Fescue Grassland Response to Seasonal Grazing Regimes
Ya Ha Tinda Ranch
Central East Slopes Alberta

Progress Report
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Year 1 Progress Report

Fescue grasslands are threatened communities in the Canadian Prairie Provinces. Historically, bison (Bison bison) and elk (Cervus elaphus) grazed the rough fescue (Festuca campestris) communities in the Rocky Mountain foothills primarily in winter, but changes in migratory behavior of elk may lead to increased year-long grazing of these grasslands. Most studies of grazing on mountain rough fescue communities have focused on the plant community responses to summer cattle grazing, and less is known of impacts from native herbivores. Because both domestic and native grazing occur in foothills along the Red Deer drainage, this location provides an excellent site to study the utilization patterns of domestic and native herbivores and the response of rough fescue to seasonal grazing regimes.

This project has 4 major objectives. First, to understand the large-scale patterns of ungulate distribution and forage utilization, we are counting ungulate pellet groups and recording percent cover of standing biomass and plant species in plots systematically placed across the grasslands at Yah Ha Tinda. Second, we will resample long-term, Parker Three-step vegetation transects on the Ya Ha Tinda to determine changes in plant composition since their establishment in the 1950's. The Parker Three-step transects will not be re-visited until the end of July 2002 and are not addressed in this report. Third, long-term ungulate exclosures were established in fall 2000, and we documented baseline plant composition within and adjacent to the exclosures for long-term monitoring purposes. Fourth, within the exclosures we have conducted the first year of a 2-year field experiment to investigate short-term responses of rough fescue and soil N to different seasonal clipping regimes. The focus of this experiment is nitrogen dynamics resulting from grazing regimes, rather than plant species responses. A better understanding of plant-soil nutrient dynamics is important for the long-term conservation and management of rough fescue grasslands on the Ya Ha Tinda ranch.

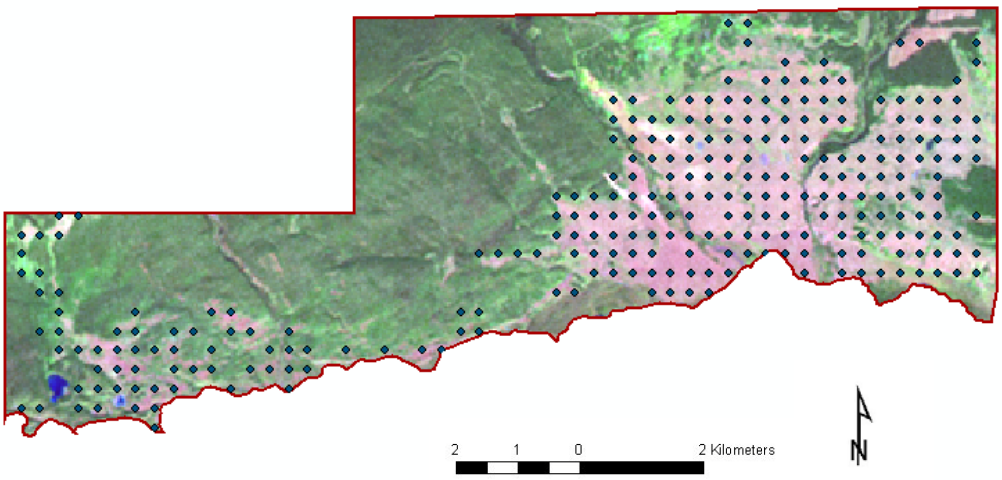
Broad-scale Patterns of Ungulate Use

Broad-scale surveys of current ungulate use of the grasslands at the Ya Ha Tinda ranch provide a baseline for documenting changes in patterns of use by native and domestic herbivores over time. We have conducted 3 of 4 seasonal (Table 1) surveys of ungulate distribution and utilization on the ranch. Spring surveys were conducted during the first two weeks of May and represent grazing on the ranch during the dormant season. Fall surveys were conducted during the last two weeks of September and represent grazing on the ranch during the growing season. A systematic grid of sampling sites located at 250-m intervals was placed across the grasslands on Ya Ha Tinda using a random starting point on a map (Fig. 1). UTM locations of these sites are given in Appendix 1 for future reference. During each survey, sample sites were located with a global positioning system (GPS), and site variables including slope position, percent

Table 1. Dates, number of survey participants, and plot sizes sampled on broad-scale grassland surveys conducted in 2000-2001 across the Ya Ha Tinda in Central Alberta.

Survey	*Date*	*Person Days*	*# Plots (25 m^2)*	*# Plots (100 m^2)*
Fall 2000	23-30 Sept	14	276	0
Spring 2001	4-10 May	14	271	53
Fall 2001	19-25 Sept	14.5	277	277

Fig. 1. Location of pellet survey sites across the Ya Ha Tinda Ranch.

