Upper Falls Creek *Carex gynocrates* Grazing Study
2012 Final Report
Methow Valley Ranger District
Okanogan-Wenatchee National Forest
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Introduction:
Summer of 2012 marked the conclusion of a four-year study monitoring the effects of grazing on *Carex gynocrates* and its sensitive fen habitats in the upper reaches of Falls Creek, north of Winthrop, WA. Four study sites were established in 2009. Grazing exclosures were built in three of these sites, prior to monitoring. The study compares grazed and ungrazed portions of fen habitats containing *C. gynocrates.* Findings of this study will inform management of these sensitive habitats.

Background:
Carex gynocrates is a boreal disjunct sedge at the southernmost extent of its range in the Pacific Northwest. There are five populations of *C. gynocrates* in the State of Washington and all five are in the northern portion of the Okanogan Forest. In BC, *C. gynocrates* is more common and mainly associated with the Boreal White and Black Spruce biogeoclimatic region located in the very northeast portion of the province. In the central interior and southern portions of BC, *C. gynocrates* is found in association with the Sub-boreal Spruce, and Engelmann Spruce Subalpine-Fir biogeoclimatic regions where it is listed as secure. In all cases, the plant is associated with bogs, swamps, fens and wet meadows that occur in these upper montane and alpine habitats of BC (Klinkenberg 2008).

The study area is located in a stringer of wet fen meadows in the upper reaches of Falls Creek, approximately 18 miles north of Winthrop, Washington. The study area is accessible only by trail, an approximate 2 mile hike. The meadows are interspersed within an upper montane subalpine fir/grouse whortleberry (*Abies lasiocarpa/Vaccinium scoparium*) plant association. Elevation ranges between 5500 and 5800 feet in the study area. Upland forest composition is predominately lodgepole pine (*Pinus contorta*) in the overstory mixed with spruce (*Picea engelmannii*) in the wetter microsites, with subalpine fir and whitebark pine (*Pinus albicaulis*) occurring infrequently. Labrador tea (*Ledum glandulosum*) and *Potentilla fruticosa* border the fen edges. The fens themselves are dominated by mosses (most abundantly *Drepanocladus aduncua* and *Amblystegium riparium*) and the fewflower spikerush (*Eleocharis pauciflora*).

Figures 1 and 2: 2009 “Control” Site Conditions

Eleocharis pauciflora appears to provide the root strength that holds these ecosystems together. It will likely play a key role in the recovery of these sites. Control 6/18/2009.

The meadows of upper Falls Creek are saturated year round and surface water is common. Soils are comprised of eight to 12 inches of organic muck/ooze over a gravel substrate. These peatland ecosystems are rare across the District and comprise some of the most biologically diverse habitats on the Forest. Little-to-no limestone substrate, preferred by *C. gynocrates*, occurs on the Methow Valley Ranger District or across the Okanogan. Calcium present in these fens is thought to be derived from the decomposition of feldspars (Lentz, 2009). This makes the Okanogan unique in the underlying geology that supports peatland ecosystems compared to the Northern Rocky Mountains. Fens can be classified based on species assemblages and water characteristics. The water of poor fens typically contains Calcium (Ca) levels between 2-10 mg/L and a pH range between 4.2 and 5.8. Rich fens have Ca levels between 10-30 mg/L and higher pH than a poor fen, though still somewhat acidic. Very rich fens have the highest concentrations of calcium with Ca >30 mg/L and are basic with pH >7 (Chadde et al, 1998). Results of water tests and species assemblages place the fens in our study site into the rich fen category (Table 1). Rich and Very Rich fens are considered to be the most floristically diverse of the peatland ecosystems.

According to the site records, two of the five known populations of *C. gynocrates* in Washington State are actively grazed. The population located in our study area is the largest in the state and is grazed annually, season-long by about 30 to 50 cow/calf pairs. As mentioned before, the soils in these fens are saturated and are up to 12 inches deep. Cattle impact is most dramatically expressed in these meadows by the cumulative effects of trampling and erosion. It is not uncommon to see the soil at these sites eroded down to the gravel substrate. This study was initiated in 2009, due to a perceived deterioration in *C. gynocrates* habitat, thought to be associated mostly with annual cattle grazing. The Area Ecology program funded the study design, fence construction, and first year of data collection. ISSSSP funded the collection of vegetation data and report writing during the years of 2010-2012.

Water samples were collected only during the first year of the study. Without trend data, the exact effects of cattle grazing on the peatland chemistry of these meadows are unknown. One season's data indicates that Calcium was highest during dry conditions and lowest during the wettest periods. Acidity levels did not appear to fluctuate as much after rain events as did calcium levels. Annual water testing was discontinued after 2009; however, future post-exclusion tests may prove to be extremely informative after the sites have had some years to recover.

Table 1: 2009 Water Sampling Results in the Upper Falls Creek Fen Meadow System.

