 8: 2016 Transect Sample Plot Photos.

'Secar' Snake River wheatgrass had lower cover (18%) in grazed areas as compared to ungrazed areas (48%). 'Secar' cover was only 1% in grazed/burned areas, compared with 31% in grazed/unburned areas (Fig. 4, Appendix 6). These differences are apparent in photographs, since 'Secar' dominates most ungrazed plots (Appendix 8, Figs A8.3, A8.10-13), and comparatively smaller clumps are seen in grazed/unburned plots (Figs A8.1-2, A8.4-9), yet little can be seen in grazed/burned plots (Figs A8.14-16).

Native perennial grasses (excluding Secar) had low cover in general (7% or less), but their cover was greatest in grazed and unburned areas and lowest in the ungrazed areas (Fig. 4). Exotic perennial grasses were not seen in any transects, however, bulbous bluegrass and quackgrass (*Elymus repens*) were observed in the relevé plots. This latter species is present in roadside ditches/drainages and should be monitored to reduce/eliminate its spread to wetter areas of the study site.

Exotic annual grass cover was similar in all areas (46-50% on average). There was a very small component of native annual grass cover in all transects.

Native perennial forbs had highest cover (23%) in grazed/unburned areas and were rare in other areas. Exotic perennial forbs had low cover in grazed/burned areas, however, their abundance may increase the second year after the fire disturbance. Rush skeletonweed (*Chondrilla juncea*) was noted in Transect T5.

Exotic annual forbs had an average of 31% cover in grazed/burned plots compared to 1% in other categories. Native annual forbs were a small component of all transects, but lowest in the grazed/unburned plots.

Grazed/burned plots had almost 50% bare ground, compared with only 2% in grazed/unburned and ungrazed plots. Re-colonization of burned areas was still in progress, six months after the fire.

Moss was almost exclusively in ungrazed plots and had low or no cover in grazed plots, whether burned or unburned. Plant litter was highest in ungrazed plots, intermediate in grazed/unburned plots, and low in grazed/burned plots.

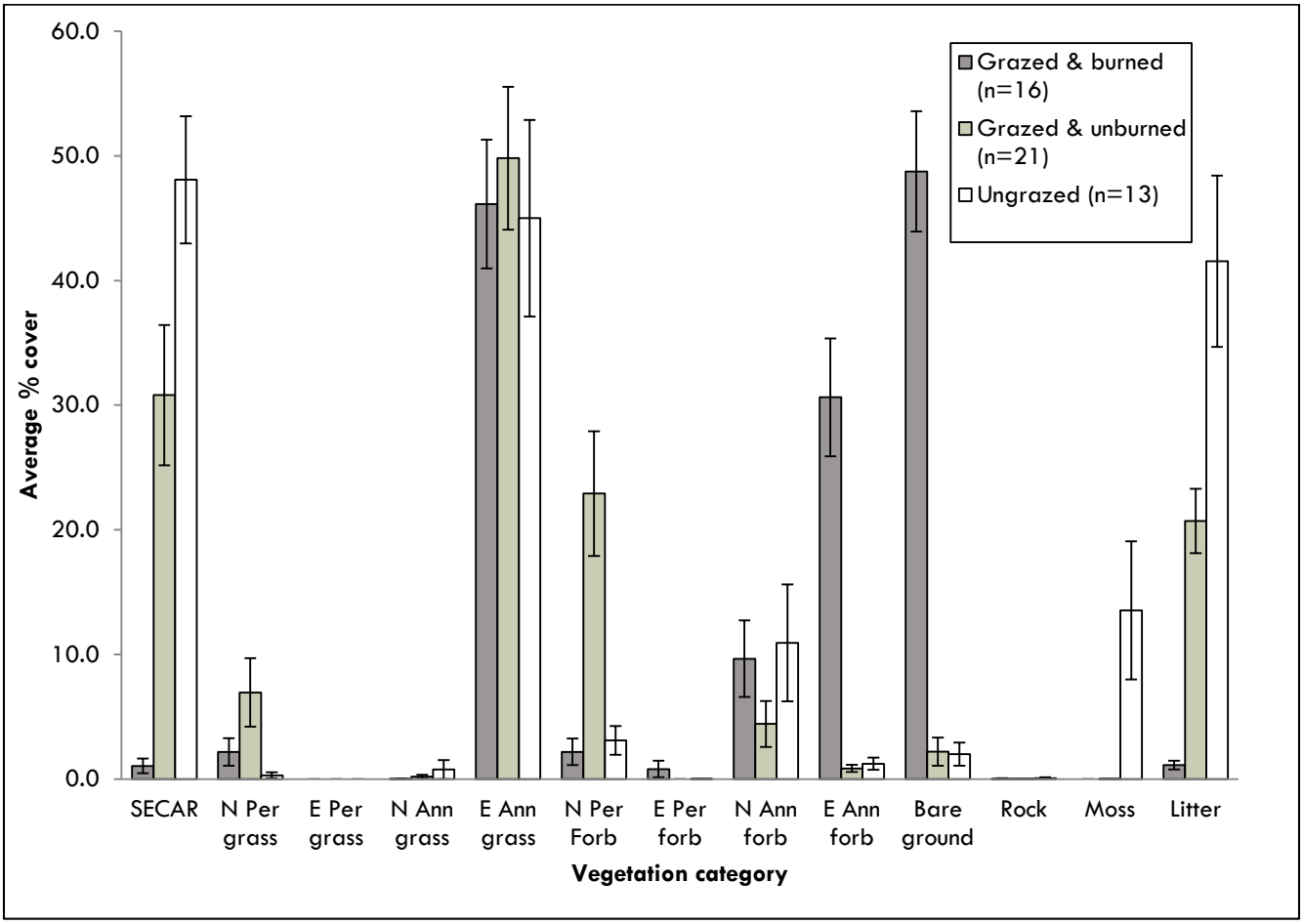

FIGURE 4. AVERAGE % COVER (+/- STANDARD ERROR) OF VEGETATION CATEGORIES IN TRANSECT PLOTS THAT WERE GRAZED AND BURNED, GRAZED AND UNBURNED OR UNGRAZED. KEY: SECAR='SECAR' SNAKE RIVER WHEATGRASS; N=NATIVE; E=EXOTIC; PER=PERENNIAL; ANN=ANNUAL.

