Grants and Education to Advance Innovations in Sustainable Agriculture

Report for SW18-103 (working version)

Ecological and Economic Benefit-Cost Comparison of Grazed and Ungrazed Prairie Land for Critical Species Protection in Western Washington

SW18-103 (project overview)

Project Type: Research and Education

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Principal Investigator:

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Workflow

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Project Information

Abstract:

Most rangelands west of the Cascades in the Pacific Northwest occur on sites that historically supported native prairie. Over 90% of the prairies in this region have been converted to agriculture or lost to development, making conservation of this rare system a top conservation priority. At the same time, the human population in this region continues to grow, demanding more from regional food production systems. Therefore, agricultural producers are under great pressure from growing needs for food production and habitat conservation. Because of this, it is increasingly recognized that effective prairie conservation can only be achieved by partnering with private landowners to develop incentivized conservation strategies that maintain productive farms. Through a unique collaboration between agricultural producers, conservation scientists, economists, sociologists, regulators and agricultural researchers, we propose to evaluate if and how agricultural productivity can be maintained or enhanced in working landscapes while simultaneously accruing conservation value for rare native plants and animals. Through replicated on-farm experimental demonstrations, we will quantify the ‘ecological lift’ generated

by conservation tools (altered grazing regimes, spring rest period, seeding native species). Additionally, we will evaluate the costs and benefits associated with conservation actions, to provide guidance on strategies and expenses for agricultural producers. Finally, we will survey producers to identify concerns, questions and needs (financial, technical, other) surrounding habitat conservation on their properties. The combined ecological, economic and social survey data will help guide government incentive programs. We expect this work to identify opportunities for agricultural producers to increase the conservation value of their properties, while maintaining or even enhancing their bottom line. Study findings and educational materials resulting from the demonstration trials will be communicated through peer-reviewed publications, presentations at academic conferences, a published grazing management guidebook, and a series of collaborative regional workshops for agricultural producers, researchers, extension agents, and land managers.

Project Objectives:

1. Develop a regional network of three grazed prairie research sites to demonstrate and evaluate effects of conservation tools on prairie habitat. This objective will:
   a. Implement conservation tools for target species and habitats, with focus on management intensive grazing, exclusion during critical flowering periods and/or native seeding.
   b. Evaluate impact of conservation installations through a range of habitat and species abundance metrics over 3 years.
2. Utilizing the regional network of grazed and ungrazed prairie sites, quantify the financial benefits and costs associated with managing critical habitat and species on grazed prairie as compared to ungrazed conservation prairie over a 3-year period. This objective will:
   a. Provide practical financial information to farmers, the conservation community, and the county planners concerning the costs of meeting HCP requirements on grazed and ungrazed prairie both on private and protected sites.
   b. Develop enterprise budgets and a benefit-cost analysis to inform HCP acreage targets for protecting critical species on grazed land relative to conservation preserve land.
3. Engage private landowners by administering a social survey focused on landowner needs for increased involvement in land conservation programs (conservation easements, HCP, Safe Harbor Agreement). This objective will:
   a. Engage producers and regulatory entities in a productive discussion on incentives needed for habitat conservation on working lands.
   b. Provide feedback for regulatory programs on effective strategies to engage private landowners.
4. Present opportunities for technical assistance related to habitat management and discuss economic and landowner incentive opportunities with agricultural producers, regulatory agencies and conservation land managers through several mechanisms:
   a. Workshop series, with field tours of the agricultural demonstration sites and native prairie preserve sites. Field tours will be sponsored by WSU, CNLM, Thurston County Conservation District and NRCS.
   b. WSU-Extension technical bulletin providing management guidelines and financial data for conservation tools; and two published manuscripts in peer-reviewed journals.
   c. Presentation of findings at regional and national conferences.

Cooperators

Fred Colvin - Producer
Marty Chaney (Researcher)

Chris Chaput
Kathleen Painter (Researcher)

Research

Hypothesis:

1. Implementation of conservation grazing practices will shift habitat value towards that of ungrazed native upland prairie, as measured by native species richness, percent native groundcover, and butterfly behavior.
2. Occupancy of endangered or threatened species, such as Mazama pocket gopher, is not significantly different between grazed and ungrazed prairie sites.
3. Implementation of conservation grazing practices will not reduce overall forage productivity.
4. Integrating conservation practices into grazed working lands will not disrupt the economic cost:benefit balance for the farmer.
5. Integrating grazed working lands into conservation practices can result in significant economic contributions to the regional economy
6. Appropriate and beneficial incentives and approaches can be identified from farmers and ranchers to improve participation and trust in conservation programs and conservation partners.

Materials and methods:

Three farm sites (Colvin Ranch, Fisher Ranch and Riverbend Farm) and three upland prairie sites (Johnson Prairie, West Rocky Prairie, and Wolf Haven) were chosen for this study to represent a range of forage quality and practices and upland prairie habitat conditions. Within each farm site, six 1-acre paddocks were chosen for Conservation Grazing Practice (CGP) treatments, along with paired 1-acre Business as Usual (BAU) paddocks (see site maps in Appendix A). Assigned CGP treatments were developed through the NRCS Site Inventory Planning process (NRCS, 2017) and reflect site-specific conditions and desired natural resource outcomes for each ranch (Table 1).

Table 1. Business as Usual and Conservation Grazing Practice Treatments for each farm site

Farm Site	BAU Treatment	CGP Treatment
Colvin Ranch	MiG with spring deferment	Native seeding
Fisher Ranch	Rotational grazing w/ spring deferment	Pulse winter grazing; native seeding
Riverbend Farm	Continuous grazing	MiG w/ spring deferment; native seeding

Six areas within each of the selected native upland prairie (NUP) sites were also chosen as replicate plots to provide a comparison to the BAU and CGP treatments at the farm sites (Appendix A). We placed a 15 m x 15 m grid over maps of each of the 1-acre treatment plots at each site and randomly chose 5 subplots within each treatment plot. A range of community and species-specific variables were measured in these plots (Table 2).

Table 2. Parameters measured

Treatments (independent variables)	Business as Usual grazing (BAU), Conservation Grazing Practices (CGP), Native Ungrazed Prairie (NUP)
Site responses (response variables in BAU and CGP)	Forage residue (biomass) in 2018 with additional measures planned for 2019-20: forage quality (ADF, NDF, CP, TDN), percent edible forage
Plant community (response variables)	Native and non-native species richness and diversity, percent cover of trees, shrubs, forbs, native grass, and forage grass; abundance of butterfly nectar and host plants
Gophers (response variables)	gopher mounds/grid cell
Butterfly behavior (response variable)	Move lengths, turning angles and diffusion rates
Soil measures (site-level co-variates)	soil classification, soil nutrients

Figure 1. The ten species selected for native seeding into farm sites. See Appendix B for full species descriptions.