Sample Date	Control		Site 1 w/ exclosure		Site 2 w/ exclosure		Site 3 w/ exclosure		Site 4 no exclosure		note
	CA mg/L	**pH**	**CA mg/L**	**pH**	**CA mg/L**	**pH**	**CA mg/L**	**pH**	**CA mg/L**	**pH**	
6/12/09			7.2	6.94	9.55	7.04	6.8	7.00			Spring run off
6/26/09	12.6	7.43							10.1	7.08	Cattle already in mdws – spring run off
9/9/09	15.0	7.5	10.7	6.31	15.0	6.71	10.6	7.31	11.2	7.4	After first rain ~ 1" ppt between 9/3 & 9/6
9/28/09	18.4	6.94	10.4	6.9	24.6	6.10	23.4	6.82	16.0	6.83	No ppt since 9/6 -- driest conditions for sampling
10/18/09	13.4	7.36	8.5	6.85	10.9	6.6	8.4	6.96	8.05	7.04	ppt between 10/12 & 10/16 was about 0.6"

Three grazing exclosures were built in 2009, in seperate meadows, in order to collect data on site recovery post-grazing. At two sites (Sites 1 and 2), 15.39x15.39 meter square (50 X 50 ft) exclosures were constructed. Due to the size and shape of Site 3, the exclosure built in it was 12.19 X 18.29 meters (40 X 50 ft). Eight transects, four inside the exclosure and four outside, were installed at each site and were permanently monumented. A fourth site (referred to as the Control), also had eight transects installed; however, no exclosure was constructed.

Table 2: Physical Aspects of the Upper Falls Creek Fen Study Sites

	Site 1	Site 2	Site 3	Control
Aspect	90^0	100^0	176^0	122^0
Elevation (ft)	5865	5501	5829	5718
Slope	18%	10%	28%	28%

The study was conducted during August of years 2009 through 2012 at all four sites. Therese Ohlson was the initiator and District Botanist in charge of the study from 2009 to 2011, while in 2012 Kelly Baraibar took over as District Botanist. David Bowden, Botany Technician, assisted from 2010 to 2012. Cattle accessed the "Control" site during years 2010-12, negating its usefulness as a non-grazed area; however, data was still collected at this site. In 2010, cattle got into the exclosure at site 1. In 2011 cattle got into the exclosure at site 3. 2010 and 2011 were some of the wettest years on record in this locality. Timing and cattle usage were not consistant, year-to-year.

In fall of 2011 a drift fence was constructed to exclude cattle from the upper reaches of Falls Creek entirely. This fence was a mitigation to protect this fen ecosystem from further grazing resulting from a recently completed Allotment Management Plan Revision. An opening was intentionally left in the fence during the summer of 2012, in order to allow cattle access during this final year of the study. After data collection, a gate was added to the fence in the Fall of 2012 to complete the exclusion.

Methods:

At each site, eight transects are permanently monumented with beginning and ending stakes. With the exception of the "Control" site, four of the eight transects are inside an exclosure and four are outside. Transects are 14 meters long and spaced 3.5 meters apart in a series of four parallel lines. At Site 3, transects were spaced 3 meters apart due to exclosure size. On each transect, ten ¼m^2 quadrats placed at 3.5 meter intervals are read. Cover was recorded for each species along with percent bare ground, surface water, litter, and the depth of exposed roots in cm. Additionally, qualitative data such as the amount of erosion, depth of penetrative impact, and overall site condition was collected and trend photos were taken at established photo points. During the 2012 study year, all sampling methods were consistent with 2009, 2010, and 2011.

Crew size varied from year to year, but contained no less than four members each year. The amount of time spent on the study depended on funding. During the years of 2009, 2010, and 2012 the study was conducted over a two week time period. In 2011 the study was conducted in one week, with a larger crew. Time constraints and inconsistencies in personnel placed limitations on the quality of data collected. There was no time or funding for ground-truthing. All quality control was done post-measurement. New crew members were used every year, and no single person was present for all four years of the study.

Several of the factors measured were difficult to achieve consistent data on. At the beginning of each year's work, the group would do a few test plots in order to make sure that everyone was more or less in the same ballpark in their measurements of cover. Measurements of litter were often inconsistent, even after several practices plots and adjustments. This is probably due to the fineness of dead grass, as well as the ambiguity in distinguishing between litter and organic much/ooze – another category that was measured. Cover categories would sometimes occur in compact layers, the top obscuring the lower ones from measurement. Litter would

often be obscured by densely cespitose graminoids. Moss cover was also somewhat inconsistent, probably due to the same reasons. When reading plots, we attempted to identify every species, however, grazing and/or lack of distinguishing characteristics prevented this occasionally. Measurements of depth of exposed roots (called depth of erosion in our data) were also problematic, as we were frequently measuring the amount of exposed soils/roots in hoof prints filled with water and mud. Water cover was very inconsistent, and could vary simply based on where the plot reader was standing or sitting, squishing more water into the plot. It would obviously fluctuate based on recent rain, or annual groundwater levels. Measurement of *C. gynocrates* itself was problematic, due to its tiny size and frequent lack of seed-heads. For all of these reasons, it was determined that our analysis would focus mostly on *C. gynocrates,* the vegetation categories of graminoids (AG – all graminoid species combined) and forbs (FB), and the abiotic category of bare ground (BG). These categories were the least problematic, and contained sufficient data at each site for adequate comparison (with the exception of *C. gynocrates* at site 2).

Results:

Site 1:
This site is the lowest of the four, and usually the first accessed by cattle; however, it is removed from the main trail by about 50 meters, so cattle sometimes bypass it for site 2 which is directly accessed by the main trail, just a quarter-mile north of Site 1. Cattle usage at this site was fairly consistent from year to year. In the second year of the study, cattle were able to graze inside the exclosure, due to snow damage to the fencing; however, very little utilization was detected in the exclosure. This site was the first to be recorded every year, and as such was susceptible to the highest levels of measurement error of all the sites. New crew members were used for measurements every year, and no single person was present for every year of the study, allowing for inconsistencies in methods and competencies. Site one was the de-facto training site every year. It is included for comparison with the data from the other sites, but it is not recommended to be used as part of the final analysis.

