Ya Ha Tinda Elk & Predator Study

Annual Report 2015 - 2016

Submitted to:
Parks Canada, Alberta ESRD
& Project Stakeholders

Prepared by:
Jodi Berg, Eric Spilker,
Josh Killeen &
Evelyn Merrill
University of Alberta

Mark Hebblewhite
University of Montana

10 May 2016

ACKNOWLEDGEMENTS

We thank Parks Canada staff Blair Fyten, David Gummer, and Bill Hunt for providing logistical and financial support, especially during the winter capture season. For their never-ending help, patience and understanding, we thank the Ya Ha Tinda ranch staff: Rick and Jean Smith, Rob Jennings, and Tom McKenzie. Anne Hubbs (AB ESRD), Rachel Cook (NCASI), P.J. White (NPS), Bruce Johnson (OR DFW), Shannon Barber-Meyer (USGS), Simone Ciuti (U Alberta), and Holger Bohm (U Alberta) all provided helpful advice and discussions, and Dr. Todd Shury (Parks Canada), Dr. Geoff Skinner (Parks Canada), Dr. Asa Fahlman, Dr. Rob McCorkell (U Calgary), and Dr. Owen Smith (U Calgary) gave their time, expert knowledge, and assistance during winter captures.

For guidance in dog training and for providing our project with great handlers and dogs, our appreciation goes to Julie Ubigau, Caleb Stanek, and Heath Smith from Conservation Canines. We also thank local residents, Alberta Trapper Association of Sundre and Friends of the Eastern Slopes Association for their interest in the project.

University of Alberta staff, volunteers, and interns assisted for various lengths of time, in various tasks surrounding the calf captures, monitoring, and logistics. We especially thank Celie Intering, Sabrina Wales, and Casey Berg.

PROJECT SUPPORTERS

This work would not have been possible without the financial and in-kind support from: Parks Canada, Natural Sciences and Engineering Research Council, Alberta Conservation Association, Alberta Environment and Parks, Minister's Special License- Hunting for Tomorrow and Alberta Fish and Game, University of Alberta, University of Montana, Rocky Mountain Elk Foundation, TD Friends of the Environment, Alberta Sport, Parks, Recreation & Wildlife Foundation, Safari Club International Foundation, Safari Club – Northern Alberta Chapter, International Association for Bear Management, the Wild Sheep Foundation Alberta, Center for Conservation Biology – University of Washington, Friends of the Eastern Slopes Association; and NASA (USA).

SUGGESTED CITATION

Berg, J.E., E. Spilker, J. Killeen, M. Hebblewhite, and E. Merrill. 2016. Ya Ha Tinda elk and predator study: Annual report 2015-2016. Department of Biological Sciences, University of Alberta, Edmonton, AB, Canada. 56 pp.

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 studies of the Ya Ha Tinda (YHT) elk herd, including monitoring of adult female elk survival/mortality, migratory behavior, pregnancy rates, population size, ungulate pellet group counts, and grassland production on YHT grasslands up to 15 March 2016 (Section I). The report also includes preliminary summaries of years 3 and 4 of a study conducted by PhD student, Jodi Berg, at the University of Alberta addressing elk calf survival and cause-specific mortality (Section II), and a predator scat distribution study conducted by MSc student, Eric Spilker, at the University of Alberta (Section III).

In February-March 2015 and 2016, 64 and 46 adult female elk were free-range darted from horses. Pregnancy rates were 94% and 96%. All pregnant elk were collared and fit with vaginal implant transmitters (VITs) in both years to monitor elk calf survival. As of 15 March 2016 a total of 76 elk remain collared, including 46 GPS- and 30 VHF-collared elk.

We monitored VHF- and GPS-collared resident and eastern migrant elk on an almost daily basis during 2015 to determine migratory status and survival. In summer 2015, 29% of the GPS/VHF-radio-collared elk migrated to the east, on or near lands operated on by Sundre Forest Products – West Fraser and Shell Energy Canada. Twelve percent of the GPS- and VHF- radio-collared adult female elk migrated west into Banff National Park (BNP), and 59% remained resident on YHT. Of those elk that migrated into or through BNP in spring 2015, 5% went west and 7% went south. Spring migration ranged from 17 March to 4 July and fall migration from 11 August to 27 September.

Based on VITs and/or location of neonatal elk calves in 2015 (n = 54), 14% of cows gave birth in Banff National Park, 23% of cows gave birth to the north of the ranch mostly in the Bighorn Creek cut blocks and along Scalp Creek, 27% of the cows gave birth to the east of YHT, and 36% gave birth near YHT. No calves of the 8 pregnant, marked cows that migrated into BNP in spring 2015 were captured, but VITs of 5 cows were located later in the summer, and indicated that elk calved along the Panther, Cascade, and Bow valleys.

Thirty-four calves (22 residents, 12 eastern migrants) were captured and monitored in May and June 2015. The median birth date for calves (n = 103) born in 2013 – 2015 was 30 May and the mean mass at birth was 17.7 ± 2.1 kg (n = 76). Calves of resident and eastern migrant elk equipped with radio ear tags were monitored 1-3x daily for mortality from a distance from birth through September, and monthly thereafter. Of these 34 calves, 14 (41%) were alive as of 15 March 2016. Of the known mortality causes in 2013 - 2015, most were attributed to bears (43%), followed by wolves (7%), and cougars (7%).

During the summers of 2014 and 2015, we used scat detection dogs to survey 1,057 km of transects distributed among 57 25-km^2 grid cells. Between both years we found a total of 1,259 carnivore scats. The carnivore family group with the highest number of scats detected were canids (62%) followed by ursids (30%) and felids (8%).

