2014

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DISCLAIMER

This progress report contains preliminary data from ongoing academic research directed by the University of Alberta that will form portions of graduate student theses and scientific publications. Results and opinions presented herein are therefore considered preliminary and to be interpreted with caution, and are subject to revision.

EXECUTIVE SUMMARY

This report summarizes activities from the long-term monitoring of the Ya Ha Tinda (YHT) elk herd and second-year efforts (1 April 2014 to 15 October 2014) aimed at understanding the role of calf survival in the persistence of the YHT elk population. Major objectives included continued long-term monitoring of adult female survival/mortality, migratory behaviour, pregnancy rates, and population size; capture and tagging of calves to determine survival and cause-specific mortality; and conducting scat surveys to determine relative diets between the predators and evaluate existing predator distribution maps.

In February and March 2014, 48 cow elk were free-range darted. One of these cows was not pregnant (2%) and yet still collared; all pregnant elk were collared (71% retained their current collars or had collars replaced) and fit with vaginal implant transmitters (VITs) in preparation for capturing and tagging calves in spring/summer 2014. As of 1 April 2014 a total of 77 elk were collared (30 GPS, 47 VHF) or ~ 27% of total adult female population.

In winter 2013/14, the pregnancy rate was 94%. Starting in January 2014 we monitored all VHF and GPS-collared resident and eastern migrant elk on an almost daily basis to determine migratory status and survival. In summer 2014, 31% of the radio-collared adult female elk migrated to the east, on or near lands operated on by Sundre Forest Products – West Fraser and Shell Energy Canada. Fifteen percent of the radio-collared adult female elk migrated west into Banff National Park, and 54% remained resident on YHT. We detected the mortalities of 2 radio-collared adult female elk, one killed by hunters in August 2014, while the other death occurred in June, and cause of death remains unknown (it appears she may have drowned because the collar was found on the banks of the Red Deer River, while the vaginal implant was found upstream in the river).

Based on VITs and/or location of neonatal elk calves (n = 50), 11 cows gave birth in Banff National Park (22%), 7 cows gave birth to the north of the ranch, mostly in the Bighorn Creek cut blocks and along Scalp Creek (14%), 13 cows gave birth to the east of YHT (26%), and 19 cows gave birth in the vicinity of the ranch (38%). Thirty-three calves (21 residents, 11 eastern migrants, and 1 unknown) were captured via ground monitoring vaginal implant transmitters in May and June 2014. The median birth date for calves born in 2013 – 2014 was 27 May and the mean mass at birth was 17.6 ± 2.1 kg. Calves equipped with radio ear tags were monitored 1-3x daily from a distance for mortality. Thirteen of the 33 calves were alive as of 15 October 2014. Of the known mortality causes in 2014, most were attributed to bears (48%), followed by wolves (14%), and cougars (10%).

Between May and September 2014, we collected over 500 scats from wolves and coyotes (canids), bears (ursids), and lynx and cougar (felids) through scat detection dog surveys in a 5x5-km sample grid. We also collected an additional 50 scats collected at elk mortality sites and opportunistically for diet analysis. DNA was collected on scats to verify species, but DNA results are not available yet. Assuming we have identified species correctly, we detected 0.55 ± 0.48 (mean ± SD) canid scats/km, 0.33 ± 0.45 ursid scats, and 0.03 ± 0.06 felid scats along transects on the grid. We detected canid scats in 92%, ursid scats in 75%, and felid scats in 25% of the 48 grid cells. Diet analysis of wolves, bears, and coyotes was started in September 2014.

OVERVIEW

Since 2000, a collaborative program has been ongoing between researchers at the Universities of Alberta and Montana, Parks Canada, Alberta Conservation Association and other natural resource groups within Alberta to determine how changes in the Ya Ha Tinda (YHT) elk population are affected by abiotic (climate) and biotic (predation, human, harvest, habitat management) factors, and habitat dynamics. Our focus has been on understanding the changing migratory behavior of elk and the trophic dynamics within this predator-prey-montane grassland system. Population modeling predicted the YHT herd would stabilize due to density-dependent predation, but the herd has continued to decline. Continued monitoring points to 2 possible mechanisms: (1) an interaction between wildfire and/or prescribed burning and predation on calves, particularly by grizzly bears which are attracted to burns, and/or (2) apparent competition whereby high predation on adult and juvenile elk by a community of predators is maintained by an increasing population of white-tailed deer. Thus, understanding the role of calf survival is the missing link in our overall understanding of this system. Our studies of the elk population at Ya Ha Tinda represent one of the longest elk population studies in a system with intact natural predators, including wolves (*Canis lupus*), grizzly bears (*Ursus arctos*), and human hunting.

This report summarizes activities from the long-term monitoring of the YHT elk herd and the first 6 months of our second-year efforts from 1 April 2013 to 15 October 2014 aimed at understanding the role of calf survival in the persistence of the YHT elk population. Our major objectives were:

1) Continue long-term monitoring to estimate pregnancy rates, adult female survival/mortality, migratory behaviour, population size, and grassland productivity.

2) Capture and ear tag calves with radio-transmitters of pregnant females. Monitor calves to determine survival and cause-specific mortality. Determine the effects of migratory behaviour and habitat selection on calf survival.

3) Conduct scat surveys using scent detection dogs to determine relative diets between the large carnivores and evaluate existing predator occupancy maps.

1) LONG-TERM MONITORING

Ground Counts

In general, maximum minimum ground counts of the cow-calf herd in winter were conducted from horseback when the majority of animals were joined together in one large group on Ya Ha Tinda ranch grasslands (Table 1). We feel confident these counts represent the majority of the cow-calf herd because all radio-collared cows were present in the group, and no other large groups of elk were present on the ranch grasslands when these counts were made.

Table 1. Maximum minimum population counts of cow-calf elk herd obtained from the ground in late winter (1 Feb. to 30 Apr.) at Ya Ha Tinda, Alberta, Canada.

Date	Total #
12-Feb-13	286
11-Mar-13	277
14-Mar-13	253
16-Mar-13	263
18-Mar-13	259
19-Mar-13	282
26-Mar-13	236
27-Mar-13	274
2013 Avg.	**266.3**
07-Feb-13	335
18-Mar-14	332
07-Mar-14	338
09-Mar-14	333
10-Mar-14	338
04-Apr-14	387
06-Apr-14	335
07-Apr-14	256
08-Apr-14	286
10-Apr-14	322
2014 Avg.	**326.2**

Aerial Counts

No summer aerial surveys were conducted in 2014, nor were winter aerial surveys conducted in winter 2013/14. Given the importance of the aerial survey data in understanding population trends in the long-term perspective in this population (Hebblewhite et al. 2006), we recommend aerial surveys be coordinated between ASRD and PC in winter 2014/15.

Pellet Plot Surveys

We also continued long-term pellet counts in the grassland (<60% canopy cover; McInenly 2003) of the Ya Ha Tinda and forested and shrubby regions adjacent to the grasslands (Table 2, Fig. 1) to provide a within-season assessment of ungulate grazing pressure and relative abundance and distribution. Spring pellet counts in 2014 were conducted during 12-16 and 21 May and represented winter use of the ranch. Fall counts occurred during 12-19 September 2014 and represent summer use. Plots were 25 m^2 and located in a systematic grid at 250-m intervals across the grasslands.

Pellet groups were defined as containing at least 8 pellets and counted if >50% of the group was within the plot. Ungulate species recorded included elk, deer (*Odocoileus virginiana, O. hemonius*), horse (*Equis*), and moose (*Alces alces).* Color, weathering, and shape of pellets were used to determine pellet species and age. Elk pellets deposited in the winter had a squared bullet shape, while summer pellets transition to a soft coalesced or disc form (Murie and Elbroch 2005). Deer pellets were similar but smaller, typically under 1 cm in length. Black pellets were considered recently deposited, whereas grey or white color indicated pellets deposited last season or even a year earlier. The presence of wolf (*Canis lupus)*, coyote (*Canis latrans*), and bear (*Ursus arctos*) scat was recorded when encountered.

Table 2. Number of plots sampled, and minimum, maximum, mean, and standard deviation of past (McInenly 2003, Spaedtke 2009, Glines et al. 2011) and recent elk pellet groups counted, and deposition rates (#/day) observed during winter and summer elk pellet surveys at the Ya Ha Tinda ranch, Alberta, Canada.

Season	Year	n	Min	Max	Mean	S.D.	No./Day	S.D.
Summer	2000	275	0	8	0.57	1.07		
Summer	2001	277	0	10	0.42	1.03	0.003	0.008
Summer	2005	37	0	3	0.78	1.00	0.008	0.010
Summer	2006	37	0	2	0.38	0.59	0.003	0.005
Summer	2007	45	0	3	0.31	0.67	0.003	0.006
Summer	2008	367	0	10	1.08	1.69	0.011	0.017
Summer	2009	325	0	8	0.84	1.32	0.006	0.009
Summer	2010	379	0	18	1.39	2.28	0.011	0.019
Summer	2011	356	0	6	0.43	0.89	0.004	0.008
Summer	2012	382	0	2	0.08	0.32	0.001	0.002
Summer	2013	366	0	5	0.23	0.63	0.002	0.005
Summer	2014	374	0	8	0.28	0.79	0.002	0.007
Winter	2000/01	270	0	24	3.01	3.33	0.013	0.014
Winter	2001/02	272	0	21	3.94	2.60	0.017	0.018
Winter	2004/05	37	0	16	3.76	3.12	n/a	n/a
Winter	2005/06	38	0	14	2.74	3.36	0.011	0.013
Winter	2006/07	46	0	16	2.85	3.48	0.011	0.014
Winter	2007/08	120	0	16	1.47	2.31	0.007	0.011
Winter	2008/09	356	0	25	1.70	2.55	0.008	0.011
Winter	2009/10	359	0	16	1.37	2.09	0.006	0.010
Winter	2010/11	356	0	19	1.15	2.11	0.005	0.008
Winter	2011/12	357	0	16	0.90	1.80	0.004	0.001
Winter	2012/13	378	0	21	0.95	1.67	0.004	0.009
Winter	2013/14	358	0	22	0.63	1.32	0.003	0.009

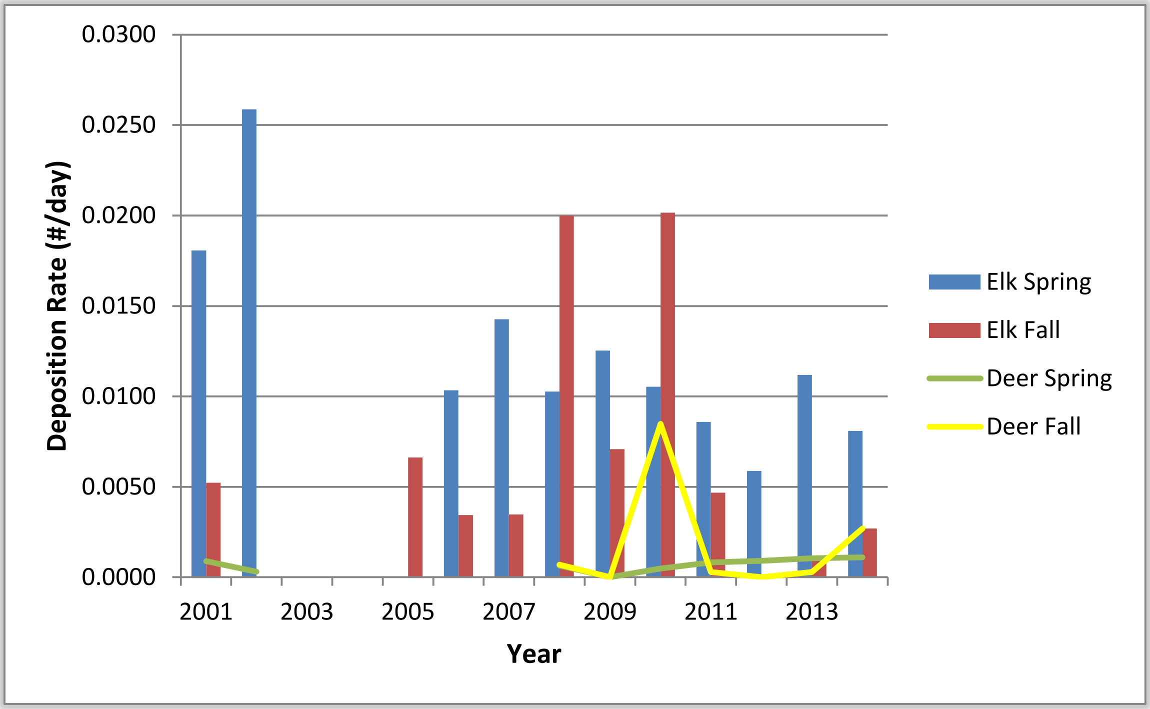

Figure 1. Changes in deposition rates (#/day) averaged across plots surveyed every year (n = 29) over time from winter 2000/01 to summer 2014; pellet groups counts were conducted at the Ya Ha Tinda ranch, Alberta, Canada.

Grassland Productivity

To document annual vegetative growth and end-of-summer forage abundance, we continued to monitor vegetation on the YHT grassland and compared these results to earlier years (2008 – 2010) when vegetation sampling was similar.

We used the spatial extent of the YHT grassland digitized by McInenly (2003) from a satellite image (excluding continuous forest portions), and verified in the field as non-forest based upon canopy cover of <60%. Vegetation was sampled at 60 locations that were at least 500 m apart on a sampling grid (Fig. 2). Total standing biomass (TSB), including new growth (CAG) and standing last year's growth (LYG) was determined using a "disc-pasture-meter" measurement (Vartha and Matches 1977, Dorgeloh 2002) in each of the 4 corners of a 5x5-m^2 plot at each of the 60 sites. This method measures plant "bulk density" and consists of sliding a 0.25-m^2 base plate (weight = 222 g) over a 1-m long calibrated aluminum meter stick. After dropping the disc from the top of the meter stick, the settling height (accurate to 0.5 cm) was recorded. In every plot, the proportion of TSB that was CAG and LYG was visually estimated, and cover was visually estimated for the broad vegetation classes of grasses, forbs, shrubs, and bare ground.

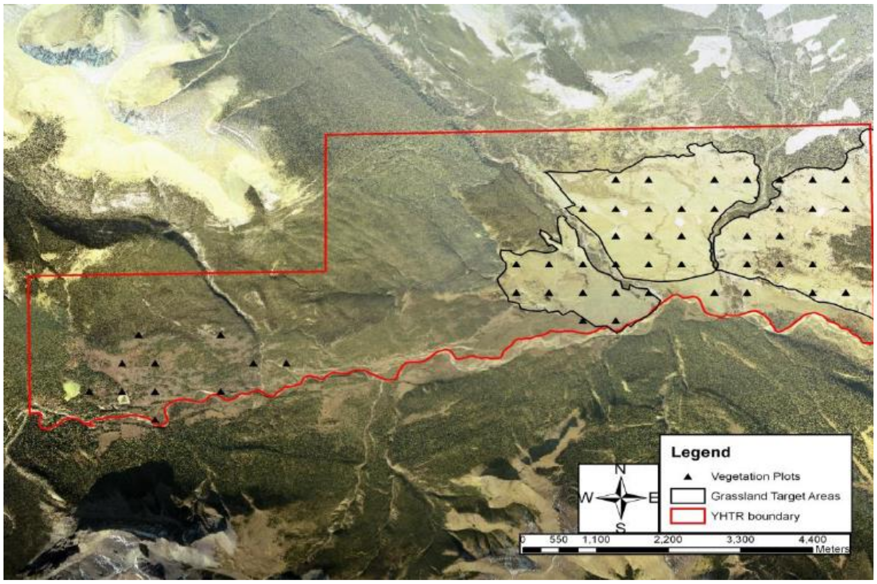

Fig. 2. Location of 45 permanent grassland sites where vegetation was sampled from 2005 - 2010. Additional sites were added for a total of 60 after 2010. Sites are part of a more extensive grid randomly located on the Ya Ha Tinda ranch, Alberta, Canada, for purpose of counting elk pellet groups. Figure credit: Spaedtke

Height of the drop disc method was related to total standing biomass (TSB) by clipping all TSB in plots directly adjacent to the permanent vegetation plots. Once a drop disc measurement was taken, TSB greater than 2 cm in height was clipped, dried at 100^o for at least 24 hours and weighed. A linear regression of biomass ($g/0.25\ m^2$) dry weight and drop disc height was developed that explained 76% ($P < 0.001$) of the variation in dry weight, and multiplied by 4 to report plant biomass on a m^2 basis (Spaedtke 2009).