We constructed the necessary semi-permanent infrastructure for CGP treatments at Riverbend Farm (creating rotational paddocks) in Fall 2018 and seeded a site-specific mix of native species into each of the CGP treatment paddocks at each site in October-November 2018 (Figure 1).

Figure 1. The ten species selected for native seeding into farm sites. See Appendix B for full species descriptions.

Vegetation monitoring

To determine the native and non-native species richness in each site and each treatment (prior to treatment implementation), we recorded all plant species present in each of the five 15 m x 15 m subplots within each plot in each treatment (CGP, BAU, NUP) in spring 2018. Additionally, we recorded the percent cover of trees, woody shrubs, native forbs, native grasses, and abundance of butterfly resource species in each subplot.

Gopher monitoring

Mazama pocket gophers are 100% fossorial, making measures of abundance extremely difficult and labor intensive. Instead of tracking abundance through live-trapping, we have chosen to track presence/absence sign (i.e., mounds; Figure 2) and use these data to determine occupancy estimates. Occupancy as a metric of population status that indicates the proportion of the landscape that is being utilized by the target species. This technique requires repeat visit surveys of fresh mounds within the treatment areas so that seasonal and annual impacts to mound-building are accounted for. We visited plots three times in Fall 2018 with a 3- to 5-day interval between visits. Each survey consisted of searching plots until fresh gopher mounds were located. Repeat surveys will be conducted again each spring and fall throughout the project period to determine how occupancy is changing over time within each treatment.

Figure 2. Old gopher mound with native Ranunculus occidentalis growing out of it at Colvin Ranch.

Butterfly behavior

In high quality habitat, animals tend to have movement paths comprised of short, quick steps and high turning angles (Schultz, 1998; Brown et al, 2017). This behavior results from concentrated individual search behavior in areas with high reward (high density of resources or oviposition/ reproductive sites) in contrast to highly mobile search behavior in areas with low reward (low density of resources or reproductive sites, often called "matrix") and often called an "Area Restricted Search" (e.g. Weimerskirch et al, 2007; Sabarros et al, 2014; Kolzsch et al, 2015). With measures of move rate and turning angle, we can calculate habitat-specific diffusion rates.

We quantified behavior at nine sites in each of the three management categories. We observed two species: silvery blues (*Glaucopsyche lygdamus*) in the early season and ochre ringlets (*Coenonympha tullia eunomia*) in the mid and late season. We conducted our observations by releasing an individual and following it at a distance for up to 60 minutes. Each individual's behavior was recorded and position marked with a pin flag every 15 seconds. From these observations we calculated the move length, turning angles, and diffusion rate in each habitat category. The data in 2018 will be used for the observational and experimental portion of the butterfly portion of this project, with 2018's data as the baseline. Butterfly host plant and nectar data were also collected, which will be analyzed in 2019.

Initial butterfly evaluation at West Rocky prairie.

Soil nutrient assessment

Baseline soil nutrient status was evaluated in fall 2018 from the three cooperating ranch sites and the three prairie sites. Where soil conditions allowed, fifteen ¾" soil cores from each replicate were obtained to a depth of 8 inches. In instances where rockiness prevented soil auger penetration, at least one exposed face soil sample from each quadrant of each replicate was collected to 8". The exposed face consisted of exposing a vertical soil profile to 8”, which required an approximately 6” x 6” area excavation through gravelly conditions. Whether by soil core or exposed face, all sub-samples in each replicate were combined, and a composite sample of two cups from each of six replicates on all six research sites were prepared for shipping to A&L Soil Testing Laboratories in Portland, OR. Samples were maintained in refrigeration prior to shipping, then wrapped with gel packs in bubble wrap for transit. Samples were analyzed for nitrogen, phosphorous, potassium, calcium, magnesium, sulfur, iron, copper, zinc, manganese, boron, pH, cation exchange capacity, organic matter and estimated nitrogen release.

Forage biomass sampling

Forage biomass was quantified by sampling the two primary forage production flushes per season. The first was a spring growth period between approximately March and the beginning of June at which point dry conditions effectively precluded further growth and forage dormancy began. The second was a fall growth period between approximately mid-September when fall precipitation began, and the end of October when cool conditions limited further growth.

Figure 3. Installing grazing exclusion cage at Riverbend Farm.

Year one spring biomass sampling was limited by April award of grant funding, and consequently spring forage sampling occurred after cattle had accessed fields on two of three ranch sites. Spring 2018 sampling therefore underestimated forage production, but was executed regardless to refine and implement protocol for subsequent sampling. Biomass sampling consisted of utilizing a 4.8 ft^2 cable ring cast randomly twice to the left and twice to the right along a 100-ft transect in each replicate at each research site. Four sub-samples from each replicate were dried at 55 degree C for five days at the WSU Puyallup Research and Extension Center. Dried sub-sample weights were obtained to the nearest one-tenth gram, and averaged to provide six replicate values per site.

Fall forage biomass sampling was obtained utilizing the same protocol at the prairie sites as described above due to lack of a need for sampling cages to exclude grazing cattle. Fall forage biomass estimation on ranch sites followed implementation of treatments at all sites in summer 2018.

This increased the number experimental units from six to twelve, consisting of six conservation grazing practice (CGP) units and six business as usual (BAU) units per site. Eighteen grazing exclusion cages were constructed (Figure 3) and installed one each per business as usual unit at the ranch sites. This suboptimal single-sample estimation used in 2018 will be augmented by two additional biomass sub-samples per BAU in years two and three. Four sub-samples were collected and averaged from the CGP units as planned grazing practices in CGP allowed sampling prior to cattle grazing.

Sampling for forage biomass utilizing a NRCS cable hoop method.

In year two (2019), eighteen grazing cages will be installed on CGP units (paired to the existing eighteen in BAU units). Two biomass sub-samples per approximately ¾ acre experimental unit will be collected in addition to each exclusion cage samples, resulting in three sub-samples averaged per unit.

Forage height

Forage height was evaluated only from ranch sites. Ten height measurements from ground-level were recorded by walking a random circuit through each replicate for BAU and CGP units. Sub-sample heights were averaged to provide a single height estimation per replication for both BAU and CGP treatments. In addition, three height measurements were recorded per grazing exclusion cage, providing an estimation of grazing activity outside the cages for BAU and CGP. Total biomass production was evaluated directly from biomass as well as height, utilizing calculations of biomass per inch.

Preparing AmeriCorps volunteers for field work at Riverbend Ranch.

Soil taxonomy work

Taxonomic soil descriptions were completed by the USDA Natural Resource Conservation Service Soil Survey staff operating out of Olympia, WA. From one to three soil pits were excavated at research sites depending on landform diversity, namely presence or absence of mound landforms associated with south Sound prairies. Both mound and intermound soil pits were dug on sites with mounds, as well as pits at other landforms by site such as a lowlying area. Soil taxonomic work consisted of excavating soil with shovels to appropriate diagnostic horizons, which typically did not exceed approximately 100 cm. Methods presented in the NRCS Field Book for Describing and Sampling Soils, version 3.0, were utilized to document site characteristics including parent material, landforms, land shape and drainage, as well as diagnostic features (i.e.diagnositic horizons), and a soil pit descriptions consisting of horizonation, color, texture, and structure. Full soil taxonomic descriptions were included in a final report by NRCS staff.