Bare ground decreased over the four year period, both inside and outside the exlosure; however bare ground inside the exclosure was consistently lower than outside, and the decrease in bare ground inside the exclosure between 2009 and 2012 is significant while that of outside the exclosure is not. In the first year of the study, there was no statistical difference between the levels of bare ground inside and outside of the exclosure. In the following three years, there was marked difference between levels of bare ground inside and outside the exclosure, with outside being greater.

All categories saw a decline in cover, with the possible exception of litter. Litter data was not collected properly at Site 1 in 2009, and had to be thrown out. Concurrent decline in ground cover and bare ground is problematic. Data at this site does not tend to follow the pattern observed at the other four sites.

Carex gynocrates was not recorded in sufficient quantities to provide for proper statistical analysis. Data for *C. gynocrates* at Site 1 is inconclusive.

Table 3: Site 1 Mean Cover of Vegetation Categories, Bare Ground, and Litter. Inside and Outside Exclosure.

Inside Exclosure

	AG	FB	SH	MO	BG	LI	CAGY
2009	40.9	14.3	3.5	26.8	27.0		0.0
2010	48.2	16.1	2.8	54.9	8.9	40.0	1.0
2011	43.6	20.0	2.5	43.4	13.3	32.2	0.4
2012	33.1	13.5	3.2	22.4	14.1	31.1	0.2

Outside Exclosure

	AG	FB	SH	MO	BG	LI	CAGY
2009	35.7	11.2	0.6	30.1	34.9		0.2
2010	35.8	8.1	0.3	41.5	26.5	22.6	0.1
2011	33.3	9.4	0.5	36.1	30.3	16.4	0.0
2012	33.1	9.8	0.5	29.8	28.6	20.9	0.4

AG = all graminoids, FB = forbs, SH = shrubs, MO = moss, BG = bare ground, LI = litter, CAGY = *Carex gynocrates*

Figure 3: Site 1 Data Comparison Over Time

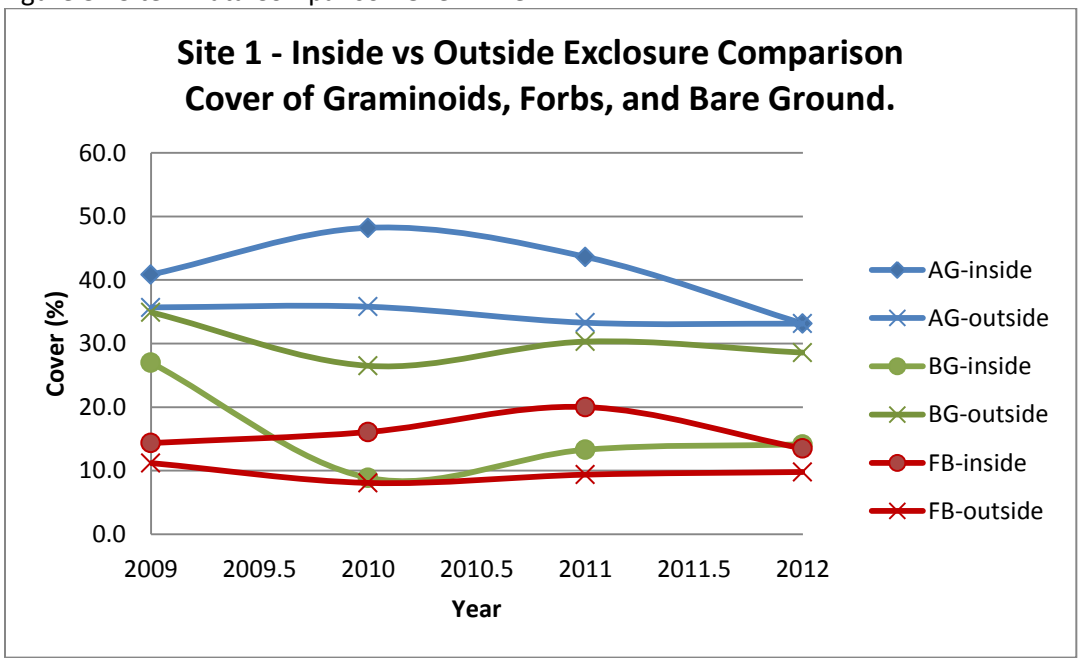
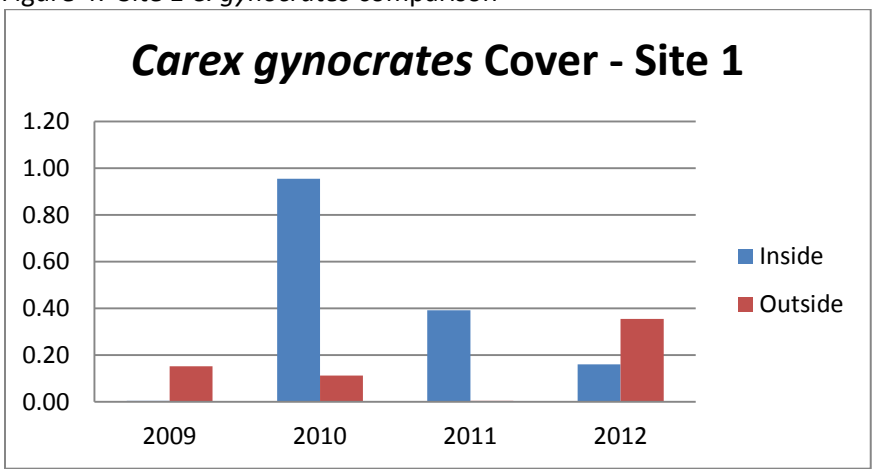