Monthly estimates of standing CAG within a plot were derived as the product of the TSB (derived from the recorded height of the drop disc) and the visually estimated proportion of TSB that was current growth (CAG). CAG attributed to forbs, graminoids, and shrubs was determined from the product of CAG and the relative proportion of cover of each plant group, where relative proportion denotes the proportion of vegetative cover within a plot. At each site, the vegetation values of the 4 plots were averaged, and we report values that represent monthly means ± SE across sites (n = ~60/sampling period). For comparison, we calculated similar measures for the same sites in 2005 - 2007 based on data collected by Spaedtke (2009).

Table 3. Mean ± SD of total standing biomass (standing dead plus CAG), total current annual growth (CAG), and current annual growth of graminoids, forbs, and shrubs (g/m2) measured in July on the grassland of YHT ranch, Alberta, Canada, 2005 - 2010 and 2012 - 2013.

	Standing Biomass		Total CAG		Graminoid		Forb		Shrub		CAG
Year	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	(%)
2005	205.8	45.3	145.1	31.9	101.8	22.4	36.5	8	6.5	1.4	0.7
2006	160.2	56.5	99.8	40.2	73.5	33.3	22.2	17	4.1	11.4	0.62
2007	182	51.8	142	51.3	95.5	40.8	40.3	27.6	6.2	12.2	0.78
2008	289.2	181.4	166.1	105.7	84.8	35.7	42.2	28.5	39.5	84.6	0.57
2009	193.7	160.5	122	80	78.7	41.4	25	17.4	18.3	45.7	0.63
2010	249.3	202.6	148.8	92	100.2	64.1	34.1	26.9	14.5	40.1	0.6
2012	175.9	73.7	120.3	55.2	73.2	47	22	17	5.9	13.2	0.67
2013	171.8	90.9	104	57.1	57.6	50.1	26.3	25.6	5.1	8.2	0.63

Adult Elk Capture and Handling 2014

In February and March, 2014, 48 elk were free-range darted, immobilized, and subsequently collared (28 GPS; 20 VHF; Fig. 3). Fourteen animals received new collars (29%), while 34 (71%) animals had collars replaced or kept their current collar. Elk were palpated for pregnancy and fit with vaginal implant transmitters (VITs) if determined pregnant (Appendix I). All elk were ear-tagged in both ears (with the exception of one re-captured elk which already had identification tags but did not have a collar). Hair and blood samples were taken from all elk. A vestigial canine tooth was removed for aging after blocking the nerve with Lidocaine. Body condition and chest girths were measured. The animals were kept on oxygen during the immobilization and vitals were monitored. Forty-seven of the 48 elk (98%) were pregnant and had a VIT inserted.

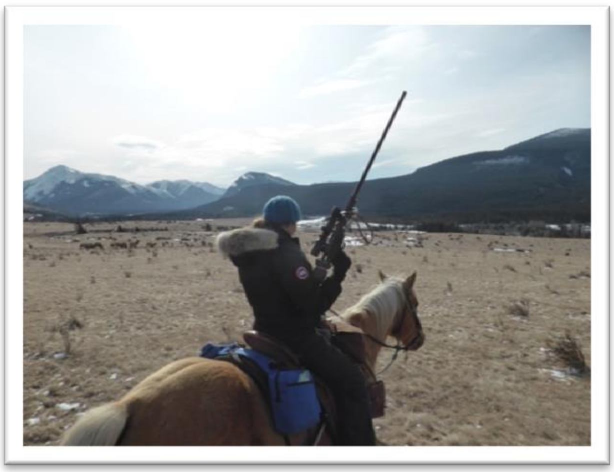

Figure 3. Chemically immobilizing elk to determine pregnancy and fit elk with radio collars. *Photo credit: Dr. Asa Fahlman*

As a result of winter capture efforts, the YHT elk herd entered spring 2014 with a total of 77 collars (approximately 27% of the total adult female population), in the herd.

Adult Elk Telemetry and Movements:

We have monitored a total of 268 unique collared adult female elk from 2002 - 2014 in the YHT herd. On average, we have had 86 adult female elk radio-collared per year, with 75 VHF collars/year and 11 GPS collars/year, with a range of 4 - 30 GPS collars deployed in any one year (Table 4). Because some elk wear both GPS and VHF collars at different times during their monitoring, the total numbers of unique VHF and GPS-collared elk are not independent (Table 3). On average, individual elk are collared for a duration of 3.1 years. From VHF-collared elk, we have obtained an average of 20 (range 9 -55) VHF locations/elk/year. For the GPS-collared elk, we have deployed GPS collars once on a total of 79 unique elk, collecting an average of 5,003 locations/elk, and 627,296 GPS locations in total.

Beginning in January 2014, we monitored 47 VHF and 30 GPS (*n* = 77) collared resident and migrant elk on an almost daily basis to determine migratory status and survival (Fig. 4). GPS collars recorded location every 15 min during May and June, and every 2 hr during other months of the year.

We located western migrants and any missing elk throughout the summer with the help of Parks Canada employees. Thirteen collared elk migrated west of the ranch for the majority of the summer. One died most likely in May or June (ID: YL25) and 7 were heard near Hector and Bow Lakes at the end of the June 2014 (ID: OR11, OR15, OR17, OR33, OR78, YL104, YL106). OR19 was heard near Windy Cabin in July 2014, OR24 was seen near Scotch camp cabin in July 2014 and GR513 was caught on the Lone Pine camera station in the Cascade valley between Stoney and Cuthead creeks on 26 June 2014. BL251 was not heard until her migration back to the ranch in September 2014. She was travelling on the Cascade Fire Road by the old elk trap. BL288 migrated into Banff National Park to calve up Tyrrell Creek on 23 May 2014, came back to the ranch 3 June 2014, and returned to Divide Creek from 24 June until 10 August 2014.

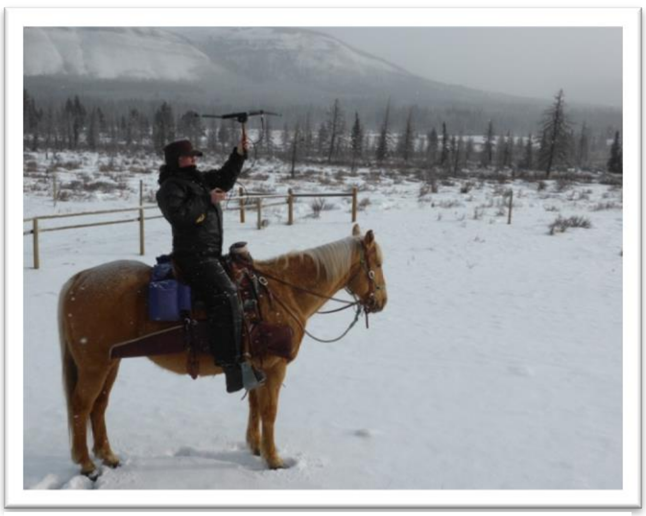

Figure 4. Monitoring newly-collared animals during the winter capture season. *Photo credit: Dr. Asa Fahlman*

Table 4. Summary radio-telemetry table for VHF and GPS-collared elk from 2001 to 2014 in the Ya Ha Tinda elk herd, Alberta, Canada. The table shows total number of elk collared/year, number and average number of VHF/GPS locations/individual elk, and total number of locations. Note that the total number of unique VHF and GPS-collared elk do not add up because some elk wear both kinds of collars, and because individual elk occur in multiple years (3 on average).

Year	# Elk Collared	# Elk Newly Collared	Total VHF Locs.	Total # VHF-collared	Mean VHF Locs./Elk	Total # GPS-collared	Total GPS Locs.	Mean GPS Locs./Elk
2002	41		2,045	37	55	4	11,192	2,798
2003	81		2,858	73	39	8	36,342	4,543
2004	99		1,891	74	26	25	88,152	3,526
2005	92		983	81	12	11	51,498	4,682
2006	113		1,392	99	14	14	126,342	9,024
2007	103		872	94	9	9	86,926	9,658
2008	81		1,027	81	13	0	0	0
2009	108		1,339	101	13	7	27,157	3,880
2010	97		936	91	10	6	40,542	6,757
2011	87		988	81	12	6	17,651	2,942
2012	63		547	60	9	3	2,749	916
2013	77	25	1,673	55	30	22	138,745	6,307
2014	77	14		47		30		
Avg.	86		1,379	75	20	11	52,275	5,003
Totals	268		16,551	974		145	627,296	

Adult Mortality

Since 1 April 2014, mortality signals from radio-collars were detected using ground and aerial telemetry, and were investigated from the ground or via helicopter as quickly as possible (in 2014, less than 24 hours for collared residents and eastern migrants, and less than 3-5 months for collared western migrants. One collared female (ID: BL267) was killed by hunters in August 2014, while YL25 died in June; cause of death is unknown but it appears she may have drowned (see Appendix III for additional details).

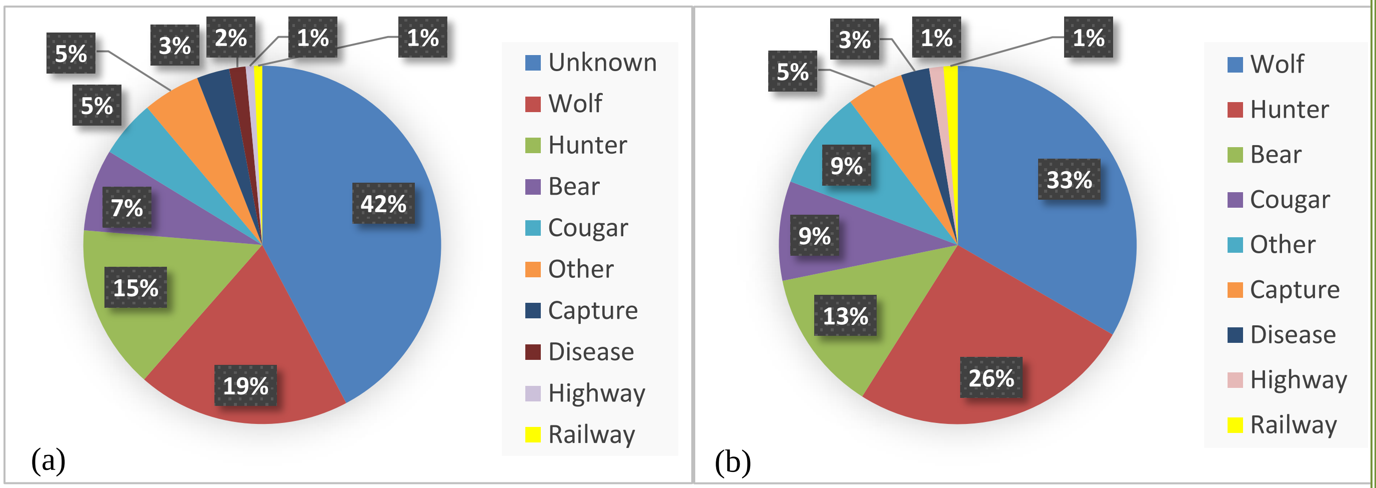

Figure 5. Mortality causes for radio-collared adult female elk (*n* = 135) from 2002 – October 2014 in the Ya Ha Tinda elk population, Alberta, Canada. (a) shows all mortalities, including unknowns (*n* = 135), and (b) shows only known-causes of mortality excluding unknowns (*n* = 78).

Summer and Winter Calf:cow Ratios:

For all observations of groups of collared, tagged, and/or un-collared elk, we recorded time, date, location, and the numbers of tagged elk in the herd, whenever possible. We followed the criteria of Smith and MacDonald (2002) to sex- and age-classify elk in groups to obtain demographic data. Although we attempted to classify yearling females in the field, this practice is not recommended except by very skilled observers at very close range, as body size of yearling females is variable and there is considerable risk of misclassification (Dean et al. 1976, Smith and MacDonald 2002). Therefore, we included classified yearling females in the adult female total. Observations were made from a distance to avoid disturbing the elk (on average 30-100 m from horseback, and 100-500 m from the ground or truck). Here, we examine trends in recruitment from 2001 – 2014 by examining the calf:cow ratio in late winter (1 Feb. – 30 Apr.), and the calf:cow ratio in summer (1 June – 31 Aug.) following Hebblewhite (2006, Appendix 1B) and Czaplewski et al. (1983) using the following:

$$Y_{ij} = \frac{\sum_{i=1}^{n} calves_i}{\sum_{i=1} cows_i} \qquad \text{Eq. 1}$$

where i = 1 to n elk herds classified within season-year j, i.e., 2013 recruitment. We calculated the standard error in Y_{ij} assuming errors were binomially distributed following Czaplewski et al. (1983):

$$SE = \sqrt{\frac{Y_{ij}(1-Y_{ij})}{k_{ij}}} \qquad \text{Eq. 2.}$$

where Y_{ij} is the calf:cow ratio for season-year j, and $k_{ij} = \sum_{i=1}^{n} calves_i + \sum_{i=1}^{n} cows_i$, namely, the total number of elk counted in any given season-year (Czaplewski et al. 1983).

Table 5. Calf:cow ratio data in late winter (1 Feb. to 30 Apr.), Ya Ha Tinda elk herd, Alberta, Canada. Adult female total includes female yearlings.

Year	Total # Classified	# of Groups	ADF Total	YOY Total	Calf:cow	SE
2002	1942	20	1362	188	0.138	0.009
2003	6296	70	5490	493	0.090	0.004
2004	4381	35	3563	533	0.150	0.006
2005	229	10	183	19	0.104	0.021
2006	2144	19	1552	347	0.224	0.010
2007	2316	14	1909	346	0.181	0.008
2008	--	--	--	--		
2009	1568	13	1310	222	0.169	0.010
2010	454	6	348	86	0.247	0.021
2011	1035	13	813	90	0.111	0.010
2012	545	2	524	18	0.034	0.008
2013	568	2	506	57	0.113	0.013
2014	2832	14	2106	643	0.305	0.009
Average	2025.83	18.1667	1638.83	253.5	0.155	0.008

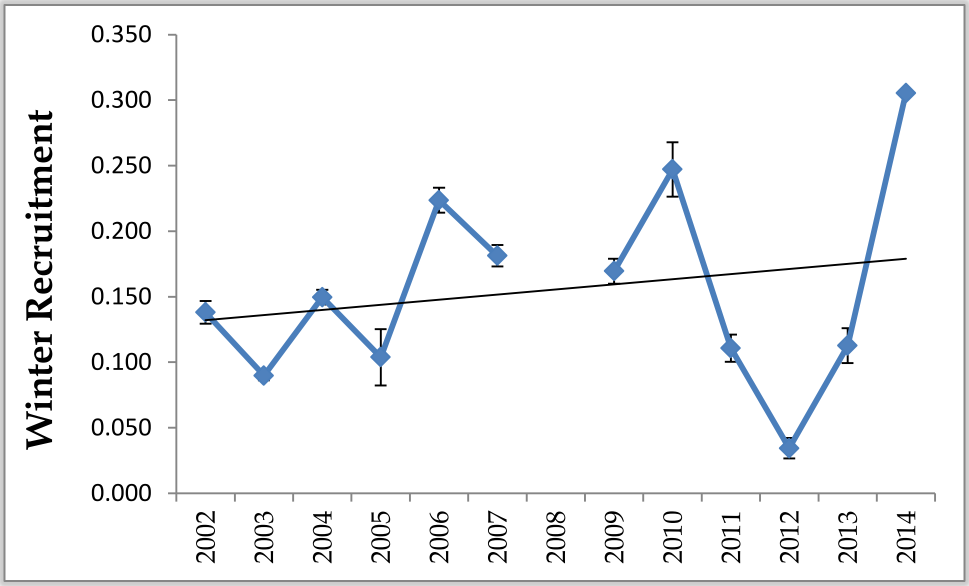

Figure 7. Calf:cow ratio data in late winter (1 Feb. – 30 Apr.) from 2002 - 2013 for the Ya Ha Tinda elk herd, Alberta, Canada. Adult female total includes female yearlings.