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SECTION I: Elk Population Numbers, Demography, and Movement

A collaborative research program has been ongoing since 2000 between researchers at the Universities of Alberta and Montana, Parks Canada, Alberta Fish and Wildlife, Alberta Conservation Association and other natural resource groups to determine how changes in the Ya Ha Tinda (YHT) elk population and their habitats have been influenced by abiotic (climate) and biotic (predation, human harvest, habitat management) factors. Our long-term focus has been on understanding the changing migratory behavior of elk and the trophic dynamics within this predator-prey, montane system. Over the last few decades migrant to resident ratio has substantially decreased from 12:1 (1977-1987) to 3:1 (1988-2004) (Hebblewhite et al. 2006) to more recently a ratio closer to 1:1 (Berg et al. 2014). Additionally, it appears that a new migratory strategy is emerging with a larger proportion of the migratory elk heading east of the YHT towards areas with potentially higher amounts of recreation and resource extraction industries rather than west into Banff National Park (Killeen et al. 2016). In the early 2000s, adult cow elk migrating into Banff National Park were found to have access to higher-quality forage but were also exposed to high wolf-caused mortality (Hebblewhite and Merrill 2011). Population modeling predicted the YHT herd would stabilize due to density-dependent predation, but the herd has continued to decline (Glines et al. 2011). Recent cow:calf ratios have indicated that calf survival of elk migrating east on to industrial forest may have higher calf survival. Further, our past studies of predation risk on elk has focused on wolves (*Canis lupus*), whereas the Ya Tinda is a multi-predator system. As a result we expanded our focus to address the community of predators in this area, in particular in relation to calf mortality. 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

This report summarizes activities up to 15 March 2016 including:

(1) long-term monitoring of the YHT elk herd demography, movements, population size
(2) results from the third and fourth-year efforts of the elk calf mortality study, and
(3) scat-based surveys of predators.

Population Monitoring

Ground Counts

In general, the highest 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. Highest minimum population counts of elk herd obtained from the ground in late winter (1 Feb. to 30 Apr.) at Ya Ha Tinda, Alberta, Canada.

Date	Total #
7-Feb-13	335
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 Average	**273.9**
7-Mar-14	338
9-Mar-14	333
10-Mar-14	338
18-Mar-14	332
4-Apr-14	387
6-Apr-14	335
7-Apr-14	256
8-Apr-14	286
10-Apr-14	322
2014 Average	**325.2**
9-Feb-15	358
9-Mar-15	352
2015 Average	**355.0**

Aerial Surveys

No summer aerial surveys were conducted in 2015. In winter 2014/15, a total count of 377 elk (including 331 in the cow-calf herd, 17 bulls, and 29 unknown animals) on the Ya Ha Tinda was obtained. 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 continue to be coordinated between Alberta Environment and Parks Canada each winter.

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 are conducted during May and represent winter use of the ranch. Fall counts occur during September 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 (*Equus*), 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
Summer	2015	376	0	9	0.52	1.08	0.004	0.009
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
Winter	2014/15	372	0	12	0.78	1.86	0.003	0.008

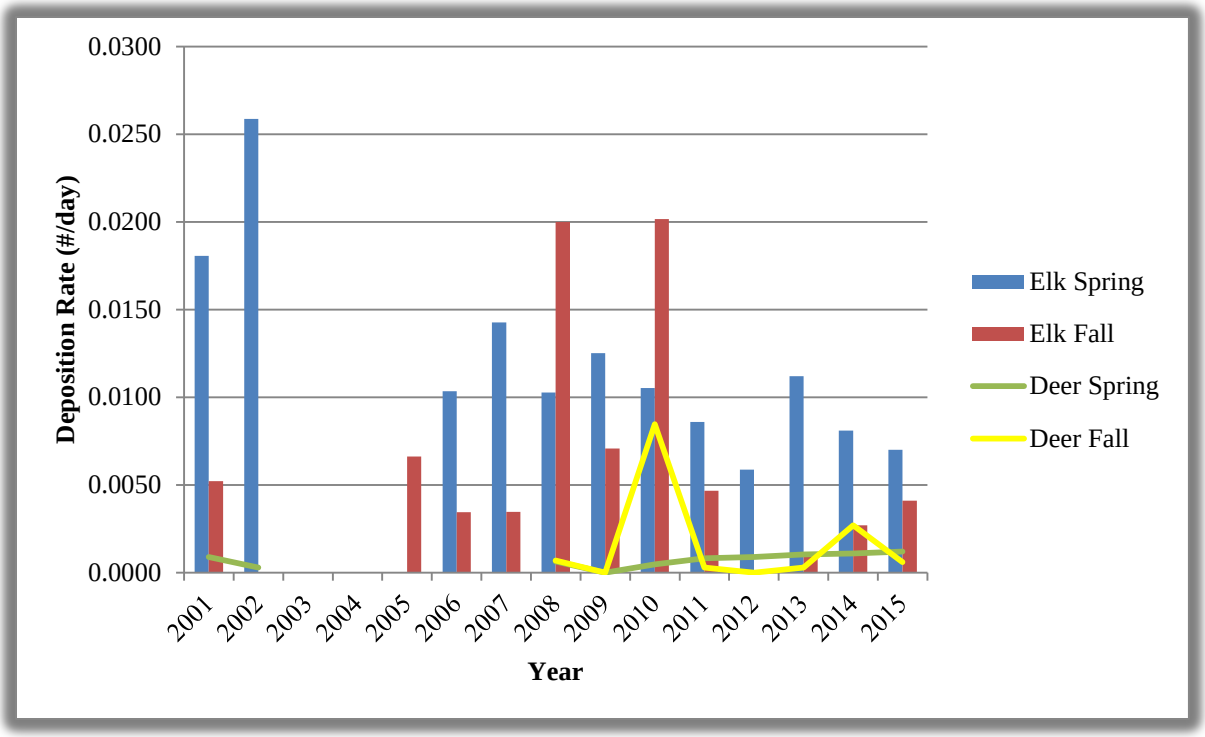


Fig.1. Changes in deposition rates (#/day) averaged across plots surveyed every year (*n* = 29) over time from winter 2000/01 to summer 2015; pellet groups counts were conducted at the Ya Ha Tinda ranch, Alberta, Canada.

Adult Elk Capture and Handling 2015 and 2016

In February and March, 2015, 64 elk were free-range darted, immobilized, and subsequently collared (26 GPS; 38 VHF; Fig. 3). Elk were palpated for pregnancy and fit with vaginal implant transmitters (VITs) if determined pregnant (Appendix I-1). All elk were ear-tagged in both ears. 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. Sixty of the 64 elk (94%) were pregnant and had a VIT inserted.

Fig. 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 2015 with a total of 74 collars (approximately 26-28% of

the total adult female population), in the herd.

In February, 2016, 46 elk were free-range darted, immobilized, and subsequently GPS-collared. The same samples and measurements were taken as in the previous year. Forty-four of the 46 elk (96%) were pregnant and had a VIT inserted. As a result of winter capture efforts, the YHT elk herd is entering spring 2016 with a total of 80 collars (though 4 collared elk are considered dead/missing), in the herd.