Figure 4: Site 1 *C. gynocrates* comparison



Site 2:

This site is the most easily accessible to cattle, as it directly borders the main trail. Consequently, grazing is the most intense at this site. Little to no *C. gynocrates* was actually recorded in the transects at this site; however, data on other categories is still useful for comparison.

While forbs and graminoids showed little difference between inside and outside the exclosure, levels of bare ground diverged dramatically in the final year, with outside having much more bare ground than in.

Graminoids inside the exclosure have consistently higher cover levels than outside, but this may just be a characteristic of the site, rather than the result of cattle exclusion. The data for both treatments are roughly parallel.

It is worth noting that litter levels outside the exclosure dropped dramatically during the course of the study. While there was also a decrease in litter inside the exclosure, it was not as dramatic. This is the only site that experienced such a marked decline in litter.

Table 4: Site 2 Mean Cover of Vegetation Categories, Bare Ground, and Litter. Inside and Outside Exclosure.

Inside Exclosure

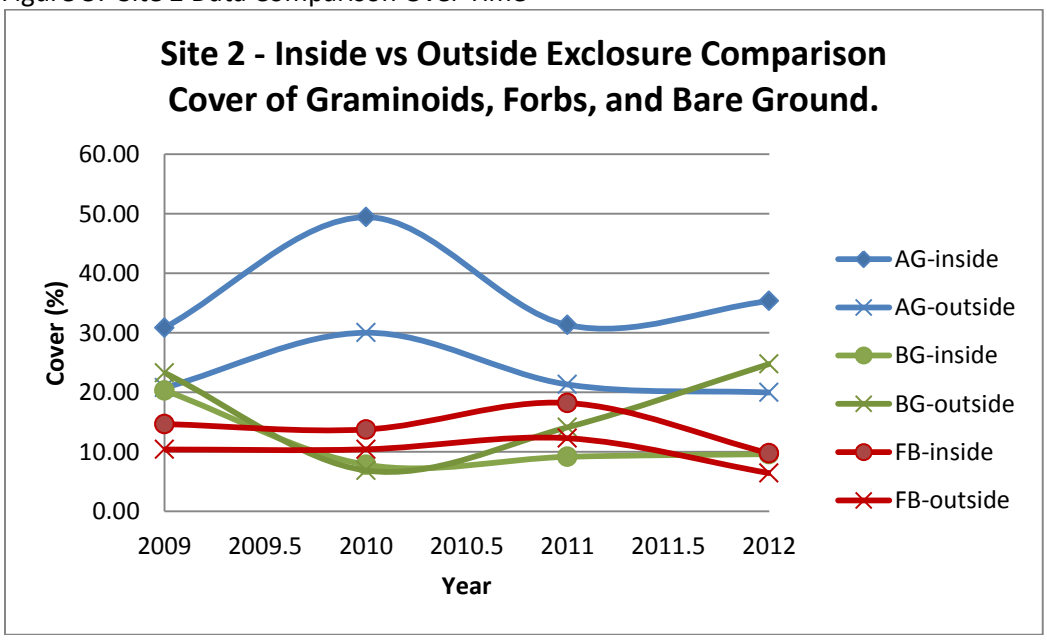
	AG	FB	SH	MO	BG	LI
2009	30.87	14.68	9.18	37.83	20.33	37.90
2010	49.43	13.77	8.48	70.14	7.85	20.67
2011	31.31	18.21	8.91	61.02	9.17	11.01
2012	35.34717	9.765857	9.886266	60.38639	9.624686	11.12712

Outside Exclosure

	AG	FB	SH	MO	BG	LI
2009	20.78	10.41	0.96	42.60	23.27	40.36
2010	30.02	10.43	0.87	66.08	6.88	14.00
2011	21.31494	12.29181	0.467192	68.39202	14.14047	4.828565
2012	19.97005	6.434014	0.7375	62.08583	24.7696	3.58801

AG = all graminoids, FB = forbs, SH = shrubs, MO = moss, BG = bare ground, LI = litter

Figure 5: Site 2 Data Comparison Over Time



Site 3:
This site is easily accessed via the main trail; however, it is further up the Falls Cr drainage than both site 1 and 2. In 2011, the exclosure fence at this site was broken and cattle were able to graze inside the excluded area. Significant signs of grazing were found inside the exclosure that year.

The data at this site shows almost no difference between treatments, aside from the differences that were already inherent in the locations of transects. Bare ground did show a net decrease inside the exclosure, versus no change outside; however, the divergence between the two is nothing like that seen at Site 2. *Carex gynocrates* cover was consistently higher inside the exclosure than outside, and showed a net increase inside.

Table 5: Site 3 Mean Cover of Vegetation Categories, Bare Ground, and Litter. Inside and Outside Exclosure.

