Ya Ha Tinda Exclosure Study:
Plant Composition & Fescue Growth

PROGRESS REPORT SUBMITTED TO: PARKS CANADA

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BACKGROUND

Fescue grasslands are some of the most threatened communities in the Canadian prairie provinces with only about 5% of the grasslands remaining in pre-settlement condition (Vujnovic 1998). Recently this plant community been described as endangered by Environment Canada (Trottier 2002). The rough fescue complex in Canada extends from the foothills region east of the Canadian Rocky Mountains over the prairie provinces into southwestern Manitoba (Pavlick and Looman 1984) with three rough fescue species defining the grasslands over this geographic range. The montane fescue (*Festuca campestris*) community is found mainly in the foothills region between 1000 and 1700 m. These grasslands are some of the most productive among the prairie grasslands in North America (Willms et al. 1996).

The Ya Ha Tinda is located in the foothills of the central east slopes of the Rocky Mountains of Alberta adjacent to Banff National Park (BNP) along the Red Deer River Valley. This area includes a montane rough fescue grassland of ~2000 ha (Spaedthat has provided grazing opportunities for both domestic and native ungulates (Benn et al. 1988). Although this area was excluded from Banff National Park in 1931, Parks Canada has retained ownership for training and wintering horses. The area also has served as winter range for the migratory Ya Ha Tinda elk herd. In the 1970s almost the entire Ya Ha Tinda elk herd migrated 25-50 km west to summer in BNP. Recent research shows that the migratory portion of the elk herd is declining faster than would be expected based on population declined alone, and the number of elk summering on the grasslands is now greater than 30 years ago (Hebblewhite et al. 2006, Spaedtke unpubl. rept. 2007).

In response to concerns about the fescue grasslands, six exclosures were established by Parks Canada at Ya Ha Tinda in fall 2000 for initiating studies on the integrity of the fescue grassland with and without grazing. Exclosure sites were selected to represent the range of grassland productivity and types of elk use on the ranch at the time. Sites were designated as primary (chernozemic, till plains) and secondary (brunisolic, alluvial fan, outwash) productivity based on soils (Seel and Wiebe 1988). Fall 2000 pellet group counts across the grassland and staff expertise were used in selecting areas of varying amounts of ungulate use (see McInenly and Merrill 2002: Table 4). Species composition within and adjacent to the exclosures were first sampled in 2001 and details of those results are given by McInenly and Merrill (2002). In this report, we provide data from the second sampling of the exclosures, which occurred in July 2007.

METHODS

Five of the six exclosures sampled are within the main fescue grassland area of the Ya Ha Tinda ranch while one exclosure is located approximately 7 km to the west of the main grassland area (Fig. 1). Each exclosure (22 x 22 m) is paired with an adjacent plot of similar size within 20 m of the exclosure. Detailed photos for each exclosure in 2007 are given in Appendix I of this report.

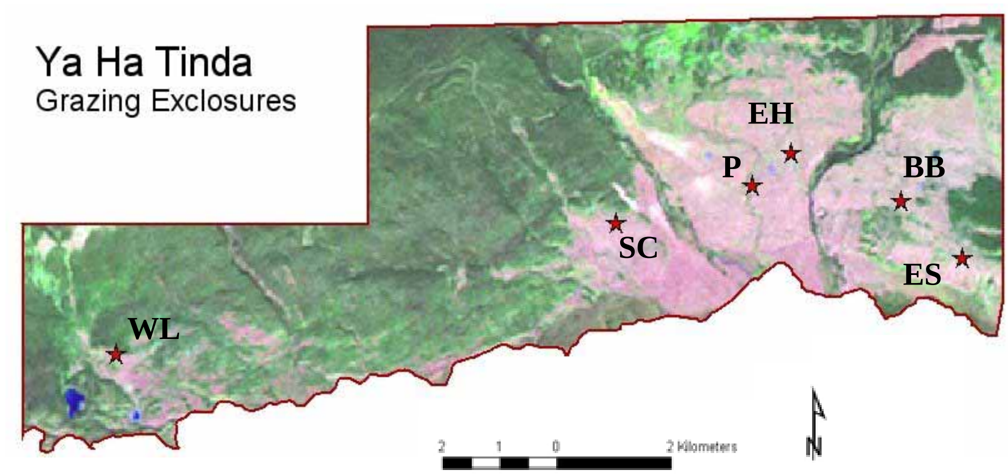

Fig. 1. Grazing Exclosures on the Ya Ha Tinda Ranch. Locations of West Lakes (WL), Scalp Creek (SC), Pasture (P), Elk Hill (EH), Bog Birch (BB), and East Slope (ES) exclosures.

Percent canopy cover was recorded by species in 20 0.10-m^2 plots placed at 1-m intervals along a permanently marked 22-m transect down the middle of the exclosed and unexclosed plots between 19-23 July 2007. Unknown plants comprising <1% of cover were not included in the following analyses. In addition to species cover, we recorded standing dead and fallen litter (dead plant material lying horizontal to the ground but not part of the humus). We calculated Jaccard Coefficient (*Sj*) (Jaccard 1912) at the genus level to reflect plant community similarity inside and outside the exclosures at a site. A high value of this index indicates areas are similar to each other in composition. We also clipped four 0.25-m^2 plots located randomly off the transects inside outside the exclosure. Clippings were separated into current year graminoids, forbs, and standing dead and fallen litter. Materials were clipped to 2 cm aboveground. Biomass was dried for 48 hours at 100^o C and weighed the to nearest 0.01g. To quantify recovery of fescue plants, we measured plant height and basal diameter of 2 arbitrarily chosen plants at 2-m intervals along the transect (n=40). Calculation of basal diameters followed that of McInenly (2003: Appendix II). We compared the abundance of the biomass components and measures of plant robustness inside and outside the exclosure using a t test pairing by site. We examined the correlation in biomass components across sites using a Pearson correlation coefficient and pooling data from inside and outside the exclosures. While we tested for differences in biomass across sites, we did not test for differences among sites because data were limited (i.e., n=4/site)

RESULTS

Plant Community Similarity and Composition

The Jaccard index of similarity (S_j) between plant communities inside and outside the exclosures ranged from 0.24 to 0.67 and were lowest for the 3 most centrally located study sites (Fig. 2: Scalp Creek, Pasture, and Elk Hill), indicating these sites appear to most modified by grazing.

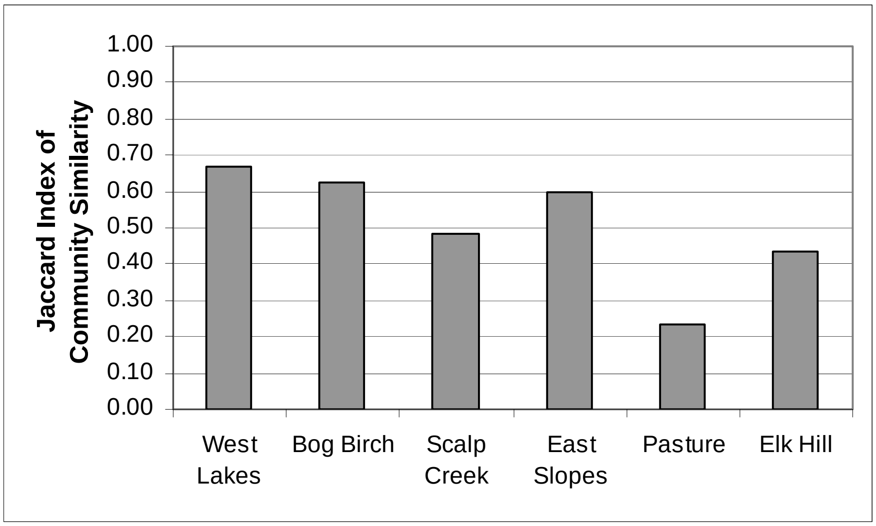

Fig. 2. Jaccard index of similarity (S_j) describing the similarity in plant communities inside and outside the 6 exclosures in July 2007 at Ya Ha Tinda, Alberta.

Three major differences were apparent in community structure as a result of grazing. First, there was a change in graminoid composition with an increase in *Festuca campestris* inside the exclosures and a concomitant decrease in *Bromus* spp., *Agropyron* spp. and *Helictotrichon hooker*i relative to outside the exclosures (Table 1). Total graminoid cover did not differ inside and outside the exclosures because of these opposing trends. Second, grazing maintained a higher diversity (Fig. 3) and mean cover (Table 1) of forbs outside the exclosure relative to inside the exclosures. Only at West Lakes was forb diversity equal inside and outside the exclosures (Fig. 3). In particular, six forb genera exhibited significant declines without grazing: *Anemone*, *Aster*, *Campanula*, *Cerastium*, *Hedysarum*, and *Oxytropis* (Table 1). The exception was at the West Lakes exclosure, which appears to be on the most xeric site (McInenly 2003:Table 3.5). Third, bare ground decreased and litter, both standing dead and fallen litter, increased inside the exclosures relative to outside the exclosures (Table 1). This effect was visually obvious from fence-line comparisons (Fig. 4).