Adult Elk Telemetry

We have monitored a total of 286 unique collared adult female elk from 2002 - 2016 in the YHT herd. On average, we have had 85 adult female elk radio-collared per year, with 70 VHF collars/year and 14 GPS collars/year, with a range of 4 - 46 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 collected an average of 5,003 locations/elk, and 627,296 GPS locations in total.

Beginning in January 2015, we monitored 49 VHF and 25 GPS (n = 74) collared resident and migrant elk on an almost daily basis to determine migratory status and survival (Fig. 4). In 2016, we are monitoring 30 VHF- and 46 GPS-collared elk. GPS collars record locations every 15 min during May and June, and every 2 hr during other months of the year (Fig. 4).

In 2015, we located western migrants and any missing elk throughout the summer with the help of Parks Canada employees. One elk (ID: OR13) was located on Mt. Nestor in the Spray drainage. Three elk were located near Hector Lake, Bow Valley (IDs: OR17, OR78, YL104). One elk was located along Tyrrell Creek and the Clearwater River (ID: OR60). One elk was located along the Panther River (ID: OR89). A mortality signal was located and the collar retrieved for OR95 along the Dormer River. The following VITs were located: YL131 near Douglas Lake, OR51 east of Windy Cabin, OR65 in Dogrib Creek, OR56 and GR513 south of Cuthead Cabin.

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

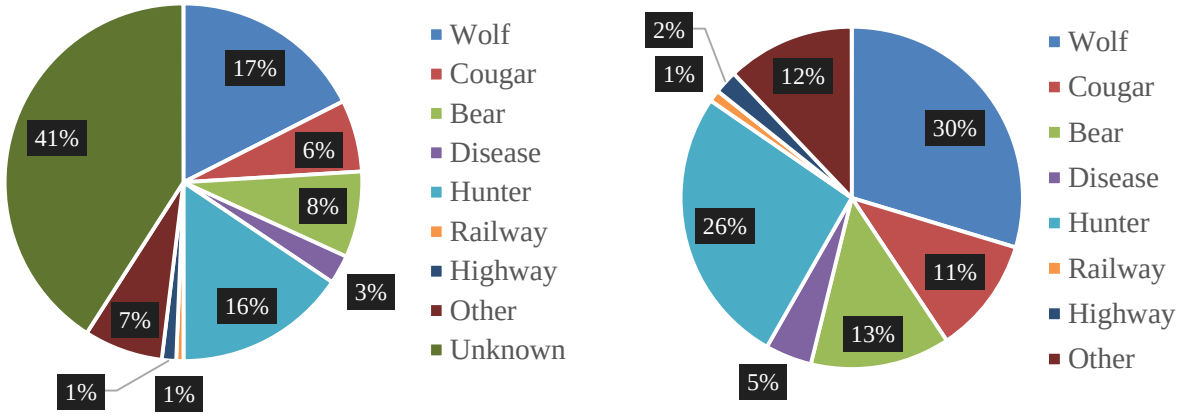
Table 4. Summary radio-telemetry table for VHF and GPS-collared elk from 2001 to 2016 in the Ya Ha Tinda elk herd, Alberta, Canada. The table shows total number of adult female elk collared/year, number and average number of VHF/GPS locations/individual elk, and total number of locations. Note that the 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	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	1,673	55	30	22	138,745	6,307
2014	77	1,267	47	27	30	212,780	7,093
2015	74	419	49	9	25	178,770	7,151
2016	76		30		46		
Average	85	1,303	70	20	14	72,775	5,329
Totals	286	18,237	1,053		216	1,018,846	

Elk Demography

Adult Mortality

Since 1 January 2015, 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; Fig. 5).



(a) (b)

Fig. 5. Mortality causes for radio-collared adult female elk (n = 154) from 2002 – 15 March 2016 in the Ya Ha Tinda elk population, Alberta, Canada. (a) shows all mortalities, including unknowns (n = 154), and (b) shows only known-causes of mortality excluding unknowns (n = 91).

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 – 2016 by examining the calf:cow ratio in late winter (1 Feb. – 30 Apr.; Table 5, Fig. 6), and the calf:cow ratio in summer (1 June – 31 Aug.; Table 6, Fig. 7) 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. Cow:calf 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	Cow:calf	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
2015	1198	9	914	142	0.155	0.011
Average	1962.154	17.462	1583.077	244.923	0.155	0.008

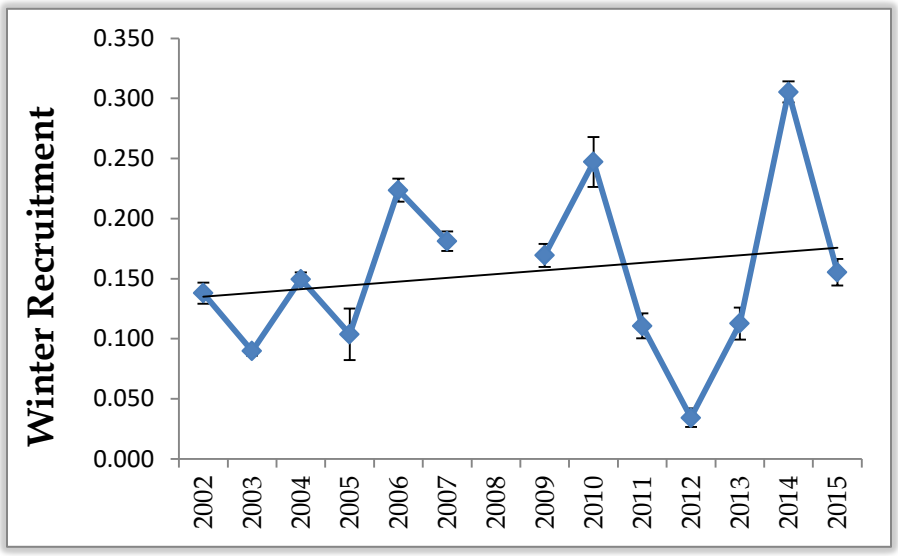


Fig. 6. Calf:cow ratio data in late winter (1 Feb. – 30 Apr.) from 2002 - 2015 for the Ya Ha Tinda elk herd, Alberta, Canada. Adult female total includes female yearlings.