Research results and discussion:

Vegetation work

We found that native species richness varied by site, with native upland prairie sites hosting an average of 16 – 21 native species, while the farm sites hosted an average of only 1.7 – 7.6 native species (Table 3). A similar pattern existed when organized by treatment: the NUP treatment had over three times as many native species as both the BAU and CPG treatments (Figure 4). There was not as much variability among sites and treatments in the non-native community: non-native richness ranged between 13 – 23 species across all sites.

To compare the plant communities among sites, we utilized non-metric multidimensional scaling ordination to visualize the similarity /dissimilarity between the plant communities at each site (Figure 5). The native upland prairie sites (Johnson, West Rocky, Wolf Haven) all cluster together, representing fairly similar community composition. The farm sites also cluster together, largely separate from the prairie sites, except for Fisher Ranch. Some of the plant communities at Fisher Ranch are similar to those at Johnson Prairie. Interestingly, there are nine plots at Fisher Ranch that host communities that are completely distinct from the rest of the ranch and from any of the other sites. We are in the process of identifying these plots and determining what components of the community separate them from all others.

As we collect additional plant community data after implementation of the CGP treatments, we will display the BAU, CGP and NUP treatments and track how they change over time.

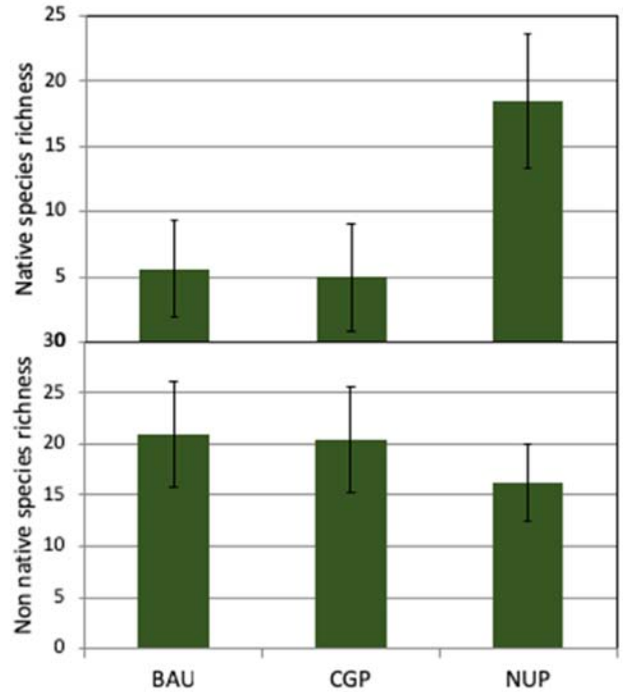

Figure 4. Native and non-native species varied by treatment. Means ± 1SD are presented (n=3).

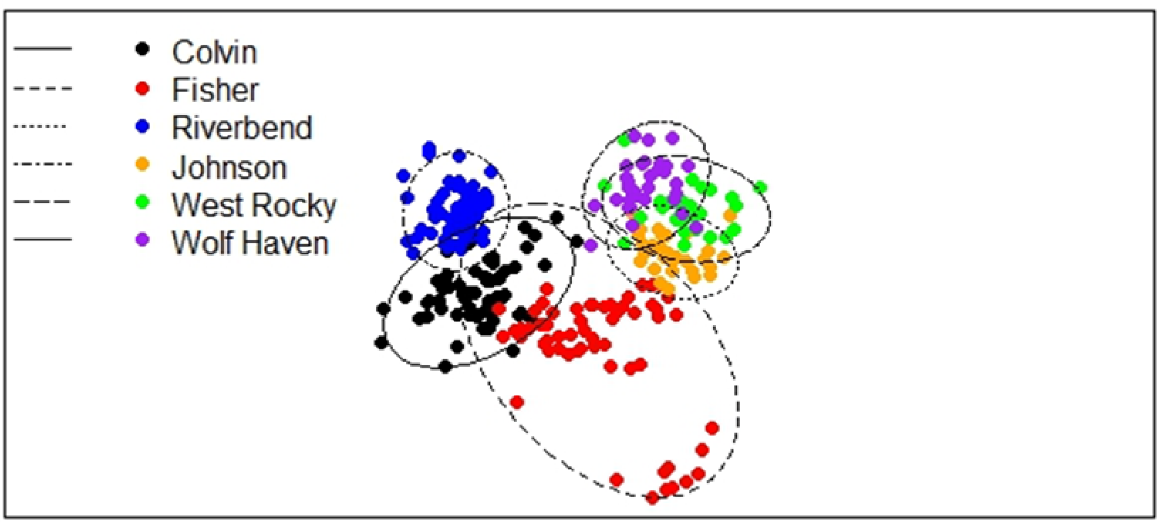

Figure 5. Non-metric multidimensional scaling (NMDS) ordination of the plant communities at each of the ranch and prairie sites in this study. Each dot represents the entire plant community in a single plot. The farther apart the dots are from each other, the more dissimilar the plant communities are. Different sites are represented by different colors.

Table 3. Summarized Soils, Plant Community, Forage Availability and Gopher Occupancy Site Data as Expressed as the Sample Mean ± 1SD.

		Farm sites			Upland Prairie Sites		
Habitat Metric	**Variable**	**Colvin**	**Fisher**	**Riverbend**	**Johnson**	**West Rocky**	Wolf Haven
Soils	Nitrogen (NO3-N) ppm	8.16 ± 3.06	11.16 ± 4.79	6.16 ± 1.60		12.50 ± 7.12	8.33 ± 0.82
	Phosphorus (Weak Bray) ppm	49.83 ± 23.72	5.16 ± 6.11	99.83 ± 30.29		1.00 ± 0.00	2.00 ± 2.45
	Potassium (K) ppm	93.00 ± 27.68	63.33 ± 18.81	135.50 ± 34.51		53.00 ± 3.90	65.17 ± 10.61
Plant Community	Native species richness	6.65 ± 2.60	7.6 ± 4.20	1.7 ± 1.44	18.07 ± 4.23	16.2 ± 5.49	21.07 ± 4.59
	Non-native species richness	23.47 ± 3.98	17.88 ± 6.05	20.85 ± 3.59	18.2 ± 3.36	13.73 ± 3.58	16.73 ± 3.02
Forage availability	Fall forage biomass (ton/acre)	1.02 ± 0.23	0.26 ± 0.15	0.19 ± 0.07	0.58 ± 0.41	0.37 ± 0.16	0.24 ± 0.09
Gopher occupancy	Proportion occupied	0.82 ± 0.26	0.64 ± 0.20	0.74 ± 0.18	1.25 ± 0.38	0.94 ± 0.44	1.08 ± 0.34

Gopher Occupancy

Gopher occupancy ranged from 35% of at Fisher Ranch to 80% at Wolf Haven (Table 3). When evaluated by treatment, the BAU treatment was 37% occupied, while the NUP treatment was 61% occupied (Figure 6). Because the CGP treatments had not yet been implemented at the time of monitoring, any difference between the BAU and CGP treatment areas reflect natural variation on the landscape.