Plant Production and Litter Accumulation

Litter accumulation was highly correlated with grass standing biomass in July across sites (r = 0.94, P <0.001) inside and outside the exclosures. Forb production in July was generally inversely related to both litter and grass production (r ~ -0.4), but the relationship was not consistent enough across sites and inside and outside the exclosures to be statistically significant (*P* =0.13 to 0.20). Litter inside the exclosures averaged 738.7 ± 283.1 g/m^2, which is 8x greater (*P*=0.002) than outside the exclosures (86.9 ± 69.0 g/m^2). Similarly, green grass (current growth) averaged 2x greater (*P* =0.02) inside the exclosures than outside (476.7 ± 157.8 vs. 228.1 ± 62.2 g/m^2). In contrast, forb biomass was ~30% greater (*P*=0.004) outside (171.7 + 43.02 g/m2) than inside (134.1 + 53.40) the exclosures. Based on live grass and litter accumulation inside the exclosures, productivity appeared highest at the Elk Hill and Pasture exclosure sites while forb biomass appeared highest at Elk Hill (Fig. 5; not statistically tested because n=4/site).

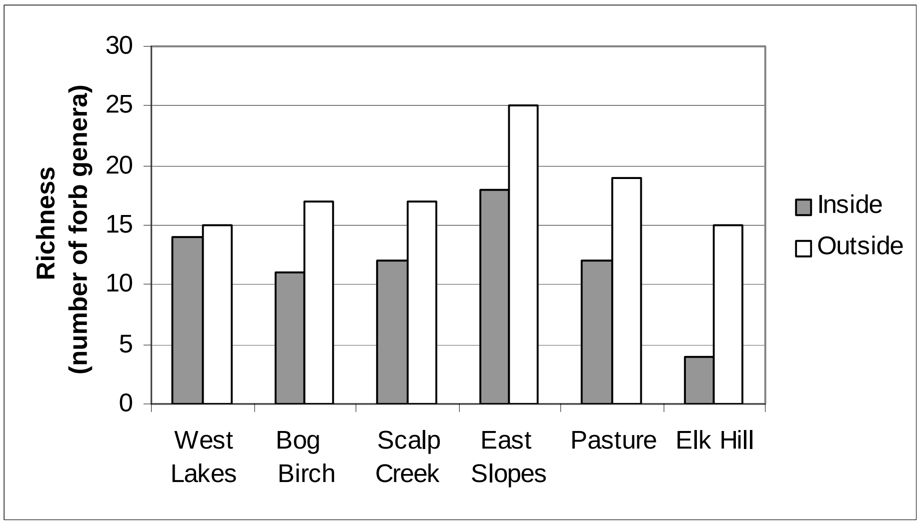

Fig. 3. Forb diversity (number of genera) inside and outside the 6 exclosures at Ya Ha Tinda Ranch, Alberta in July 2007 after 7 years of grazing exclusion.

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Fig. 4. Fence-line comparison showing differences in standing dead and graminoid litter and forb abundance inside and outside the Pasture exclosure at Ya Ha Tinda, AB after 7 years of grazing exclusion.

Table 1. Species percent cover inside (IN) and outside (OUT) 6 exclosures in a fescue grassland in July 2007 after 7 years of grazing exclusion at the Ya Ha Tinda, Alberta.

	West Lakes		**Scalp Creek**		**East Slope**		**Bog Birch**		**Pasture**		**Elk Hill**		**Average**		
	IN	**OUT**	**IN**	**OUT**	**IN**	**OUT**	**IN**	**OUT**	**IN**	**OUT**	**IN**	**OUT**	**IN**	**Out**	**P-value[1]**
Bare ground	0.00	0.00	0.00	1.60	0.00	0.00	0.00	0.20	0.00	0.80	0.00	0.95	0.00	0.59	0.07
Elk/horse feces	0.00	0.25	0.00	1.35	5.55	0.60	0.00	0.60	0.00	1.45	0.00	2.45	0.93	1.12	
Rock	0.00	0.10	0.00	0.35	0.00	0.00	0.00	0.00	0.00	0.05	0.75	0.60	0.13	0.18	
Wood	0.00	0.00	0.00	0.00	0.00	3.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63	
Lichen/moss	0.95	13.65	0.00	2.25	0.00	0.90	1.95	2.85	0.00	0.00	0.00	0.00	0.48	3.28	
Standing dead	7.95	0.00	5.30	0.00	4.10	3.45	2.75	0.00	4.90	1.35	5.40	0.00	5.07	0.80	0.01
Litter	56.30	31.10	51.10	36.20	60.70	39.70	63.95	33.65	64.25	40.30	69.00	46.25	60.88	37.87	<0.01
Graminoids															
Agropyron spp.	0.50	2.25	0.00	0.70	0.30	1.20	0.70	3.80	0.00	1.75	1.15	2.90	0.44	2.10	<0.01
Bromus spp.	1.80	1.45	1.60	7.90	3.40	8.70	7.00	11.75	2.15	3.55	0.15	2.75	2.68	6.02	0.02
Calamagrostis monticola	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Carex spp.	2.55	4.40	0.00	0.00	1.80	2.10	0.00	15.10	0.00	3.40	0.40	8.00	0.79	5.50	
Elymus innovatus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Festuca campestris	18.15	10.10	22.50	12.20	12.20	12.30	6.45	5.50	18.30	16.00	20.65	11.75	16.38	11.31	<0.01
Helictotrichon hookeri	0.15	0.65	1.40	2.50	0.30	1.35	0.00	0.10	0.75	1.75	0.55	2.55	0.53	1.48	0.01
Juncus spp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Kobresia myosuroides	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.90	0.00	0.00	0.00	0.00	0.00	0.15	
Koeleria macrantha	0.00	0.45	0.85	1.10	0.00	0.35	0.30	1.15	0.20	1.25	0.25	0.10	0.27	0.73	
Poa spp.	0.00	0.00	0.05	0.35	0.10	0.05	0.00	0.00	0.00	0.20	0.45	1.15	0.10	0.29	
Total graminoids	**23.15**	**19.30**	**26.40**	**24.75**	**18.10**	**26.05**	**14.45**	**38.30**	**21.40**	**27.90**	**23.60**	**29.20**	**21.18**	**27.58**	
Forbs															
Achillia millifolia	0.00	0.00	0.00	0.00	0.05	0.50	0.60	2.60	0.00	0.00	0.00	0.00	0.11	0.52	
Agoseris glauca	0.10	0.00	0.90	0.00	0.40	1.25	0.00	0.00	0.40	2.00	0.00	1.00	0.30	0.71	
Allium cernum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Androsace chamaejasme	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.90	0.00	0.20	0.00	0.00	0.01	0.18	
Anemone spp.	0.00	1.90	1.00	0.85	0.00	0.10	0.00	0.00	0.10	1.55	0.00	2.00	0.18	1.07	0.08
Antennaria parvifolia	0.05	0.20	0.00	0.45	0.00	0.60	0.00	0.00	0.00	1.15	0.00	0.00	0.01	0.40	
Artemesia spp.	0.00	0.00	0.90	1.55	0.45	0.00	0.00	0.00	1.10	0.20	0.80	2.05	0.54	0.63	

	West Lakes		Scalp Creek		East Slope		Bog Birch		Pasture		Elk Hill		Average		
	IN	**OUT**	**IN**	**OUT**	**IN**	**OUT**	**IN**	**OUT**	**IN**	**OUT**	**IN**	**OUT**	**IN**	**OUT**	**P-value**
Aster spp.	0.00	0.00	0.00	0.40	0.15	0.85	0.00	0.15	0.00	0.70	0.00	0.60	0.03	0.45	0.01
Astragalus spp.	0.40	0.00	0.00	2.80	0.00	0.20	0.00	0.00	0.00	0.55	0.00	0.20	0.07	0.63	
Campanula rotundifolia	0.20	2.00	0.00	2.80	0.55	1.25	0.00	0.00	0.20	2.75	0.00	0.35	0.16	1.53	0.04
Castilleja spp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Cerastium arvense	0.00	0.80	0.45	2.35	0.30	0.75	0.00	0.95	0.15	1.50	0.00	1.20	0.15	1.26	<0.01
Commandra spp.	0.00	0.95	0.00	0.00	0.00	1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	
Crepis ranunculus	0.00	0.00	0.00	0.10	0.05	0.10	0.00	0.15	0.00	0.00	0.00	0.00	0.01	0.06	
Delphinium glaucum	0.20	0.00	0.00	0.00	0.00	1.80	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.30	
Dodecatheon conjugens	0.00	0.45	0.15	0.00	0.35	0.20	0.00	0.00	0.05	0.05	0.00	0.00	0.09	0.12	
Epilobium angustifolium	0.00	0.00	0.00	0.00	0.00	0.00	4.55	3.70	0.00	0.00	0.00	0.00	0.76	0.62	
Erigeron elatus	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	
Fragaria virginiana	0.00	0.00	0.00	0.00	0.00	0.00	0.05	5.10	0.00	0.00	0.00	0.00	0.01	0.85	
Galliardia aristada	0.50	1.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.28	
Galium boreale	0.10	1.55	0.10	0.40	1.35	1.60	0.20	0.90	1.50	0.20	0.20	0.20	0.58	0.81	
Gentianella amarella	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.00	0.10	0.00	0.17	
Geranium spp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Geum triflorum	5.70	7.35	10.35	6.35	6.60	2.65	0.25	3.10	2.10	4.10	0.00	0.00	4.17	3.93	
Hedysarum alpinum	0.30	0.95	0.00	0.35	1.35	4.05	1.00	1.10	1.75	6.30	0.15	4.65	0.76	2.90	0.05
Lathyrus ochroleucus	0.00	0.00	0.00	0.00	0.15	0.10	0.00	1.35	0.00	0.00	0.00	0.00	0.03	0.24	
Linum lewisii	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Myosotis asiatica	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Oxytropis spp.	0.25	3.70	0.00	6.30	0.00	0.85	0.00	1.65	0.00	3.30	0.00	2.20	0.04	3.00	0.01
Ranunculus cardiophyllus	0.10	0.30	0.00	0.35	0.15	0.00	0.00	0.00	0.10	0.40	0.00	0.70	0.06	0.29	
Sisyrinchium spp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Smilacina stellata	0.35	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.10	0.06	0.04	
Solidago multiradiata	0.35	0.75	0.05	0.40	0.40	2.95	0.20	0.10	0.00	0.95	0.00	0.00	0.17	0.86	
Taraxacum officinale	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Thalictrum venulosum	0.00	0.00	0.50	0.65	0.55	0.05	0.00	0.00	0.60	0.25	0.10	0.00	0.29	0.16	
Vicia americana	0.00	0.00	0.40	0.10	0.80	1.75	0.95	1.00	0.00	0.00	0.00	0.00	0.36	0.48	
Viola spp.	0.00	0.00	0.10	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.35	0.02	0.10	
Zygadenus elegans	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	