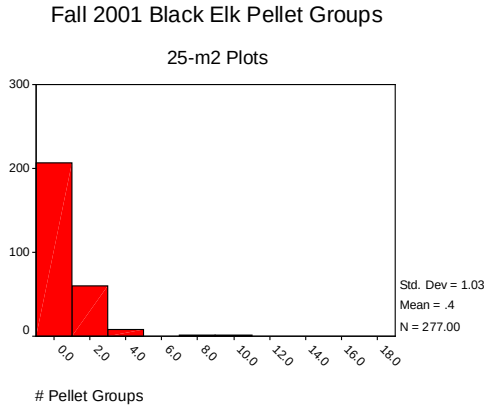


slope, aspect (degrees), elevation (m), distance to cover (m), distance to water (m) and distance to human activity (m) were recorded at each site. During each survey, percent cover of standing dead plant material, rough fescue and bareground within a 25-m^2 plot were visually estimated. In fall 2001, percent cover of shrubby cinquefoil (Potentilla fruticosa), bog birch (Betula galndulosa), bearberry (Arctostaphylos uva-ursi), willow (Salix spp.), aspen (Populus tremuloides), white spruce (Picea glauca), lodgepole pine (Pinus contorta) and creeping juniper (Juniperus horizontalis) also were estimated. Number of elk, deer/sheep, and horse pellet groups were counted within each 25m^2 plot. A pellet group was defined as at least 8 pellets and the distribution of the pellets were taken into account in distinguishing between groups. To indicate the age of the pellet groups, pellet groups were recorded as black, gray or white for elk, deer and sheep, or dark and light for horses in all surveys except in fall 2000 when only black pellets were counted. Black pellets were considered to have been deposited since the last sampling period. To examine the potential influence of plot size on pellet counts, pellet groups were counted within a 100-m^2 plot at a sub-sample of survey plots in spring 2001 and in all plots in fall 2001.

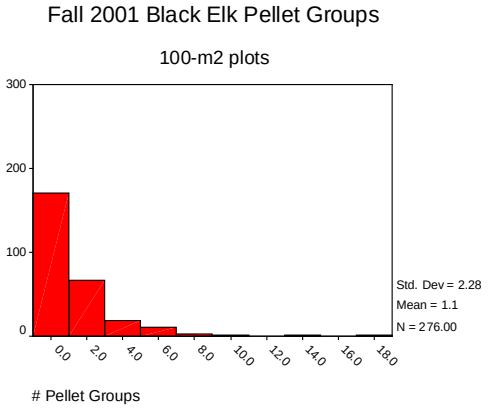
To date, only the analysis of the pellet group data has been completed and is reported here. In comparing plot sizes, there were more zero counts on 25-m^2 plots, particularly in the spring surveys (Fig. 2). However, pellet group counts in 25 m^2 were linearly correlated with counts at 100 m^2 ($P < 0.05$). Seasonal differences in plot size relationships may be due to changes in density (e.g. pellet groups are fewer and are more patchy in distribution over the growing season).

Fig. 2. Count of recent (black) elk pellet groups by plot size.

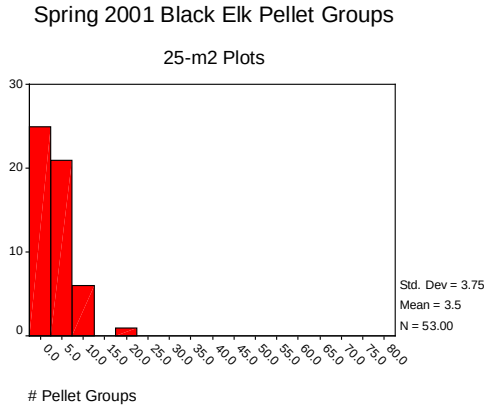
A.



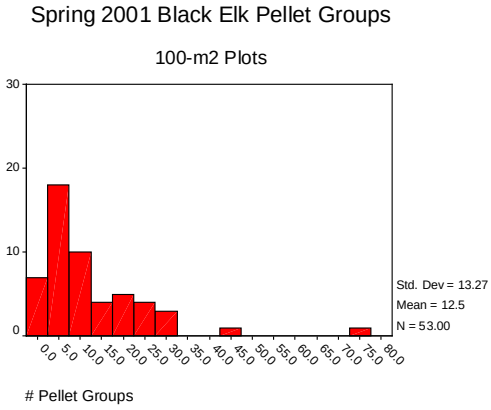
B.



C.



D.



Spring Black PG within 100m^2 = 1.071 + 3.284 (PG within 25m^2) $N = 53$, $r = 0.86$, $\underline{P}<0.00$ Eq. 1

Fall Black PG within 100m^2 = 0.238 + 2.010 (PG within 25m^2) $N = 277$, $r = 0.83$, $\underline{P}<0.00$ Eq. 2

Based on the coefficients in the above equations, counts of the number pellet groups in 25 m^2 underestimated the count in plots of 100 m^2 and this trend was greatest in fall when pellet counts were lowest. We suggest that the number of pellet groups within 100-m^2 plots may have been underestimated because observers tended to undercount overlapping pellet groups as total pellet groups decreased. Because of this possibility, and because of

the time required to count pellet groups in 100-m^2 plots is much higher, especially during spring surveys when as many as 76 pellet groups were counted in a single plot, we recommend remaining with a 25-m^2 plot size for long-term monitoring. However, we also recommend that a subsample (n=30) of plots be taken at both the 25-m^2 and 100-m^2 plot size so results of these surveys can be directly compared to other pellet group counts conducted within 100-m^2 plots in the park.

Elk pellet counts were adjusted to a per day basis to account for different time intervals between seasons. Fall elk pellet counts were somewhat higher in 2000 that in 2001 (Wilcoxon signed-rank test, $P = 0.005$), while pellet counts were approximately 4 times higher (Wilcoxon signed-rank test, $P < 0.001$) during the spring survey than during fall surveys (Table 2).

Table 2. Summary of the number of recent (black) elk pellet groups (#/25 m^2) counted in 2000 and 2001during spring and fall elk pellet surveys on the Ya Ha Tinda Ranch in Central Alberta.