Forage biomass

Biomass production ranged widely from 0.19 to 1.02 ton per acre for ranch sites, and from 0.23 to 0.57 tons per acre for ungrazed prairie (Figure 7). Biomass production was generally the highest on the rotational grazing ranch site, Colvin Ranch, while high stocking rates at Fisher impeded ability to implement rest periods between grazing rotations. Additionally, low productivity at Fisher may be linked to lower phosphorus and potassium

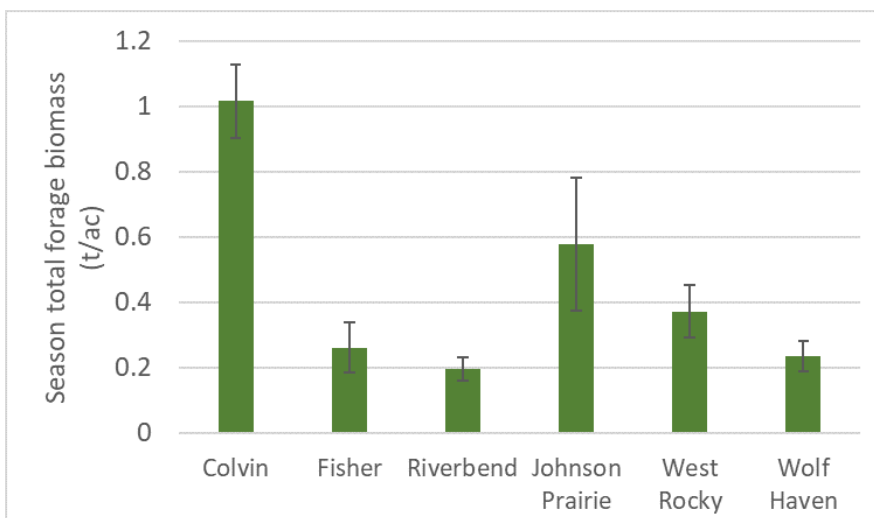

Figure 7. Total season biomass (tons/acre) at cooperating ranch sites and prairie preserve sites.

levels at this site (Table 3). Forage biomass at Riverbend Ranch was underestimated in 2018 due to absence of exclusion cages at the outset of the grant project term. As a result, only fall forage biomass was reported for this ranch.

Lower biomass production at two ungrazed prairie sites (West Rocky and Wolf Haven) correlated with lower nutrient levels at these sites, in particular phosphorus and potassium (Table 3).

Fall forage utilization below a 3-4 inch grazing height is discouraged in conservation grazing practices generally. Leaving forage requires rancher to forgo usage, anticipating greater spring biomass productivity as a result. Percent forage utilization provided an indication of the extent to which this strategy was implemented by different ranch operations (Figure 8).

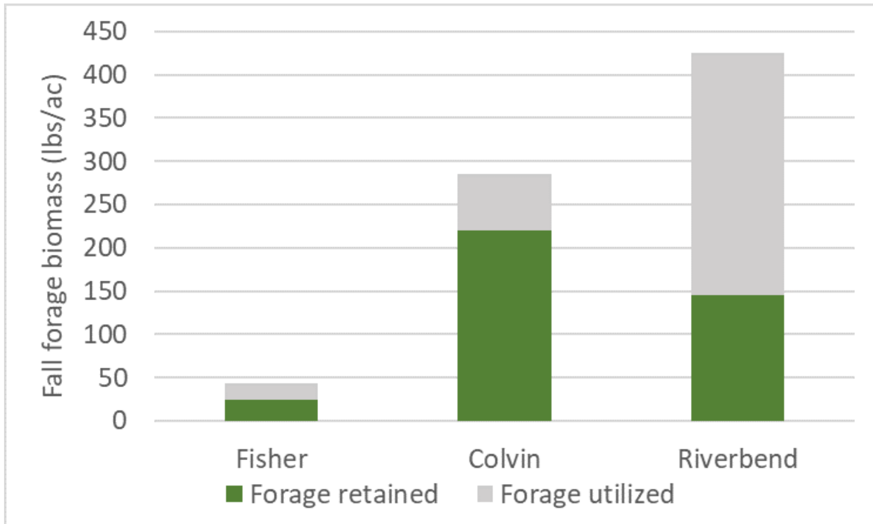

Figure 8. Estimation of forage utilized during the fall growing season, as measured by the difference in forage biomass between exclusion cages and grazed area outside the exclusion cages.

Fall forage utilization at the Fisher site was the heaviest (45%) as compared between that site and Colvin. The 66% utilization estimated at Riverbend resulted from fall treatment implementation consisting of native plant seeding operations. Tractor and seed drill passes matted the biomass and hampered sample collection. Forage at the Fisher site was too low for these operations to have the same effect, while estimations at Colvin Ranch compared samples sites that had not been grazed (exclusion cages) to sites that were grazed but not seeded (Business as Usual treatment). The most conservative fall forage utilization (23%) occurred at the Colvin site, where an explicit goal of encouraging early spring growthwas pursued.

*Estimation of "utilization" at Fisher and Colvin resulted from a direct comparison between excluded and grazed areas where no seeding took place, whereas this estimation of utilization at Riverbend occurred between an excluded area compared to a grazed area that had also been seeded, inflating the measure of utilization (due to trampled forage from tractor traffic and seeding activity).

Forage height

Forage height estimations did begin to indicate treatment effects among grazed sites, although statistical analyses have not been completed. Business as usual forage heights ranged from an average 0.9 in. at Fisher to 2.66 in. at Colvin, with an intermediate value of 1.36 in. at Riverbend (Figure 9). As indicated in Figure 9, forage height within the treatment area (CGP) did not differ markedly at Fisher (0.96 in) or Colvin (2.45 in) but increased at Riverbend (3.23 in) due to implementation of fall grazing exclusion as prescribed in the conservation grazing practices for this site. Treatment applied at Fisher and Colvin were limited to seeding, which did not appreciably alter forage utilization.