5.3. Discussion

Baseline vegetation monitoring at Dalles Mountain Prairie in 2016 suggests that:

- Grazing appears to be have desired positive results on the plant community, including:
    - Lower cover of 'Secar' and plant litter.
    - Few aggressive exotic perennial grasses and forbs are present.
        - This reduces additional management actions required for problematic species.
        - Quackgrass was restricted to wetter areas.
    - Higher native perennial forb cover and slightly higher native perennial grass cover.
    - Higher native species diversity in uncultivated areas.
    - Minimal difference in cover of exotic annual grasses as compared to ungrazed areas, though monitoring will continue to track soft brome, cheatgrass, mesdusahead, North Africa grass and annual fescue.
- There are no major invasive species or management headaches, with the exception of:
    - Redstem stork's bill – particularly in the fire line area – this area could be treated with herbicide and replanted with a native species mix.
    - Rush skeletonweed – noted on a single transect and an outbreak of 100 plants was found by Bob Hansen and removed by Steve Van Vleet in 2016. The outbreak area is to be monitored and controlled by spot spraying over several years.
- Other invasive species, such as bulbous bluegrass and other grasses, would not be easy to control over the whole area. An option would be to target patches of grasses by broadcasting grass-specific herbicide and then replanting with native grasses.
- The wildfire in 2015 appears to have reduced 'Secar' and litter, while increasing bare ground cover, which may be at risk of invasion by exotic species.

5.4. Recommendations and Next Steps

Initial recommendations for grazing and restoration at Dalles Mountain Prairie include:

- Retaining the current experimental design with future amendments if needed. The monitoring established in 2016 should be sufficient to monitor progress over time. If funding becomes available, more transects and plots could be added to increase the sampling size.
- Continue grazing in Pastures 1-3 in fall 2016 with similar intensity to that used in 2014. Remain adaptive and flexible and monitor weather and soil conditions and the associated impact of cattle during the grazing period.
- The divisions between Pastures 1-3 can be dropped unless it is helpful for cattle management.
- Give Pasture 5 another year of rest to recover from the wildfire.
- Create patches of native diversity by targeted herbicide control of exotics and planting of native species, particularly forbs.
- Do not reseed or replant natives into monitoring transects or plots until the study is complete.

A list of potential species available for seeding and draft base restoration plan will be available later in 2016.

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APPENDIX 1. PHOTOGRAPHS OF DALLES MOUNTAIN PRAIRIE

Fig. A1.1. Grazed area of Pasture 3, 18 Feb., 2016

Fig. A1.2. Ungrazed area of Pasture 4, showing dominance of 'Secar' Snake River wheatgrass, and the planting rows that are still visible, 18 Feb., 2016

Fig. A1.3. Ungrazed area of Pasture 4, showing dominance of 'Secar' Snake River wheatgrass, 4 May, 2016

Fig. A1.4. Boundary of Pasture 1 (grazed; left) and Pasture 4 (ungrazed; right) showing greater dead leaf matter in the ungrazed 'Secar', 4 May, 2016

Fig. A1.5. Broad-leaf lupine and Carey's balsamroot within a diverse native species area in Pasture 3 that was previously uncultivated, 4 May 2016

Fig. A1.6. Carey's balsamroot within a diverse native species area in Pasture 3 that was previously uncultivated, 4 May 2016

Fig. A1.7. Arrow-leaf buckwheat within a diverse native species area in Pasture 3 that was previously uncultivated, 4 May 2016

Fig. A1.8. Broad-leaf lupine in Pasture 5, 5 May 2016

Fig. A1.9. Unburned grassland (right) and the area that was burned in Sep. 2015 (left), Pasture 3, 18 Feb., 2016

Fig. A1.10. Unburned grassland (left), the fire line, and the area that was burned in Sep. 2015 (right), Pasture 4,18 Feb., 2016

Fig. A1.11. Burned area of Pasture 5, 5 May 2016

Fig. A1.12 Setting up transect T5 in Pasture 5, 5 May 2016

Fig. A1.13 Setting up Plot 1 in Pasture 3, 4 May 2016

APPENDIX 2. GRAZING STUDY PLAN, STEVE VAN VLEET (WSU)

PLAN TO INCREASE PLANT DIVERSITY TO CULTIVATED PRAIRIE (DALLES MOUNTAIN STATE PARK)

The following rehabilitation plan is for a 180-acre fenced pasture within The Dalles Mountain State Park. This pasture was cultivated and planted with a mix of Secar, a bluebunch wheatgrass cultivar, and Sherman Big Blue in 1992, and is now dominated by Secar. WSU Extension will perform this plan as a research project, to be coordinated by WSU Extension and State Park. State Park will select a livestock producer to manage grazing cattle within the 180-acre project area during the term of this research project. No payment will be made to the livestock producer for the use of his/her cattle to graze the project area. WSU Extension will put up a sign at the site, designating the area as a research project.

Site Characteristics and Plant Species Inventory

The 180-acre research site is characterized by rolling hills of pasture dominated by a bluebunch wheatgrass cultivar, Secar, and also has limited populations of other bunchgrasses, exotic annuals, and native forbs. Native plant cooperators prepared a preliminary inventory of plant species in the project area in April, 2008. Although the habitat is in generally fair to good condition, with few weedy areas, the Secar cultivar is nonnative to the area and has become a monoculture that now comprises eighty percent of the 180-acre project area.

Management Goal

The primary goal of this rehabilitation plan is to increase the biological and vegetation diversity in the 180-acre project area (Exhibit A) using sound grazing management practices. This plan will aid in restoring biodiversity and progress towards a natural composition of grass and forbs. Secondary goals include sustainable grazing to preserve the historical landscape and wildfire fuel reduction.

Objectives in Reaching Goal

a. Reduce SECAR litter levels and competition so that native forbs and grasses can recruit towards composition and cover levels approaching those identified in reference areas.
b. Maintain health of existing grasses.
c. Create conditions for native plants to germinate and establish throughout the bluebunch monoculture and suppress the germination and establishment of exotics.
d. Encourage grazing of Secar bluebunch and undesirable plants to reduce their vigor and favor growth of desirable species.

Justification for Restoration Plan

Grazing of cattle in the fall is the chosen method to restore the project area from a Secar bluebunch monoculture to a condition of desirable vegetative diversity. Cattle were selected to graze the area for various reasons, specifically because:

1. When offered an array of grazing choices, cattle graze 70% grass. Grass is the target of this ecological restoration project.
2. Certain management tools (e.g., fire, tillage) could intensify the dominance of Secar bluebunch, and other tools by themselves such as interseeding would likely have a limited impact due to a competitive disadvantage.
3. Grazing cattle will remove decadent forage.
4. By their hoof action, the cattle will promote litter-to-soil contact for winter and spring decomposition and organic matter return.
5. The hoof action will also promote seed-to-soil contact for enhanced germination of native forb and grass species.
6. Grazing is a historical use in the park and limited targeted grazing is deemed desirable to help maintain the cultural landscape.