	West Lakes		Scalp Creek		East Slope		Bog Birch		Pasture		Elk Hill		Mean		P-value
	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	
Total Forbs	**8.60**	**22.90**	**15.15**	**26.20**	**13.65**	**23.45**	**7.85**	**22.75**	**8.05**	**26.75**	**1.25**	**15.70**	**9.09**	**22.96**	<0.01
Shrubs															
Betula glandulosa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.00	0.00	0.00	0.00	0.00	0.07	
Populus tremuloides	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	
Potentilla spp.	1.75	5.30	0.00	0.15	2.75	1.05	1.45	0.10	1.40	1.40	0.00	0.60	1.23	1.43	
Rosa acicularis	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	
Salix spp.	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.15	0.00	0.00	0.00	0.00	0.17	0.03	
Total Shrubs	**1.75**	**5.30**	**0.00**	**0.15**	**2.85**	**1.30**	**2.45**	**0.65**	**1.40**	**1.40**	**0.00**	**0.60**	**1.41**	**1.57**	

[1]P-values indicated from t-tests between percent cover inside and outside exclosures paired by site.

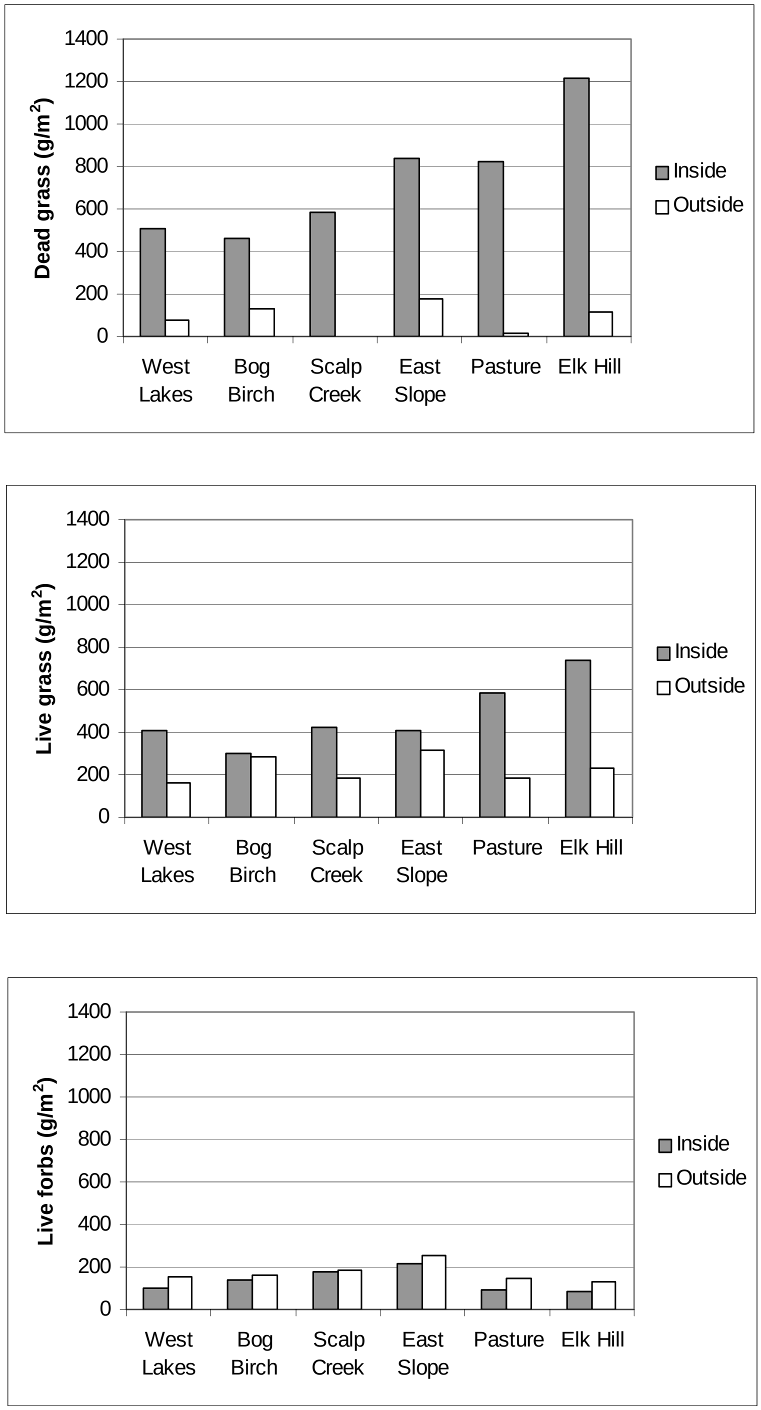


Fig. 5. Biomass of live grasses and forbs and dead grass (standing dead and fallen litter) inside and outside 6 exclosures at Ya Ha Tinda Ranch, Alberta in July 2007 after 7 years of grazing exclusion. Significant difference existed between inside and outside the exclosures for dead grass (P=0.002), live grass (P =0.02) and live forbs (P=0.004).

Fescue Recovery

Considerable recovery of *Fescue campestris* plants was evident after 7 years of exclusion from grazing. Plants exhibited higher percent canopy cover (P< 0.001) inside the exclosure than outside the exclosures (Table 1), and individual plants were more robust (Table 2). Inside the exclosures fescue plants averaged 2x as tall as outside (38.0 ± 2.75 vs. 17.9 ± 5.12 cm, P <0.001), and had basal diameters that averaged 7x as large as plants outside the exclosures (53.6 ± 46.8, vs. 7.52 ± 3.89 mm^2, P = 0.05; Table 2, Fig. 6). In particular, several very large fescue plants were found within the Bog Birch exclosure (Fig. 7).

Table 2. Plant height (cm) and basal diameters (cm^2) of forty *Fescue campetris* plants inside and outside 6 exclosures in July 2007 after 7 years of grazing exclusion at Ya Ha Tinda, Alberta.

		Height		Basal diameter	
		Mean	SD	Mean	SD
West Lakes	Inside	33.30	5.55	24.97	25.66
	Outside	16.70	4.32	7.28	6.34
Bog Birch	Inside	38.65	7.61	135.14	455.95
	Outside	25.35	5.87	8.98	10.31
Scalp Creek	Inside	38.78	6.32	27.78	29.85
	Outside	14.13	3.21	6.56	10.64
East Slope	Inside	40.3	9.05	11.21	18.64
	Outside	23.05	6.59	2.92	5.12
Pasture	Inside	39.53	5.68	40.14	27.92
	Outside	12.83	2.89	5.12	6.34
Elk Hill	Inside	41.03	8.34	82.57	59.01
	Outside	15.10	3.54	14.27	15.98

Fig. 6. Basal diameters of *Festuca campestris* outside exclosures (left) compared to diameters inside (right) exclosures in July 2007.

Fig. 7. One of a few robust *Festuca campestris* plants inside the Bog Birch exclosure at Ya Ha Tinda Ranch, Alberta in July 2007 after 7 years of grazing exclusion.

DISCUSSION

Current growth of graminoids by July inside the exclosures at Ya Ha Tinda was similar to ungrazed, peak standing crop reported for *Festuca campestris* grasslands in the Porcupine Hills near Stavely, Alberta (Willms et al. 1996:398 g/m^2). Rough fescue in particular showed considerable recovery after 7 years, with plants inside the exclosures being taller and having larger basal areas. In contrast, McInenly (2003:65) found no significant differences in plant height (P= 0.13), or basal area (P = 0.72) between plants inside and outside the same exclosures in August after only 2 years of release from grazing. However, even after 7 years without grazing, individual fescue plants averaged shorter (33-41 cm) than plants at Stavely, which were either ungrazed (60-63 cm) or lightly grazed (49-51 cm). Similarly, accumulation of litter inside the exclosures at Ya Ha Tinda was generally lower than those reported for sites near Stavely (Willms et al. 1996:

1588 g/m^2, standing plus fallen litter). Because current growth seems similar, differences in plant heights and litter accumulation may be related to previous grazing history. Fescue grasslands sites studied at Stavely were exclosed from grazing in 1983 and resampled in 1988 (6 years), but these grassland sites were only lightly grazed prior to exclosure (Willms et al. 1996), and they may have recovered more quickly. However, it is also likely that sampling protocols for collecting fallen litter contributed to some of this difference between areas. Litter in the Stavely study included mulch to the mineral layer, while our sampling removed litter to 2 cm above ground level.