Inside Exclosure

	AG	FB	SH	MO	BG	LI	CAGY2
2009	31.84671	18.70471	0.933554	13.55822	39.1402	8.867854	0.6775
2010	49.51085	20.23474	0.77625	46.5001	9.402364	42.44195	2.6525
2011	25.60407	13.5448	0.352537	42.42012	19.79407	28.18316	0.44125
2012	36.53563	13.91854	0.659329	22.77593	31.84365	43.89694	0.97

Outside Exclosure

	AG	FB	SH	MO	BG	LI	CAGY2
2009	17.70265	20.64743	9.055053	26.17995	34.6609	16.38276	0.1025
2010	30.6968	25.19148	13.10142	49.05903	12.53898	27.1948	0.1525
2011	12.97242	15.04884	9.001769	43.36668	21.07277	16.79003	0.10875
2012	24.20189	20.56384	8.7175	40.22785	34.37439	15.90453	0.14

AG = all graminoids, FB = forbs, SH = shrubs, MO = moss, BG = bare ground, LI = litter, CAGY = *Carex gynocrates*

Figure 6: Site 3 Data Comparison Over Time

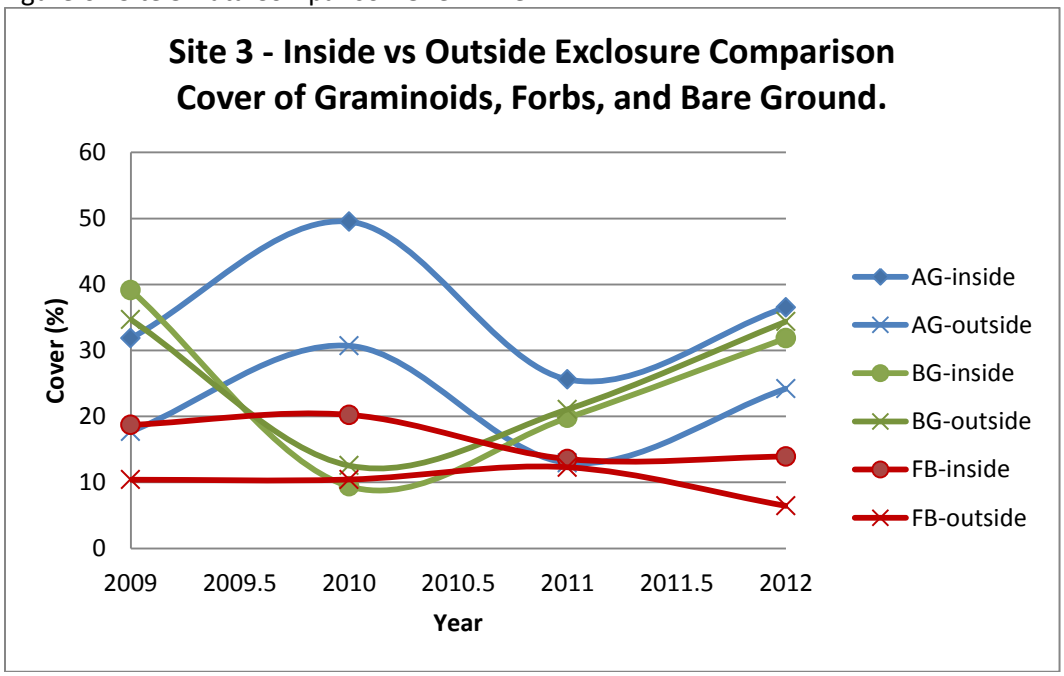
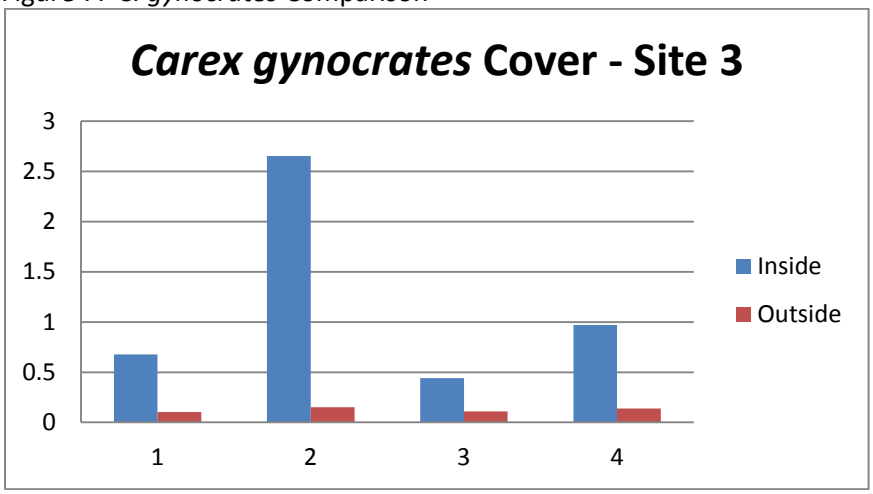


Figure 7: *C. gynocrates* Comparison



Control:
This site was the furthest up the drainage, and is accessed by a side-trail. Originally it was thought that cattle didn't access this site, therefore it could be used as a sort of control. Cattle accessed the site in 2010, 2011, and 2012. The data collected may still be useful in comparing trends. For example, though the site was grazed in 2010, all vegetation cover increased in that year – consistent with the pattern observed at sites 2 and 3.