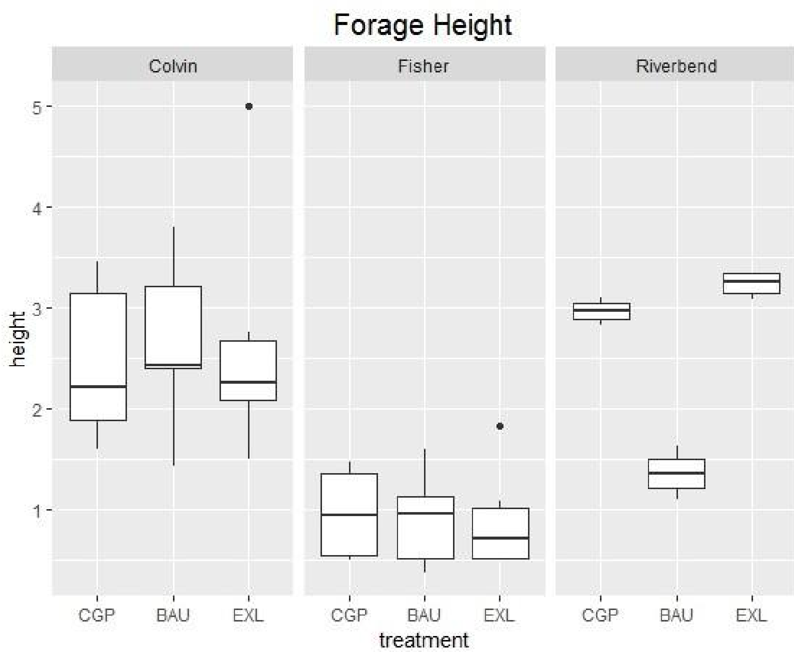

Figure 9. Fall forage height (in) at three ranch sites and according to treatment, including conservation grazing practice (CGP) and business as usual (BAU), as well as forage sampled from within exclusion cages (EXL) at each site.

Forage height in exclusion cages was not apparently different at Colvin and Fisher sites, despite some fall grazing and hence utilization that was detected via biomass estimation at the Colvin site. Exclusion cage placement in 2018 grazing season may not have been early enough at Fisher, or a pattern of long-term overgrazing has slowed forage recovery even when rest is implemented. Overall, fall forage utilization (Figures 10 and 11) as measured by forage height showed little to no difference across treatments, as would be expected, at Fisher and Colvin, as seeding was the implemented treatment. Estimated forage utilization at Riverbend decreased markedly in CGP as compared to BAU, following a grazing prescription to retain 3 in. or more stubble height going into the winter.

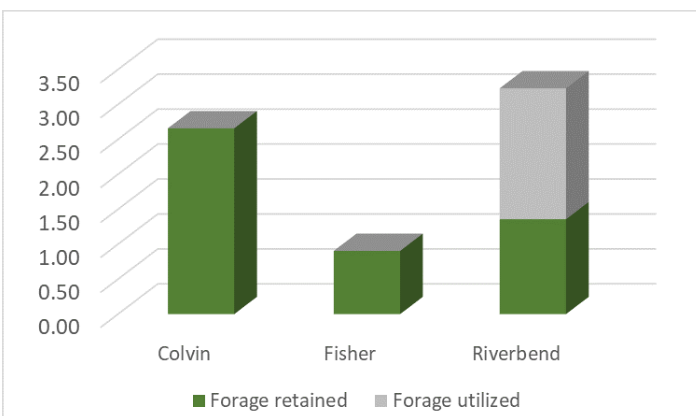

Figure 10. Comparison of forage utilized in 'business as usual' treatments during the fall growing season across ranch sites, as measured by the difference in

forage height (in) between exclusion cages, and 'business as usual' grazed areas outside the exclusion cages.

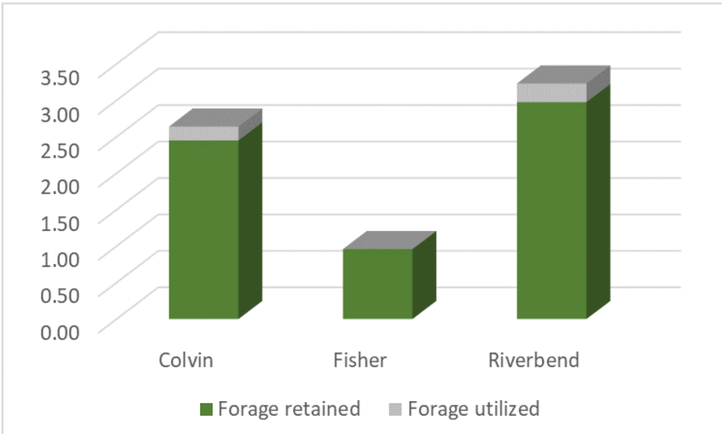

Figure 11. Comparison of forage utilized in 'conservation grazing practice' treatments during the fall growing season across ranch sites, as measured by the difference in forage height (in) between exclusion cages, and 'conservation grazing practice' grazed areas outside the exclusion cages.

Butterfly Behavior

Silvery blue females may have been affected by grazing, as indicated by dispersal rates that were much lower in the ungrazed native upland prairie sites (Figure 12). This was an indication of the area restricted search pattern exhibited in areas with high reward. Silvery blue males did not appear to differ in their diffusion rates. Ochre ringlets did not exhibit a trend in dispersal rates across management types, regardless of sex (Figure 13). These methods will be repeated in 2020 to gather final experimental data. It is expected that a larger sample size will reveal more pronounced trends in diffusion rates across management types.

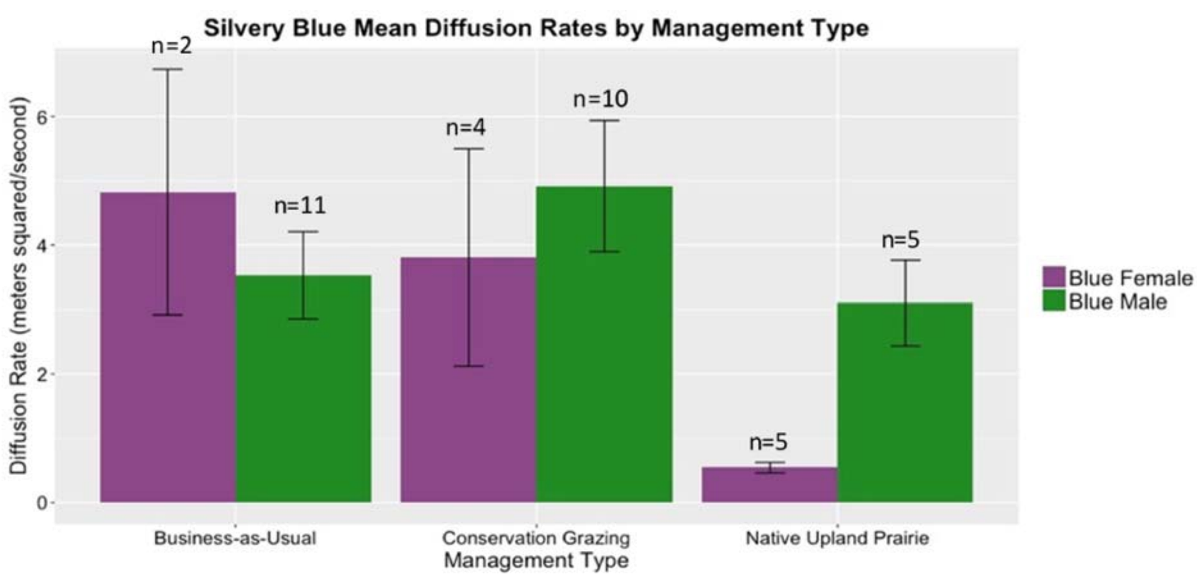

Figure 12. A bar plot showing the mean diffusion rates of male and female silvery blue butterflies under each management type.