Nonetheless, litter at Ya Ha Tinda averaged 8x greater inside the exclosures than outside, and accumulation likely was sufficient to alter the soil moisture dynamics as well as light penetration and temperature regimes (Willms 1987, Dormaar et al. 1989, Naeth et al. 1991a,b, Willms and Chanasyk 2006). Indeed, litter accumulation inside the exclosures is likely a dominant factor now influencing the change in plant community composition. Jaccard indices of community similarity indicated divergence of plant communities inside and outside the exclosures because the values in 2007 were 14-65% lower than for the same sites in 2001, except at the Bog Birch site (McInenly and Merrill 2002: Fig. 9). Smaller difference at the Bog Birch exclosure may be related to high soil moisture at this site. McInenly (2003:Table 3.5) reported soil moisture in June and September 2002 at the Bog Birch site were at least 13% (June) and 25% (September) greater than all other sites. We believe the difference in this area is related to a high clay content in the soil, but this has not been fully assessed.

The divergence in community structure also reflects higher diversity and abundance of forbs outside the exclosures than inside, as well as shifts in graminoid composition. Similar shifts have been reported in grazed montane fescue grasslands in other parts of Alberta (Willms et al. 1987). Community divergence appears to be greatest within the central area of the Ya Ha Tinda ranch, indicating large herbivores have had their greatest impact on plants communities in this portion of the ranch. These patterns are consistent with the overall pattern of winter and summer use indicated by distribution of pellet groups of elk and horses sampled in 2000-2002 (McInenly 2003) and with the distribution of locations of radiocollared elk during the winter of 2002-2004 (Robinson, unpubl. memo). However, further comparison should be made with more recent pellet group counts (Spaedtke, unpubl. data) conducted to indicate ungulate distribution patterns during a period of aversive conditioning of elk when elk were led off the grassland during summer. Changes in community structure inside the exclosures are expected to continue because recovery of robust fescue plants has been noted to take between 14 to 42 years depending on previous grazing history (McLean and Tisdale 1972, Willms et al. 1985).

In this progress report we provide information only on aboveground plant abundance and composition of the Ya Ha Tinda grassland. A manuscript (McInenly et al. in prep.) is anticipated, which compares these data in more detail to similar data collected in July 2001 (McInenly and Merrill 2002) to assess the resilience of the fescue communities at Ya Ha Tinda to grazing. As part of long-term, *intensive* studies of the Ya Ha Tinda grasslands, we recommend sampling root biomass and soil N types (NO_3, NH_4 and mineralization rates) inside and outside the exclosures in June and September of

2008 to make similar comparisons of these ecological indicators to those measured values in 2002 (McInenly 2003). We also recommend augmenting the *intensive* studies (while maintaining the current long-term control plots) to better understand the interactions among grazing, fire, and responses to earlier seasonal precipitation and higher summer temperature regimes that are predicted to occur in this region with climate change (Sauchyn and Kulshreshtha 2007). Initiating broad-scale studies of the interactions of fire and herbivory on the interface of fescue grassland and forests would add to our understanding of theses dynamics and provide context for the small-scale studies. We view the efforts for *intensive* and *extensive* studies as complimentary in addressing the integrity of the grasslands in and adjacent to the Ya Ha Tinda.

REFERENCES

Benn, B.K., Steel, and P., Wiebe. 1988. Botanical Data- Appendix V *In*: K. Steel and P. Wieb. 1988. 2nd Progress report: Range Improvement Project, Ya Ha Tinda Ranch, West Central Alberta. Environment Canada, Canadian Parks Service, Western Region, Calgary, Alberta.

Dormaar, J.F, S.Smoliak, W. Willms. 1989. Vegetation and soil responses to short-duration grazing on fescue grasslands. Journal of Range Management 42:252-256.

Hebblewhite, M., E.H. Merrill, L.E. Morgantini C.A. White, J.R. Allen, E. Bruns, L. Thurston, and T. Hurd. 2006. Is the migratory behavior of montane elk herds in peril? The case of Alberta's Ya Ha Tinda elk herd. Wildlife Society Bulletin 34: 1280-1294.

Jaccard, P. 1912. The distribution of flora of the alpine zone. New Phytologist 11:37-50.

McInenly, L.E., and E.H. Merrill. 2002. Fescue grassland response to seasonal grazing regimes. Ya Ha Tinda Ranch, Central East Slopes of the Rocky Mountains, Alberta. Progress report submitted to Parks Canada. 22pp.

McInenly, L.E. 2003. Seasonal effects of defoliation on montane rough fescue. MSc. Thesis. University of Alberta. Edmonton, AB. 126. pp.

Mclean A., and E.W. Tisdale. 1972. Recovery Rate Of Depleted Range Sites Under Protection From Grazing. Journal Of Range Management 25: 17-23.

Naeth, A. A., A.W. Bailey, D.S. Chanasyk, and D.J. Pluth. 199a. Waterholding capacity of litter and soil organiz matter in mixed and fescue grassland ecosystems of Alberta. Journal Range Management

Naeth, A. A., A.W. Bailey, D.J. Pluth D.S. Chanasyk, and R.T. Hardin 1991b. Grazing impacts on litter and soil organic matter in mixed prairie and fescue grasslands of Alberta. Journal Range Management 44:7-12.

Pavlick, L.E. and J. Looman. 1984. Taxonomy and nomenclature of rough fescues. *Festuca altaica*, *F. campestris*, (F. scabrella var. *major*), *F. hallii* in Canada and the adjacenet part of the United States. Journal Botany 62:1739-1749.

Sauchyn, D., and S. Kulshreshtha 2007. The Prairies. *In* From Impacts to Adaptation: Canada in a Changing Climate 2007, edited by D.S. Lemmen, F.J. Warren, J., Lacroix and E. Bush; Government of Canada, Ottawa, ON.

Seel, K. and P. Wiebe 1988. 2nd progress report: Range Improvement Project, Ya Ha Tinda Ranch, West Central Alberta. Environment Canada, Canadian Parks Service, Western Region, Calgary Alberta. 213pp. Appendices.

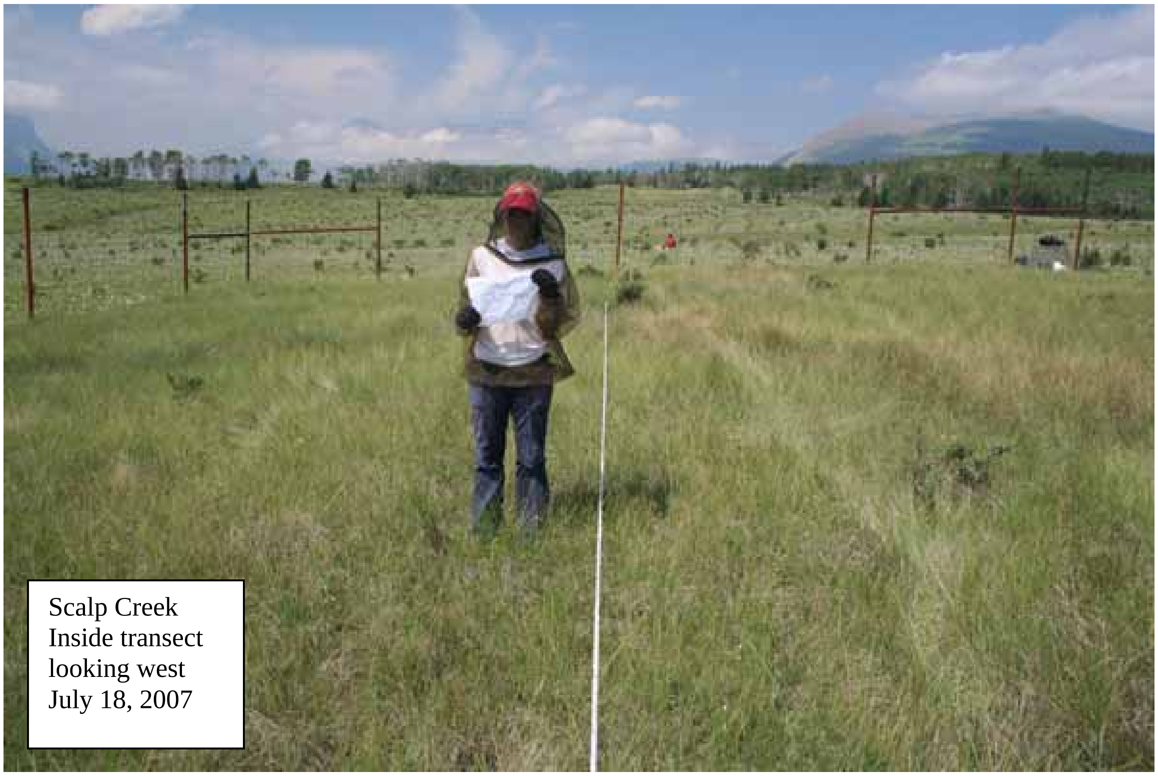
Stout, D.G., A. McLean, and D.E. Quinton. 1981. Growth and phonological development of rough fescue in the interior of British Columbia. J. Range Management 34:455-459.
Trottier, G. 1992. Conservation of Canadian Prairie Grasslands: A landowner's guide. CWS, Ottawa. 92 pp.
Vujnovic, K. 1998. Small-scale plant species composition and diversity in relation to environmental and disturbance factors in Fescue. MSc Thesis. University of Alberta. 165 pp.
Willms, W.D, and D.S. Chanasyk. 2006 Grazing effects on snow accumulation on rough fescue grasslands. Rangeland Ecology & Management 59: 400-405.
Willms, W.D., B.W. Adams, and J.F. Johan. 1996. Seasonal changes of herbage biomass on the fescue prairie. Journal Of Range Management 49: 100-104.
Willms, W.D., S. Smoliak, and J.F. Dormaar. 1985. Effects of stocking rates on rough fescue grassland vegetation. Journal Range Management 38:220-225.
Willms, W.D, S.Smoliak, and A.W. Bailey. 1986. Herbage production following litter removal on Alberta native grasslands. Journal Range Management 39:536-540.
Willms, W.D. 1987. Response of rough fescue (*Festuca scarabella*) to light, water, temperature, and litter removal, under controlled conditions. Canadian Journal Botany. 66: 429-434,

Appendix I. Photographs inside and outside the six exclosures at Ya Ha Tinda in July 2007.