Survey	*N*	*Min*	*Max*	*Mean*	*Std. Deviation*	*Mean/ day*	*Std. Deviation*	*C.V. %*
Fall 2000	263	0	8	0.57	1.07	0.004	0.008	200
Spring 2001	270	0	76	3.01	3.33	0.014	0.016	114
Fall 2001	276	0	10	0.42	1.04	0.003	0.007	233

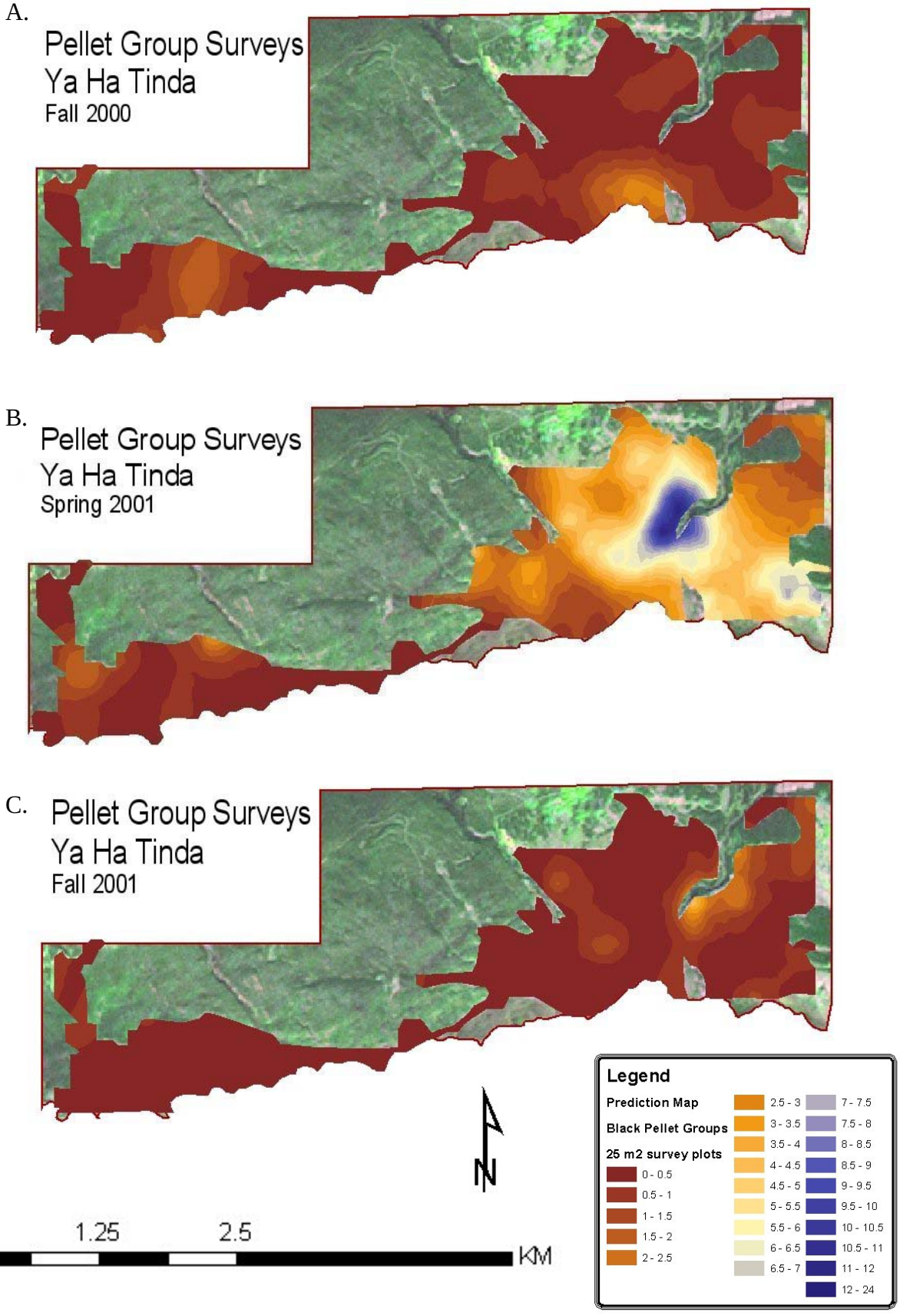
To map broad-scale elk use patterns, counts of recent (black) elk pellet groups within 25-m^2 plots were extrapolated across the Ya Ha Tinda grassland using ordinary kriging with a lag (h) equal to 250 m and trend removal at 100% local scale in *Geostastical analyst in ArcMap* 8.1. Different spherical models were used for each season to predict pellet groups at unsampled sites across the landscape (Table 3).

Table 3. Parameters of the spherical model used in ordinary kriging to estimate the number of elk pellet groups at unsampled sites within grasslands at Ya Ha Tinda ranch in the central east slopes of Alberta.

Season	Nugget	Partial Sill	Range	Mean error	RMS	Avg. Standard Error
Fall 2000	0.6303	0.1753	1976.4	0.0058	0.9890	0.8496
Spring 2001	4.4629	0.6393	979.3	0.0315	2.748	2.269
Fall 2001	0.4188	0.0836	1231.7	-0.0017	0.9975	0.6965

Elk appear to use the eastern portion of the ranch to a greater extent than the western portion in both summer and winter (Fig. 3), while the West Lakes area of the ranch appears to be utilized at the same level throughout the year. Higher use on the eastern portion of the ranch may be due to low snow accumulations in winter, a more

Fig. 3. Kriged maps of recent (black) elk pellet groups on Ya Ha Tinda.