Table 6. Cow:calf ratio data (1 June – 31 Aug.), Ya Ha Tinda elk herd, Alberta, Canada. Adult female total includes female yearlings.

Year	Total # Classified	# of Groups	ADF Total	YOY Total	Cow:calf	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
2015	996	42	701	195	0.278	0.015
Average	1796	100	1342	308	0.230	0.012

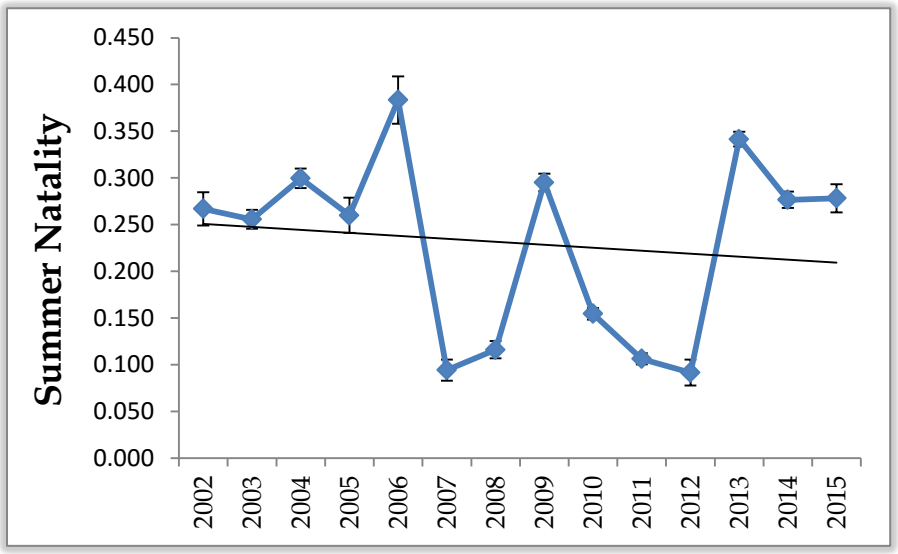


Fig. 7. Calf:cow ratio data in summer (1 June – 31 Aug.), Ya Ha Tinda elk herd, Alberta, Canada. Adult female total includes female yearlings.

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
2015	27	0.22	8	0.23	--	--

[a] as reported by Parks Canada in November 2013

Pregnancy Rates

In February and March, 2015, 64 elk were rectally palpated; 4 elk were not pregnant. The pregnancy rate was 94% (Table 8, Fig. 8).

In February, 2016, 44 of 46 elk (96%) that were rectally palpated were pregnant. Pregnancy rates appear to have increased over the past decade (Fig. 8).

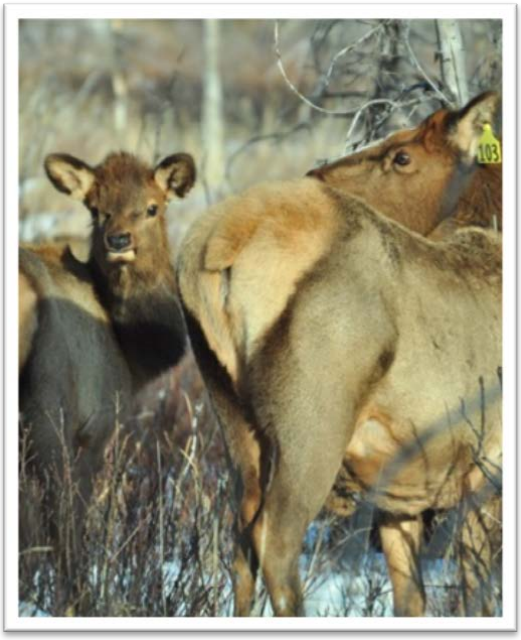


Table 8. Pregnancy rates in late winter across all years except 2007 and 2010 for the Ya Ha Tinda elk herd, Alberta, Canada.

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
2015	60	64	0.938
2016	44	46	0.957
Total	**401**	**466**	**0.819**

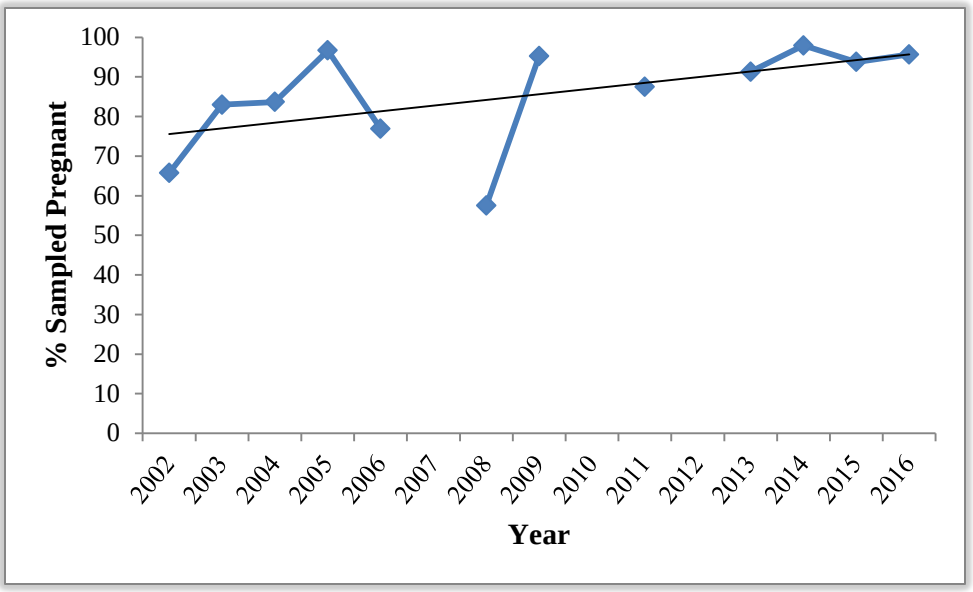


Fig. 8. Pregnancy rates in late winter across all years except 2007 and 2010 for the Ya Ha Tinda elk herd, Alberta, Canada.