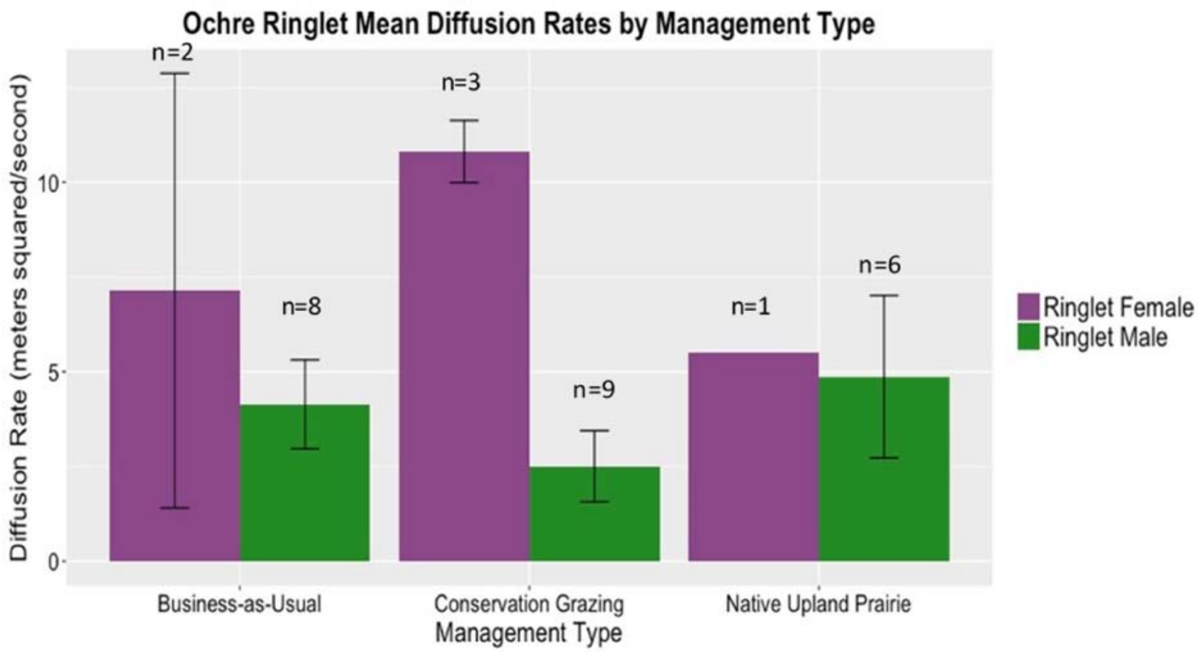

Figure 13: A bar plot showing the mean diffusion rates of male and female ochre ringlet butterflies under each management type.

Soil taxonomic work

The majority of soil profiles at ranch and prairie preserve sites classified as either the Spanaway (Typic Humixercept) or Nisqually (Pachic Humixerept) series, or a higher-taxa Pachic Humixercept (i.e. there is no existing soil series that would be a good fit). In general, the Spanaway-like soils were found in intermound areas, and the Nisqually-like soils were found on the mound sites that had a deeper, darker surface horizon(s). The higher-taxa Pachic Humixerepts, were described as Loamy-skeletal as compared to the sandy Nisqually, or sandy-skeletal Spanaway, meaning they had slightly more clay content within the control section. One outlier was a poorly drained, Norma soil found near a drainage ditch on one of the ranch research sites.

Describing soils at Colvin Ranch.

Based on these sites, a fairly clear pattern of deeper, more organic rich surface A horizons found on mounded areas with thinner A horizons found in the intermound position emerged. In addition, in general the mounded areas had either less rock fragment content by volume and/or smaller rock fragment diameter within the surface A horizons.

In general, soil pit descriptions mostly conformed (though did not capture the higher taxa) to soil units mapped on NRCS Web Soil Survey (Table 4). Full soil pit descriptions are available upon request.

Table 4. *Mapped soil series and soil series as verified by soil pit descriptions at ranch and prairie preserve research sites*

Site	Mapped soil series	Soil pit description	Notes
West Rocky	Spanaway Nisqually complex	Mound: Nisqually or higher order taxa Intermound: Spanaway	Mound land form resulted in loamier soil (slightly higher clay and silt content) than typical Nisqually
Wolf Haven	Spanaway Nisqually complex	Mound: Nisqually Intermound: Spanaway	
Johnson Prairie	Not complete	Not complete	
Riverbend	Nisqually	Upland pit: Nisqually Pit near drainage: Norma	Clay, loam content not elevated as in higher taxa Pachic Humixerept.
Colvin	Spanaway Nisqually complex	Mound: Nisqually or higher order taxa Intermound: Spanaway	Mound site with elevated clay and silt content in A1 horizon
Fisher	Spanaway Nisqually complex	Upper field: Nisqually or higher order taxa Lower field: Nisqually or higher order taxa	Both sites with elevated clay and silt content in A1 horizon
Maynard Mallonee	Alvor, Reed, Chehalis, Newberg	Not complete	

Appendix A.

Figure 1. Location of all ranch sites and native upland prairie sites within Thurston County, Washington State, USA.