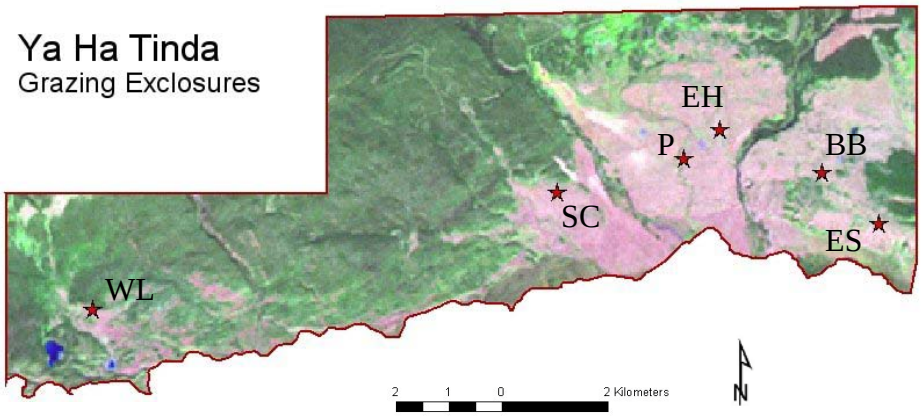


moderate climate, higher grassland productivity, an avoidance of predators, or an association with the horses. Elk used the Bighorn campround, Bighorn falls, or the horse pastures during the winter or summer because relatively high elk pellets are found in these areas. Elk pellet groups are highly concentrated around the Bighorn creek during the winter (Fig. 3:B). This location has a south-facing slope and is close to cover. Elk use shifted from the flats along the Red Deer River in the growing season of 2000 to the bench upslope along the Bighorn Creek in the growing season of 2001 (Fig. 3:A and C). This may be related to drier conditions in the growing season of 2001 than 2000. The influence of these factors on elk distribution will be explored with a more detailed analysis in the future.

Baseline Exclosure Data

To initiate long-term studies on grassland species composition with and without grazing, six grazing exclosures (500 m^2) were built in the fall of 2000. Five of the exclosures were located in the eastern portion of the Ya Ha Tinda Ranch and one in the western portion of the ranch (Fig. 4).

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.



Exclosure sites were selected to represent the range of grassland productivity and types of current ungulate use on the ranch (Table 4). Sites were designated as primary (chernozemic, till plains) and secondary (brunisolic, alluvial fan, outwash) productivity based on soils (Seel and Wiebe 1988). Fall pellet surveys were used to stratify the area into high elk and horse use.

Three exclosures were placed adjacent (<50 m) to Parker Three-step transects established by the Canadian Wildlife Service in 1958 (Flook 1960) by randomly selecting a cardinal direction and placing the nearest northern corner of the exclosure in line with the arm of the parker transect. Two additional exclosures were placed on the grassland, at sites stratified by levels of elk and horse use, by selecting a point generated at random within mapped use-strata (ArcView GIS 3.2). A third exclosure was randomly-selected within the low-use stratum (ArcView GIS 3.2) but the exclosure was placed only near this site because access for heavy equipment to build the exclosure was not possible.

Sites were post-stratified by productivity level. A 500-m^2, paired un-exclosed site was established within 15 m of each exclosure.

Table 4. Location, productivity and ungulate use classes of sites where 6 long-term exclosures were established on the Ya Ha Tinda Ranch in the central east slopes of Alberta.

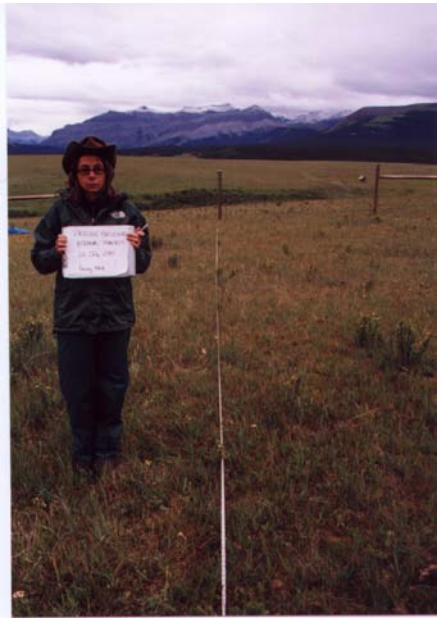
Site	*Easting*	*Northing*	*Production class*	*Ungulate Use* *Elk Use Horse Use*
Pasture	599940	5733310	Primary	High summer/winter by ungulates
Bog Birch	601907	5733118	Primary	Low summer/ high Winter by ungulates
Elk Hill	600457	5733733	Primary	Elk only year-round
Scalp Creek	598134	5732833	Secondary	High summer/winter by ungulates
West Lakes	591515	5731157	Secondary	Low summer/ high Winter by ungulates
East Slope	602728	5732380	Secondary	Elk only year-round

Vegetation was sampled at each site between 25 July and 1 August 2001 as part of the long-term monitoring of vegetation in the exclosures. Canopy cover and species abundance were recorded within twenty 0.10 m^2 Daubenmire frames placed at 1-m intervals along a permanently marked, 22-m transect down the center of the exclosure, and along a paired transect outside the exclosure. This design was adapted so comparisons could be made to data collected by the Alberta Environment Land and Forest Service within long-term cattle exclosures in areas adjacent to the ranch (Willoughby, pers. comm. and Tannas, pers. comm). Community similarity among transects inside and outside each exclosure was calculated at the genus level using the Jaccard Coefficient (Sj) (Jaccard 1912). Nonparametric Mann-Whitney tests were used to test for differences in percent canopy cover of forbs, graminoids, woody shrubs and trees, bare ground, ground litter, and rough fescue on transects inside (internal) and outside (external) the exclosures at each site. Because not all species have been verified, we report results primarily to the genus level.