Migratory Behaviour

Classifying Migrants and Residents

We classified individual behaviour as migrant or resident using the Net Squared Displacement (NSD) method (Bunnefeld et al. 2011, Borger and Fryxell 2012, Spitz 2015) combined with post-hoc spatial rules and visual confirmation in a GIS. NSD measures the cumulative squared displacement from the starting location. We fitted linear and non-linear movement models to NSD for each individual in each year (hereafter referred to as elk-years) for migrant, mixed migrant, resident, nomad and disperser behaviour (Bunnefeld et al. 2011, Spitz 2015). The best movement model was then selected using AIC_c. Because there were no mixed migrants or nomads in our population these models were excluded from comparisons. Elk classified as dispersers were re-classified as migrants because in almost all cases the dispersal movement model was the best fitting because the elk either died or lost its collar during migration or while on its summer range. All model fitting was carried out using the R package *MigrateR* (Spitz 2015). GPS data was resampled to 1 location per day at random. For VHF data we attempted to use the NSD method but this was only successful for 222 VHF elk-years due to small sample sizs. Where possible the remaining VHF elk-years were classified visually using a GIS. Because of the misclassification of residents as migrants in cases of summer range expansion we used a post-hoc spatial constraint to ensure correct classification in these cases. For an individual to be considered resident it had to remain within 15 km of the winter range during summer. Some individuals also showed short duration ‘exploratory movements’ which we did not consider true migratory behaviour. To account for these cases we considered an individual to be migratory only if it had non-overlapping seasonal ranges for a minimum of 30 days.

Table 9. The total number of elk tracked using GPS collars in each year, with their classification as western, southern, northern, or eastern migrants or residents. Note that the total tracked does not necessarily match the total collared (Table 4) because not enough locations were recorded to determine migratory status for every animal. The total percentages of elk that were migrant or resident in each year are also shown.

	Total	Migratory Status					Migrant	Resident
Year	Tracked	West	South	North	East	Resident	%	%
2002	3	2	0	0	0	1	66.7	33.3
2003	7	4	2	0	0	1	85.7	14.3
2004	16	3	3	5	0	5	68.8	31.2
2005	7	1	0	0	0	6	14.3	85.7
2006	9	2	0	2	0	5	44.4	55.6
2007	8	0	0	1	0	7	12.5	87.5
2008	0	0	0	0	0	0	-	-
2009	7	0	0	0	0	7	0	100
2010	7	0	0	0	1	6	14.3	85.7
2011	3	0	0	0	1	2	33.3	66.7
2012	0	0	0	0	0	0	-	-
2013	19	1	1	0	3	14	26.3	73.7
2014	28	4	0	0	7	17	39.3	60.7
2015	21	1	3	0	6	11	47.6	52.3
Total	**135**	**18**	**9**	**8**	**18**	**82**	**39.3**	**60.7**

Table 10. The total number of elk tracked using VHF collars in each year, with their classification as western, southern, northern, or eastern migrants or residents. Note that the total tracked does not necessarily match the total collared (Table 4) because not enough locations were recorded to determine migratory status for every animal. The total percentages of elk that were migrant or resident in each year are also shown.

	Total	Migratory Status					Migrant	Resident
Year	Tracked	West	South	North	East	Resident	%	%
2002	39	13	4	5	1	16	59.0	41.0
2003	86	17	8	12	2	47	45.3	54.7
2004	75	14	9	10	3	39	48.0	52.0
2005	58	11	11	3	4	29	50.0	50.0
2006	66	11	7	2	5	41	37.9	62.1
2007	54	5	5	0	7	37	31.5	68.5
2008	50	1	0	0	4	45	10.0	90.0
2009	62	1	3	1	1	56	9.7	90.3
2010	65	7	8	1	12	37	43.1	56.9
2011	65	11	9	1	24	20	69.2	30.8
2012	40	2	2	0	26	10	75.0	25.0
2013	74	1	0	0	26	47	36.5	63.5
2014	55	1	2	1	18	33	40.0	60.0
2015	21	1	0	0	6	14	33.3	66.7
Total	**810**	**96**	**68**	**36**	**139**	**471**	**41.9**	**58.1**

There were 945 elk-years of data from 312 individuals which were successfully classified as migrant or resident, with 135 of those from GPS-collared animals and 810 from VHF-collared animals. There was considerable variance between years but overall we classified a mean of 41.5% (n = 392) of elk as migrants and 58.5% of animals as residents (n = 553, Fig. 9). During the period 2006-2010 the marked elk sample was biased towards residents for the aversive conditioning studies at this time. In 2015 we classified 40.5% (n = 42) of tracked elk as migrants, a similar proportion to the previous 2 years (Tables 9, 10).

Migratory Routes

From the movements of the 392 elk-years of migratory behaviour we defined four major migration routes (Fig. 10). Elk using the first route travel up to 64 km west of the Ya Ha Tinda ranch, moving along the Red Deer River drainage into Banff National Park in the direction of Lake Louise. Elk using the second route travel up to 47 km south-west of the ranch, moving along either the Panther or Dormer River drainages. The third route is to the north, with elk travelling up to 36 km towards the Clearwater River, some directly north and others first travelling west and then turning to the north. Finally elk using the fourth route travel up to 24 km east onto industrial forest lands (see Killeen et al. 2016 for additional details). The proportion of elk using the western and northern migrations has declined from 2002-2015 while the proportion migrating east has increased (Fig. 11). In 2015 only 5% of the tracked elk migrated west, 7% migrated south and 29% migrated east with none migrating north.

Timing of Migration

We estimated the timing of migration using the fitted NSD migration models in which the midpoint of spring migration is a term included in the model and the midpoint of return migration is a derived parameter (Spitz et al. 2015). Sample size was greater in spring due to mortality or loss of collars before return migration. In spring 50% of elk had migrated by 03-June and 95% had migrated by 11-July while in fall 50% of elk had migrated by 17-September and 95% of elk had migrated by 01-Novemeber (Fig. 12).

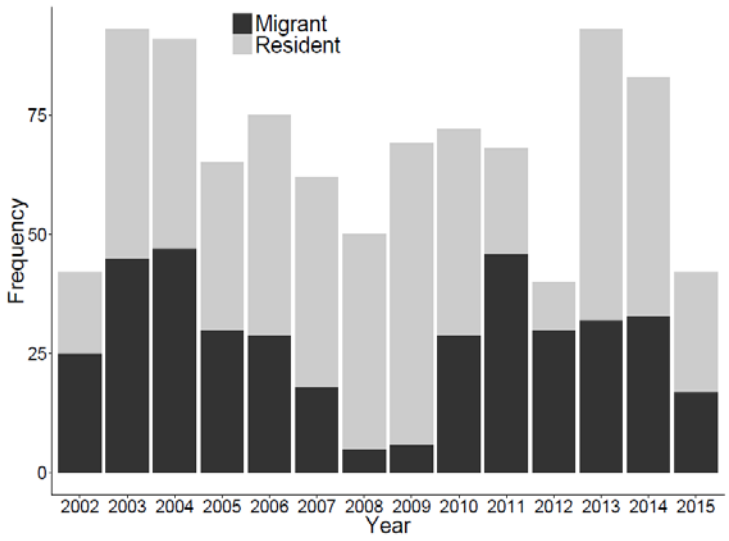


Fig. 9. The numbers of elk classified as migrant or resident in each year, including both GPS-collared and VHF-collared individuals.