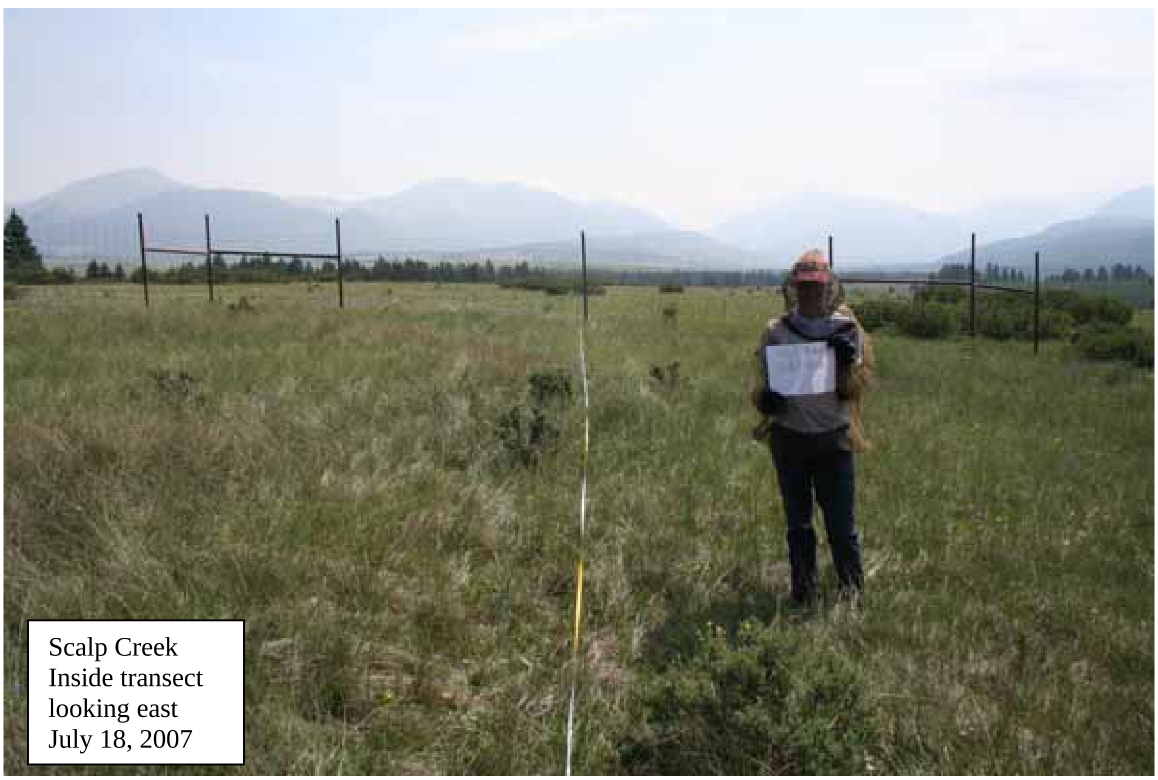
Scalp Creek Exclosure

Scalp Creek
Outside transect
looking east
July 18, 2007

Scalp Creek
Outside transect
looking west
July 18, 2007



Scalp Creek
Inside transect
looking west
July 18, 2007



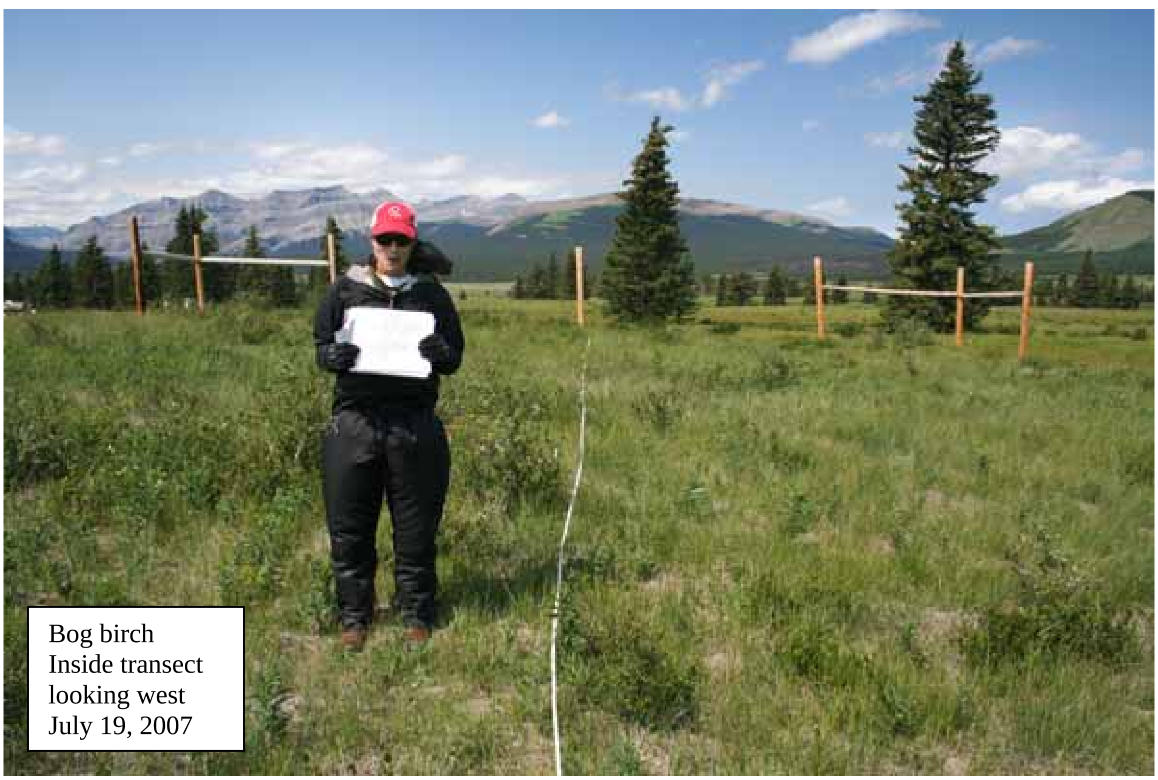
Scalp Creek
Inside transect
looking east
July 18, 2007

Bog Birch Exclosure

Bog Birch
Outside transect
looking east
July 19, 2007

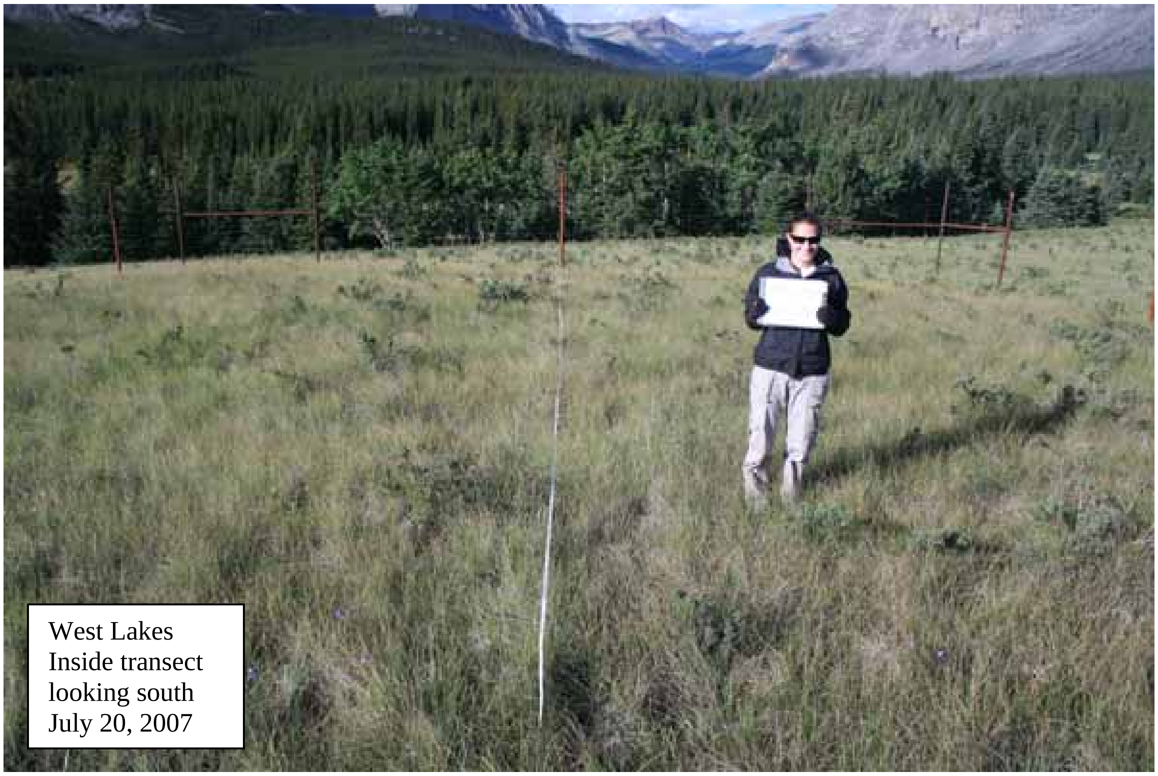
Bog birch
Outside transect
looking west
July 19, 2007