While spring grazing has been shown to eliminate balsamroot, a forb targeted for increase through this restoration effort, fall grazing is not likely to damage balsamroot. The grazing will also have nominal impact on bluebunch wheatgrass plants since it will take place well after the critical growth period of internode elongation, which generally occurs April 1 - June 1, depending on moisture and temperature conditions in the spring. Fall grazing also avoids any incidental grazing of forbs that are a parallel set of goal plants for this site. Moseley & Brewer report in the Targeted Grazing Handbook (2006) that late season grass use is most effective for shifting plant community composition toward non-weedy forbs. Fall grazing also dispels any potential concerns for ground-nesting birds that may utilize this pasture.

The purpose of this cooperative research project is ecological rehabilitation and is not intended to promote grazing, particularly as an unrestricted practice on all grassland not having the same history and characteristics as the Dalles Mountain Ranch project area.

Implementation needs

1. Baseline monitoring
    a. Establish baseline monitoring data to evaluate the effects of grazing
        1. Prepare native and invasive plant inventory
        2. Determine photo monitoring points
        3. Establish monitoring transects
        4. Invertebrate inventory-primarily pollinators
    b. Determine vegetation inventory and ecosystem health
        1. Evaluate rangeland and EKG transects
        2. Take photographs from established photo points
        3. Collect forage biomass samples
2. Exclosures
    a. Establish exclosure within the project area to compare grazed with ungrazed acreage. Exclosure will contain secar and non-secar (native) dominated rangeland.
    b. Establish a 20- to 30-acre non-grazed control parcel (Parcel 5) within the study area. We will also use our baseline information for comparison

   c. Purchase fencing materials at a cost of $1000; additional fencing materials will be borrowed or acquired as needed. Most fencing has been purchased as of 9/1/2008.
3. Permanent perimeter fencing check
   State Park employees and livestock producer will maintain an existing perimeter fence.
4. Internal pasture fencing
   The 200-acre grazing area will be divided into 4-5 rotational pastures. Turbo electric wire will be used to separate the pastures.
5. Water facilities
   1500-2500 gallon water tanks will be placed in each rotational pasture as it is utilized. Water will be hauled by the livestock producer to the tanks. Currently piping of water to area
6. Supplements
   Livestock producer and WSU Extension will determine locations of salt/protein supplements to promote even livestock distribution (materials to be purchased by livestock producer).
7. Reseeding native species
   WSU Extension and native plant cooperators will identify areas for reseeding native plant species.

Proposed action

1. Verify baseline inventory of spring forbs and grass species, separated as to the acreage to be grazed and the excluded areas (exclosures).
2. Fence off the non-grazed control parcel (Parcel 5) and two exclosures using one-strand poly- or turbowire, and designate a reference site.
3. Establish permanent photo monitoring sites inside and outside exclosures and collect spring photos and pre-grazing fall photos.
4. If deemed necessary, confine the cattle for a period of 10-14 days before releasing them onto the project area. During confinement, the cattle will be fed a weed-free forage. Implement fall grazing according to the following forage consumption constraints:

Area	160 acres
Forage production	~1000 lb/ac
Usable forage total	80,000 lbs
# cattle (dry cows)	130
Daily consumption	30 lbs/cow
Total daily consumption	~4000 lbs.
Total grazing days	~20
Residual goal	4" on PSSP

5. Monitor residual grass height at 5-14 days to ensure utilization goals are achieved, and not knowing exact consumption or total forage weights.
6. Provide protein supplement as necessary as old stems and late season current year forage will be low in crude protein, likely inadequate in energy for dry cows. Protein supplement, preferably low-moisture blocks, could also help encourage grazing in certain areas and discourage impact in others, such as near water.
7. Integrated pest management will be addressed for all noxious / invasive weed species. In the event of an invasive weed introduction (such as an expansion of an existing invasive species or the establishment of a new noxious weed species), integrate other management tools (e.g., hand pulling, digging, herbicides) on a targeted basis.
8. If reseeding is deemed necessary, the native plant cooperators will assume primary responsibility for selecting the native plant species, sources, seeding and monitoring protocols and areas to be reseeded. Prior to seeding with native species, the seeding component of this plan shall be submitted to all parties involved in writing for review and inclusion as a part of this restoration .
9. Use adaptive management to tailor future grazing plan based on plant response and monitoring results from 2009 fall grazing.
10. Should ecological degradation occur, the grazing study may be modified, suspended or cancelled, upon determination by WSU Extension, State Park and native plant cooperators.
11. The use of statistical analysis (SAS) will be used to evaluate invertebrate diversity and vegetative diversity.

MONITORING

Rangeland health monitoring will follow a subset of the methods provided in Herrick, et al, 2005, Monitoring Manual for Grassland, Shrubland, and Savanna Ecosystems, available through the USDA-ARS Jornada Experimental Range. The method was designed specifically to serve as a quantitative protocol for measuring soil stability, hydrologic function, and biotic integrity over time.
We will install 5 permanent monitoring locations, one inside the ungrazed exclosure and four inside the four grazing paddocks to be established with temporary electric fencing.

Line-point intercept
The line-point intercept with height provides basic data for evaluating trend. Each hub has three 50m transects with data collected at each meter, for a total of 150 data points. This method provides percentages of bare soil, basal cover, canopy cover, soil litter coverage, species composition, and vegetation structure. 2/2016 This type of monitoring was deemed unreliable in gathering large scale changes

Species richness plots
Rangeland health is positively correlated with biodiversity, particularly a diversity of desirable native perennial forbs and grasses. One of the goals on this site is rehabilitation toward a vegetation association that is closer to the expected native composition. The local Native Plant Society will collect data on 10x30 meter species richness plots as described in Monitoring Manual Vol. 2, page 57-58. This will be a modification of the Whittaker method described in the manual in that we will only collect data on one transect, rather than all three, and will not collect data on the smaller plot sizes nested inside the 10x30. The species richness plot will be on the transect in each hub that is closest to 180 degrees (south), centered on the transect line.

Invasive species
The Klickitat County Noxious County Weed Control Board will monitor extent of current weed populations. If necessary, the belt transect method could be applied to more carefully measure weed species that are widely and evenly distributed rather than in discrete patches. This method provides a

density metric that can be compared over time, similar to total area of weed patches that could be compared over time.