Table 6. Calf:cow ratio data (1 June – 30 Aug.), Ya Ha Tinda elk herd, Alberta, Canada. Adult female total includes female yearlings.

Year	Total # Classified	# of Groups	ADF Total	YOY Total	Calf:cow	SE
2002	662	59	487	130	0.267	0.018
2003	1873	109	1455	372	0.256	0.010
2004	2012	105	1459	437	0.300	0.011
2005	598	32	427	111	0.260	0.019
2006	394	17	266	102	0.383	0.025
2007	736	38	605	57	0.094	0.011
2008	1367	55	1103	128	0.116	0.009
2009	2438	71	1782	526	0.295	0.009
2010	3884	322	2943	455	0.155	0.006
2011	2870	306	2343	249	0.106	0.006
2012	443	22	404	37	0.092	0.014
2013	3857	91	2761	943	0.342	0.008
2014	3013	137	2057	569	0.277	0.009
Average	1857.4615	104.9	1391.7	316.6	0.226	0.012

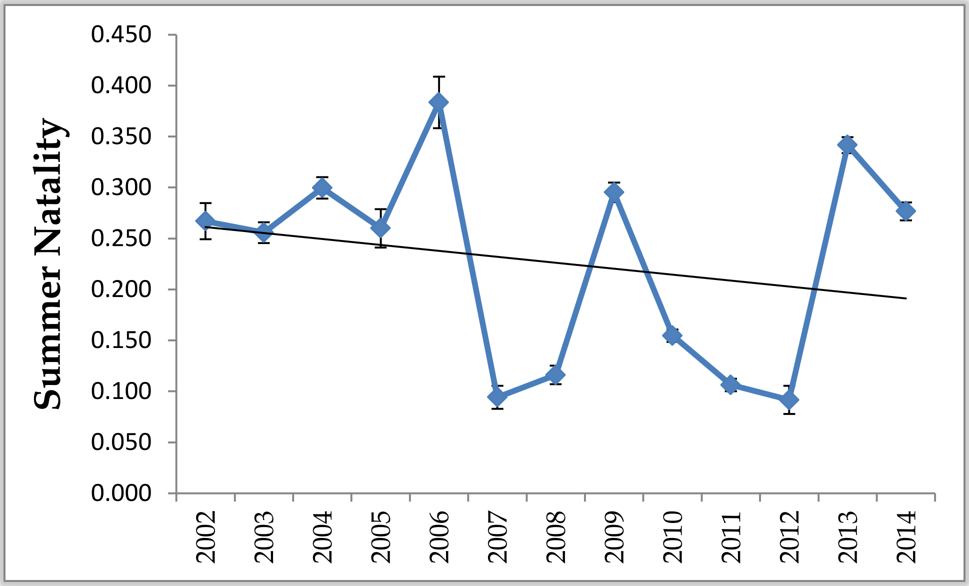

Figure 8. Calf:cow ratio data in summer (1 June – 31 Aug.), Ya Ha Tinda elk herd, Alberta, Canada. Adult female total includes female yearlings.

Table 7. Average calf:cow ratios between 1 June and 31 August in the migratory segments of the Ya Ha Tinda elk herd, Alberta, Canada.

Year	*n*	Residents	*n*	Eastern Migrants	*n*	Western Migrants
2013	29	0.22	13	0.37	--	0.29[a]
2014	34	0.19	24	0.54	6	0.17

[a] as reported by Parks Canada in November 2013

Migratory Behaviour:

In summer 2014, 31% of the radio-collared adult female elk migrated to the east, on or near lands operated on by Sundre Forest Products – West Fraser and Shell Energy Canada. Fifteen percent of the radio-collared adult female elk migrated west into Banff National Park and 54% remained resident on YHT (Table 8).

Table 8. Migratory status of collared elk in the Ya Ha Tinda elk herd during the summers 2013 - 2014, Alberta, Canada. Number of observations (n) is based on telemetry and visual observations.

Year	***n***	**% Residents**	***n***	**% Eastern Migrants**	***n***	**% Western Migrants**
2013		50		40		10
2014	38	54	21	31	10	15

Pregnancy Rates:

In February and March, 2014, 48 elk were rectally palpated. Only 1 elk was not pregnant. The pregnancy rate was 98% (Table 9, Fig. 9).

Table 9. Pregnancy rates in late winter across all years except 2007 and 2010 for the Ya Ha Tinda elk herd, Alberta, Canada

Year	# Pregnant	Total Sample	% Total
2002	23	35	0.657
2003	39	47	0.830
2004	41	49	0.837
2005	29	30	0.967
2006	20	26	0.769
2007			
2008	23	40	0.575
2009	40	42	0.952
2010			
2011	14	16	0.875
2012			
2013	21	23	0.913
2014	47	48	0.979
Total	**297**	**356**	**0.819**

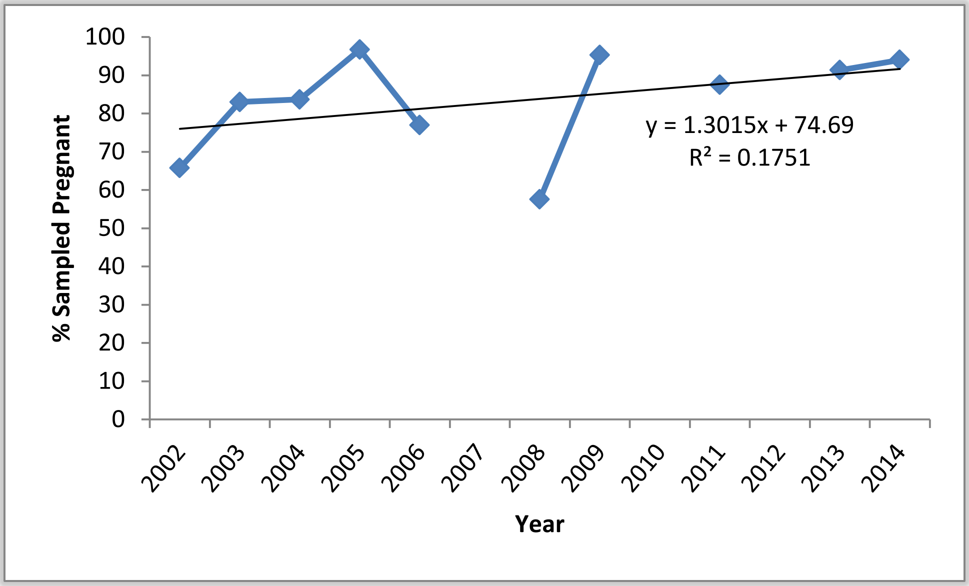

Figure 9. Pregnancy rates in late winter across all years except 2007 and 2010 for the Ya Ha Tinda elk herd, Alberta, Canada.

2) CALF CAPTURES AND MONITORING

Calving Areas:

In 2014, of the approximately 266 adult female elk that wintered on the Ya Ha Tinda, 47 had vaginal implant transmitters (VITs). Based on VITs and/or location of neonatal elk calves (*n* = 50), 11 cows gave birth in Banff National Park (22%), 7 cows gave birth to the north of the ranch mostly in the Bighorn Creek cut blocks and along Scalp Creek (14%), 13 cows gave birth to the east of YHT (26%), and 19 cows gave birth in the vicinity of the ranch (38%; Fig. 10, Appendix IV).

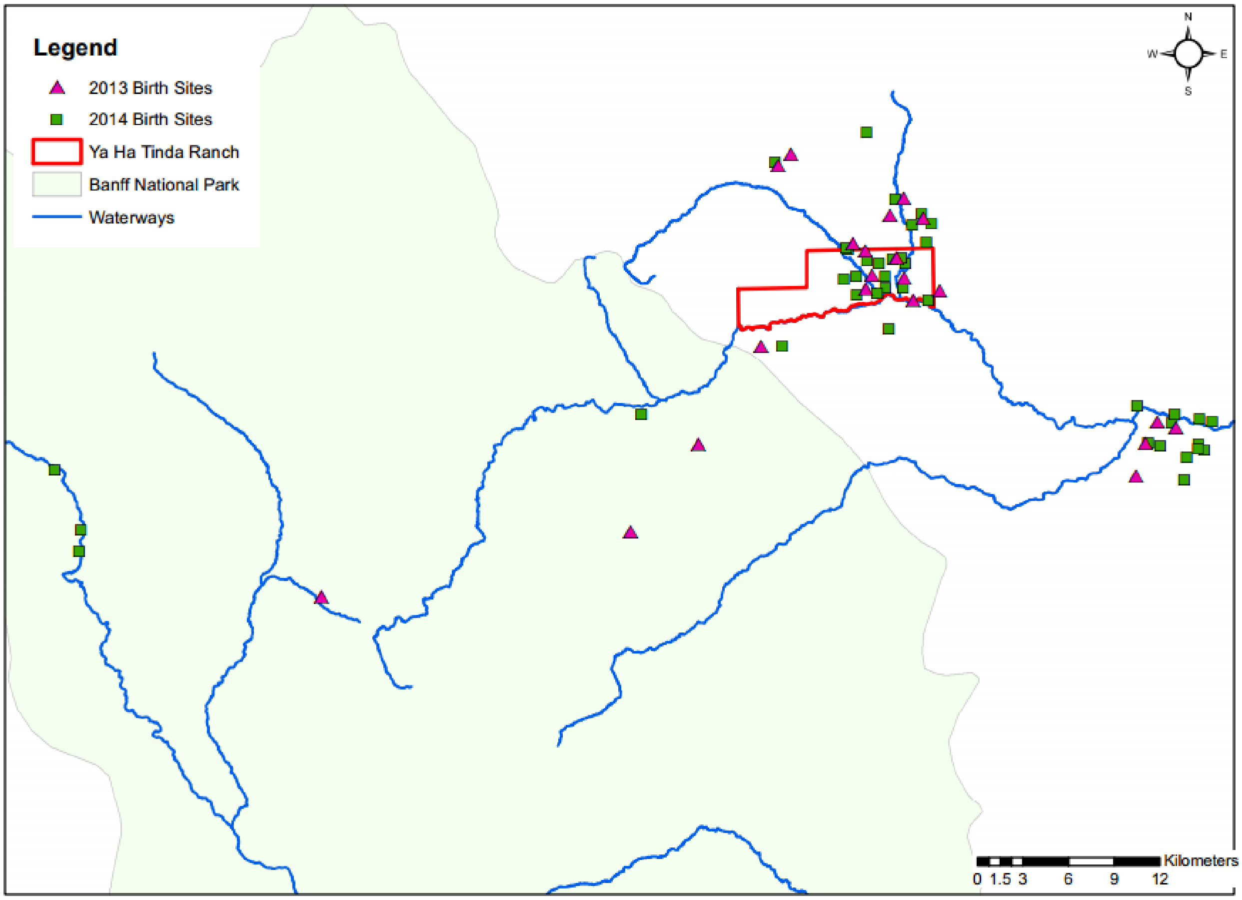

Figure 10. Birth sites of 61 elk calves located through use of vaginal implant transmitters (VITs) and/or neonatal elk calves, Alberta, Canada, in 2013 - 2014.

Calf Capture Effort 2014

In May and June, 2014, 33 elk calves (21 residents, 11 eastern migrants, 1 unknown) calves were captured from the ground and subsequently ear-tagged. We were unable to capture 19 calves from cows with VITs that migrated large distances right before giving birth, or into BNP (Appendix IV). The 33 calf captures involved ~ 45 days of actual monitoring and capture effort in the field. Teams of 2 monitored the VITs on a daily basis, several times per day; when a VIT was expelled, the team attempted to locate and capture the calf (*n* = 28). Calves were also captured on an opportunistic basis (*n* = 5; Appendix V). Most of the

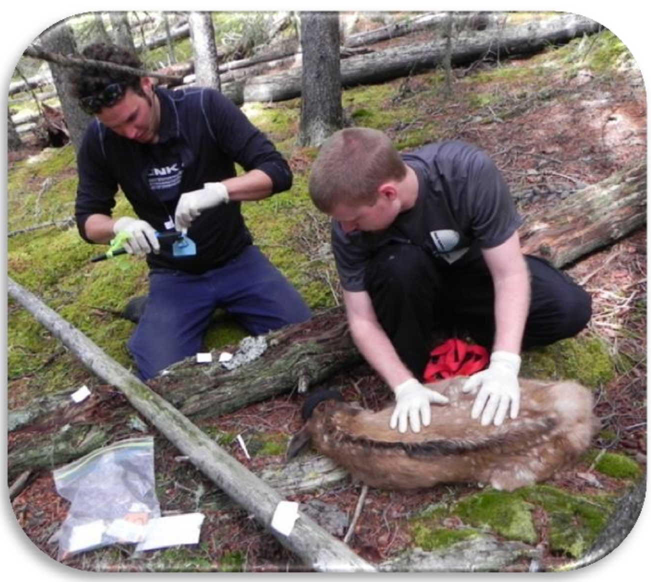

Figure 11. Calf captures in May and June, 2014, in the Ya Ha Tinda elk herd, Alberta, Canada, were limited to less than 10 minutes, including measurements and attachment of the ear tag. *Photo credit: Celie Intering*

calves were captured within 300 m of the location of the VIT representing the birth site; however, 5 calves were captured opportunistically so their birth sites remain unknown.

Once a calf was captured, measurements and weight were taken, which aid in estimating age as well as determining factors which affect calf survival (Figs. 11 and 12). Calves were equipped with a GPS radio collar (*n* = 2) or VHF radio transmitting ear tags (*n* = 31) to allow for regular relocation and monitoring, and to locate calves when the signal indicates they have remained unmoved for > 4 hours. Calves were released within 10 ± 3 minutes of capture.

Figure 12. Hair samples were collected and measurements taken on calves captured in May and June, 2014, in the Ya Ha Tinda elk herd, Alberta, Canada. *Photo credits: Celie Intering*

Calving:

The median date of birth, and the overall median birth date, for calves born in 2014 (*n* = 39), as well as the total sample of calves born in 2013 – 2014 (*n* = 57), was 27 May (range = 9 May – 24 June; Fig. 14). Because the calves were captured at various ages, we used the rates of gain determined by linear regression for maternally nursed elk calves described by Robbins et al. (1981) to correct birth weight. We multiplied the average rate of gain (0.8 kg/day) by the age in days of each calf and subtracted this from weight at capture to calculate the mean weight at birth in 2014 to be 18.0 ± 2.1 kg (*n* = 29; Fig. 13). The overall mean weight at birth in 2013 – 2014 was 17.6 ± 2.1 kg (*n* = 44).

The median birth date for calves in the Ya Ha Tinda herd is close to that of elk calves captured in Yellowstone, where the median birth date was also 28 May (Barber-Meyer, Mech, and White 2008). This date appears slightly earlier than the birth date reported by a study in Pennsylvania, in which 52% of all documented births of elk occurred in the first week of June (DeVivo et al. 2011), and the peak birth date of 1 June reported by Johnson (1951).

Although a small sample size, elk calves in the Ya Ha Tinda herd appeared to weigh slightly more at birth than elk calves captured by Barber-Meyer, Mech, and White (2008; 14-15 kg), but weights appeared similar to those of male calves captured by DeVivo et al. (2011; 16.6 kg; females averaged 13.7 kg).