Bog birch
Inside transect
looking east
July 19, 2007

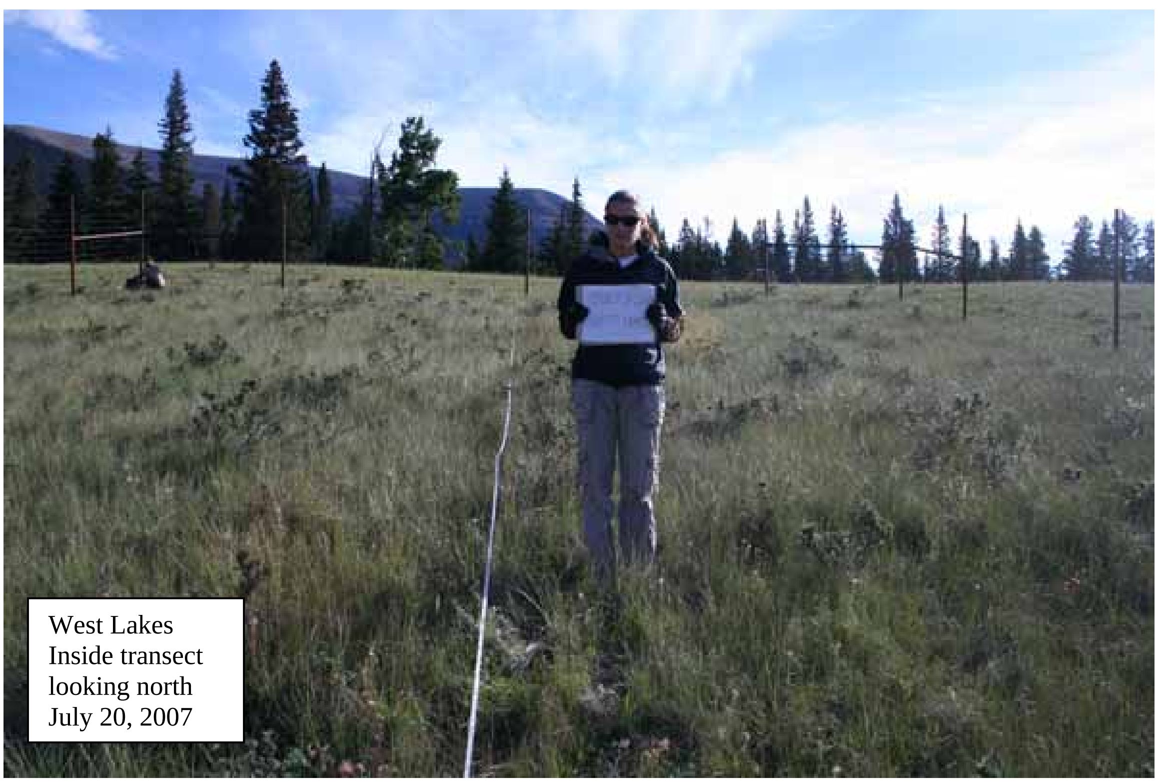


Bog birch
Inside transect
looking west
July 19, 2007

West Lakes Exclosure



West Lakes
Inside transect
looking south
July 20, 2007



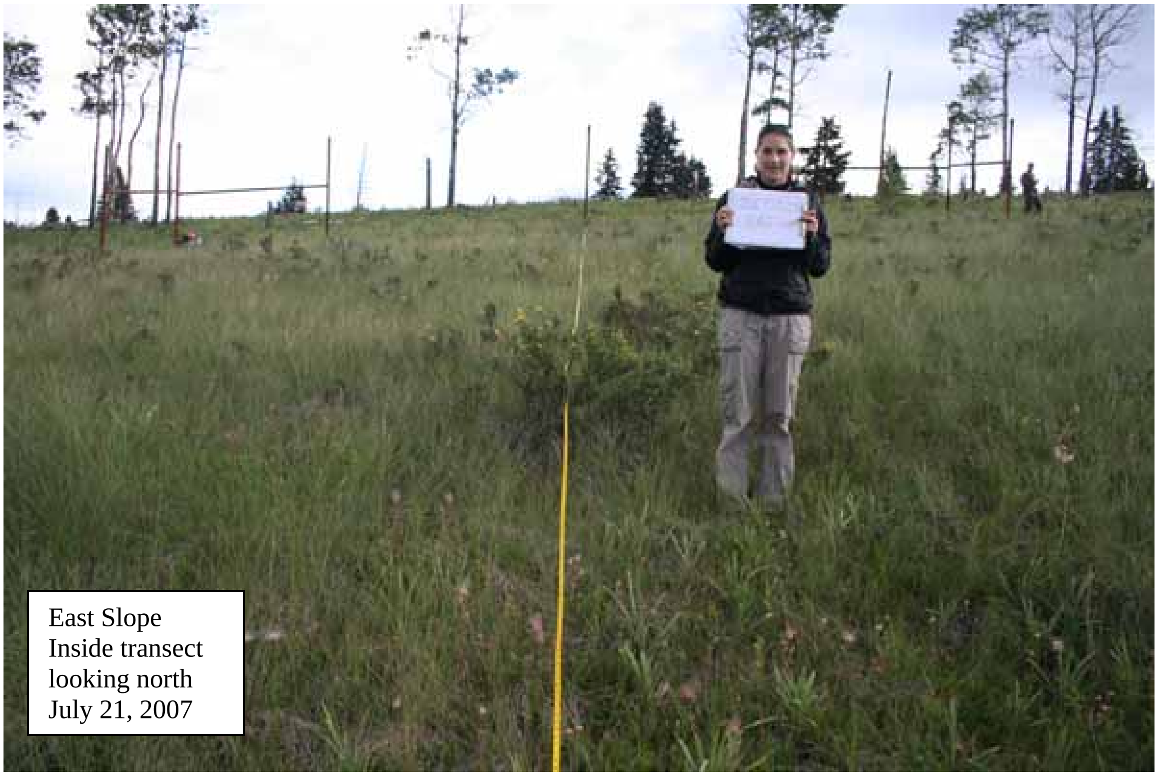
West Lakes
Inside transect
looking north
July 20, 2007

West Lakes
Outside transect
looking south
July 20, 2007

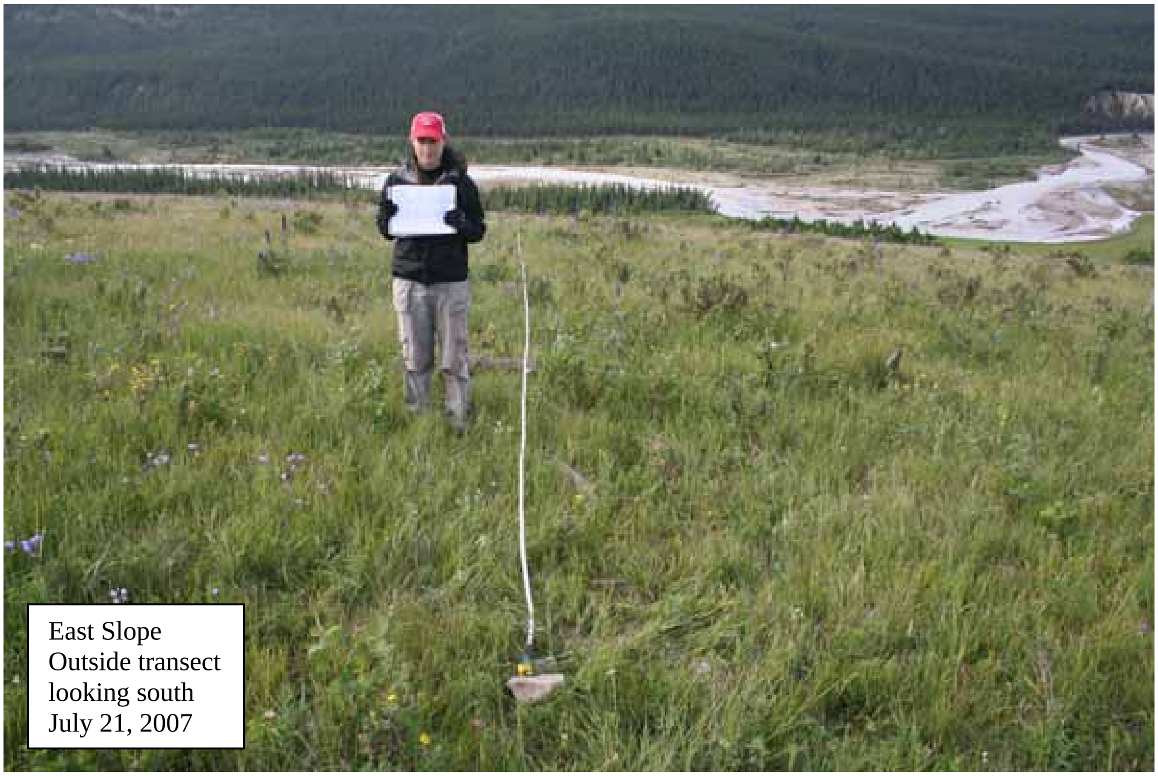
West Lakes
Outside transect
looking north
July 20, 2007