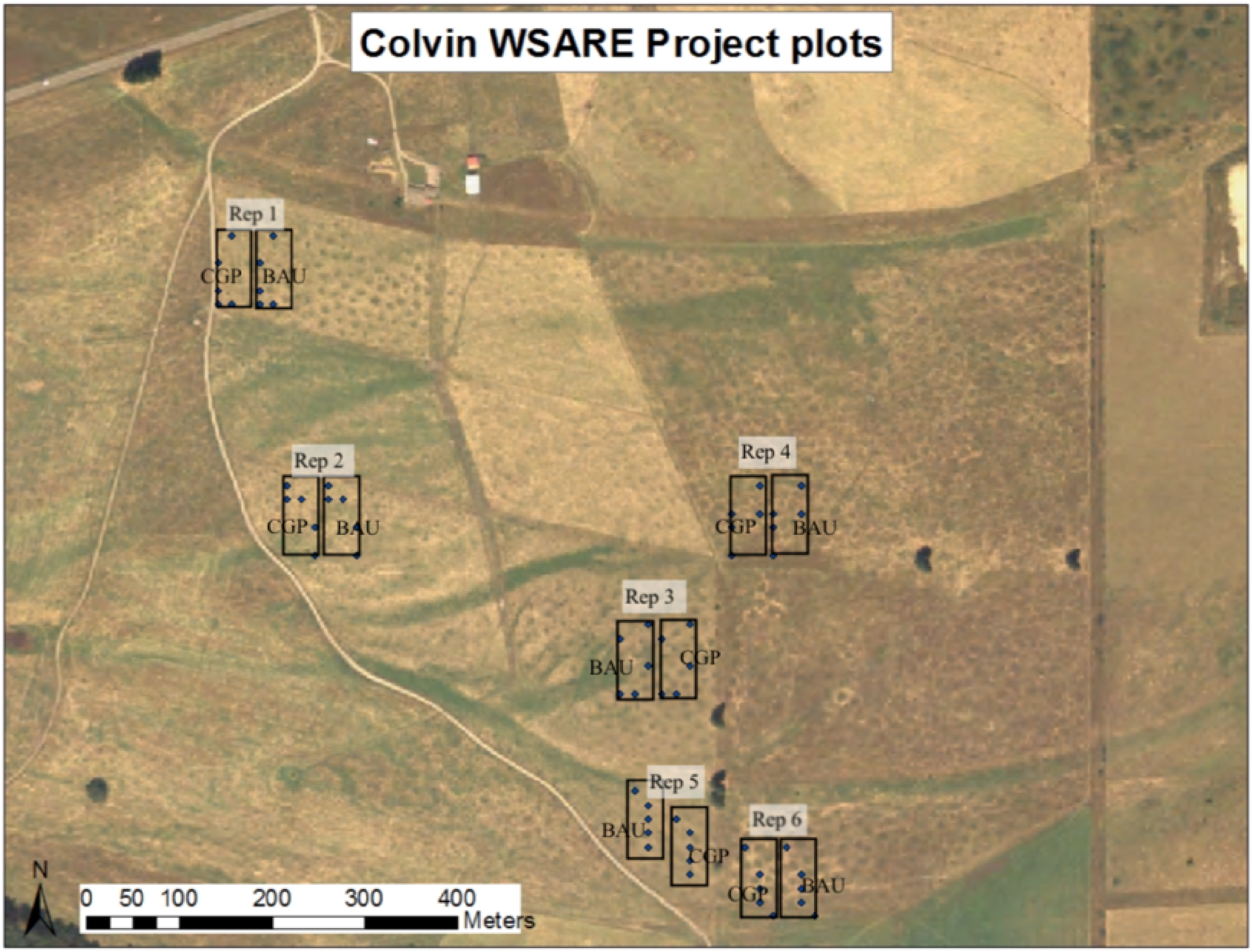

Figure 2. Replicate 1-acre CGP and BAU paddocks at Colvin Ranch

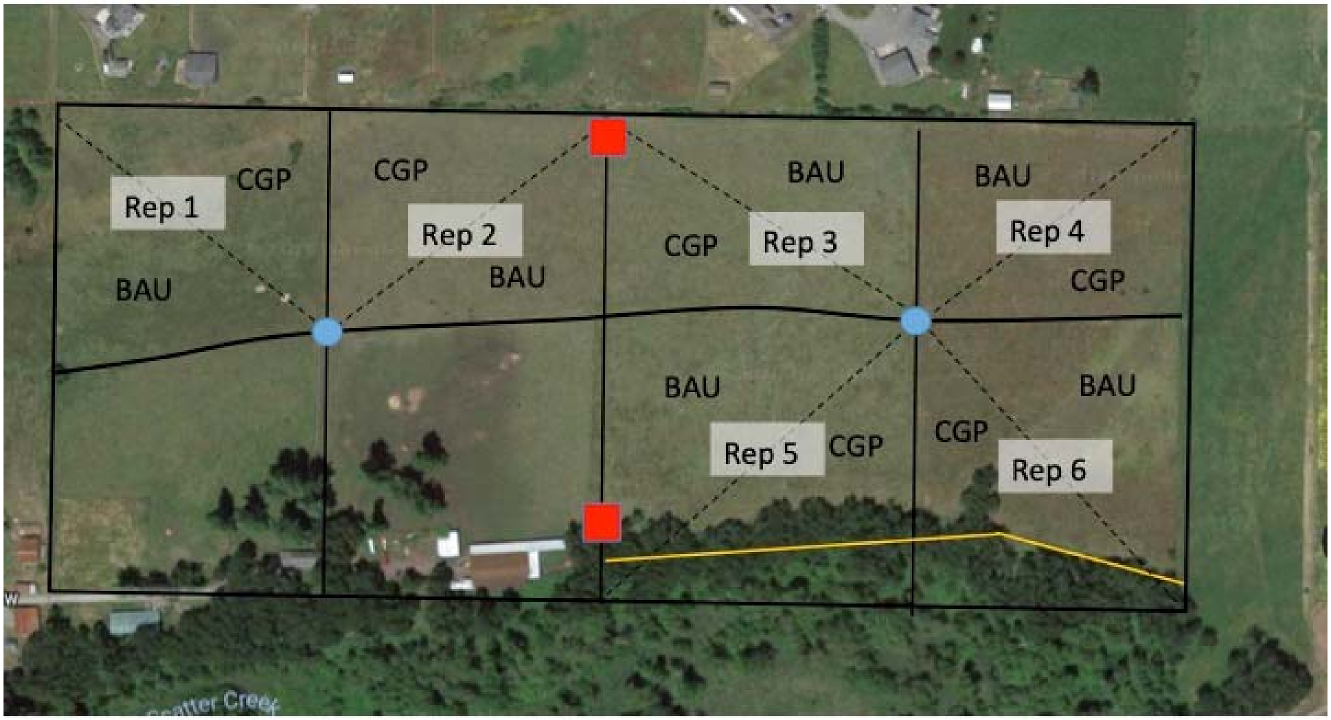

Figure 3. Replicate 1-acre CGP and BAU paddocks at Fisher Ranch

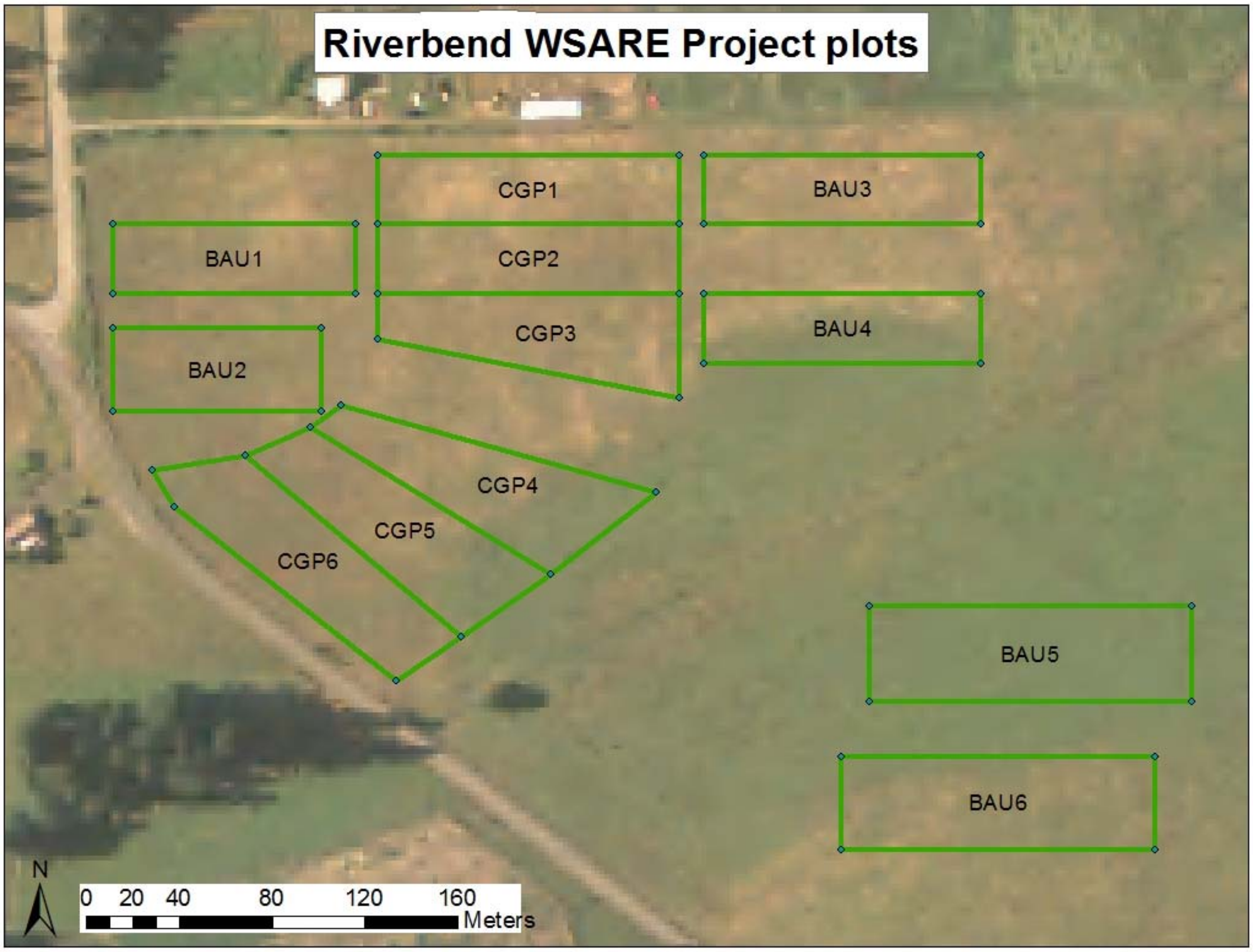

Figure 4. Replicate 1-acre CGP and BAU paddocks at Riverbend Farm

Appendix B. Species seeded into farm sites, along with life history and seeding rates

Scientific Name	CODON	Common Name	Family	Life History	Sites where seeded	Seeding Rate (lbs/acre)	PLS/m^2
*Castilleja levisecta**	CASLEV	Golden paintbrush	Orobanchaceae	Perennial, hemi-parasite	Colvin, Riverbend	0.350	297.589
Cerastium arvense	CERARV	Field chickweed	Caryophyllaceae	Annual	Fisher, Colvin, Riverbend	0.022	13.916
Collinsia parviflora	COLPAR	Maiden blue-eyed Mary	Scrophulariaceae	Annual	Fisher, Colvin, Riverbend	0.153	12.436
Eriophyllum lanatum	ERILAN	Oregon sunshine	Asteraceae	Perennial	Riverbend	0.059	16.768
Lomatium triternatum†	LOMTRI	Nineleaf biscuitroot	Apiaceae	Perennial	Fisher, Colvin, Riverbend	0.353	5.205
Lupinus bicolor	LUPBIC	Bicolor lupine	Fabaceae	Annual, legume	Fisher, Colvin, Riverbend	0.246	5.182
Microseris laciniata	MICLAC	Cut-leaf microseris	Asteraceae	Perennial	Fisher, Colvin, Riverbend	0.062	6.093
Plectritis congesta	PLECON	Sea blush	Caprifoliaceae	Annual	Fisher, Colvin, Riverbend	0.110	17.646
Ranunculus occidentalis	RANOCC	Western buttercup	Ranunculaceae	Perennial	Fisher, Riverbend	0.213	9.621
Viola adunca	VIOADU	Hookedspur violet	Violaceae	Perennial	Fisher, Colvin, Riverbend	0.113	16.864

PLS = Pure Live Seed

** Only seeded CASLEV into 3 of the paddocks at Colvin and into 6 plots (1 per paddock) at Riverbend due to limited seed availability. Seeding rate of CASLEV at Riverbend was slightly higher than other sites: 309 PLS/m^2;*

† Only seeded into plots, not the entire paddock, at Fisher due to limited seed availability

4 Farmers participating in research