The **Pasture** exclosure is in the middle of the horse pasture and is paired with a parker transect (Fig. 5). Predominant species during peak biomass at this site included rough fescue, old-man's whiskers (Geum triflorum), Hooker's oat grass (Helictotrichon hookeri), June grass (Koeleria macrantha) and sedges (Carex spp). Rough fescue accounts for 26.35% of the canopy cover at the pasture exclosure. The **Elk Hill** exclosure is in close proximity to the Pasture exclosure (Fig. 4), but has a steeper slope and drier site conditions (Fig. 6). Dominant species at this exclosure include rough fescue (12.8%), Hooker's oat grass, locoweed (including Oxytropis cuisickii, O. monticola, and O. splendens), pasture sagewort (Artemesia frigida) and sedge species. Elk Hill and Pasture exclosures appeared to have more woody shrubs outside than inside the exclosures, but this difference was not significant ($P > 0.05$). The **Scalp Creek** exclosure is paired with a Parker transect but is on slightly less productive soils than thePasture, Elk Hill and Bog Birch exclosures (Fig. 7). Scalp Creek is similar in species

Fig. 5. Pasture Exclosure

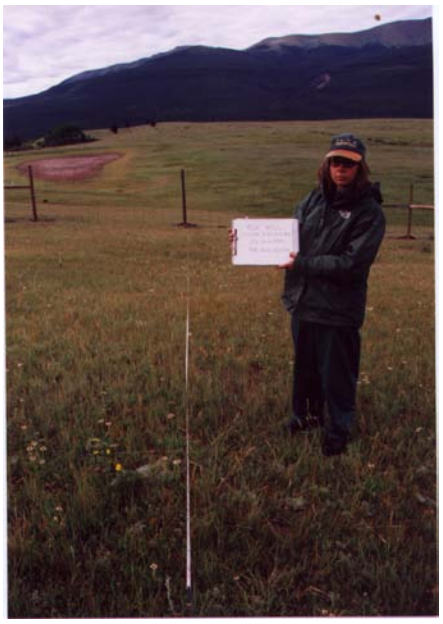
October 2000



Pasture Internal Transect
25 July 2001

Pasture External Transect
25 July 2001

Fig. 6. Elk Hill Exclosure

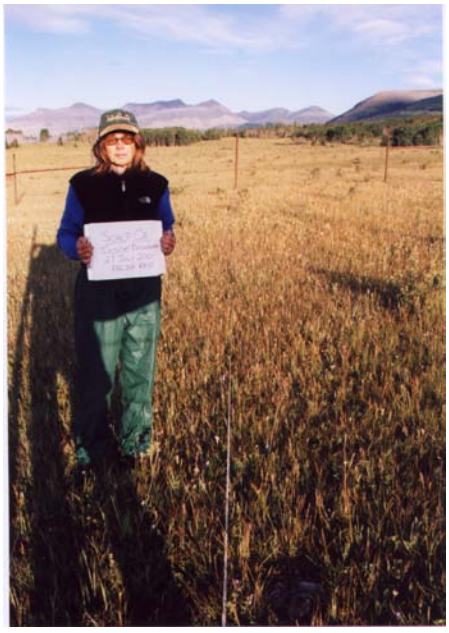


Elk Hill Internal Transect - 26 July 2001

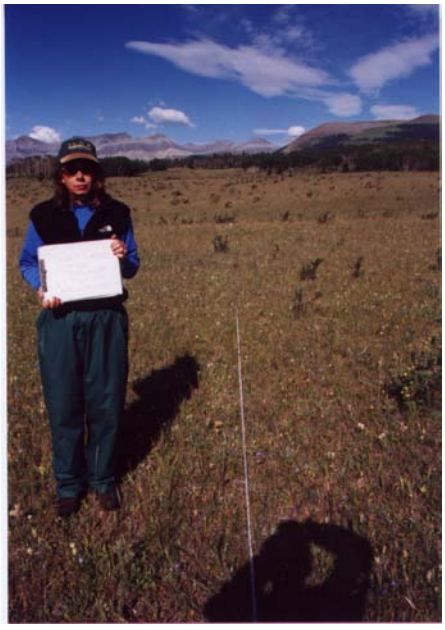
Elk Hill External Transect on 26 July 2001

Fig. 7. Scalp Creek Exclosure

July 2001



Scalp Creek Internal Transect
27 July 2001



Scalp Creek External Transect
27 July 2001

composition to the Elk Hill and Pasture exclosures, having locoweed, old man's whiskers, hooker's oatgrass, rough fescue (8.7%) and sedges as the predominant species. Internal and external transects at **Elk Hill and Scalp** Creek had similar graminoid genera composition.

The **West Lakes** (Fig. 8) exclosure is the most distant from all other exclosures (Fig. 4), and is most similar to the Scalp Creek exclosure. Dominant species at West Lakes include shrubby cinquefoil, locoweed, rough fescue (10.7%), old man's whiskers, and sedges. Transects at **Scalp Creek** had the most similar community composition inside and outside the exclosures, whereas **West Lakes** had the least similar composition, particularly forb genera (Fig. 9 and 10) inside and outside the exclosures. The **East Slope** exclosure appears to have the most diversity (Fig. 11 and 12), containing a wide variety of forbs, and has the second highest percent canopy cover of rough fescue (18.6%). This exclosure is also paired with a Parker transect. Dominant species at this site include rough fescue, old man's whiskers, pussytoes (Antennaria parvifolia), slender wheatgrass (Agropyron trachycaulum and Agropyron-Elymus hybrids), and sedges. The **Bog birch** exclosure is the only exclosure not on a SW slope and appears to be the most different site (Fig. 13). Dominate at this site is hairy wild rye (Elymus innovatus), fireweed (Epilobium angustifolium), rough fescue, yarrow (Achillea millifolium) and more mesic-site sedges are the dominant species. Rough fescue accounts for 8.6% of the canopy cover at the Bog birch exclosure. The area around the **Bog Birch** exclosure was mowed in early June to control the shrubs in early June 2001, however this resulted in a difference in canopy cover along the transect of only 1.9 percent.