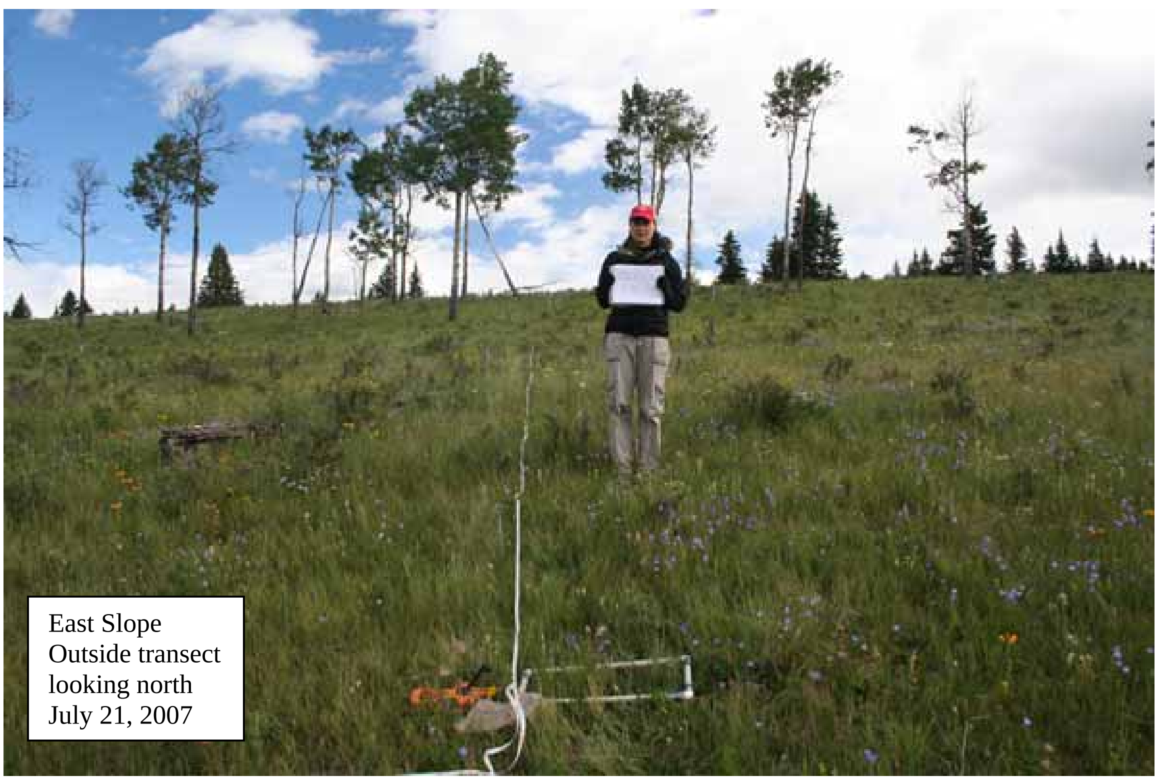
East Slope Exclosure

East Slope
Inside transect
looking south
July 21, 2007

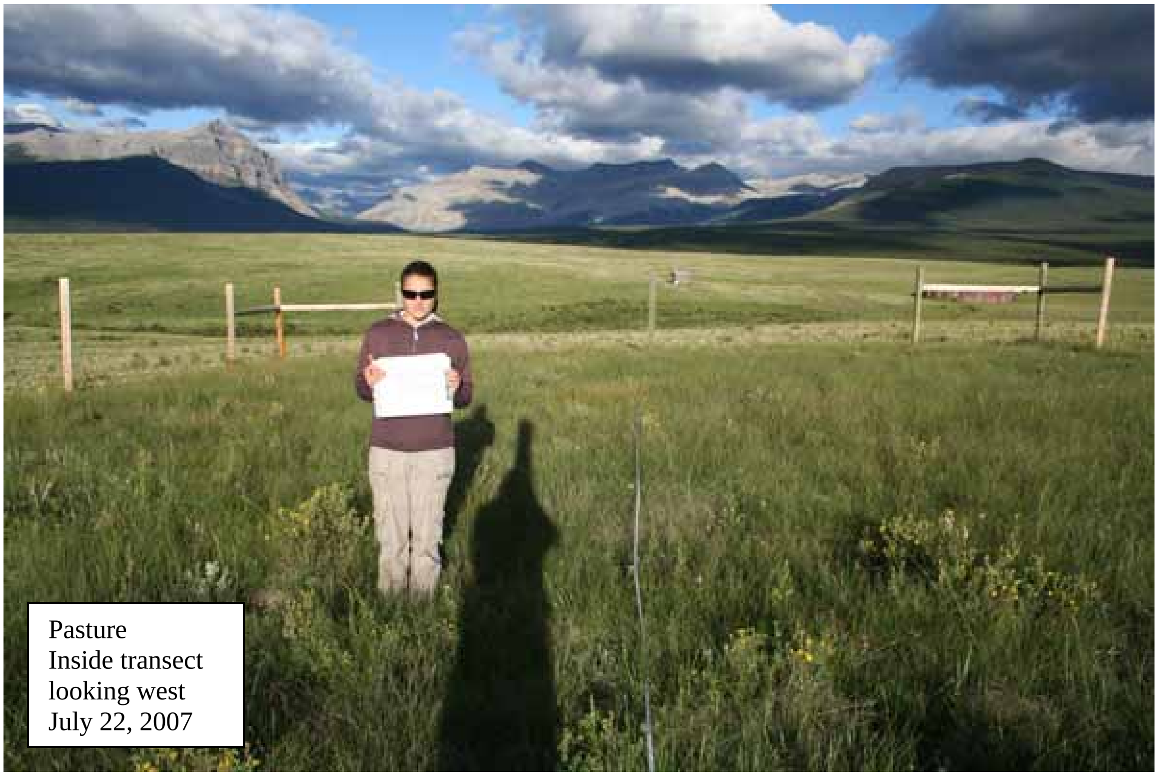


East Slope
Inside transect
looking north
July 21, 2007

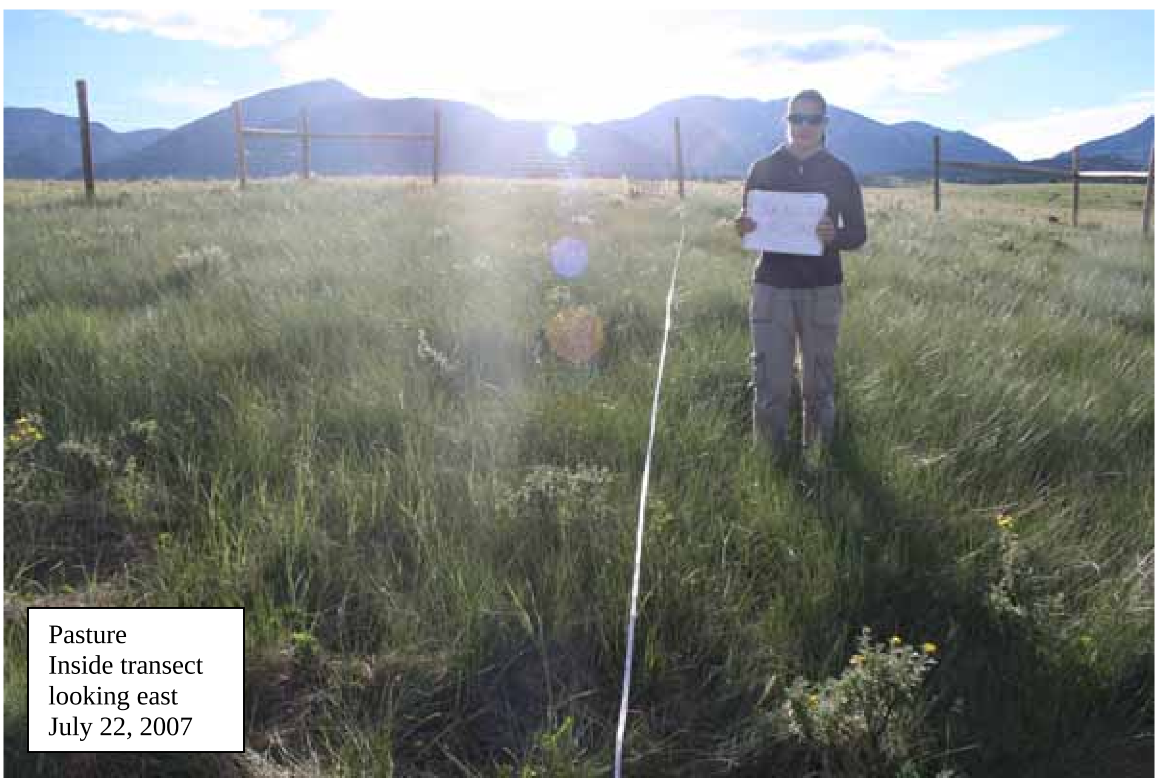

East Slope
Outside transect
looking south
July 21, 2007


East Slope
Outside transect
looking north
July 21, 2007

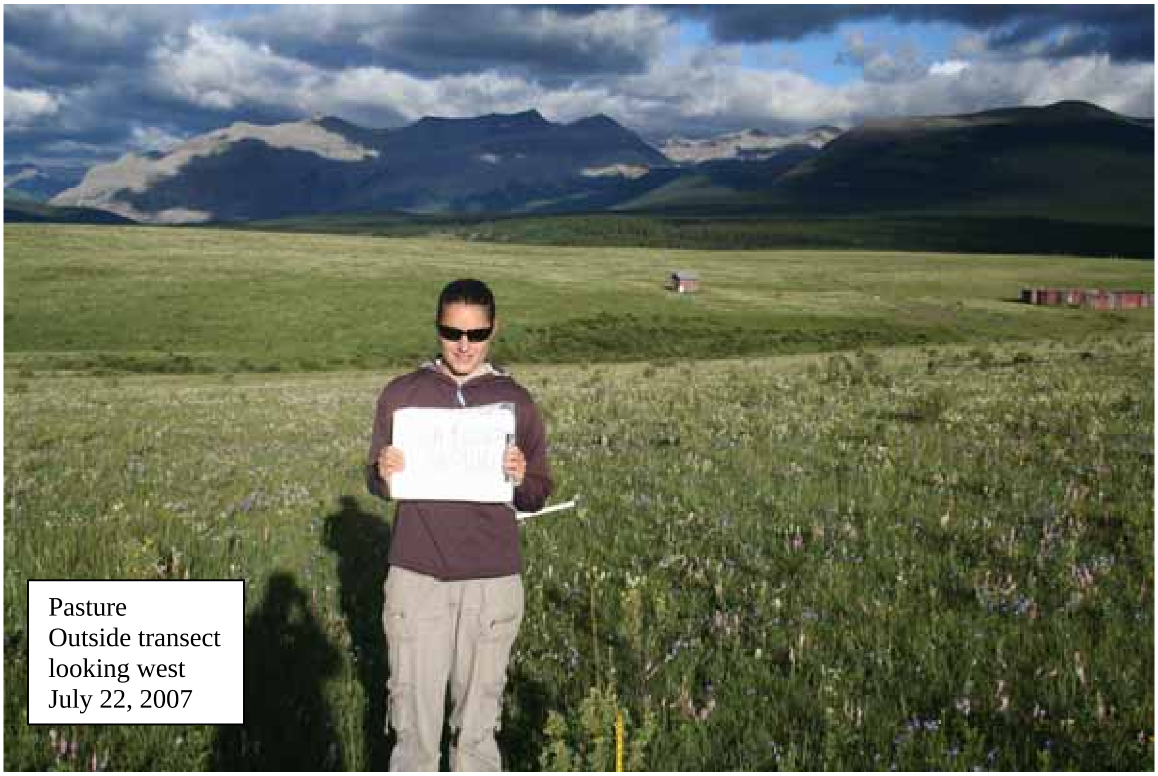
Pasture Exclosure



Pasture
Inside transect
looking west
July 22, 2007