APPENDIX 3. SUMMARY OF CATTLE GRAZING AT DALLES MOUNTAIN PRAIRIE 2009-2015

		Pasture			
Year		1	2	3	5
2009	acres	16	16	27	
	no. cattle	122	122	122	
	days	7	7	5	
	timing	Nov	Nov	Nov	
	cattle days/acre	53.4	53.4	22.6	
2010	acres				75
	no. cattle	0	0	0	112
	days				8
	timing				Nov
	cattle days/acre				11.9
2011	acres	16	16	27	38
	no. cattle	134	134	134	134
	days	9	7	7	8
	timing	Nov	Nov	Nov-Dec	Nov
	cattle days/acre	75.4	58.6	34.7	28.2
2012	acres	0	16	27	86
	no. cattle		118	118	115
	days		8	11	16
	timing		Nov	Nov	Apr-May
	cattle days/acre		59.0	48.1	21.4
2013	acres	0	0	0	86
	no. cattle				82

Year		Pasture			
		1	2	3	5
	days				28
	timing				Nov-Dec
	cattle days/acre				26.7
2014	Pasture	1,2,3			5
	acres	60.5			86
	no. cattle	172			172
	days	15			10
	timing	Nov-Dec			Dec
	cattle days/acre	42.6			20.0
2015	no. cattle	0	0	0	0

DALLES MOUNTAIN RANCH REHABILITATION PROJECT

A cooperative partnership between Western SARE, Washington State University, Washington State Parks, and Native Plant Society

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Abstract

Historically a cattle ranch, the Dalles Mountain Ranch was acquired by Washington State Parks ("State Parks") in 1994. Within the ranch is a 180-acre parcel of pasture and native range that had been tilled and seeded to 'Secar' bluebunch wheatgrass in 1992. Over time, this parcel degraded and became a monoculture of bluebunch wheatgrass; while it can never be returned to its original state, the overall goal of the rehabilitation project is to manage the degraded parcel using state-of-the-science management to enhance vegetative diversity while incorporating livestock production. Dormant season cattle grazing using a holistic management approach began in 2009. Pastures of varying sizes were set up and permanent sampling transects and photo points were placed throughout the study area. The permanent sampling transects were used to evaluate vegetative cover, species richness and the reestablishment of grasses and forbs.

After dormant season rotational grazing, species richness measured in pastures 1−3 increased overall. Vegetative cover changed over time. Overall perennial and annual grass cover decreased while perennial and annual forb cover increased the year following grazing. Perennial forbs generally increased in both pastures while litter generally decreased in pastures 1 and 3.

Introduction

The Conservation Reserve Program (CRP) began in 1985. Since then, this government program has been a key subsidy program for the conservation of highly erodible lands and to benefit wildlife. Washington state currently has over 1.46 million acres of land enrolled in the program with over $83 million paid out to landowners each year. In the next 3 years, over 497,000 acres of CRP will be expiring (Conservation reserve program statistics, 2013) and will require sustainable management. Unfortunately, over the past 15 years, the CRP program has tightened limits on options to manage enrolled lands; the result is old, decadent stands of oxidizing, dying bunchgrasses. Grazing, in particular, has been restricted as a management tool even though many of our grassland ecosystems coevolved with herbivores (Stebbins, 1981). Livestock grazing is not only a valuable conservation method, but is oftentimes the best method for restoring degraded grasslands. This project looks at managed cattle grazing as a tool to not only improve the health and regeneration of perennial grasses on idle lands but to enhance the diversity and cover of perennial grasses and forbs.

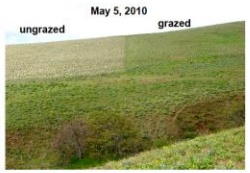
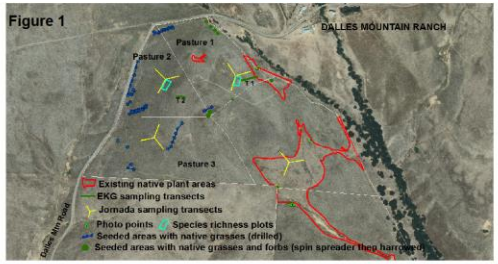


Table 1 Jornada Species Richness

Species Richness (% increase)	2010	2011	2012
Pasture 1	20	15	10
Pasture 2	17	5	7
Pasture 3	7	0	0

Figure 1



Materials and Methods

Prior to introducing livestock onto the project site, various methods of data collecting were implemented. Jornada sampling transects were placed in each pasture, while EKG transects (Land EKG, 1994) and 5 permanent photo points were established throughout the project area. All fence locations, sampling points, biomass clippings, invasive plant populations, watering areas, water lines, current native plant habitat and revegetation areas were mapped via GPS (Figure 1). Species richness data were collected from Jornada transects while percent coverage data was collected from EKG transects based on ecological features (bare ground, forbs, grasses, litter). A feed analysis was done on Secar grazed and ungrazed plots in 2010 and 2012. Visual vegetation changes were captured using photos collected from permanent photo points at specific times throughout each year.

Table 2 Dalles Mountain Ranch Cover Analysis 2009-2012

	Cover	2009 (%)	2010 (%)	2011 (%)	2012 (%)
Transect 1 (Pasture 1)	perennial grass	48	39	61	55
	annual grass	31	29	20	13
	perennial forbs	7	13	13	17
	annual forbs	1	1	2	3
	litter	13	16	3	12
	bareground	0	2	1	0
Transect 2 (Pasture 3)	perennial grass	36	35	36	35
	annual grass	51	55	50	54
	perennial forbs	3	5	8	6
	annual forbs	2	0	1	1
	litter	6	1	0	0
	bareground	0	4	5	4

Table 3 Feed Analysis: 'Secar' Bluebunch Wheatgrass 2010 and 2012

	Grazed Pasture	Ungrazed Control
Laboratory Values	100% Dry Matter	100% Dry Matter
Crude Protein	7.8	5.8
Acid Detergent Fiber (ADF)	42	48.5
Neutral Detergent Fiber (NDF)	62	62
Estimated Values		
Relative Feed Value	87	79
TDN	53.8	46.8
Digestible Protein	3.3	1.4
Digestible Dry Matter (DDM)	56.3	51
Dry Matter Intake (DMI)	1.95	1.95
Digestible energy (Mcal/kg)	2.38	2.06
Metabolizable energy (Mcal/kg)	1.95	1.63

Goals and Objectives

Various goals and objectives were developed for the rehabilitation of the 180-acre parcel at Dalles Mountain Ranch with the intent to reclaim the site to a natural composition of forbs and grasses, as follows:

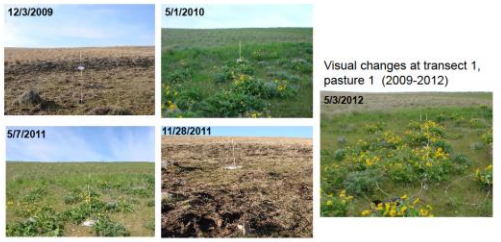
1.Reduce Secar litter levels and competition so that native forbs and grasses could recruit towards composition and cover levels identified in reference areas.
2.Maintain health of existing grasses.
3.Create conditions for native plants to germinate and establish throughout the Secar monoculture and suppress the germination and establishment of exotics.
4.Encourage grazing of Secar and undesirable plants to reduce vigor and favor growth of desirable species.