Graminoids decreased overall, while bare ground and forbs barely changed. This is the only site that saw a slight increase in bare ground in 2010. Fluctuations in *Carex gynocrates* cover over the four years parallels that seen inside the exclosure at site 3.

Table 6: Control Mean Cover of Vegetation Categories, Bare Ground, and Litter.

	AG	FB	SH	MO	BG	LI	CAGY2
2009	37.33651	15.20165	7.659404	19.81446	34.72519	22.82216	0.825076
2010	42.78712	16.90142	8.545489	36.31049	34.95753	38.80543	2.162936
2011	23.20833	11.02675	5.938438	37.92625	21.65735	30.76477	0.843701
2012	23.4324	11.12261	7.141991	26.75866	33.36524	31.48284	1.391878

Figure 8: Control Data Comparison Over Time

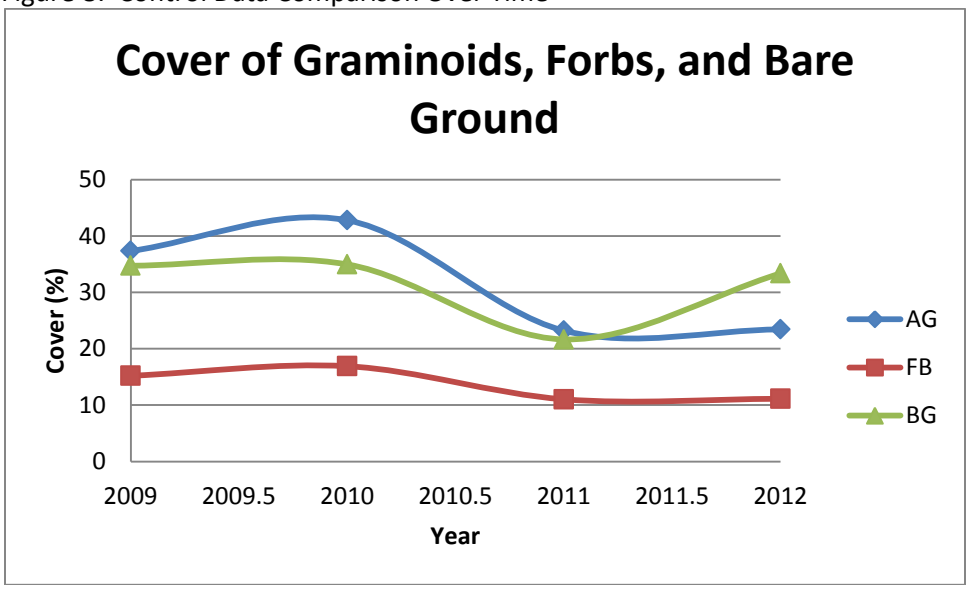
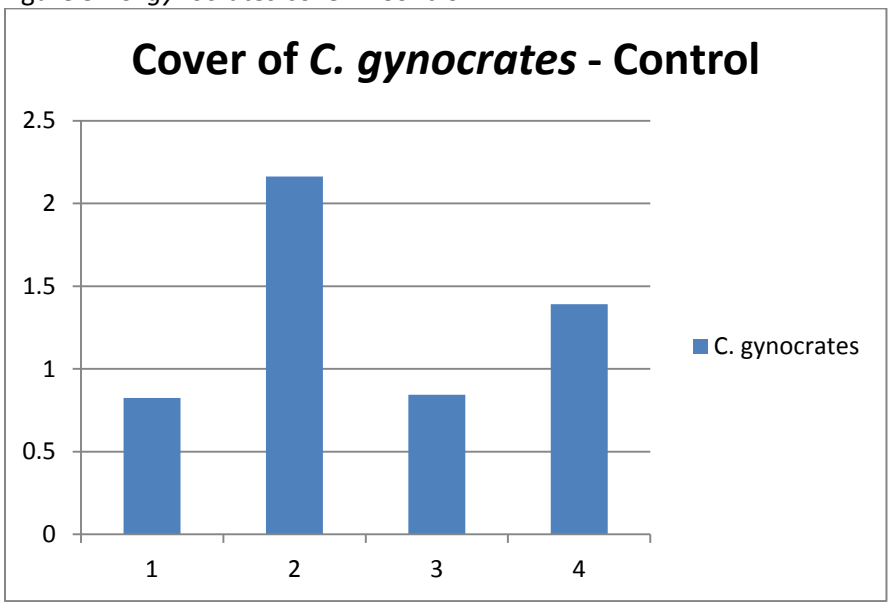