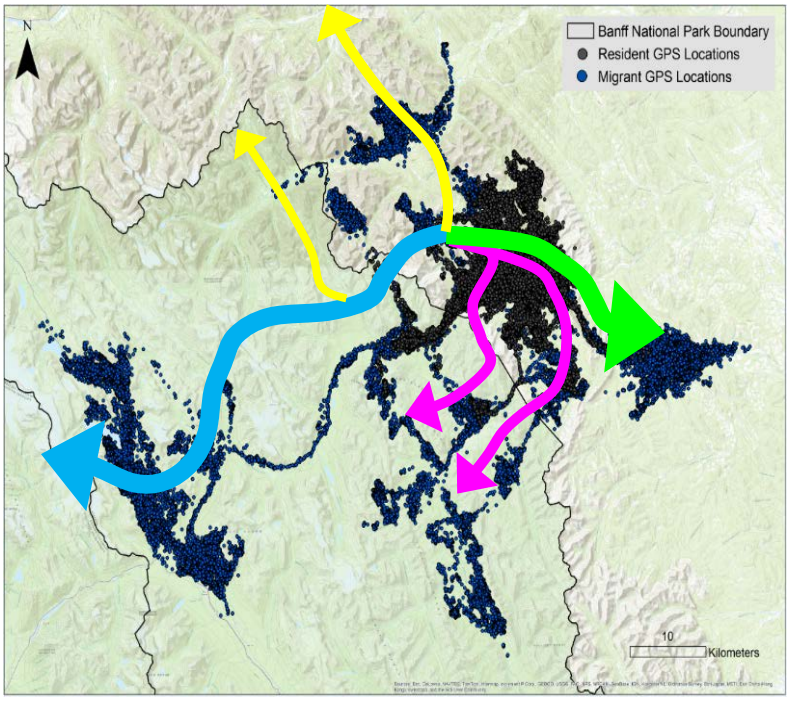


Fig. 10. Locations of all GPS-collared elk are shown (migrants – grey dots, residents – blue dots) with the 4 major migration routes used by GPS and VHF collared elk denoted by arrows. Of 944 tracked elk-years there were 392 GPS- and VHF-collared elk which migrated, with 12% of the total collared population migrating west via the blue route, 5% the north via the yellow routes, 8% south via the pink routes, and 17% east via the green route. There were also 553 residents (59% of total tracked).

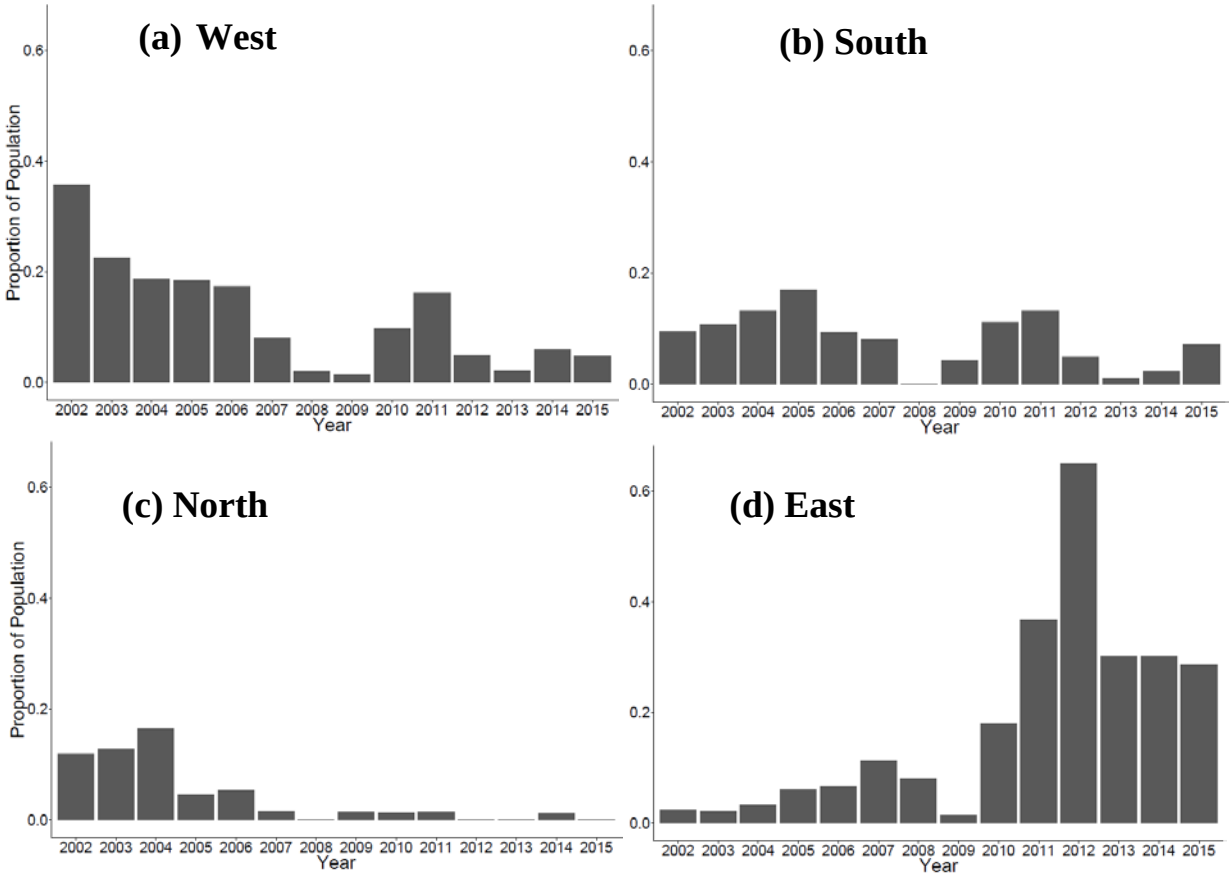


Fig. 11. The proportion of the total elk population using each of the 4 major migratory routes from 2002 to 2015. The routes of the migratory segments are shown in Fig. 10.