After careful consideration, dormant season grazing of cattle was chosen as the preferred method to rehabilitate the project site from a Secar monoculture to a condition of desirable vegetative diversity. Cattle were the grazer of choice for deliberate reasons.

- In considering the grazing habits of various animals, cattle graze 70% grass, the target of the project.
- Certain management tools (e.g., fire, tillage) could actually intensify the dominance of Secar; singular tools would likely have a limited impact due to a competitive disadvantage.
- Grazing cattle would remove decadent forage and improve the quality of the grasses.
- By their hoof action, cattle would promote litter-to-soil contact for winter and spring decomposition and organic matter return.
- The hoof action would also promote seed-to-soil contact for enhanced germination of native forb and grass species.

Results and Conclusions

Use of managed dormant season grazing from 2009-2012 increased species richness and vegetative cover. Species richness increased throughout each pasture after grazing (Table 1). Pasture 1 had the highest increase in species richness from 2010-2012. Overall perennial and annual grass cover decreased while perennial and annual forb cover increased the year following grazing (Table 2). Perennial grass (Secar) either increased (pasture 1) or remained constant (pasture 3) throughout. Annual grass decreased in pasture 1 and remained constant in pasture 3. Perennial forbs generally increased in both pastures while litter generally decreased in pastures 1 and 3. In the grazed pastures, crude protein and digestible protein improved by over 1 percent; grass health of the grazed pastures was better than that of the ungrazed pastures (Table 3). The visual differences between pastures is shown by the photos collected from the permanent photo points.



Visual changes at transect 1, pasture 1 (2009-2012)

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Stebbins, G.L. (1981). Coevolution of Grasses and Herbivores. Annals of the Missouri Botanical Garden. 68(1), 75-86.

Conservation Reserve Program Statistics. United States Department of Agriculture, Farm Service Agency. Available online at http://www.fsa.usda.gov/FSA/webapp?area=home&subject=copr&topic=rms-css. Accessed 3/25/2013.

APPENDIX 5. DALLES MOUNTAIN PRAIRIE COMPILED SPECIES LIST

Scientific name	Common name	Form	Life Cycle	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/s	p	n	2
Asclepias fascicularis	Mexican whorled milkweed	f	p	n	2
Balsamorhiza careyana	Carey's balsamroot	f	p	n	1,2
Bromus diandrus	ripgut brome	g	a/p	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 attenuatus	attenuate Indian paintbrush	f	a	n	1,2
Centaurea solstitialis	yellow star-thistle	f	a	e	2
Chondrilla juncea	rush skeletonweed	f	p	e	1,2
Cichorium intybus	chicory	f	b/p	e	1,2
Cirsium undulatum	wavyleaf thistle	f	b/p	n	2
Clarkia gracilis	slender clarkia	f	a	n	2
Claytonia perfoliata	miner's lettuce	f	a/p	n	1,2
Collinsia parviflora	maiden blue eyed Mary	f	a	n	2
Collomia grandiflora	grand 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

Scientific name	Common name	Form	Life Cycle	Native	Source
Cuscuta sp.	dodder				2
Delphinium nuttallianum	twolobe larkspur	f	p	n	2
Dodecatheon conjugens	Bonneville shootingstar	f	p	n	1,2
Draba verna var. boerhaavii	spring draba	f	a	e	2,3
Elymus repens	quackgrass	g	p	e	1
Elymus elymoides	bottlebrush squirreltail	g	p	n	1,2
Elymus wawawaiensis "SECAR"	Snake River wheatgrass "SECAR" cultivar	g	p	n	1
Epilobium brachycarpum	tall annual willowherb	f	a	n	2
Epilobium densiflorum	denseflower willowherb	f	a	n	2
Epilobium sp.	willowherb	f	?	?	3
Ericameria nauseosus	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	a/p	n	2
Erodium cicutarium	redstem stork's bill	f	a/b	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 columbiana	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/b	e	2
Lagophylla ramosissima	branched lagophylla	f	a	n	1,2

Scientific name	Common name	Form	Life Cycle	Native	Source
Lamium amplexicaule	henbit deadnettle	f	a/b	e	3
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 grayi	Gray's biscuitroot	f	p	n	2
Lomatium macrocarpum	bigseed biscuitroot	f	p	n	2,3
Lomatium nudicaule	barestem biscuitroot	f	p	n	1,2
Lomatium piperi	Indian biscuitroot	f	p	n	2,3
Lomatium triternatum	nineleaf biscuitroot	f	p	n	1,2
Lupinus aridus lepidus	desert lupine	f	p	n	2
Lupinus bicolor	minature lupine	f	a	n	1,2
Lupinus latifolius	broadleaf lupine	f/s	p	n	1
Lupinus leucophyllus	velvet lupine	f	p	n	2
Lupinus polycarpus	smallflower lupine	f	a	n	2
Lupinus sericeus	silky lupine	f/s	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
Marah oreganus	coastal manroot	f	p	n	2
Medicago lupulina	black medick	f	a/p	e	2
Medicago sativa	alfalfa	f	p	e	1,2
Melilotus officinalis	sweetclover	f	a/b/p	e	2
Microsteris gracilis	slender phlox	f	a	n	1,2
Myosotis discolor	changing forget-me-not	f	a/p	e	3

Scientific name	Common name	Form	Life Cycle	Native	Source
Myosotis sp.	forget-me-not?	f	a/p	e	2
Nemophila sp.	Nemophila	f	a	n	3
Olsynium douglasii var. douglasii	Douglas' grasswidow	f	p	n	2
Penstemon richardsonii var. richardsonii	Richardson's penstemon	f/s	p	n	2
Perideridia gairdneri	Gardner's yampah	f	p	n	2
Phlox speciosa	showy phlox	f/s	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	a/b/p	e	2
Plectritis macrocera	longhorn plectritis	f	a	n	3
Poa bulbosa	bulbous bluegrass	g	p	e	1,2
Poa secunda	"Sherman" Sandberg bluegrass	g	p	n	1
Polygonum aviculare	prostrate knotweed	f	a/p	e	2
Pyrrocoma carthomoides. var. carthomoides	largeflower goldenweed	f	p	n	1,2
Rigiopappus leptocladus	wireweed	f	a	n	2
Rosa woodsii var. ultramontana	pearhip rose	s	p	n	2
Rumex crispus	curly dock	f	p	e	2
Rumex maritimus	golden dock	f	a/b	n	2
Rumex occidentalis	Western dock	f	p	n	1
Saxifraga integrifolia	wholeleaf saxifrage	f	p	n	1,2
Senecio integerrimus	lambstongue ragwort	f	b/p	n	1,2
Sisymbrium altissimum	tall tumblemustard	f	a/b	e	2
Sonchus oleraceus	common sowthistle	f	b	e	1
Taeniatherum caput-medusae	medusahead	g	a	e	1