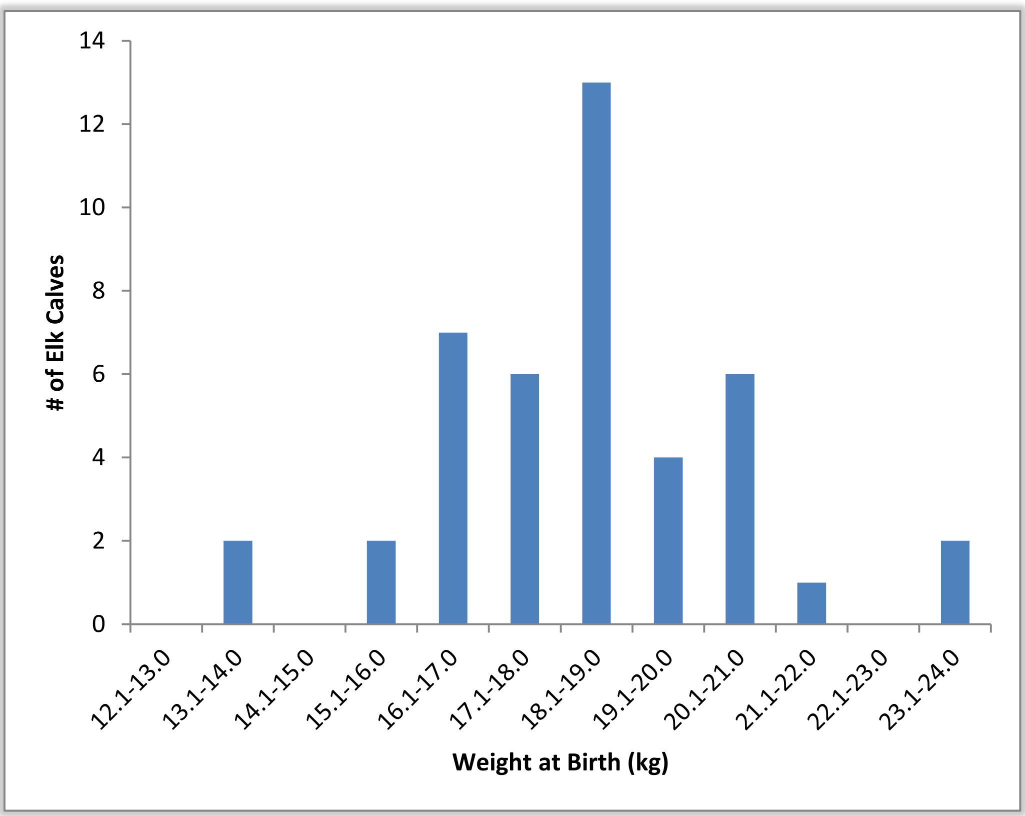

Figure 13. Weights at birth for calves captured (*n* = 44) in the Ya Ha Tinda elk herd, Alberta, Canada, in 2013 and 2014. We used the estimated daily growth rate of the calves to back-calculate weight at birth from weight at capture.

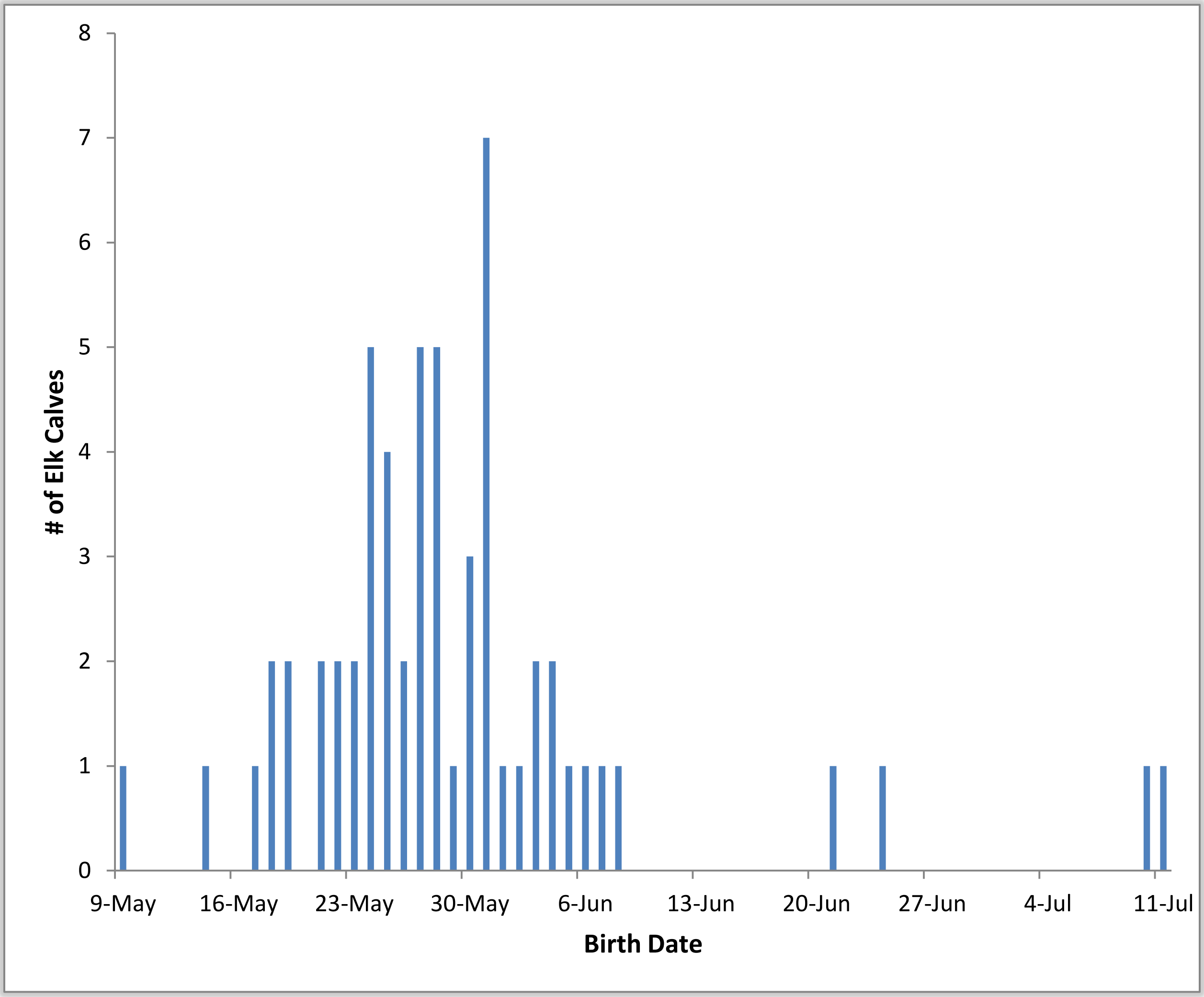

Figure 14. Birth dates for calves born (*n* = 59) in the Ya Ha Tinda elk herd, Alberta, Canada, 2013 - 2014. Known birth dates ranged from 9 May to 11 July.

Photo credit: Celie Intering

Post-capture Monitoring:

All animals were closely monitored (2-5x daily) from a distance with telemetry in the 1-2 days following capture to check for capture-related injuries or complications. Thereafter, calves were monitored from a distance at least once daily throughout summer and fall. In winter, calves were monitored less frequently (2-5x weekly).

Mortality signals were investigated as soon as possible after the signal was detected, usually within 24 hr from the time of death (Fig. 15). Most calves died within the first 10 days of life (Fig. 17). Investigators thoroughly searched mortality sites for evidence from predators or other causes of death, such as disease or weather. In 2014, of known causes of death, bears were responsible for the majority (Fig. 16, Appendix VIII). Two mortalities were predator-caused, but there was insufficient evidence to determine which predator was responsible. One calf was born undeveloped prematurely; the carcass was submitted to the wildlife lab at Alberta Sustainable Resource Development for necropsy. Unfortunately there was insufficient material to provide a definitive diagnosis regarding the stillborn calf as part of the calf had been scavenged; internal organs were not present, the thyroids were normal, and no significant gross or histologic lesions were apparent in the brain.

Figure 15. Calf mortalities in the Ya Ha Tinda elk herd, Alberta, Canada, in 2013 - 2014 were investigated as quickly as possible to determine cause of death based on sign from predators, disease, or weather. *Photo credits: Laura Burns*

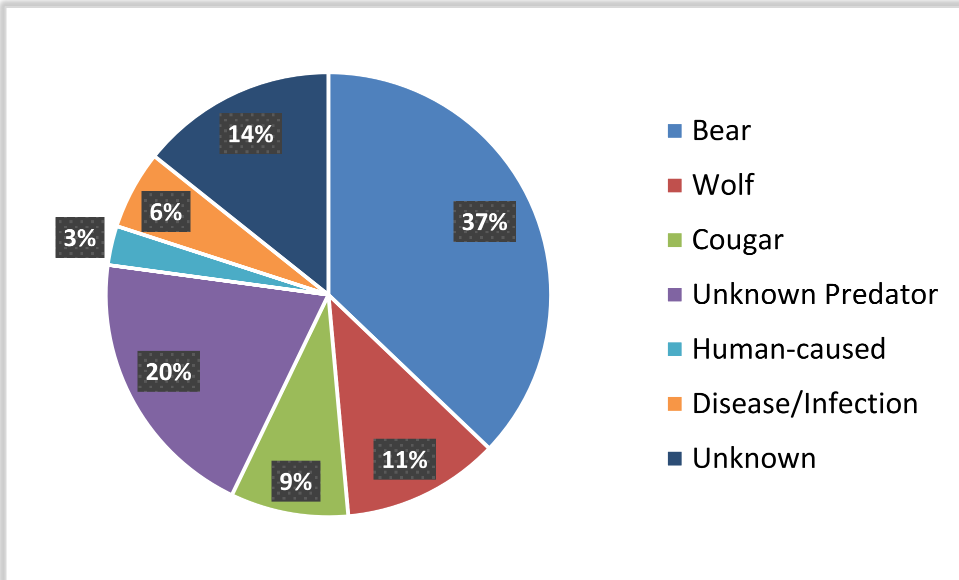

Figure 16. Causes of death of elk calves (*n* = 35) in the Ya Ha Tinda elk herd, Alberta, Canada, in 2013 - 2014. Note that chart ignores differences in timing of the different causes of mortality (i.e., predation by bears tends to occur earlier in the neonatal period compared to that of other predators).

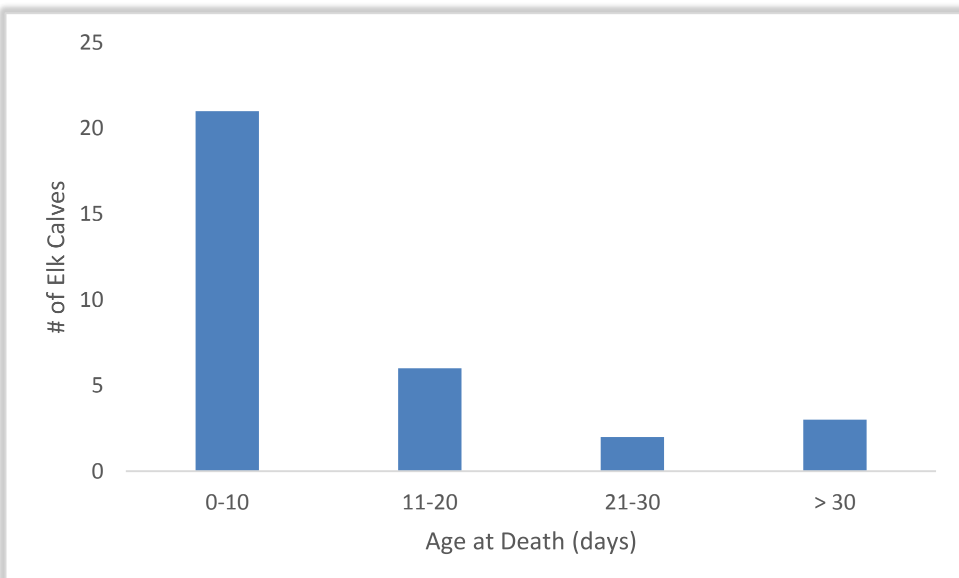

Figure 17. Age at death of elk calves (*n* = 32) in the Ya Ha Tinda elk herd, Alberta, Canada, in 2013 - 2014.

Calf Survival:
Of the 33 calves captured and tagged in 2014, 13 were still surviving as of 15 October 2014 (Table 12). Seven of these calves belonged to resident cows, while 6 were born to eastern migrants.

To gain additional information on survival of calves, we also identified radio-collared and/or ear-tagged cows with and without calves following methods of Eggeman (2012). Cow-calf pairs were obtained by visually observing the groups.

Twenty-seven GPS/VHF-collared or ear-tagged resident cows were observed with calves at the Ya Ha Tinda ranch over the summer and fall (Appendix IX). Eighteen of these cows (67%) were confirmed to have lost their calves by the end of October. Seven resident cows were never observed with a calf. Two of these cows (IDs: BL288, BL295) were identified as pregnant in the winter during captures, left the ranch to calve, and subsequently came back without a calf (Fig. 10).

Eighteen GPS/VHF-collared or ear-tagged eastern migrants were paired with a calf over the summer and fall. Seven of these subsequently lost their calves, and 3 cows were never observed with a calf. BL267 had a calf but was taken by poachers or hunters in August 2014; it is unknown whether or not her calf is surviving.

OR78, YL104, and YL106 migrated into BNP and gave birth near Hector Lake along the Bow River; it is unknown whether their calves have survived as no observations have been made since they returned to the ranch in October. OR24 gave birth in BNP but she was observed without a calf later in summer. YL58, GR513, and OR19 were never observed with calves. These observations will be analyzed in a mark-resight framework similar to Eggeman (2012) to complement our radiocollared elk calf survival monitoring.

Birth Site Characteristics:

To determine whether birth site selection is most influenced by local vegetative features or broad-scale predation risk, we located birth sites through use of vaginal implant transmitters or neonatal calves. After the cows and calves left the capture area, birth and bed sites, and 1 random site for each, were visited in June 2014 and characteristics (location, slope, elevation, canopy cover, tree density, vegetation, and hiding cover) were measured (Fig. 18). Canopy cover was estimated with a densiometer. Tree density and shrubby vegetation were counted in a belt transect measuring 30 x 4 m, placed in a random direction and centered on the sites. We measured the amount of horizontal cover (i.e., hiding cover for calves) at the sites using cover board estimates taken from each of the four cardinal directions from distances of 10 and 30 m, and taken from both kneeling and standing positions to approximate predator eye height (Panzacchi et al. 2010). We expect to characterize selection of calf birth and bed sites between migrants and residents, and between cows with calves which have survived and cows with calves which have not survived, in relation to predation risk of the general calving area and vegetation at the birth or bed site and their interaction.

Preliminary analysis of birth sites vs. random sites for the different characteristics (slope, elevation, canopy cover, tree density, vegetation, and hiding cover) indicate no significant difference (Kruskal-Wallis: $\chi^2 = 38.40$, $p > 0.05$) between the sites. When conducting *a posteriori* pairwise comparison of birth sites amongst migratory strategies using Wilcoxon rank sum test, elevation was significantly lower east of YHT than on any other calving ground ($p < 0.01$). Birth sites north or west of YHT were significantly higher compared to the ranch ($p < 0.01$). There was a slight difference in hiding cover at 30 m among migratory strategy ($\chi^2 = 9.73$, $p = 0.05$). We expect that our current sample sizes are low for detecting significant difference amongst the migratory strategies and for the different characteristics.