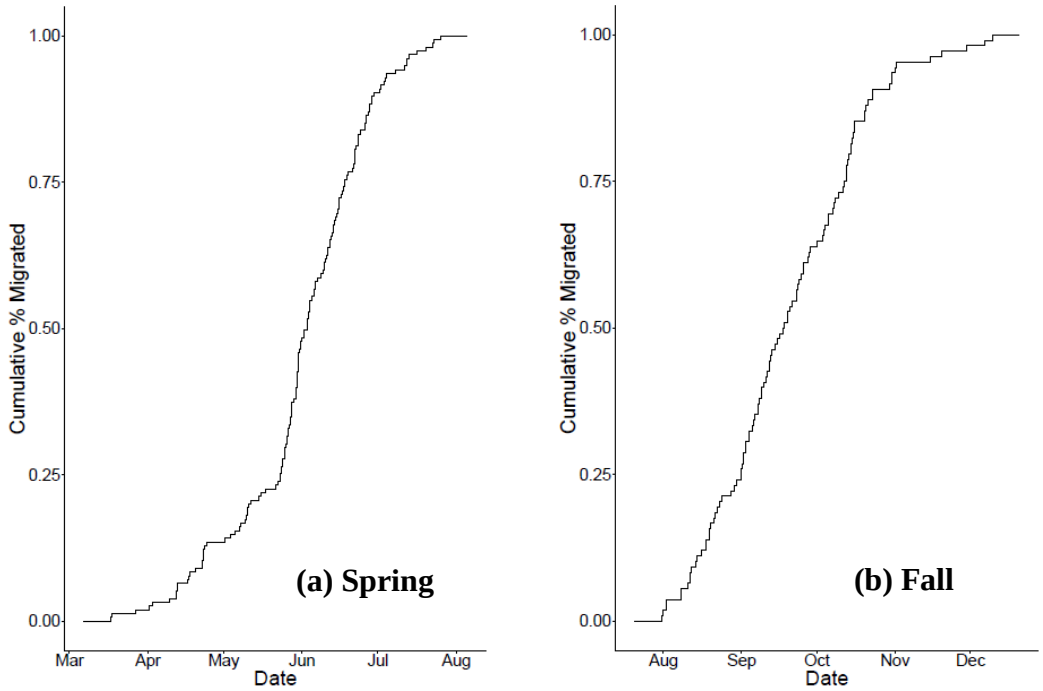


Fig. 12. The timing of migration for all routes combined in spring (N = 155) and fall (N = 108) calculated from the NSD migration models.

SECTION II: Calf Captures and Monitoring

Calving Areas

In 2015, of the adult female elk that wintered on the Ya Ha Tinda, 60 had vaginal implant transmitters (VITs). Based on VITs and/or location of neonatal elk calves (n = 54), 14% of cows gave birth in Banff National Park, 23% of cows gave birth to the north of the ranch mostly in the Bighorn Creek cut blocks and along Scalp Creek, 27% of cows gave birth to the east of YHT, 32% of cows gave birth in the vicinity of the ranch, and 4% gave birth to the south of the ranch (Fig. 13, Appendix I-4).