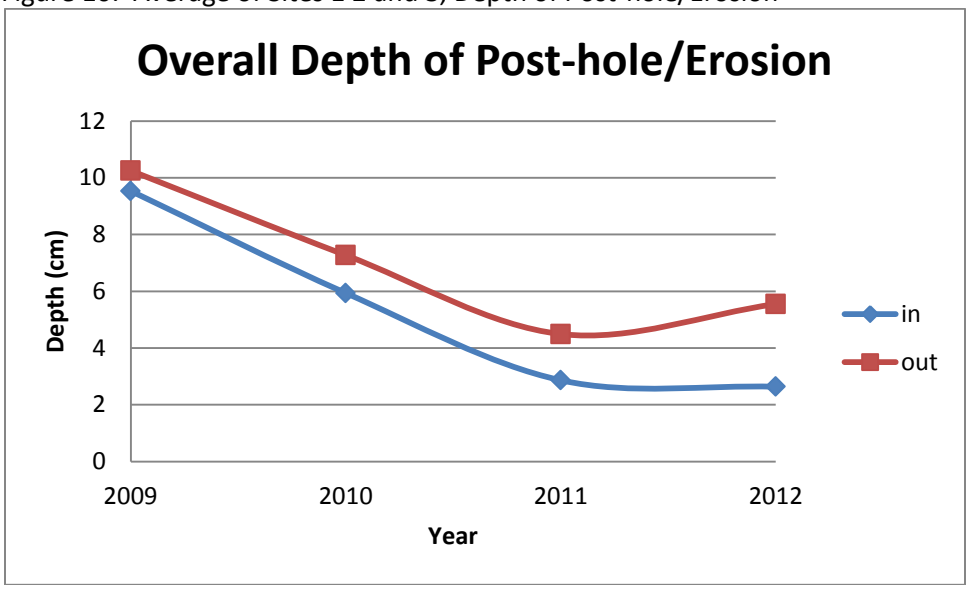
Figure 9: *C. gynocrates* cover – Control



Overall:

When charted, the data taken on the depth of post-holing and erosion followed a consistent pattern at each site – best illustrated by combining the data from sites 1 2 and 3. It shows a parallel decrease, inside and outside the exclosures, up until 2012 in which each site experienced a significant uptick outside the exclosure while the inside continued to decline.

Figure 10: Average of Sites 1 2 and 3, Depth of Post-hole/Erosion



Discussion:

This study was not designed with a specific statistical test in mind for analyzing the data. For this reason, most of the data and analysis is expressed in simple means. Wilcoxon and Mann-Whitney tests were performed on the data, however those statistics are not included in this report.

Some of the differences between 2009, 2010 and 2011 may be attributed to seasonal fluctuations. In 2010 the spring weather was the second wettest and the third coldest on record for the Methow Valley. The summer of 2011 was also unseasonably cool and wet. In 2010, the plots were also read a week earlier than in 2009 due to available resources. And in 2011 and 2012, plots were read two weeks later than in 2009 and one week later than in 2010. Since the seed shatters readily once mature, the earlier date and slower maturation of the flower, due to cooler weather in 2010, may have resulted in more detection of *C. gynocrates* inside the exclosures and at the Control site. This could be one factor driving the significant increases in *C. gynocrates* mean cover between 2009 and 2010. Another aspect could be changes in cattle use in 2010 and 2011 outside the exclosures. Due to the late snow melt in these meadows in 2010-2011 and the availability of good forage below the meadows, there has been a decrease in utilization. However, the rapid increase of *C. gynocrates* was not evident in 2011, compared to 2010. Since cover percent calls can be subjective and we have experienced crew turnover year after year, consistency could be a factor in some changes of cover from year to year. Overall, *C. gynocrates* cover has increased inside the exclosure most notably in Sites 1 and 3 (see figure 4 below).

Site 2 is by far the most heavily grazed of any of the sites included in the study since it is the flattest of the sites and there is easy access to Falls Creek for water, therefore there may not be an increase in *C. gynocrates* cover outside the exclosure. However, *C. gynocrates* cover inside the exclosure is low compared to other sites. Analysis has been done on Site 2 to look at other factors besides accessibility that may be driving the decreased amount of *C. gynocrates* cover inside and outside the exclosures. Erosion, calcium, pH levels, bare ground, and water cover data were compared across sites and across years. The only significant factor was the difference in the water cover at Site 2 compared to the other sites. Water cover outside of the exclosure at Site 2 is comparable to the other sites; but water cover inside the exclosures is significantly different (see Figure 2 below). It is hard to determine what factors are driving the difference in water cover inside the exclosure, and if the low amounts of water cover are driving the low amount of *C. gynocrates* cover.

Overall, the most notable difference between grazed and ungrazed portions of the study sites was in the amount of bare ground. Over the course of four years, the amount of bare ground inside exclosures decreased overall, while outside it remained unchanged or even increased somewhat.
Our data for *Carex gynocrates* is somewhat baffling, and does not lend itself to any conclusions of trend or even correlate to treatments. The pattern observed in population fluctuations at the grazed "Control" site is a near match to that seen inside the exclosure at Site 3. The population outside the exclosure at Site 3 does not reflect this pattern, but that may just be due to the negligible amount of *C. gynocrates* present outside.

The study area has been grazed for over a century. Recovery to a more natural condition will undoubtedly be slow. Vegetation cover is consistently higher inside the exclosures, however over the course of four years we witnessed parallel patterns in cover inside and outside the exclosures. These parallel patterns indicate that factors other than cattle grazing are behind the fluctuations witnessed in our data. The only notable divergence from these patterns was that of bare ground, especially at Site 2.

Conclusion:
The data, after four years, shows an overall increase in vegetation cover and decrease in bare ground inside the grazing exclosures. Vegetation inside the exclosures is consistently more vigorous than that outside. With the passage of time, this pattern of diminishing bare ground and increasing plant cover is expected to continue. Increased root mass and plant vigor will rebuild the soils at these sites, repairing damages to the sensitive habitat that *C. gynocrates* depends on. Data on *C. gynocrates* was inconclusive; however, at all sites *C. gynocrates* was more vigorous inside exclosures than out. It stands to reason that the health of the habitat will correlate to the health of the species.