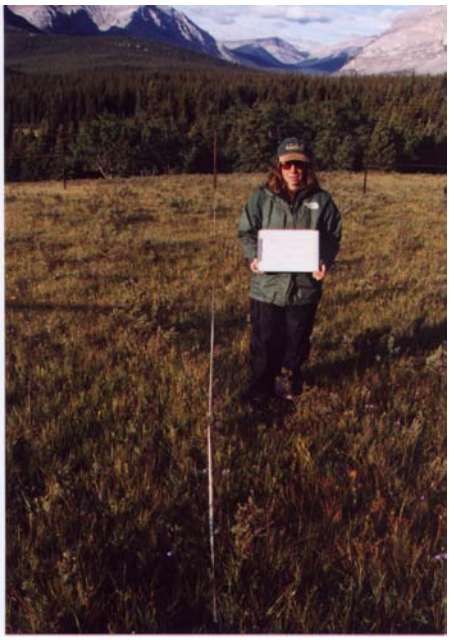
Community similarity inside and outside exclosures was higher within sites for graminoids than for forbs or woody shrubs and trees (Fig. 9, 14 and 15). Only four shrubs or trees (shrubby cinquefoil, Potentilla fruticosa; bog birch, Betula glandulosa; willow, Salix spp.; and trembling aspen, Populus tremuloides) were observed on transects at the exclosure sites. Some exclosure sites showed differences between vegetative and ground cover on internal and external transects. Bare ground cover was greater outside the Pasture and Elk Hill exclosures ($p = 0.000$) and ground litter was a greater outside the Pasture, Elk Hill, Scalp Creek, West Lakes, and East Slope exclosures ($P < 0.05$). The percent cover of forbs was higher inside Scalp Creek and East Slope exclosures ($P < 0.05$) and graminoid cover was higher inside Scalp Creek and West Lakes exclosures ($P < 0.05$). Rough fescue was higher in the Pasture, Bog Birch, Scalp Creek, and West Lakes exclosures ($P < 0.05$).

Seasonal Grazing Experiment

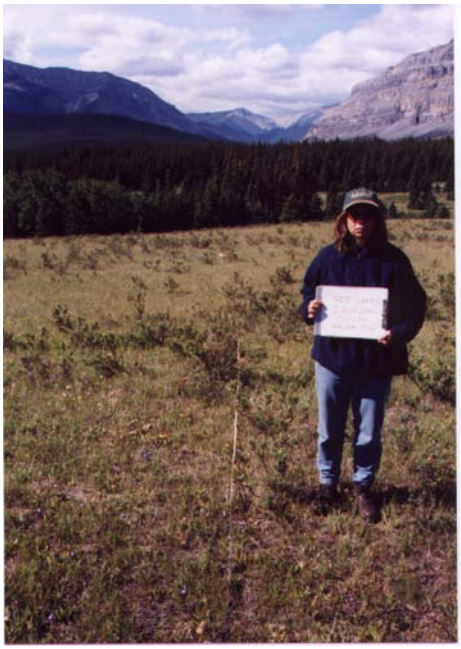
At each exclosure, fifteen 2 m^2 plots were subjected to 4 clipping treatments (no clipping, winter, winter and spring, or year-round clipping) and 1 natural grazing treatment (elk and horse grazing outside the exclosure) in 2001. Clipping heights (4 cm in winter, 3 cm in spring, and 4 cm in summer) were determined based upon average height of defoliation outside exclosures. Plots were clipped during the winter between January 27 – February 22, during spring between May 14-19, during summer between June 11-23. Plots were sampled for differences in species composition and above-ground