Education

No education

Educational & Outreach Activities

2 Consultations

1 Published press articles, newsletters

2 Webinars / talks / presentations
1 A project webpage was developed where reports, events and updates related to the research project have been posted: https://extension.wsu.edu/thurston/agriculture/on-farm-conservation/prairie/

Participation Summary

No participation

Education/outreach description:

Bussan, S. 2018. Can conservation grazing maintain habitat quality for butterflies? Presentation at the Entomological Society of America Conference. Vancouver, BC.

- Audience was scientists or other professionals in the fields of entomology and/or ecology. Approximately 30 attendees.
- The topic of the talk was the butterfly behavior in grazed and ungrazed prairie. The graphs from this talk and description of the results are included in the report.

Bussan, S. 2018. A review of the literature on butterflies and cattle grazing. Presentation and panel discussion at the Cascadia Prairie Oaks Partnership meeting. Eugene, OR.

- Audience was scientists or other professionals in the field of prairie ecology. Approximately 100 attendees.
- The topic of the talk was the literature on butterflies and cattle grazing, as a framework and introduction for a session on cattle grazing in prairies.

Two consultations were held in 2018 focused mostly on working with cooperating farmers on this project. We completed the two planned farmer work sessions gathering economic data on grazing operations that will be used to complete a *Fifty Head Cow-Calf Grazing Enterprise Budget in South Puget Sound*, and secondly to gather feedback on a farmer-rancher survey evaluating perspectives on conservation programs for working lands.

Learning Outcomes

No learning outcomes

Project Outcomes

1 Grant received that built upon this project
1 New working collaboration

Participants

No participants