Figures 11 and 12: Time Lapse Comparison

Site 3 Transect 2 Inside Exclosure 8/19/2009

Site 3 Transect 2 Inside Exclosure 8/25/2011

Figures 13 and 14: Time Lapse Comparison

Site 1 Transect 2 Inside Exclosure 8/19/2009

Site 1 Transect 2 Inside Exclosure 8/25/2011

A non-vascular inventory of the area would be useful. Only the two dominant mosses were collected for identification within this study area. *Meesia triquetra*, an uncommon moss found only in calcium-rich fens is known to occur with *Carex chordorrhiza* in another fen within the Falls Creek drainage. *Meesia uliginosa*, a R6 WA Strategic species, is also found in association with the above two species and is usually only found in alpine or arctic regions (Lawton 1971). Because many of the species associated with the fens in the Falls Creek drainage are arctic or boreal disjuncts, we should take advantage of this opportunity to further expand our knowledge of these rare mosses.

Utricularia minor is an R6 Washington Strategic species and was found growing in the study area. An NRIS Site form has been completed and entered into the NRIS database for *U. minor*. In 2011, the NRIS site form was updated to capture changes in cover.

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Appendix 1: Upper Falls Creek Fen Meadow Species List As Of 2011

Alphabetical Species List	List by Abundance – Based on Quadrat Mean % Cover
Abies lasiocarpa	*Eleocharis pauciflora*
Agrostis thurberiana	*Carex luzulina*
Anemone parviflora	*Potentilla fruiticosa*
Angelica arguta	*Carex scopulorum var. prionophylla*
Antennaria lanata	*Dodecatheon pulchellum*
Arnica mollis	*Carex illota*
Aster foliaceus	*Aster foliaceus*
C. gynocrates	*Caltha leptosepala*
Caltha leptosepala	*Pinguicula vulgaris*
Carex aurea	*Erigeron peregrinus*
Carex buxbaumii	*Tofieldia glutinosa*
Carex illota	*Ledum glandulosum*
Carex jonesii	*Leptarrhena pyrolifolia*
Carex limosa	*Carex gynocrates*
Carex luzulina	*Parnassia fimbriata*
Carex scopulorum	*Equisetum fluviatile*
Carex scopulorum var. prionophylla	*Equisetum arvense*
Carex utriculata	*Antennaria lanata*
Cirsium edule	*Juncus regelii*
Dodecatheon dentatum	*Epilobium palustre*
Dodecatheon pulchellum	*Anemone parviflora*
Eleocharis pauciflora	*Dodecatheon dentatum*
Epilobium angustifolium	*Pinus contorta*
Epilobium glaberrimum	*Equisetum variegatum*
Epilobium palustre	*Carex buxbaumii*
Equisetum arvense	*Picea engelmannii*
Equisetum fluviatile	*Salix rigida*
Equisetum variegatum	*Trollius laxus*
Erigeron peregrinus	*Senecio triangularis*
Eriophorum angustifolium	*Salix commutata*
Eriophorum polystachion	*Carex aurea*
Fragaria virginiana	*Fragaria virginiana*
Gaultheria ovatifolia	*Carex utriculata*
Juncus ensifolius	*Stellaria obtusa*
Juncus longistylis	*Mitella pentandra*
Juncus regelii	*Spiranthes romanzoffiana*
Kalmia microphylla	*Vaccinium scoparium*
Ledum glandulosum	*Platanthera dilatata*
Leptarrhena pyrolifolia	*Eriophorum polystachion*
Ligusticum canbyi	*Smilacina stellata*

Alphabetical Species List	List by Abundance – Based on Quadrat Mean % Cover
Listera convallarioides	*Streptopus roseus var. curvipes*
Lonicera involucrata	*Utricularia minor*
Mitella pentandra	*Juncus ensifolius*
Parnassia fimbriata	*Epilobium angustifolium*
Picea engelmannii	*Kalmia microphylla*
Pinguicula vulgaris	*Lonicera involucrata*
Pinus albicaulis	*Pyrola picta*
Pinus contorta	*Arnica mollis*
Platanthera dilatata	*Erioporhum angustifolium*
Potentilla diversifolia	*Symphyotrichum foliaceum*
Potentilla fruticosa	*Veratrum viride*
Pyrola picta	*Agrostis thurberiana*
Sagina saginoides	*Senecio pauciflorus*
Salix commutata	*Epilobium glaberrimum*
Salix rigida	*Trisetum spicatum*
Senecio cymbalaria	*Carex utricularia*
Senecio pauciflorus	*Juncus longistylis*
Senecio triangularis	*Angelica arguta*
Senecio vimbrilioides	*Senecio cymbalaria*
Smilacina stellata	*Senecio vimbrilioides*
Spergularia rubra	*Cirsium edule*
Spiranthes romanzoffiana	*Gaultheria ovatifolia*
Stellaria obtusa	*Ligusticum canbyi*
Streptopus roseus var. curvipes	*Spergularia rubra*
Symphyotrichum foliaceum	*Abies lasiocarpa*
Tofieldia glutinosa	*Veronica wormskjoldii*
Trisetum spicatum	*Carex jonesii*
Trollius laxus	*Carex limosa*
Utricularia minor	*Listera convallarioides*
Vaccinium scoparium	*Pinus albicaulis*
Veratrum viride	*Sagina saginoides*
Veronica wormskjoldii	*Eleocharis pauciflora*

Figure 15: Microsite conditions with *C. gynocrates* in photo center.