Fig. 8. West Lakes Exclosure

August 2001



West Lakes Internal Transect
1 August 2001



West Lakes External Transect
1 August 2001

Fig. 9. Community similarity along transects within sites

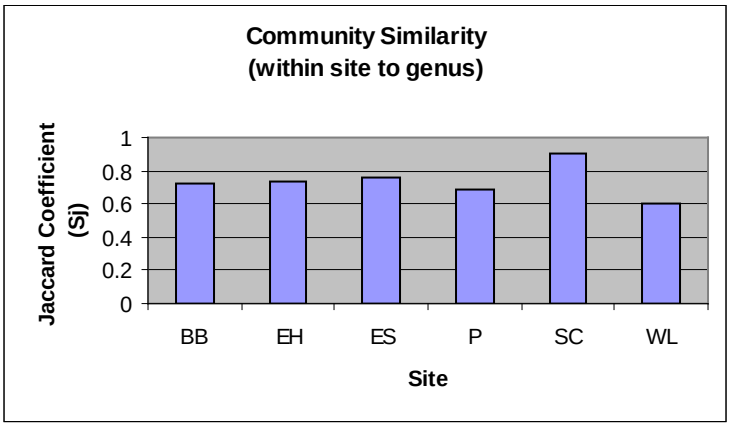


Fig. 10. Similarity of forb cover on exclosures inside and outside each site

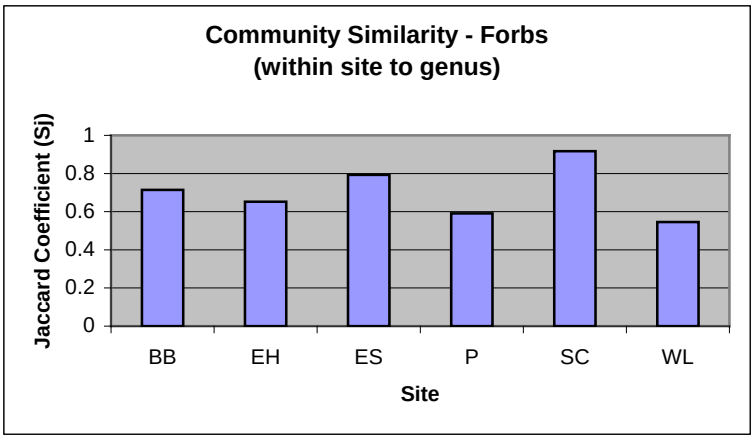


Fig. 11. Richness of genera at each exclosure site

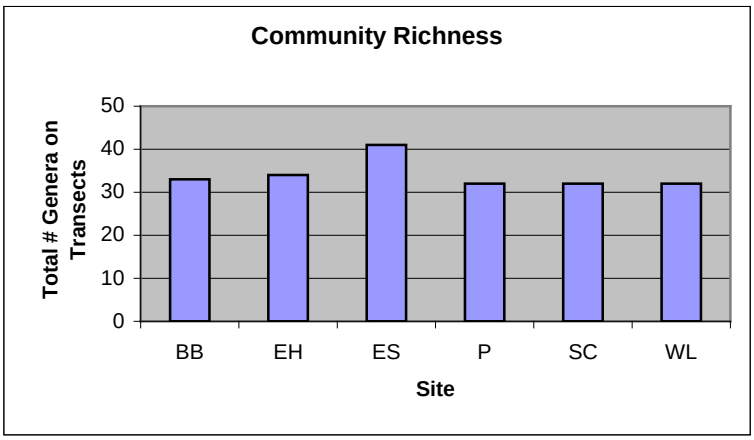
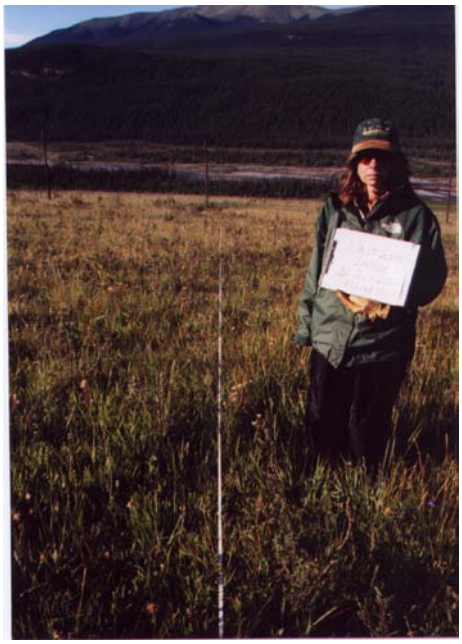


Fig 12. East Slope Exclosure

January 2001

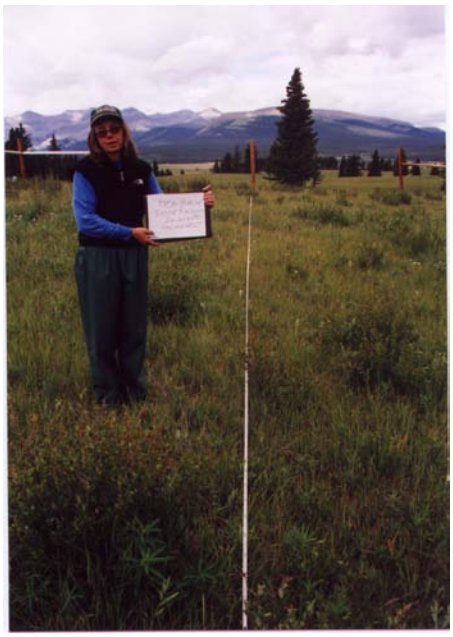


East Slope Internal Transect
31 July 2001

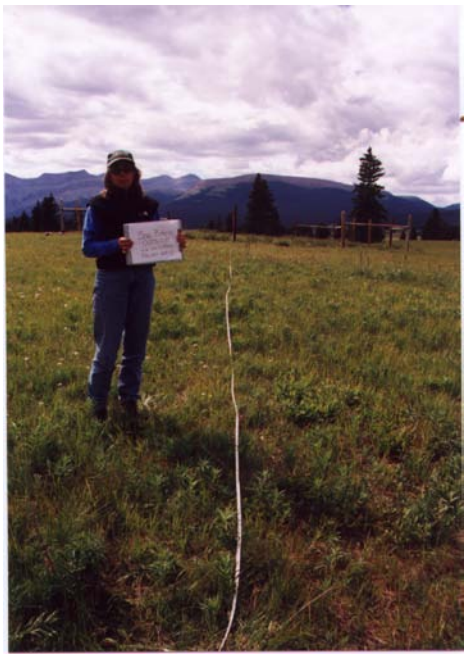
East Slope External Transect
31 July 2001

Fig. 13. Bog Birch Exclosure

Bog Birch Exclosure – June 2000
(note: external area mowed to ~10cm 1st week of June 2001)



Bog Birch Internal Transect
26 July 2001



Bog Birch External Transect
26 July 2001

Fig. 14. Similarity of graminoid cover on exclosures inside and outside each site