Scientific name	Common name	Form	Life Cycle	Native	Source
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 var. howellii	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
Vulpia sp.	6-week fescue?	g	a	e	3
Yabea (Caucalis) microcarpa	false carrot	f	a	n	3
Key					
f = forb or herb					
s = subshrub or shrub					
g = grass or graminoid					
a= annual					
b = biennial					
p = perrenial					
e = exotic					
n = native					
Source					
1 = IAE monitoring in 2016					
2 = Bob Hansen records					
3 = WSP monitoring in 2006					
Naming convention: USDA NRCS Plants Database http://plants.usda.gov/					

APPENDIX 6. 2016 PLOT DATA

Species	Common name	Form	Life Cycle	Status	Plot 1		Plot 2		Plot 3		Plot 4		Plot 5	
					Pasture 3		Pasture 2		Pasture 4		Pasture 4		Pasture 4	
					Cover Class	Sociability Class	Cover Class	Sociability Class	Cover Class	Sociability Class	Cover Class	Sociability Class	Cover Class	Sociability Class
Achillea millefolium	common yarrow	f	p	n	1	4	+	4	r	5	r	5		
Agoseris heterophylla	annual agoseris	f	a	n	+	5	r	5	+	4				
Allium acuminatum	tapertip onion	f	p	n									+	4
Amsinckia menziesii	Menzies' fiddleneck	f	a	n	+	4	+	4			+	4		
Balsamorhiza careyana	Carey's balsamroot	f	p	n	3	2					3	2	1	3
Bromus hordeaceus	soft brome	g	a	e	4	2	3	4			2	2		
Bromus tectorum	cheatgrass	g	a	e	1	3	3	2	3	2	4	1	r	4
Calochortus macrocarpus	green-banded Mariposa lily	f	p	n	r	5								
Chondrilla juncea	rush skeletonweed	f	p	e										
Cichorium intybus	chicory	f	p/b	e	+	5	r	5						
Claytonia perfoliata	miner's lettuce	f	a/p	n					r	4				
Collomia grandiflora	grand collomia	f	a	n	r	5								
Crepis occidentalis	Western hawksbeard	f	p	n					r	5	r	5		
Dodecatheon	Desert Shooting Star	f	p	n	+	4								

Species	Common name	Form	Life Cycle	Status	Plot 1		Plot 2		Plot 3		Plot 4		Plot 5	
					Pasture 3		Pasture 2		Pasture 4		Pasture 4		Pasture 4	
					Cover Class	Sociability Class	Cover Class	Sociability Class	Cover Class	Sociability Class	Cover Class	Sociability Class	Cover Class	Sociability Class
conjugens														
Elymus repens	quackgrass	g	p	e	+	4								
Elymus elymoides	bottlebrush squirreltail	g	p	n	+	5	+	4			+	4	+	5
Elymus wawawaiensis 'SECAR'	Snake River wheatgrass 'SECAR' cultivar	g	p	n			5	1	5	1	2	3		
Ericameria nauseosus	rubber rabbitbrush	f	p	n							r	5		
Eriogonum compositum	arrowleaf buckwheat	f	p	n	1	4					2	2		
Eriogonum strictum	Blue Mountain buckwheat	f	p	n	r	5							+	3
Erodium cicutarium	redstem stork's bill	f	a/b	e	1	4	+	5	+	4	+	5	r	4
Galium aparine	stickywilly	f	a	n					r	5				
Pyrrocoma carthamoides	largeflower goldenweed	f	p	n	1	4							r	5
Kickxia elatine	sharpleaf cancerwort	f	a	e	1	4								
Lagophylla ramosissima	branched lagophylla	f	a	n			+	5						
Lomatium canbyi	Canby's biscuitroot	f	p	n									1	4
Lomatium nudicaule	barestem biscuitroot	f	p	n	2	3	+	5	+	4	1	3	r	5

Species	Common name	Form	Life Cycle	Status	Plot 1		Plot 2		Plot 3		Plot 4		Plot 5	
					Pasture 3		Pasture 2		Pasture 4		Pasture 4		Pasture 4	
					Cover Class	Sociability Class	Cover Class	Sociability Class	Cover Class	Sociability Class	Cover Class	Sociability Class	Cover Class	Sociability Class
Lomatium triternatum	nineleaf biscuitroot	f	p	n	+	5	r	5	+	4	1	3		
Lupinus bicolor	minature lupine	f	a	n	+	5	r	5					+	4
Lupinus latifolius/sericeus	broadleaf lupine/silky lupine	f	p	n	1	3			+	4	2	3	1	3
Madia citriodora	lemonscented madia	f	a	n			+	5						
Madia exigua	small tarweed	f	a	n	+	4	r	5						
Madia glomerata	mountain tarweed	f	a	n	r	4	r	5					r	5
Medicago sativa	alfalfa	f	p	e					+	4	2	3		
Microsteris gracilis	slender phlox	f	a	n					+	4				
Castilleja attenuatus	attenuate Indian paintbrush	f	a	n	+	4	r	4			+	4		
Phoenicaulis cheiranthoides	wallflower phoenicaulis	f	p	n	r	5								
Poa bulbosa	bulbous bluegrass	g	p	e	5	1	4	2	r	4	3	1	5	1
Poa secunda	"Sherman" Sandberg bluegrass	g	p	n					3	2				
Rumex occidentalis	Western dock	f	p	n					r	5				
Saxifraga integrifolia	wholeleaf saxifrage	f	p	n	r	5								