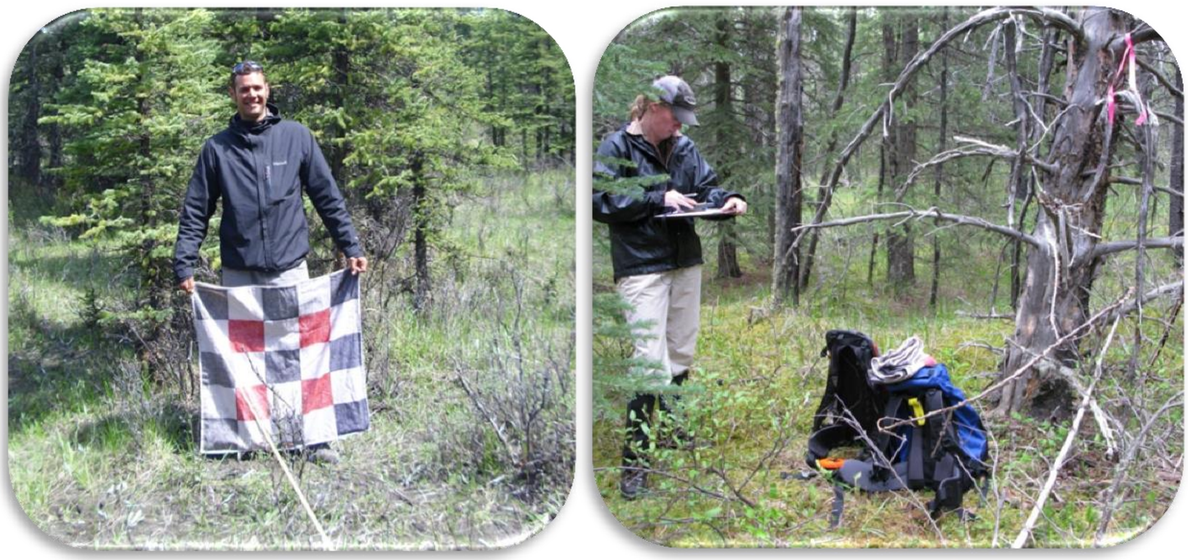

Figure 18. Birth and bed sites, and 1 random site for each, of calves captured in the Ya Ha Tinda elk herd, Alberta, Canada, were visited in 2013 - 2014 and canopy cover, slope, elevation, calf hiding cover, and shrubby vegetation, and tree density were measured. *Photo credits: Jodi Berg and Marion Calandra*

3) PREDATOR DISTRIBUTION

Building on preliminary work in 2013, we conducted a pilot study in summer 2014 for sampling predator scats to determine summer food habits and to quantify the distribution of large predators communities in and adjacent to the Ya Ha Tinda. The information collected from this effort will be used to determine the relative abundance of elk calves in the diets of 5 predators and that may help quantify the spatial risk of predation to explain shifts in the migratory patterns of the Ya Ha Tinda elk herd.

Figure 19. Surveying for predator scat using a scent detection dog near the eastern border of Banff National Park, Alberta, Canada, in 2013 - 2014. *Photo credit: Zach Taylor*

Scat collections were conducted using specially-trained dogs (Fig. 19) and a grid of sampling units (Fig. 21) established by an ongoing program that is documenting distribution of wildlife species in Banff National Park using remote field cameras (Steenweg et al. 2012). Our efforts focus on the large predators including wolves (*Canis lupus*), coyotes (*Canis latrans*), black bears (*Ursus americanus*), grizzly bears (*Ursus arctos*), cougars (*Puma concolor*), and lynx (*Lynx canadensis*). After additional field work in summer 2015, landscape patterns of predator distribution based on the scat surveys will be compared to results from the camera surveys and predictions based on past resource selection modeling because each method has limitations. Additional funding is being sought to extend the occupancy approaches we intend to use to determine relative abundance of predators by identifying individual animals based on DNA. In this report we summarize preliminary results of predators by family (ursids, canids, and felids) from 2014 and make recommendations for field sampling in 2015. Scat analysis for predator diet is currently underway at the University of Alberta and results are not yet available.

***Objectives*:**

1) Compare the composition of items in the scats of canids, ursids, and felids with particular focus on which predator's diet is highest in both calf and adult elk.

2) Determine the distribution of large carnivores including canids, ursids, and felids in the study area based on scat distribution to determine the spatial extent of predation risk.

3) Evaluate the distribution of large carnivores based on scat distribution by comparing to distributions derived from resource selection functions and remote camera photos taken in the same study area.

Methods:

We used a 5 x 5-km grid-based sampling design and surveyed 48 cells from 2 July to 12 September 2014 using 2-3 dog/handler teams (Fig. 21). Dog handlers and their dogs walked transects that covered different habitat types in individual cells as determined by examining satellite imagery. Due to difficult topography, actual survey routes often differed from the mapped survey routes because the handler/dog was restricted to what was possible to cover on foot. The survey paths within the 48 cells ranged from 5.1 – 25.7 km/cell with an average of 12.9 ± 4.0 km/cell.

When a scat was detected, a GPS location was recorded. The scats were then visibly ranked to provide a general timeline of when defecation occurred. Ranks included "Fresh", "Semi-old", "Old", and "Very old" based on moisture level, colour, weathering of fecal material, and presence of mold. "Fresh" scats were those that appeared that the mucous that covers the scat was still visible. "Very old" scats were those that most, if not all of the fecal material was gone and the remaining solid material was considerably degraded (adapted from Wasser et al. 2004). Dog handlers assessed and recorded the suspected species of the scat based on the physical appearance. In particular, coyote and wolf scats were initially distinguished based on a 2.5-cm diameter (Thompson 1952, Weaver and Fritts 1979). The dog handler also categorized confidence in the assessment as low/medium/high and a photograph was taken of scats identified with a medium or low confidence ranking for further examination in the laboratory.

All fresh (*n* = 25), 79 semi-old, and 8 old scats were swabbed for DNA using non-finished toothpicks following protocols recommended by Wildlife Genetics International (Leanne Harris, pers. comm.). The toothpick was used to gently scrape the clear mucous off fresh scats and dried mucus from semi-old and old scats from the outside of the scat while avoiding collecting fecal material. The toothpicks were placed in breathable coin envelopes then stored at room temperature to aid in desiccation necessary for preserving the DNA structure (Waits and Paetkau 2005). The DNA will be analysed to verify species identification as funding is available.

All fresh scats, ~90% of the semi-old and old, and ~25% of the very old scats (when they were the only sample of the species detected in the cell) were collected in plastic Zip-loc bags. For large-sized scats, scats were sub-sampled by selecting several handfuls throughout the pile to ensure a representative sample (Giovanna et al. 2012). Once collected, the species (or family), freshness ranking, GPS location, date, and diameter was recorded on the bag for each scat. The scat was placed in a freezer for storage (ranging from 1 hr to 3 days after collection).

In addition to those detected by the working dogs on scat surveys, we incidentally collected 50 scats while performing other portions of the study using the same collection procedures. These scats will be used for the scat composition analysis but not the distribution analysis.

For preliminary analysis, we plotted the relative abundance of scats by species (assuming we identified species correctly) across the sampling grid using ArcMap 10.1. Relative abundance of scats per 5 x 5-km cell was determined as the number of scats per linear kilometer of transect sampled. Classes of relative abundance for each species were determined by examining the frequency distribution of scats/km/cell of ursids, felids and canids (Fig. 20). Because we found a higher number of scats/cell for ursids and canids, we used relative abundance categories of (1) no scat detected, (2) low scat detection: 0.01 - 0.39 scats/km , (3) medium scat detection: 0.40 - 0.99 scats/km and (4) high scat detection: 1.00 - 2.40 scats/km for canids; and, (1) no scat detected, (2) low scat detection: 0.01 - 0.29 scats/km , (3) medium scat detection: 0.30 - 0.59 scats/km and (4) high scat detection: 0.60 - 2.38 scats/km for ursids. Due to the relatively low numbers of felid scats, we used only scat detected or scat not detected.

Results:

During the summer 2014 we detected a total of 511 scats with an additional 50 scats collected for diet analysis opportunistically. Of the scats detected by the dog handlers, 64% were from canids, 32% were from bears, and 4% were from felids (Table 13). All 511 scats collected in the 48 cells during the scat surveys were used in the preliminary mapping of scat relative abundance. Canid scats averaged 0.55 ± 0.48 scats/km (mean ± SD, range 0 - 2.40 scats/km), ursid scats averaged 0.33 ± 0.45 scats/km (range 0 - 2.38 scats/km), and felid scats averaged 0.03 ± 0.06 scats/km (range 0 - 0.28 scats/km). For canids, only 8% of the 48 cells had no scats, whereas we detected a low number (40%) and a medium number (35%) of scats in about equal number of cells, and a high number of scats in 17% of the cells (Fig. 22). Cells with high number of scats detected were somewhat more prominent in the western portion of the study area. For bears, no scats were detected in 25% of the cells and these were located mostly in the central portion of the study area. The 40% of the cells where a low number of bear scats were detected were also located in the center of the study area, whereas 21% of the cells with medium and 21% cells with a high number of scats detected were located in the eastern and western ends of the study area (Fig. 23). Felid scats were detected in 25% of the 48 cells, with most of these found from the south-west corner to north-central portion of the study area, as well as in the northeast corner of the study area (Fig. 24).

Scat Content Analysis:

Of the 511 scats collected during scat surveys, 311 (61%) were considered fresh enough to be used for diet analysis. All incidentally collected scats will also be used in the diet analysis. We expect to analyze approximately 240 of these this fall. Scat composition will be analyzed following methods of Kennedy and Carbyn (1981) and Mattioli et al. (2006) where age-class (juvenile vs. adult) can be determined for ungulate hairs based on a key by Jones et al. (2009) for at least the first 3 months of life.

Recommendations for 2015 field sampling:

- Use the preliminary data collected in in 2014 to assess sampling effort and cell sizes for improving field sampling in 2015 to develop predator occupancy models.
- Conduct a preliminary analysis of occupancy modeling to determine habitat and topographic influence features on detection rates for improving the 2015 field design.
- Further explore the possibility of using DNA and spatial recapture methods (and associated funding opportunities) to estimate relative abundance based on individuals.

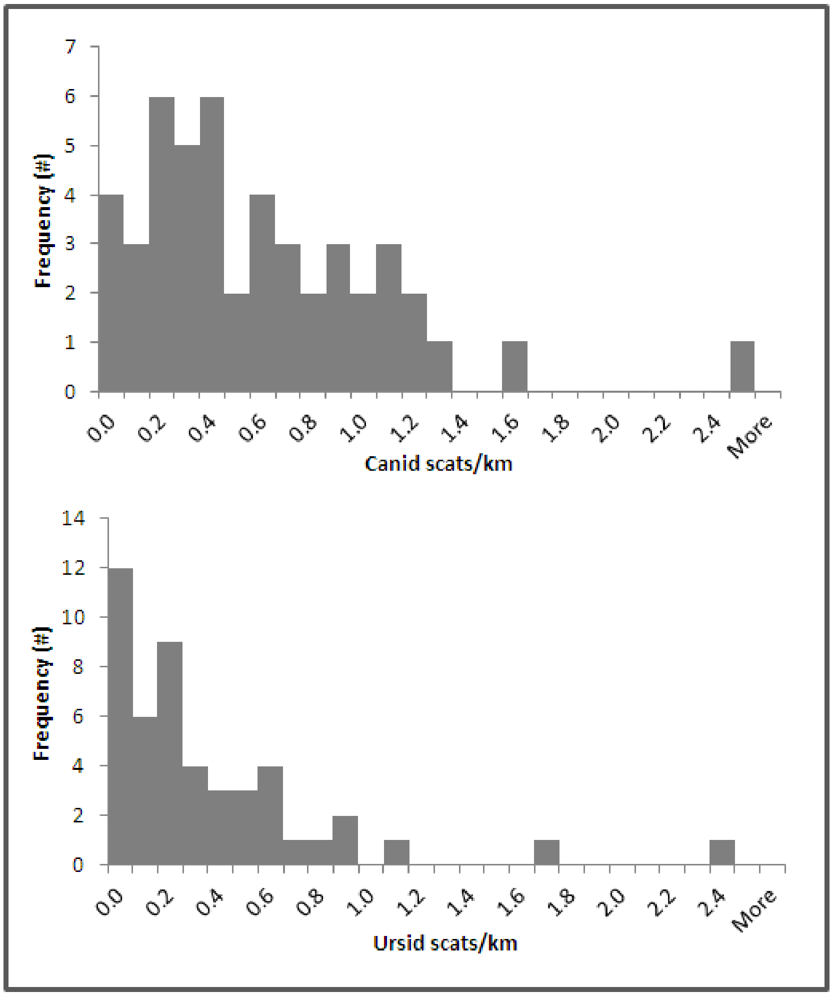

Figure 20: Histograms of canid and ursid scats/km used to determine breaks in data that delineated low/medium/high ranges of scat detection.

Table 13: Number of scats collected through scat detection dog surveys and opportunistically by freshness ranking in the Ya Ha Tinda study area, Alberta, Canada, 2013 - 2014.

Year		Bear					Canid					Felid				
		Total	Fresh	Semi-old	Old	Very Old	Total	Fresh	Semi-old	Old	Very Old	Total	Fresh	Semi-old	Old	Very Old
2013		66					235					32				
2014	Dog survey	163	15	47	73	28	328	10	66	123	129	20	0	3	17	0
	Opportunistic	18					32					0				

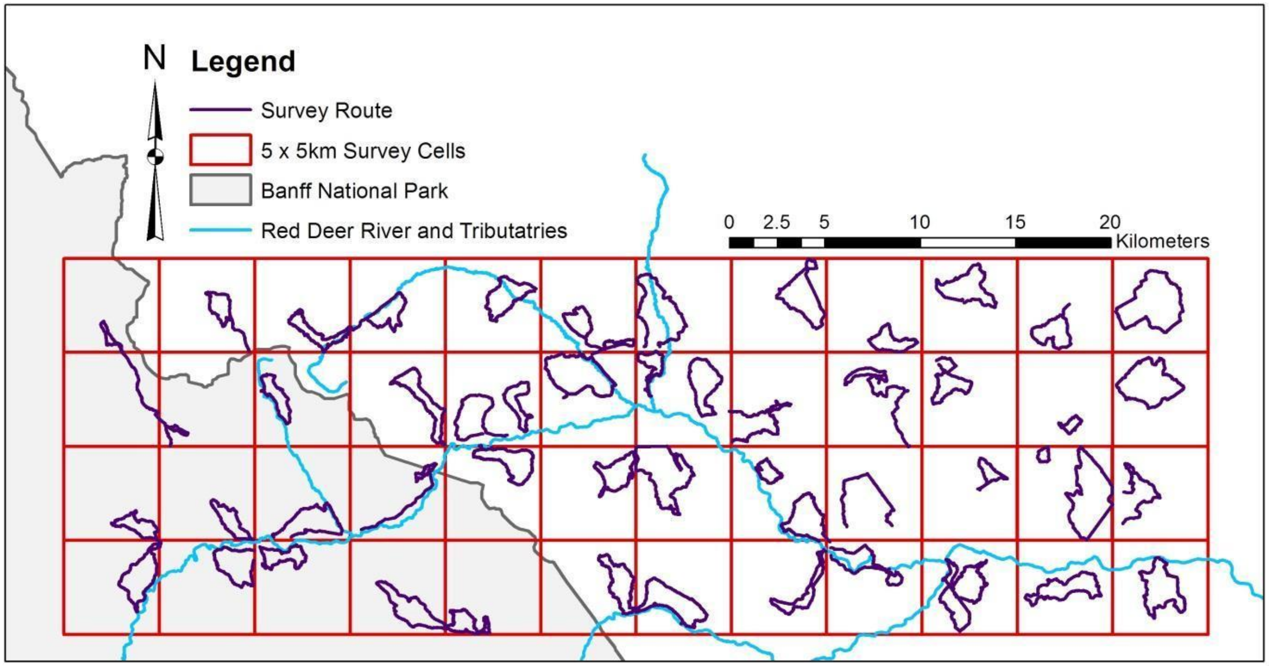

Figure 21: Grid-based sampling design composed of 5 x 5km cells and routes used to survey for scat of large carnivores in 2014, Alberta, Canada.