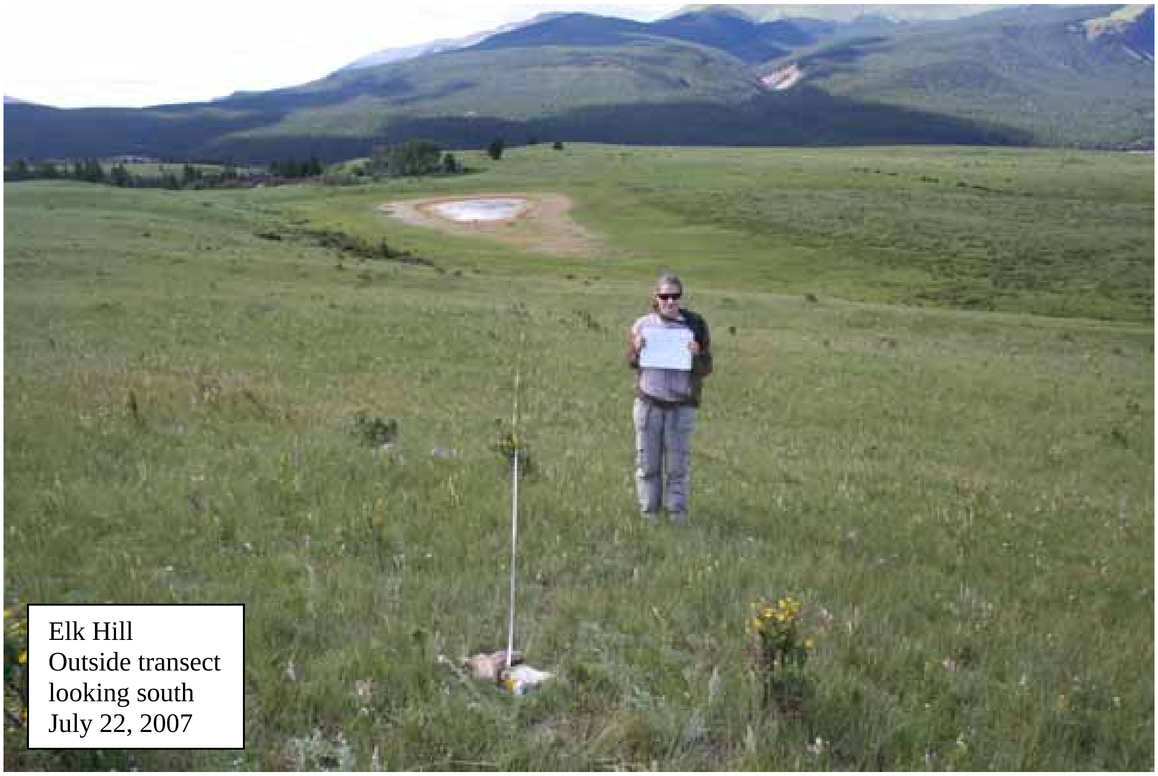
Pasture
Inside transect
looking east
July 22, 2007



Pasture
Outside transect
looking west
July 22, 2007

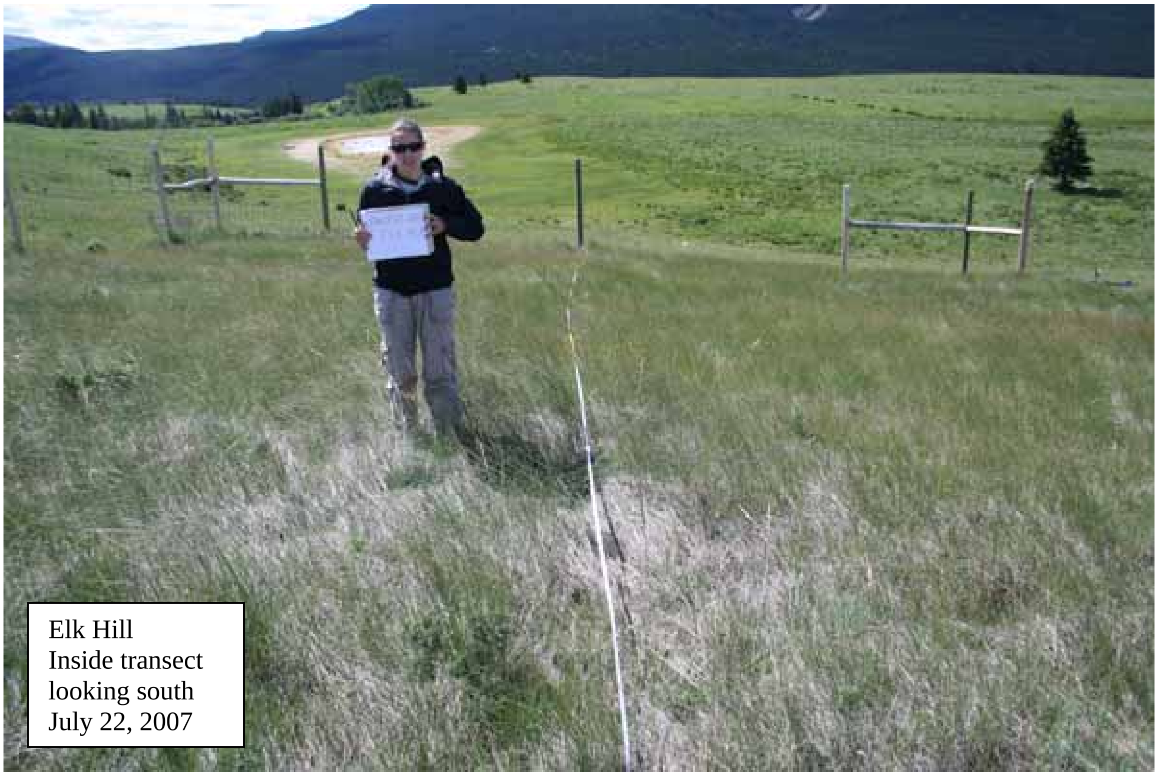
Pasture
Outside transect
looking east
July 22, 2007

Elk Hill Pasture



Elk Hill
Outside transect
looking south
July 22, 2007

Elk Hill
Outside transect
looking north
July 22, 2007



Elk Hill
Inside transect
looking south
July 22, 2007

Elk Hill
Inside transect
looking north
July 22, 2007