Species	Common name	Form	Life Cycle	Status	Plot 1		Plot 2		Plot 3		Plot 4		Plot 5	
					Pasture 3		Pasture 2		Pasture 4		Pasture 4		Pasture 4	
					Cover Class	Sociability Class	Cover Class	Sociability Class	Cover Class	Sociability Class	Cover Class	Sociability Class	Cover Class	Sociability Class
Senecio integerrimus	lambstongue ragwort	f	b/p	n					+	5				
Sonchus oleraceus	common sowthistle	f	b	e			1	3	+	4	+	4		
Taeniatherum caput-medusae	medusahead	g	a	e			2	3			1	4		
Tragopogon dubius	yellow salsify	f	a/b	e	r	5	r	5	1	2				
Trifolium arvense	rabbitfoot clover	f	a	e			r	4						
Triteleia grandiflora var. howellii	Howell's triteleia	f	p	n	r	5					r	5	r	5
Ventenata dubia	North Africa grass	g	a	e			2	3						
Vulpia myuros	annual fescue	g	a	e	2	3	+	4						
	Species Richness Total				**30**		**24**		**19**		**20**		**14**	
	Exotic				**9**		**11**		**6**		**7**		**3**	
	Native				**21**		**13**		**13**		**13**		**11**	
	Exotic grass				**5**		**6**		**2**		**4**		**2**	
	Native Grass				**1**		**2**		**2**		**2**		**1**	
	Exotic forb				**4**		**5**		**4**		**3**		**1**	
	Native forb				**20**		**11**		**11**		**11**		**10**	

Key:

f = forb or herb/subshrub

g = grass

a = annual

b = biennial

p = perennial

e = exotic

n = native

See Tables 1 and 2 for cover class and sociability class categories

APPENDIX 7. 2016 TRANSECT DATA

Transect	Pasture	Grazed	Burned	Plot	Meters from origin	Photo	SECAR	N Per grass	E Per grass	N Ann grass	E Ann grass	N Per Forb	E Per forb	N Ann forb	E Ann forb	Bare ground	Rock	Moss	Litter
T1	1	Yes	No	1	10	Y	10	0	0	0	70	40	0	1	0.01	3	0.01	0.01	10
T1	1	Yes	No	2	30	N	5	10	0	0	68	45	0	15	0.01	0.5	0.01	0	15
T1	1	Yes	No	3	50	Y	40	0	0	0	60	65	0	4	0.01	0	0	0	30
T1	1	Yes	No	4	70	N	50	4	0	0	50	40	0	8	0.01	0.01	0	0	20
T1	1	Yes	No	5	90	Y	20	4	0	0	65	35	0	25	0.01	0.5	0	0	15
T1	1	Yes	No	6	110	N	35	0	0	0	65	5	0	1	0.01	20	0	0	8
T1	1	Yes	No	7	130	N	65	2	0	0	28	8	0	0.01	0.01	0.01	0	0	30
T1	4	No	No	8	150	Y	50	3	0	0	75	0	0	25	0.01	1	0	0.01	10
T1	4	No	No	9	170	N	40	1	0	0	75	0.5	0	15	0.01	0.01	1	1	10
T1	4	No	No	10	190	Y	60	0	0	0	30	6	0	8	3	0.01	0	0.01	25
T2	2	Yes	No	1	10	Y	4	0	0	0	90	0.01	0	0.01	0.01	4	0.01	0	5
T2	2	Yes	No	2	30	N	8	45	0	0	30	0	0	0.01	2	1	0.01	0	15
T2	2	Yes	No	3	50	N	70	0	0	0	30	0	0	0.01	0.01	2	0.01	0	15
T2	2	Yes	No	4	70	Y	45	0	0	0	40	0	0	0.01	0.01	3	0.01	0	12
T2	2	Yes	No	5	90	N	35	0	0	0	35	55	0	0	3	0	0.01	0	35
T2	2	Yes	No	6	110	Y	35	5	0	0	40	35	0	0.01	3	1	0	0	25

Transect	Pasture	Grazed	Burned	Plot	Meters from origin	Photo	SECAR	N Per grass	E Per grass	N Ann grass	E Ann grass	N Per Forb	E Per forb	N Ann forb	E Ann forb	Bare ground	Rock	Moss	Litter
T2	2	Yes	No	7	130	N	30	3	0	0	35	25	0	0.01	2	0.5	0.01	0	20
T2	2	Yes	No	8	150	Y	12	25	0	0	45	18	0	0.01	0.01	0.5	0.01	0	12
T2	2	Yes	No	9	170	N	68	10	0	0	25	5	0	0.01	0.01	2	0	0	30
T2	2	Yes	No	10	190	Y	15	20	0	0	20	20	0	5	2	8	0	0	30
T3	3	Yes	No	1	20	Y	5	3	0	0.5	85	45	0	1	1	0.5	0	0	8
T3	3	Yes	No	2	40	N	55	5	0	0.5	15	8	0	12	1	0	0	0	25
T3	3	Yes	No	3	60	Y	40	8	0	0	60	20	0	1	1	0	0	0	35
T3	3	Yes	No	4	80	N	0	2	0	3	90	12	0	20	3	0	0	0	40
T3	3	Yes	Yes	5	100	Y	0	0	0	0	60	0.01	0	0.01	4	40	0.5	0	2
T3	3	Yes	Yes	6	120	N	0	5	0	0	45	0	0	2	20	40	0.01	0	1
T3	3	Yes	Yes	7	140	N	5	4	0	0.5	20	0	0	3	28	50	0.01	0	1
T3	3	Yes	Yes	8	160	N	1	3	0	0	35	0	0	0.5	18	45	0.01	0	5
T3	3	Yes	Yes	9	180	N	0	20	0	0	10	0	0	1	5	65	0.01	0	3
T3	3	Yes	Yes	10	199	Y	0	3	0	0	78	8	0	0.01	4	5	0.01	0	4
T4	4	No	No	1	10	Y	85	0	0	0	5	1	0.01	0	0	1	0	2	50
T4	4	No	No	2	30	N	45	0	0	0	60	0	0	0.01	0.01	0.01	0	3	80
T4	4	No	No	3	50	Y	30	0	0	0	70	8	0	20	0.01	0.01	0	10	75

Transect	Pasture	Grazed	Burned	Plot	Meters from origin	Photo	SECAR	N Per grass	E Per grass	N Ann grass	E Ann grass	N Per Forb	E Per forb	N Ann forb	E Ann forb	Bare ground	Rock	Moss	Litter
T4	4	No	No	4	70	N	20	0	0	0	75	12	0	7	5	2	0	0	80
T4	4	No	No	5	90	Y	25	0	0	0	70	0.01	0	0.01	0.01	4	0	70	15
T4	4	No	No	6	110	N	40	0	0	0	40	5	0	0.01	3	8	0	30	30
T4	4	No	No	7	130	N	50	0	0	0	40	8	0	2	0.01	10	0	15	40
T4	4	No	No	8	150	Y	65	0	0	10	0	0	0.01	5	3	0	0	20	40
T4	4	No	No	9	170	N	45	0	0	0	40	0	0.01	0.01	2	0.01	0	25	35
T4	4	No	No	10	190	Y	70	0	0	0	5	0	0	60	0.01	0	0	0.01	50
T5	5	Yes	Yes	1	10	Y	0	0	0	0	72	15	0	10	50	20	0	0	1
T5	5	Yes	Yes	2	30	N	0	0	0	0	60	0	0	3	60	30	0	0	0
T5	5	Yes	Yes	3	50	Y	0	0	0	0	30	0	1	10	10	85	0	0	0
T5	5	Yes	Yes	4	70	N	0	0	0	0	20	0	12	5	40	60	0	0	1
T5	5	Yes	Yes	5	90	Y	0	0	0	0	40	0	0	35	25	55	0	0	0.01
T5	5	Yes	Yes	6	110	N	0	0	0	0	35	0	0	20	53	50	0	0	0.01
T5	5	Yes	Yes	7	130	N	0	0	0	0	43	0	0	50	10	80	0	0	0.01
T5	5	Yes	Yes	8	150	Y	0	0	0	0	85	0	0	8	60	45	0	0	0.01
T5	5	Yes	Yes	9	170	N	10	0	0	0	80	12	0	4	63	30	0	0	0.01
T5	5	Yes	Yes	10	190	Y	1	0	0	0	25	0	0	3	40	80	0	0	0.01