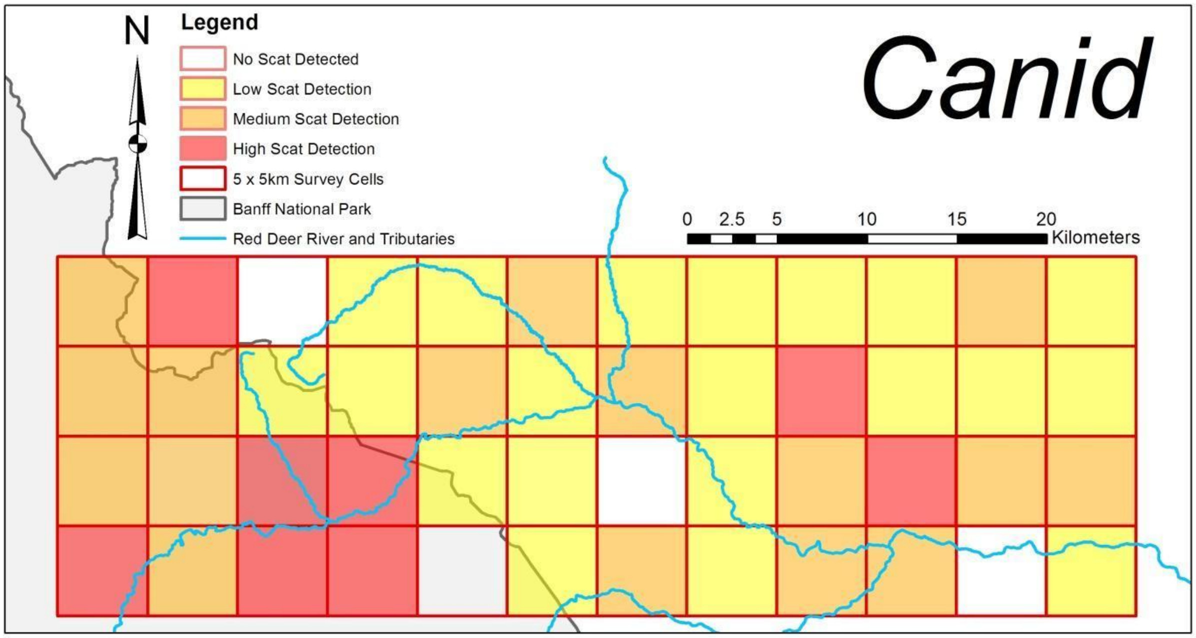

Figure 22: Relative occupancy of canid distribution based on scat collection surveys performed in 2014, Alberta, Canada.

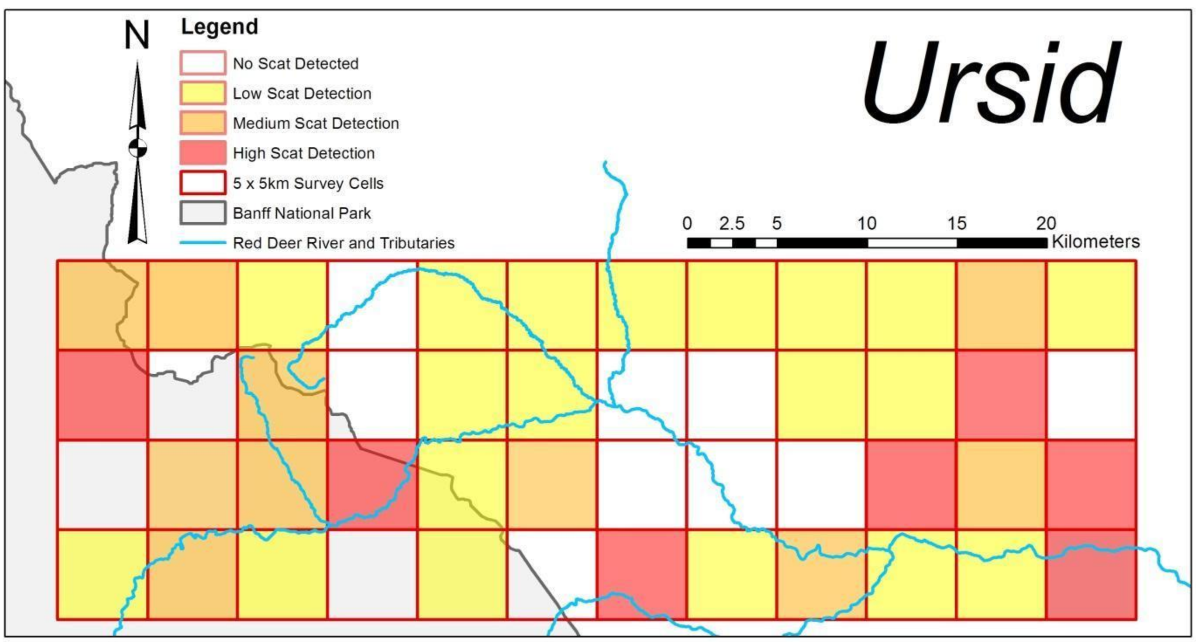

Figure 23: Relative occupancy of ursid distribution based on scat collection surveys performed in 2014, Alberta, Canada.

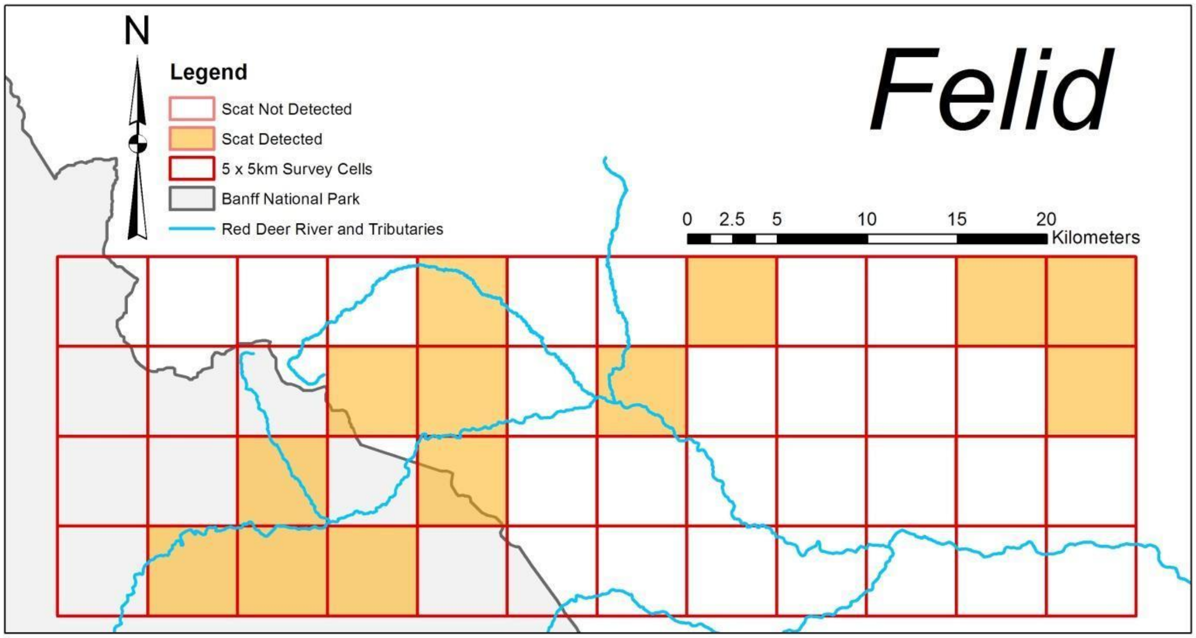

Figure 24: Relative occupancy of felid distribution based on scat collection surveys performed in 2014, Alberta, Canada.

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Appendix I. 2013 - 2014 YHT winter elk capture information.

Date	Animal ID	Method	Blood	Hair	Tooth	Preg Check	Preg nant	VIT	Collar
17-Feb-13	OR76	Ground Dart	Yes	Yes	Yes	Yes	No	No	Lotek VHF
18-Feb-13	OR77	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 3300
17-Feb-13	OR78	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 4400
18-Feb-13	OR79	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 3300
18-Feb-13	OR80	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 4400
18-Feb-13	OR81	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 4400
19-Feb-13	OR82	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 3300
2-Mar-13	OR83	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 4400
2-Mar-13	OR84	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 4400
4-Mar-13	OR85	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 4400
4-Mar-13	OR86	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Mortality; see incident report
4-Mar-13	OR87	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	ATS GPS
5-Mar-13	OR88	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 4400
5-Mar-13	OR89	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 4400
5-Mar-13	OR90	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	ATS GPS
5-Mar-13	OR91	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek VHF
6-Mar-13	OR92	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 7000
7-Mar-13	OR93	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 7000
7-Mar-13	OR94	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 7000
8-Mar-13	OR95	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek VHF
8-Mar-13	OR96	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek VHF
22-Mar-13	OR41	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 4400
22-Mar-13	OR97	Ground Dart	Yes	Yes	Yes	Yes	No	No	Lotek Lifecycle satellite
22-Mar-13	OR98	Ground Dart	Yes	Yes	Yes	No	No	No	Lotek Lifecycle prototype
22-Mar-13	OR99	Ground Dart	Yes	Yes	Yes	No	No	No	Lotek Lifecycle satellite
23-Mar-13	OR100	Ground Dart	Yes	Yes	Yes	No	No	No	Lotek Lifecycle prototype

Date	Animal ID	Method	Blood	Hair	Tooth	Preg Check	Pregnant	VIT	Collar
22/Feb/2014	OR34	Ground Dart	Yes	No	No	Yes	Yes	Yes	Lotek GPS 4400
24/Feb/2014	OR98	Ground Dart	Yes	No	No	Yes	Yes	Yes	Lotek GPS 4400
25/Feb/2014	OR39	Ground Dart	Yes	No	No	Yes	No	No	Lotek GPS 4400
26/Feb/2014	OR31	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	VHF
26/Feb/2014	OR40	Ground Dart	Yes	No	No	Yes	Yes	Yes	Lotek GPS 4400
27/Feb/2014	BL274	Ground Dart	Yes	No	No	Yes	Yes	Yes	Lotek GPS 4400
27/Feb/2014	OR23	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 4400
3/Mar/2014	YL100	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 4400
3/Mar/2014	BL245	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	VHF
3/Mar/2014	OR12	Ground Dart	Yes	Yes	Yes	Yes	No	No	Lotek GPS 4400
4/Mar/2014	YL101	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 4400
4/Mar/2014	OR15	Ground Dart	Yes	Yes	No	Yes	Yes	Yes	Lotek GPS 7000
4/Mar/2014	OR07	Ground Dart	Yes	No	No	Yes	Yes	Yes	Lotek GPS 4400
5/Mar/2014	YL102	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	GPSVHF
5/Mar/2014	OR77	Ground Dart	Yes	No	No	Yes	Yes	Yes	Lotek GPS 3300
5/Mar/2014	BL295	Ground Dart	Yes	No	No	Yes	Yes	Yes	Lotek GPS 4400
5/Mar/2014	OR96	Ground Dart	Yes	No	No	Yes	Yes	Yes	VHF
6/Mar/2014	YL103 (GR183)	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	VHF
6/Mar/2014	OR35	Ground Dart	Yes	No	No	Yes	Yes	Yes	Lotek GPS 4400
6/Mar/2014	BL284	Ground Dart	Yes	No	No	Yes	Yes	Yes	Lotek GPS 4400
7/Mar/2014	BL259	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	VHF
7/Mar/2014	YL104	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	VHF
10/Mar/2014	OR32	Ground Dart	Yes	Yes	No	Yes	Yes	Yes	VHF
11/Mar/2014	YL105	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	VHF
11/Mar/2014	OR24	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	VHF
12/Mar/2014	OR37	Ground Dart	Yes	Yes	No	Yes	Yes	Yes	Lotek GPS 4400 ARGOS
12/Mar/2014	OR06	Ground Dart	Yes	Yes	No	Yes	Yes	Yes	Lotek GPS 4400 ARGOS
13/Mar/2014	YL107	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 4400 ARGOS
13/Mar/2014	YL106	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 4400 ARGOS

14/Mar/2014	YL25	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 4400
15/Mar/2014	YL87	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 3300
16/Mar/2014	BL268	Ground Dart	Yes	Yes	No	Yes	Yes	Yes	VHF
17/Mar/2014	OR79	Ground Dart	Yes	Yes	No	Yes	Yes	Yes	VHF
17/Mar/2014	OR29	Ground Dart	Yes	Yes	No	Yes	Yes	Yes	VHF
17/Mar/2014	OR91	Ground Dart	Yes	Yes	No	Yes	Yes	Yes	VHF
18/Mar/2014	OR10	Ground Dart	Yes	Yes	No	Yes	Yes	Yes	Lotek GPS 3300
18/Mar/2014	BL257	Ground Dart	Yes	Yes	No	Yes	Yes	Yes	VHF
20/Mar/2014	YL108 (BL236)	Ground Dart	Yes	Yes	No	Yes	Yes	Yes	VHF
20/Mar/2014	BL288	Ground Dart	Yes	Yes	No	Yes	Yes	Yes	VHF
23/Mar/2014	OR100	Ground Dart	Yes	Yes	No	Yes	Yes	Yes	Lotek Lifecycle prototype
23/Mar/2014	OR78	Ground Dart	Yes	Yes	No	Yes	Yes	Yes	Lotek GPS 4400
25/Mar/2014	OR84	Ground Dart	Yes	Yes	No	Yes	Yes	Yes	Lotek GPS 4400
29/Mar/2014	OR16	Ground Dart	Yes	Yes	No	Yes	Yes	Yes	VHF
29/Mar/2014	OR85	Ground Dart	Yes	Yes	No	Yes	Yes	Yes	VHF
30/Mar/2014	OR02	Ground Dart	Yes	Yes	No	Yes	Yes	Yes	Lotek GPS 4400
31/Mar/2014	OR97	Ground Dart	Yes	Yes	No	Yes	Yes	Yes	Lotek Lifecycle satellite
31/Mar/2014	BL261	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	VHF
31/Mar/2014	OR17	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	VHF

Appendix II. Details of locations of western migrants in the Ya Ha Tinda herd, 2013 – 2014.

We located western migrants and any missing elk on 2 short helicopter flights (2 July and 4 July 2013) and 1 driving/hiking trip to Banff NP in July 2013. The collar signals of 4 western migrant elk (IDs: OR5 – upper Panther, OR 33 – Pipestone Valley, OR78 – Hector Lake, BL622 – Hector Lake; Appendix III) were heard via helicopter, and 3 additional signals (IDs: OR11, OR13, OR 17) were heard on the driving/hiking trip in the areas around Lake Louise and Hector Lake. A mortality signal from one western migrant (ID: BL272) was heard along the Cascade Fire Road by Blair Fyten on a flight in late September 2013 (see details in Appendix III).

Appendix III. Details of adult elk mortalities which occurred in the Ya Ha Tinda herd from 1 January 2013 until present.