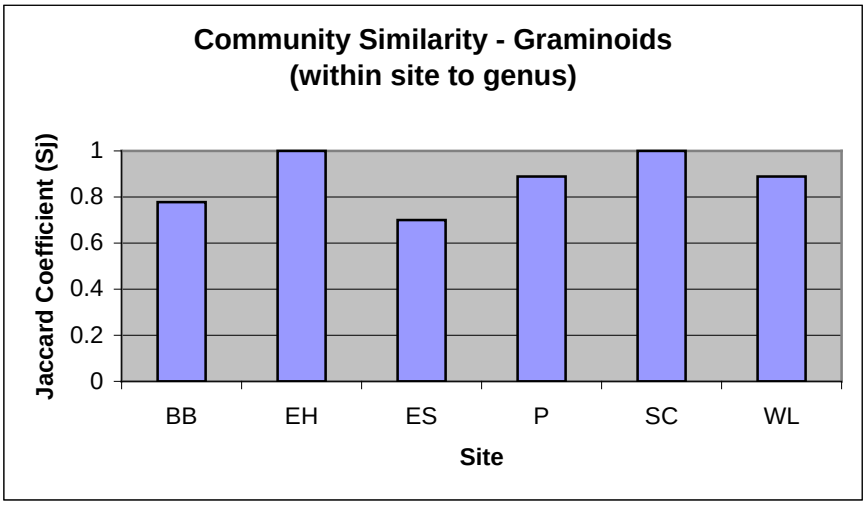
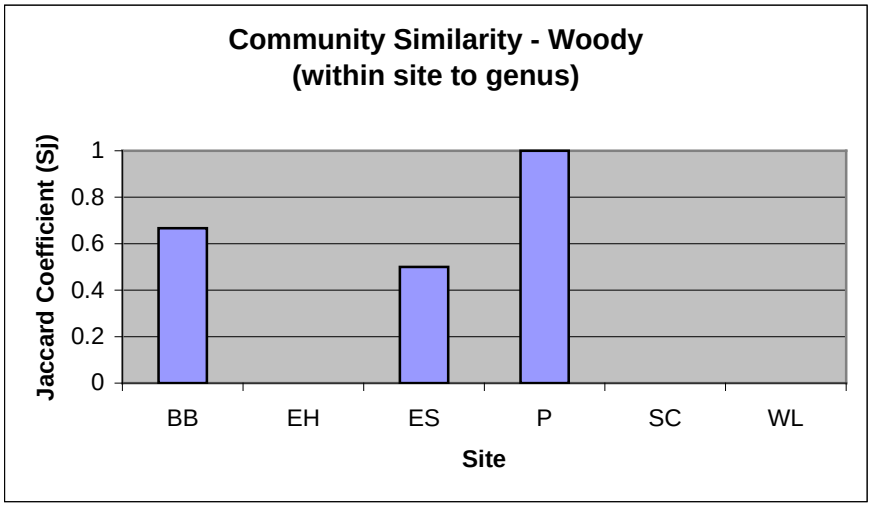


Fig. 15. Similarity of woody (shrub and tree) cover on exclosures inside and outside each site



biomass (n=90, 31 May-10 June and 2-14 August), soil mineralization rates (n=270, 13-18 June and 21-25 September), microbial biomass (n=180, 13-18 June), root biomass and length (n=180 13-18 June and 21-25 September). In addition, 25 individual rough fescue plants were subjected to the same 5 treatments at each exclosure and plant morphological measurements made (January, May, June). Treatments and sampling are repeated in 2002. Data analyses are ongoing and is not provided here.

Acknowledgements

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Appendix 1. Locations of elk pellet survey sites established in 2001 and 2002.

SITE	EASTING	NORTHING
20	599724	5735274
21	599974	5735274
48	601474	5732274
55	599974	5735024
63	601974	5735024
64	602224	5735024
67	602974	5735024
91	600474	5734774
93	600974	5734774
101	602974	5734774
122	599724	5734524
124	600224	5734524
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126	600724	5734524
127	600974	5734524
128	601224	5734524
134	602724	5734524
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151	598474	5734274
153	598974	5734274
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155	599474	5734274
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159	600474	5734274
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161	600974	5734274
162	601224	5734274
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167	602474	5734274
168	602724	5734274
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187	598974	5734024
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267	601974	5733524
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270	602724	5733524
271	602974	5733524
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287	598474	5733274
289	598974	5733274
290	599224	5733274
291	599474	5733274
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293	599974	5733274
294	600224	5733274

SITE	EASTING	NORTHING
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196	601224	5734024
199	601974	5734024
200	602224	5734024
300	601724	5733274
301	601974	5733274
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322	598724	5733024
323	598974	5733024
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327	599974	5733024
328	600224	5733024
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332	601224	5733024
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334	601724	5733024
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370	597724	5732774
371	597974	5732774
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375	598974	5732774
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380	600224	5732774
381	600474	5732774
383	600974	5732774
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SITE	EASTING	NORTHING
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297	600974	5733274
298	601224	5733274
299	601474	5733274
421	597474	5732524
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423	597974	5732524
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432	600224	5732524
433	600474	5732524
434	600724	5732524
436	601224	5732524
437	601474	5732524
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439	601974	5732524
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441	602474	5732524
442	602724	5732524
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477	598474	5732274
478	598724	5732274
479	598474	5732274
480	599224	5732274
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483	599974	5732274
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485	600474	5732274
486	600724	5732274
488	601224	5732274
491	601974	5732274
492	602224	5732274
493	602474	5732274
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SITE	EASTING	NORTHING
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389	602474	5732774
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393	590474	5732524
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535	600724	5732024
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542	602474	5732024
543	602724	5732024
544	602974	5732024
547	590724	5731774
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574	597474	5731774
575	597724	5731774
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581	599224	5731774
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595	591974	5731524
599	592974	5731524
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624	590974	5731274
627	591724	5731274
628	591974	5731274
630	592474	5731274
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633	593224	5731274
634	593474	5731274
636	593974	5731274
645	596224	5731274
646	596474	5731274
653	590974	5731024
654	591224	5731024
655	591474	5731024
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