Transect	Pasture	Grazed	Burned	Plot	Meters from origin	Photo	SECAR	N Per grass	E Per grass	N Ann grass	E Ann grass	N Per Forb	E Per forb	N Ann forb	E Ann forb	Bare ground	Rock	Moss	Litter
Average Transect T1 Grazed (7 plots)							**32.1**	**2.9**	**0**	**0.0**	**58.0**	**34.0**	**0.0**	**7.7**	**0.0**	**3.4**	**0.0**	**0.0**	**18.3**
Average Transect T2 Grazed							**32.2**	**10.8**	**0**	**0.0**	**39.0**	**15.8**	**0.0**	**0.5**	**1.2**	**2.2**	**0.0**	**0.0**	**19.9**
Average Transect T3 Grazed							**10.6**	**5.3**	**0**	**0.5**	**49.8**	**9.3**	**0.0**	**4.1**	**8.5**	**24.6**	**0.1**	**0.0**	**12.4**
Average Transect T4 (Plus 3 plots from T1) Ungrazed							**48.1**	**0.3**	**0**	**0.8**	**45.0**	**3.1**	**0.0**	**10.9**	**1.2**	**2.0**	**0.1**	**13.5**	**41.5**
Average Transect T5 Grazed							**1.1**	**0.0**	**0**	**0.0**	**49.0**	**2.7**	**1.3**	**14.8**	**41.1**	**53.5**	**0.0**	**0.0**	**0.2**
Average Grazed							**17.9**	**4.9**	**0**	**0.1**	**48.2**	**13.9**	**0.4**	**6.7**	**13.7**	**22.3**	**0.0**	**0.0**	**12.2**
Average Grazed & unburned							**30.8**	**7.0**	**0.0**	**0.2**	**49.8**	**22.9**	**0.0**	**4.4**	**0.9**	**2.2**	**0.0**	**0.0**	**20.7**
Average Grazed & burned							**1.1**	**2.2**	**0.0**	**0.0**	**46.1**	**2.2**	**0.8**	**9.7**	**30.6**	**48.8**	**0.0**	**0.0**	**1.1**
Average Ungrazed							**48.1**	**0.3**	**0**	**0.8**	**45.0**	**3.1**	**0.0**	**10.9**	**1.2**	**2.0**	**0.1**	**13.5**	**41.5**

Key: N = native; E = exotic; Ann = annual; Per = perennial

APPENDIX 8. 2016 TRANSECT SAMPLE PLOT PHOTOGRAPHS

Fig. A8.1. Transect 1 (grazed), Plot 3

Fig. A8.2. Transect 1 (grazed), Plot 5

Fig. A8.3. Transect 1 (ungrazed), Plot 10

Fig. A8.4. Transect 2 (grazed), Plot 1

Fig. A8.5. Transect 2 (grazed), Plot 4

Fig. A8.6. Transect 2 (grazed), Plot 10

Fig. A8.7. Transect 3 (grazed), Plot 3

Fig. A8.8. Transect 3 (grazed, burned, in fire line), Plot 5

Fig. A8.9. Transect 3 (grazed, burned), Plot 10

Fig. A8.10. Transect 4 (ungrazed), Plot 1

Fig. A8.11. Transect 4 (ungrazed), Plot 3

Fig. A8.12. Transect 4 (ungrazed), Plot 5

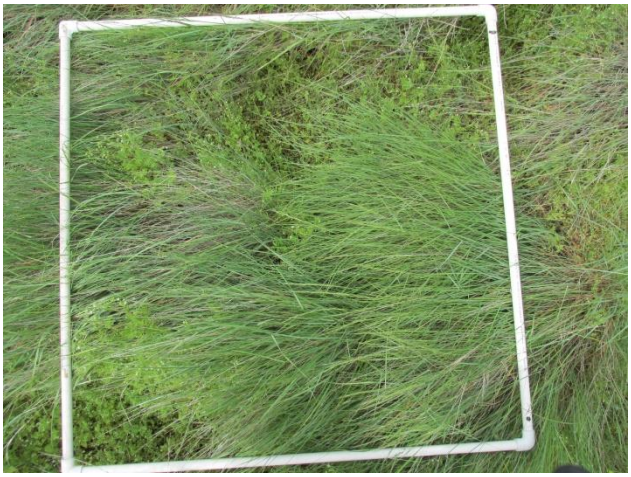

Fig. A8.13. Transect 4 (ungrazed), Plot 10

Fig. A8.14. Transect 5 (grazed & burned), Plot 1

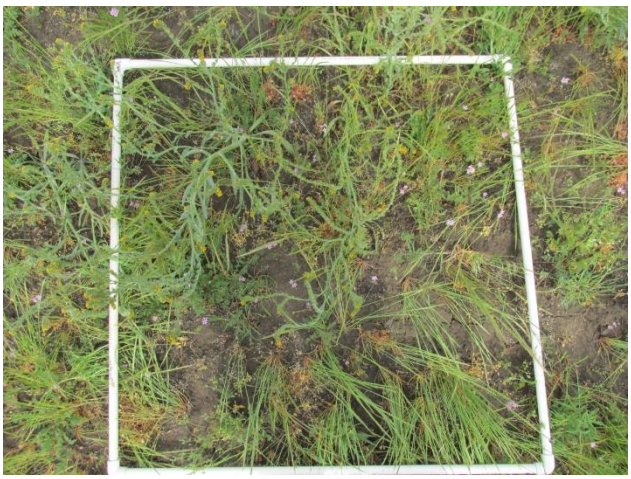

Fig. A8.15. Transect 5 (grazed & burned), Plot 5

Fig. A8.16. Transect 5 (grazed & burned), Plot 10