- OR5's collar was found on 2 July 2013 after hearing a mortality signal during a helicopter flight over Banff. Collar was buried under rocks in a drainage; did not find remains but collar appeared to have been chewed. Not seen since 30 March 2012.
- BL622 was found dead near Hector Lake in BNP (547359/5717403) during an aerial survey on 4 July 2013. After picking up a mortality signal on the helicopter flight, we found the carcass in closed habitat, a few hundred meters from the Bow River. One leg was lying 50 m from BL622. The carcass seemed old even though most of the hair and skin was still intact. There were signs of carnivore presence but unfortunately, we did not have time to investigate the mortality in detail.
- On the 22 September 2013, cow elk (ID: OR94) was heard on mortality. She was found at 10:00 lying in a ditch, about 200 meters from the road (619459/5723816). A hole 10 cm in diameter was noticed under her right shoulder. Another small hole (1 cm) was found on the other side of her body, in the middle of her belly. When moving the carcass, we could hear air going through a hole in the lungs. While driving back to the ranch to get a screwdriver for the collar we were stopped by Fish and Wildlife Officer Jason Cadzow. He offered to investigate the carcass and skin it. She had clearly suffered from a massive hemorrhage and was bruised on her back and sides, indicating a vehicle collision. This cow is the mother of calf BD13, which has since been heard alive and seen at the ranch on several occasions and appears to have joined up with other members of the herd.
- BL272 was heard on mortality by Blair Fyten during his aerial survey on 27 September 2013. We found her on 29 September 2013 in a coniferous forest to the southeast of Snowflake Lake, just off the old fire road. She had been buried by a grizzly bear and bear sign, including digging and scat, were found on the road ~100 m off the kill. Scats were also found close to the carcass. It was not possible to determine whether she had been attacked or scavenged by the bear. She was last seen and heard in March 2013 and likely died during late summer (August).
- On the 3 October 2013 at 10:00, a cow elk's head (ID: OR26) was found along with a gut pile on the edge of a cut block behind Moutain Aire Lodge (617833/5723546). ATV tracks were leaving the carcass and heading towards a forestry trail indicating she was likely killed by First Nations on 1 October 2013.
- YL 25 started her migration into Banff National Park on 23 May 2014. She was first heard on mortality on 27 May 2014. Only the collar was retrieved. It did not appear

chewed on and was too tight for the elk to remove it. It was found on the edge of a stream connected to the Red Deer River, and appeared to have spent time in the water. The cause of mortality is unknown. The VIT was accurately pinpointed in the Red Deer River upstream from the collar. The cow most likely died farther up the river.

- BL267 died on 24 August 2014 after being injured by hunters or poachers. She was most likely resting on a hill by the Coal Camp junction (bed sites were found) when she was shot. She was found 400 m away in the forest. She was totally intact apart from a bullet wound through her abdomen. She was in excellent condition and was last seen alive accompanied by a calf. Remains of a young male were also discovered at the bottom of the hill. The head had been taken along with the meat. Drag marks and ATV tracks were covering the scene. A bear had found the gut pile and buried it.

Appendix IV. Calf birth sites determined by location of VITs and/or newborn calf in the Ya Ha Tinda elk herd, 2013 – 2014.

Cow ID	Migratory Status	VIT Frequency	Date VIT Retrieved	General Birth Site	Birth Site Easting	Birth Site Northing	Calf Captured?	Calf ID	Calf Surviving?
OR41	Resident	155.525	25-Oct-13	BNP	587697	5722393	N		N
OR77	Resident	155.595	5-May-13	North of YHT	602473	5737241	Y	BH13	N
OR78	Western	155.915	27-Sep-13	BNP	562904	5712358	N		N
OR79	Resident	155.703	25-May-13	YHT	603552	5732450	Y	BC13	Y
OR80	Resident	155.974	3-Jun-13	YHT	597853	5735585	Y	BJ13	N
OR81	Eastern	155.673	29-Jun-13	East of YHT	619082	5723446	N		
OR82	Resident	155.504	1-Jun-13	Border BNP/YHT	591802	5728800	N		N
OR83	Resident	155.465	28-May-13	YHT	600699	5734631	Y	BL13	N
OR84	Resident	155.764	27-May-13	North of YHT	601172	5738472	Y	BS13	N
OR85	Resident	155.544	2-Jun-13	North of YHT	592930	5740667	N		
OR87	Resident	155.564	27-May-13	YHT	598696	5732592	Y	BI13	N
OR88	Resident	155.853	9-Jun-13	YHT	598669	5735027	Y	BT13	N
OR89	UNK	155.824	29-Sep-13	BNP	583227	5716632	N		N
OR90	Resident	155.794	1-Jun-13	North of YHT	593765	5741419	N		
OR91	Resident	155.733	19-May-13	YHT	601815	5731854	Y	BE13	Y
OR92	Eastern	155.643	19-Jun-13	East of YHT	617092	5722446	N		
OR93	Resident	155.614	28-May-13	North of YHT	600297	5737401	N		
OR94	Eastern	155.483	26-May-13	East of YHT	617866	5723815	Y	BD13	Y
OR95	UNK	155.445	Not found	UNK	UNK	UNK	N		
OR96	Resident	155.944	30-May-13	YHT	601222	5733283	Y	BG13	N
OR6	Eastern	N/A	N/A	East of YHT	616454	5720289	Y	BA13	N
OR3	Resident	N/A	N/A	YHT	UNK	UNK	Y	BF13	UNK - likely not
OR100	Resident	N/A	N/A	YHT	599080	5733475	Y	BR13	Y
GR127	Resident	N/A	N/A	YHT	UNK	UNK	Y	BN13	Y
BL290	Resident	N/A	N/A	North of YHT	UNK	UNK	Y	OR43	N
untagged	Resident	N/A	N/A	YHT	UNK	UNK	Y	BB13	N

BL245	Resident	155.943	30-May-14	North of YHT	603012	5736867	Y	RH14	Y
BL257	Eastern	155.294	24-May-14	East of YHT	618050	5722276	Y	YD14	N
BL259	Eastern	153.003	30-May-14	East of YHT	619816	5721498	Y	BQ14	N
BL261	Eastern	155.014	24-May-14	East of YHT	620630	5724025	Y	YO14	Y
BL268	Eastern	155.313	22-Jun-14	East of YHT	620593	5722395	Y	No ID	N
BL274	Eastern	155.915	28-May-14	East of YHT	620939	5722004	Y	YJ14	Y
BL284	Eastern	155.543	25-May-14	East of YHT	618828	5723730	Y	YC14	N
BL288	Western	152.902	14-Jul-14	BNP	593180	5728801	N		N
BL295	Resident	152.923	10-Aug-14	North of YHT	598771	5742856	N		N
OR02	Resident	155.213	3-Jun-14	YHT	602798	5731827	Y	YV14	Y
OR06	Eastern	155.235	18-May-14	East of YHT	619017	5724287	Y	YM14	N
OR07	Eastern	155.852	27-May-14	East of YHT	617249	5722451	Y	YU14	Y
OR10	Resident	155.113	17-May-14	YHT	601302	5734191	Y	stillborn	N
OR100	Resident	152.802	18-May-14	YHT	599555	5734202	N		
OR15	Western	155.792		BNP			N		
OR16	Eastern	152.722	23-May-14	East of YHT	616547	5724831	Y	YK14	Y
OR17	Western	152.580		BNP			N		
OR23	Eastern	155.464	10-Jul-14	East of YHT	619628	5719993	N		Y
OR24	Resident	155.414		BNP	583957	5724309	N		N
OR29	Resident	155.065	31-May-14	YHT	597264	5733157	Y	A114	N
OR31	Resident	155.592	25-May-14	YHT	599996	5732661	Y	YY14	N
OR32	Resident	152.963		BNP			N		
OR34	Resident	155.642	29-Jun-14	North of YHT	600652	5738437	N		N
OR35	Eastern	155.502	22-May-14	East of YHT	620538	5722037	Y	B114	Y
OR37	Resident	155.524	31-May-14	YHT	598071	5733393	Y	YQ14	N
OR39	Eastern	155.703	23-May-14	East of YHT	621468	5723849	N		N
OR40	Resident	155.673		BNP			N		
OR77	Resident	155.973	4-Jun-14	North of YHT	602353	5737468	Y	YX14	Y
OR78	Western	155.352	8-Jul-14	BNP	545350	5720688	N		
OR79	Resident	155.333	26-May-14	YHT	597540	5735192	N		
OR80	Resident	N/A	N/A	UNK	UNK	UNK	Y	BK14	Y

OR84	N/A	152.843	31-Mar-14	N/A	N/A	N/A	N/A		
OR85	Resident	155.053	31-May-14	North of YHT	592749	5740895	Y	YZ14	N
OR91	Resident	155.444	27-May-14	YHT	599963	5733421	Y	C114	Y
OR96	Resident	155.823	7-Jun-14	YHT	599477	5732269	Y	RD14	N
OR97	Resident	155.193	6-Jun-14	YHT	600458	5734492	Y	YT14	N
OR98	Resident	155.763	3-Jun-14	YHT	601034	5734566	Y	RG14	N
YL100	Resident	155.563	26-May-14	YHT	598789	5734447	Y	RA14	N
YL101	Resident	155.613	28-May-14	YHT	598101	5732139	Y	YA14	N
YL102	Resident	155.482	31-May-14	YHT	601142	5732678	Y	No ID	N
YL103 (GR183)	Eastern	155.733	1-Jun-14	East of YHT	UNK	UNK	Y	RF14	Y
YL104	Western	155.453	2-Jul-14	BNP	546986	5715368	N		
YL105	Resident	155.433	4-Jun-14	North of YHT	602689	5735655	Y	YW14	Y
YL106	Western	152.642	2-Jul-14	BNP	547101	5716749	N		
YL107	Resident	155.583	2-Jul-14	YHT	597409	5735286	N		N
YL108 (BL236)	Resident	152.943	13-Jul-14	YHT	600224	5729921	N		N
YL25	Western	152.982		BNP			N		
YL87	Resident	153.036	15-May-14	North of YHT	601765	5736704	Y	YE14	Y
untagged	Resident	N/A	N/A	YHT	UNK	UNK	Y	YF14	N
UNK	Resident	N/A	N/A	YHT	UNK	UNK	Y	YP14	N
untagged	Resident	N/A	N/A	YHT	UNK	UNK	Y	YB14	N
untagged	UNK	N/A	N/A	BNP	UNK	UNK	Y	KK14	UNK

Appendix V. Calves captured in May and June, 2013 - 2014, on the Ya Ha Tinda Elk Project.

Calf ID	Frequency	Cow ID	Birth Site Easting	Birth Site Northing	Capture Date	Capture Site X	Capture Site Y	Estimated Age at Capture (hrs)
BA13	152.582	OR6	616454	5720289	27-May-13	616439	5720282	24
BB13	152.253	untagged	UNK	UNK	6-Jun-13	601092	5733345	168
BC13	152.6232	OR79	603552	5732450	25-May-13	603555	5732530	27.5
BD13	152.273	OR94	617866	5723815	26-May-13	618113	5723798	24
BE13	152.612	OR91	601815	5731854	19-May-13	601815	5731854	2.5
BF13	152.293	OR3	UNK	UNK	23-May-13	600982	5733228	48
BG13	152.313	OR96	601222	5733283	30-May-13	601022	5733283	3.5
BH13	152.401	OR77	602473	5737241	5-Jun-13	602446	5737197	3.5
BI13	152.161	OR87	598696	5732592	27-May-13	598696	5732592	5
BJ13	152.563	OR80	597853	5735585	3-Jun-13	597845	5735609	15
BL13	152.201	OR83	600699	5734631	28-May-13	600699	5734631	2
BN13	152.523	GR127	UNK	UNK	26-May-13	599602	5732534	48
BR13	152.462	OR100	599080	5733475	27-May-13	599080	5733475	1
BS13	152.644	OR84	601172	5738472	27-May-13	600315	5733172	192
BT13	152.353	OR88	598669	5735027	9-Jun-13	598891	5735090	22.5
OR43	N/A	BL290	UNK	UNK	30-May-13	600441	5734634	48
RH14	148.110	BL245	603012	5736867	30-May-14	603088	5736839	24
YD14	149.622	BL257	618050	5722276	24-May-14	618038	5722300	4
BQ14	152.253	BL259	619816	5721498	30-May-14	619816	5721498	0.5
YO14	152.183	BL261	620630	5724025	24-May-14	620630	5724025	1
UN06	N/A	BL268	620593	5722395	22-Jun-14	620593	5722395	24
YJ14	149.444	BL274	620939	5722004	28-May-14	620939	5722004	6
YC14	149.512	BL284	618828	5723730	26-May-14	619240	5723659	29.5
YV14	149.531	OR02	602798	5731827	3-Jun-14	602790	5731845	2.5
YM14	149.703	OR06	619017	5724287	18-May-14	618990	5724328	5

YU14	149.811	OR07	617249	5722451	27-May-14	617249	5722451	2
UN08	N/A	OR10	601302	5734191	17-May-14	601302	5734191	2
YK14	149.552	OR16	616547	5724831	23-May-14	616547	5724831	6
A114	149.222	OR29	597264	5733157	31-May-14	597264	5733157	1.5
YY14	149.641	OR31	599996	5732661	25-May-14	599984	5732665	4
B114	149.744	OR35	620538	5722037	22-May-14	620546	5722024	7
YQ14	149.834	OR37	598071	5733393	31-May-14	598259	5733000	2
YX14	149.052	OR77	602353	5737468	4-Jun-14	602344	5737471	5
BK14	152.142	OR80	UNK	UNK	6-Jun-14	600405	5733089	120-168
YZ14	149.461	OR85	592749	5740895	31-May-14	592749	5740895	1
C114	149.242	OR91	599963	5733421	27-May-14	599358	5733588	7
RD14	152.313	OR96	599477	5732269	7-Jun-14	599477	5732269	2.5
YT14	149.602	OR97	600458	5734492	6-Jun-14	600458	5734492	1.5
RG14	152.503	OR98	601034	5734566	3-Jun-14	601118	5734664	1.5
RA14	152.644	YL100	598789	5734447	26-May-14	598755	5734344	1
YA14	149.482	YL101	598101	5732139	28-May-14	598101	5732139	2
UN07	N/A	YL102	601142	5732678	31-May-14	601142	5732678	10
RF14	152.094	YL103	UNK	UNK	1-Jun-14	613482	5723797	15
YW14	149.352	YL105	602689	5735655	4-Jun-14	602689	5735655	3.5
YE14	149.311	YL87	601765	5736704	15-May-14	601775	5736639	6
YF14	149.374	untagged	UNK	UNK	23-May-14	599668	5733152	48-96
YP14	149.151	UNK	UNK	UNK	1-Jun-14	600130	5734267	24
YB14	149.682	untagged	UNK	UNK	25-May-14	600280	5732319	<24
KK14	148.209	untagged	UNK	UNK	25-May-14	580417	5724241	24

Appendix VI. Example of calf capture form and measurements taken

YA HA TINDA Elk Calf Capture Form 2014 **Ear tag ID:** _____ **Colour:** _____ **Ear: R / L** **GPS Collar? Y / N**

Radio Tag/Collar Freq: ________________ **Magnet off? Y / N** **Initials:** ____________________

Date (ex: 01 JUN 2013): ______________ **Time start:**_______ **Time end:**_______ **Method:** Ground / Heli / Both

General Loc (drainage, etc):__________________________________ **Calf GPS Loc:**____________________________

VIT GPS Loc:__________________________ **VIT Code:**_______________________

Estimated Age (days):_________ **Mother ID:**____________ / Unknown / No ID

Umbilical cord: Moist / Dry / Absent ***NOTE:*** *METRIC!! calipers in mm,* ***TARE!***

Navel diam (~ 1.0mm): ____________ **Navel**: Bloody, moist, not scabbed / Little blood, lightly scabbed / Dry scab

Coat: Wet or matted dry; ears damp inside / Dry

Front incisors (calipers ~ 0.1mm, 0 = tooth not erupted): **Left I1 (inside edge):** ________ **(middle):**_________

Right I1 (inside):________ **(middle):**_________

Chest girth (0.5 cm): ____________ **Rt hind leg length** (0.5 cm):_____________ **Ticks?:** Y / N **Hair?:** Y / N

Weight (0.5 lb): ________ **Sex:** male / female **Rt front hoof hair to growth line** (calipers ~ 0.1 mm): _________

Bottom hooves: Entirely soft / < half hardened / All hardened **Walking surface:** Ragged / Smooth

Dew claws: Entirely soft / ~ upper 1/4" hardened / Tips soft & white / Entirely hard & dark

Stability: Unable to stand / Insecure, wobbly, legs spread / Somewhat sturdy / Very sturdy / Did not stand

Stature: Humped / Somewhat erect / Very erect

Tried to run? Y / N **Calf vocal:** No / 1-2x / 3-5x / >6x **Struggled?** Y / N ______________________________

Notes (calf condition, chase duration, predator sign, birth site, cow behavior, w/ collared cow, weather, waypoint name, photo numbers, etc, use back if necessary):____

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Collect Hair!!! **Double Check Freq!!!** **Remove Blindfold!!!**

Appendix VII. Mean measurements (range) taken on elk calves captured in the Ya Ha Tinda herd in 2013 - 2014.

			Standard Measurements							
			millimeters						**centimeters**	
	Age Class	**# of Calves**	**Navel Diam.**	**Left Incisor Inside**	**Left Incisor Middle**	**Right Incisor Inside**	**Right Incisor Middle**	**Hoof Growth Line to Hair Line**	**Chest Girth**	**Right Hind Leg**
A	Newborn - 1 day	38	13.7	0.9	3.3	1.0	3.4	10.3	61.5	41.4
			(9.0 - 27.0)	(0.0 - 4.6)	(0 - 8.6)	(0.0 - 5.0)	(0.0 - 8.7)	(0.0 - 19.0)	(57.0 - 76.0)	(37.0 - 44.8)
B	2-4 days	6	11.7	2.6	5.1	2.8	4.6	10.9	64.1	40.9
			(7.1 - 19.1)	(0.6 - 4.4)	(2.2 - 6.7)	(0.0 - 3.9)	(1.4 - 6.5)	(8.9 - 13.0)	(61.0 - 69.1)	(38.4 - 42.9)
C	5-7 days	2	8.0	4.1	6.2	4.6	6.5	10.1	70.4	43.0
			(7.4 - 8.5)	(3.4 - 4.8)	(4.1 - 8.2)	(4.5 - 4.7)	--	(7.1 - 13.0)	(70.0 - 70.8)	(42.0 - 44.0)
D	8+ days	1	12.6	6.2	8	6.3	8.7	9.5	68	43

Appendix VIII. Detected elk calf mortalities on the Ya Ha Tinda Elk Project, 2013 - 2014.

Calf ID	Frequency	Date Found	Easting	Northing	Est. Time Since Death (days)	Estimated Age (days)	Cause of Death
BA13	152.582	7-Jun-13	615832	5722111	< 1	12	Bear
BB13	152.253	8-Jun-13	601113	5734678	< 1	9	Cougar
BF13	152.293	N/A	N/A	N/A	UNK	>80	Unknown
BG13	152.313	31-May-13	601048	5733560	0.5	1	Bear
BH13	152.401	14-Jun-13	602163	5737099	1	9	Bear
BI13	152.161	13-Jun-13	598642	5734924	> 2	17	Unk. pred. - likely bear
BT13	152.353	27-Jun-13	596019	5732609	4-5	19	Wolf
BJ13	152.563	23-Jun-13	602176	5732400	2	21	Unk. pred. - likely wolf
BL13	152.201	7-Jun-13	600919	5734059	> 1	10	Bacterial septicaemia
BS13	152.644	28-May-13	600617	5732737	< 1	9	Unk. pred. - likely bear
OR43	N/A	N/A	N/A	N/A	UNK	UNK	Unknown
Untag01	N/A	18-Jun-13	619861	5724902	> 1	<10	Unknown predator
Untag02	N/A	9-Jun-13	601424	5732514	0.25	7	Unk. - pred. or human-caused
Untag03	N/A	8-Oct-13	599092	5733038	< 1	130	Human-caused
No ID (OR10)	N/A	17-May-14	601302	5734191	< 0.5	0	Stillborn
YM14	149.703	11-Sep-14	610673	5723918	4	56	Bear
YF14	149.374	25-May-14	598734	5732917	< 0.5	4	Predator
YD14	149.622	1-Jun-14	618816	5723156	< 0.5	8	Bear
YY14	149.641	30-May-14	599954	5732551	< 0.5	5	Wolf
YC14	149.512	16-Jun-14	617882	5724815	< 0.5	22	Cougar
YB14	149.682	29-May-14	600410	5732669	< 0.5	4	Wolf
RA14	152.644	29-May-14	599618	5732305	< 0.5	3	Wolf
UN04	N/A	27-May-14	600357	5734012	< 1	3	Unk. pred. - likely cougar
YA14	149.482	3-Jun-14	598034	5733441	< 0.5	6	Bear
BQ14	152.253	4-Jun-14	619814	5723735	< 0.5	5	Bear
A114	149.222	19-Jun-14	595693	5732244	3	19	Unknown
No ID (YL102)	N/A	31-May-14	601142	5732678	< 0.5	< 0.5	Bear

YQ14	149.834	3-Jun-14					Unknown
RG14	152.503	7-Jun-14	600639	5734550	< 1	4	Unk. pred. - likely cougar
YZ14	149.461	11-Jun-14	595791	5736825	3	11	Bear
YP14	149.151	13-Jun-14	600020	5732205	< 0.5	13	Bear
YT14	149.602	10-Jun-14	601028	5734146	< 0.5	4	Bear
RD14	152.313	14-Jun-14	601977	5731869	< 0.5	7	Bear
UN05	N/A	16-Jun-14	617882	1572815	< 1	7-14	Cougar
No ID (BL268)	N/A	22-Jun-14	620638	5722423	< 1	0.5	Bear

Appendix IX. Cow-calf pairs observed in the Ya Ha Tinda elk herd, 2013 - 2014.

Animal ID	Migratory Status	Presence of Calf Confirmed	How Confirmed	Absence of Calf Confirmed	How Confirmed
BL222	Resident			21-Oct-2013	Observation/In a group w/o calves
BL234				15-Jul-2013	Observation/In a group w/o calves
BL236	Resident	1-Jul-2013	Observation/Calf suckling		
BL245	Resident	14-Jul-2013	Observation/Calf suckling		
BL250	Resident	29-Jul-2013	Observation/Calf suckling		
BL260	UNK			21-Oct-2013	Observation/In a group w/o calves
BL267	Eastern	21-Oct-2013	Observation/Calf suckling		
BL274	Eastern	28-Jul-2013	Observation/Calf suckling		
BL290	Resident	30-May-2013	Calf Capture	July	Observation/No orange ear-tagged calf ever observed
BL295	Resident	29-Jul-2013	Observation/Grooming		
GR127	Resident	26-May-2013	Calf Capture		
OR2	Resident	5-Aug-2013	Observation/Calf following		
OR3	Resident	23-May-2013	Calf Capture	16-Sep-2013	Observation/By herself on more than 1 occasion
OR6	Eastern	27-May-2013	Calf Capture	7-Jun-2013	Calf Mortality
OR7	Eastern	22-Jul-2013	Observation/Calf following		Observation/In group of 4, 2 cows 2 calves
OR11	Western	16-Oct-2013	Observation/Calf suckling		
OR12	Resident			23-Jul-2013	Observation/In a group w/o calves
OR19	Western	9-Jul-2013	Observation/Calf suckling		
OR20	Eastern	20-Oct-2013	Obs./Calf following/Grooming		
OR21	Eastern			14-Jul-2013	Observation/In a group w/o calves
OR26	Eastern	28-Jul-2013	Observation/Calf suckling		**COW DIED ON 1 OCTOBER 2013**
OR27	Eastern			14-Jul-2013	Observation/In a group w/o calves
OR29	Resident	14-Jul-2013	Observation/Calf suckling		
OR31	Resident	July	Calf Capture	29-Jul-2013	Observation/In a group w/o calves
OR34	UNK			21-Oct-2013	Observation/In a group w/o calves
OR37	UNK			21-Oct-2013	Observation/In a group w/o calves
OR36	Resident	17-Jun-2013	Observation/Calf suckling		

Animal ID	Migratory Status	Presence of Calf Confirmed	How Confirmed	Absence of Calf Confirmed	How Confirmed
OR38	Resident	7-Aug-2013	Observation/Calf suckling		
OR41	Resident			JUNE	Came back to YHT w/o calf
OR77	Resident	05-June-13	Calf Capture	14-Jun-2013	Calf Mortality
OR79	Resident	25-May-2013	Calf Capture		
OR80	Resident	3-Jun-2013	Calf Capture		
OR81	Eastern	22-Jul-2013	Observation/Calf following		
OR82	Resident			JUNE	Came back to YHT w/o calf
OR83	Resident	28-May-2013	Calf Capture	7-Jun-2013	Calf Mortality
OR84	Resident	27-May-2013	Calf Capture	28-May-2013	Calf Mortality
OR85	Resident			21-Oct-2013	Observation/In a group w/o calves
OR87	Resident	27-May-2013	Calf Capture	13-Jun-2013	Calf Mortality
OR88	Resident	9-Jun-2013	Calf Capture	27-Jun-2013	Calf Mortality
OR89	UNK			21-Sep-2013	Observation/By herself
OR90	Resident			JUNE	Came back to YHT w/o calf
OR91	Resident	19-May-2013	Calf Capture		
OR92	Eastern	22-Jul-2013	Observation/Calf following		
OR93	Resident	17-Jul-2013	Observation/Calf suckling		
OR94	Eastern	26-May-2013	Calf Capture		
OR96	Resident	30-May-2013	Calf Capture	31-May-2013	Calf Mortality
OR97	Resident			2-Oct-2013	Observation/In a group w/o calves
OR98	Resident	17-Jun-2013	Observation/Calf suckling		
OR100	Resident	27-May-2013	Calf Capture		
YL20	Resident			23-Jul-2013	Observation/In a group w/o calves
BL222	Resident			9-Oct-2014	Observation/In a group w/o calves
BL234		26-Jun-2014	Observation /Grooming	8-Oct-2014	Observation/In a group w/o calves
BL245	Resident	29-May-2014	Calf Capture		
BL250	Resident	19-Aug-2014	Observation /Grooming		
BL257	Eastern	24-May-2014	Calf Capture	1-Jun-2014	Calf Mortality

Animal ID	Migratory Status	Presence of Calf Confirmed	How Confirmed	Absence of Calf Confirmed	How Confirmed
BL259	Eastern	30-May-2014	Calf Capture	4-Jun-2014	Calf Mortality
BL261	Eastern	24-May-2014	Calf Capture		
BL262	Eastern			9-Oct-2014	Observation/In a group w/o calves
BL265	Eastern			20-Jul-2014	Observation/In a group w/o calves
BL267	Eastern	10-Jun-2014	Observation/Calf suckling		**COW DIED IN AUGUST 2014**
BL268	Eastern	21-Jun-2014	Calf Capture	22-Jun-2014	Calf Mortality
BL274	Eastern	28-May-2014	Calf Capture		
BL284	Eastern	25-May-2014	Calf Capture	16-Jun-2014	Calf Mortality
BL288	Resident	1-May-2014	VIT	14-Jul-2014	Observation/In a group w/o calves
BL290	Resident			5-Aug-2014	Observation/In a group w/o calves
BL292	Resident			21-Aug-2014	Observation/In a group w/o calves
BL295	Resident	11-Jul-2014	VIT	8-Oct-2014	Observation/In a group w/o calves
GR513	Western			10-Oct-2014	Observation/In a group w/o calves
OR2	Resident	3-Jun-2014	Calf Capture	24-Jun-2014	Observation/By herself and calf missing
OR6	Eastern	18-May-2014	Calf Capture	11-Sep-2014	Calf Mortality
OR7	Eastern	27-May-2014	Calf Capture		
OR8	Eastern	10-Jun-2014	Observation/Calf suckling		
OR12	Resident				Not pregnant
OR16	Eastern	23-May-2014	Calf Capture		
OR19	Western			9-Oct-2014	Observation/In a group w/o calves
OR21	Eastern	19-Jun-2014	Observation		
OR23	Eastern	10-Jul-2014	VIT		
OR24	Western	26-May-2014	VIT	23-Jul-2014	Observation/In a group w/o calves
OR28	Eastern	5-Aug-2014	Observation/Calf suckling		
OR29	Resident	31-May-2014	Calf Capture	19-Jun-2014	Calf Mortality
OR31	Resident	25-May-2014	Calf Capture	30-May-2014	Calf Mortality
OR32	Resident	26-Jun-2014	Observation/Calf suckling	10-Oct-2014	Observation/In a group w/o calves
OR34	Eastern	1-Jun-2014	VIT	11-Jul-2014	Observation/In a group w/o calves

Animal ID	Migratory Status	Presence of Calf Confirmed	How Confirmed	Absence of Calf Confirmed	How Confirmed
OR36	Resident			5-Aug-2014	Observation/In a group w/o calves
OR37	Resident	31-May-2014	Calf Capture	3-Jun-2014	Calf Mortality
OR39	Eastern	23-May-2014	VIT	17-Sep-2014	Observation/In a group w/o calves
OR77	Resident	4-Jun-2014	Calf Capture		
OR78	Western	1-Jun-2014	VIT		
OR79	Resident	26-May-2014	VIT		
OR80	Resident	1-Jun-2014	Calf Capture		
OR81	Eastern	12-Jun-2014	Observation/Calf nursing		
OR83	Resident	16-Jun-2014	Observation/Calf suckling		
OR85	Resident	31-May-2014	Calf Capture	11-Jun-2014	Observation/In a group w/o calves
OR87	Resident	29-Jun-2014	Observation/Calf suckling	5-Aug-2014	Observation/In a group w/o calves
OR88	Resident	9-Jun-2013	Calf Capture	9-Oct-2014	Observation/In a group w/o calves
OR90	Resident	1-Jun-2014	Heard where calved in 2013	5-Aug-2014	Observation/In a group w/o calves
OR91	Resident	27-May-2014	Calf Capture		
OR92	Eastern			9-Oct-2014	Observation/In a group w/o calves
OR96	Resident	7-Jun-2014	Calf Capture	14-Jun-2014	Calf Mortality
OR97	Resident	6-Jun-2014	Calf Capture	10-Jun-2014	Calf Mortality
OR98	Resident	3-Jun-2014	Calf Capture	7-Jun-2014	Calf Mortality
OR99	Resident			21-Aug-2014	Observation/In a group w/o calves
OR100	Resident	18-May-2014	Calf Capture	19-May-2014	Calf Mortality
YL58	Western			23-Jul-2014	Observation/In a group w/o calves
YL87	Resident	15-May-2014	Calf Capture		
YL100	Resident	26-May-2014	Calf Capture	29-May-2014	Calf Mortality
YL101	Resident	28-May-2014	Calf Capture	3-Jun-2014	Calf Mortality
YL102	Resident	30-May-2014	Calf Capture	31-May-2014	Calf Mortality
YL103	Eastern	1-Jun-2014	Calf Capture		
YL104	Western	1-Jun-2014	VIT		
YL105	Resident	4-Jun-2014	Calf Capture		

Animal ID	Migratory Status	Presence of Calf Confirmed	How Confirmed	Absence of Calf Confirmed	How Confirmed
YL106	Western	1-Jun-2014	VIT		
YL107	Resident	22-May-2014	VIT	2-Jun-2014	Cow running around pasture looking for calf
YL108	Resident	12-May-2014	VIT	9-Oct-2014	Observation/In a group w/o calves

Appendix X. Other notes of interest.

Wolves:

To aid in assessing predation risk by wolves for elk, we determined the status of known den sites. In summer 2013, the ear-tag, jaw bone, and hind leg of a calf (ID: BT13) were found 20 m from a den site west of Scalp Creek and the cut block. A remote camera was put up and focused on the den entrances for ~ 1 week. Photos showed the den was active and a litter size of 3 wolf pups was counted.

A known den site in the main pasture was investigated, and at the time of the investigation in July, 2013, the den appeared unoccupied. No sign of wolf activity was detected around the site. However, after hearing wolves howling in September, 2013, we re-visited the den and found fresh wildlife trails in the grass leading to the den. In addition, some old bones had been brought to the area and appeared to have been chewed on. The wolves are known to use this den site as a rendezvous site in the summer.

Another known den site was visited in July, 2013, at West Lakes. The den is built in silt and has many entrances. Moreover it is really close to a medium-use trail and the wolves do not seem to use it anymore. No predator signs were found around it.

A last den site was visited in July, 2013, along the cutline about 500 m north of the trail. Semi-fresh grass was scattered at the bottom of the den and an old bone had been chewed on right next to an entrance. The site had probably been active earlier in the spring.