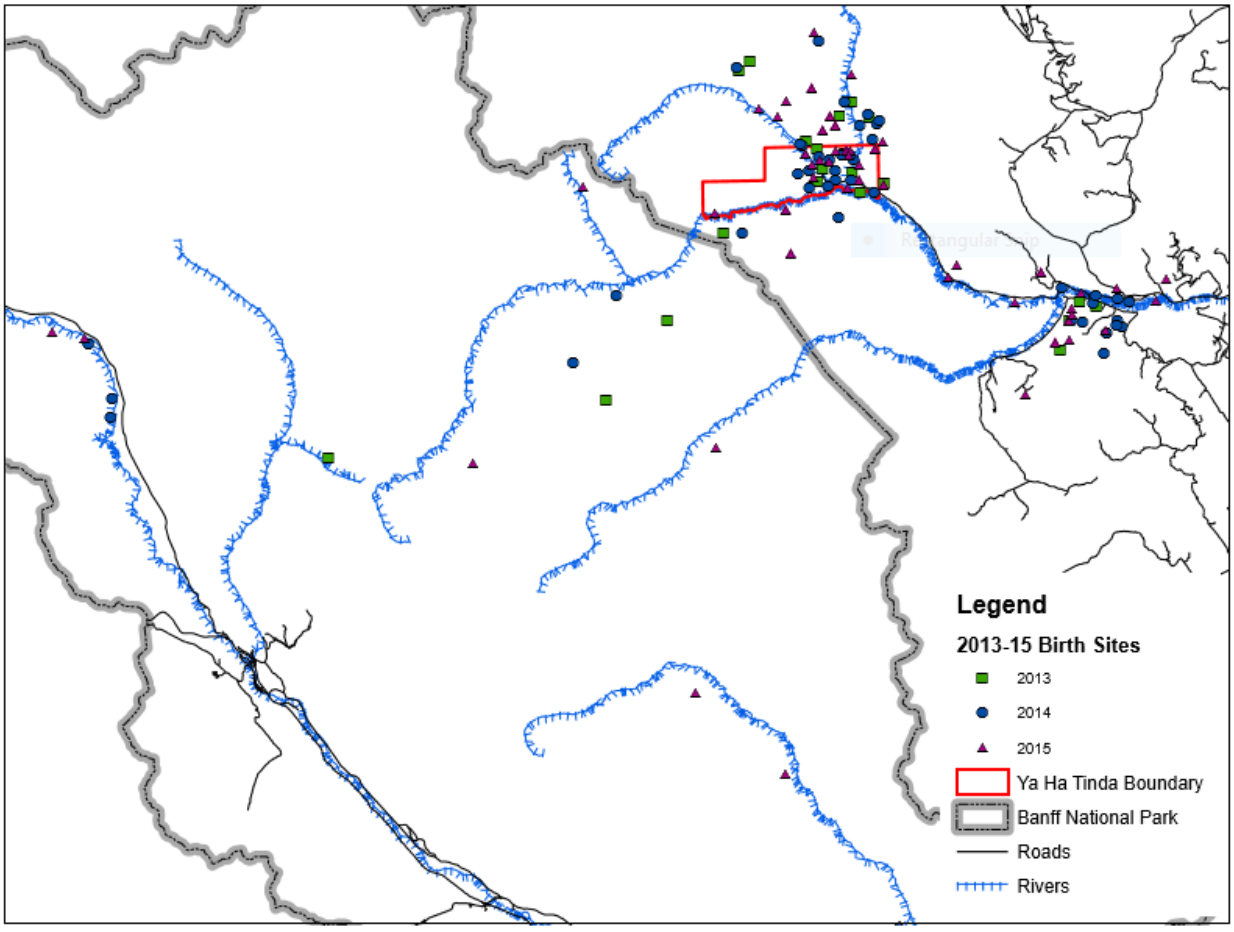


Fig. 13. Birth sites of 113 elk calves located through use of vaginal implant transmitters (VITs) and/or neonatal elk calves, Alberta, Canada, in 2013 - 2015.

Calf Capture Effort 2015

In May and June, 2015, 34 elk calves (22 residents, 12 eastern migrants) calves were captured from the ground and subsequently ear-tagged. We were unable to capture 27 calves from cows with VITs that either were dead before the calving season, or had migrated large distances right

before giving birth, or into BNP (Appendix I-4). 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 = 32). Calves were also captured on an opportunistic basis (n = 2; Appendix II-1). Most of the calves were captured within 300 m of the location of the VIT representing the birth site.

Once a calf was captured, measurements and weight were taken (Appendix II-2 & 3; Fig. 14), which aid in estimating age as well as determining factors which affect calf survival. Calves were equipped with VHF radio transmitting ear tags 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.

Fig. 14. Hair samples were collected and measurements taken on calves captured in May and June, 2015, in the Ya Ha Tinda elk herd, Alberta, Canada. *Photo credits: Celie Intering*

Calving

The median date of birth for calves born in 2013 – 2015 (*n* = 103) was 30 May (range = 9 May – 11 July; Fig. 15). 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. The overall mean weight at birth in 2013 – 2015 was 17.7 ± 2.1 kg (*n* = 76; Fig. 16).

The median birth date for calves in the Ya Ha Tinda herd is after 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) in Montana, but well within the realm of variation among the 12 neonatal elk calf studies in the western US reported by Griffin et al. (2011).

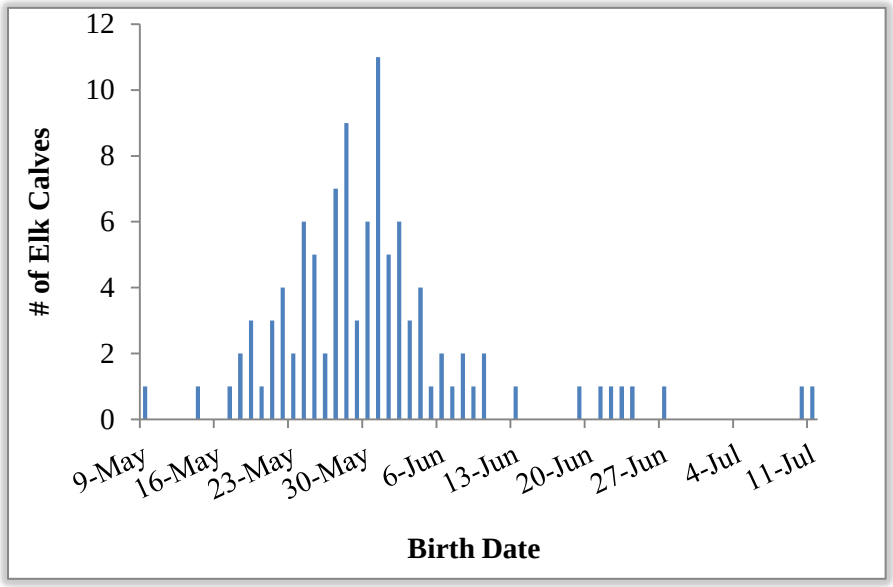


Fig. 15. Birth dates for calves born (*n* = 103) in the Ya Ha Tinda elk herd, Alberta, Canada, 2013 - 2015. Known birth dates ranged from 9 May to 11 July.

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).

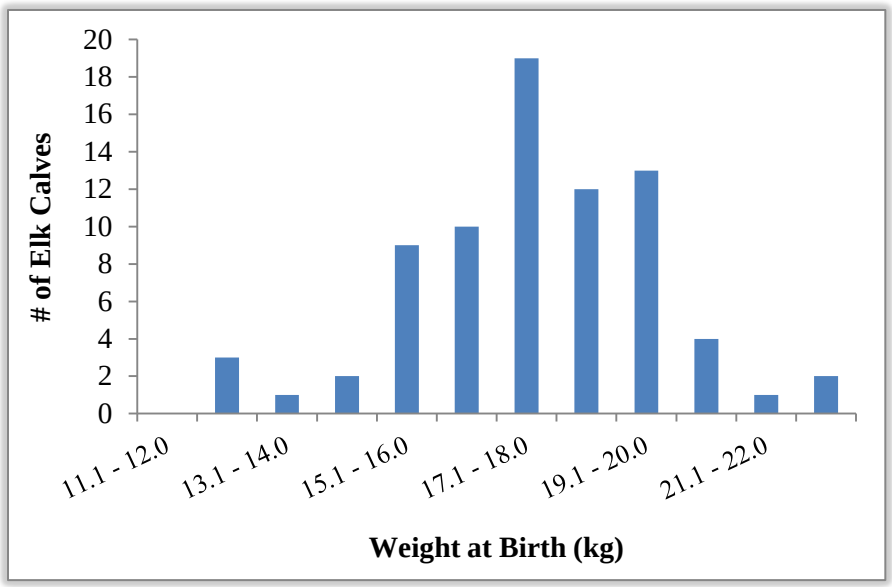


Fig. 16. Weights at birth for calves captured (n = 76) in the Ya Ha Tinda elk herd, Alberta, Canada, in 2013 - 2015. We used the estimated daily growth rate of the calves to back-calculate weight at birth from weight at capture.

Post-capture Monitoring and Survival

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. 17). Most calves died within the first 10 days of life (Fig. 18). Investigators thoroughly searched mortality sites for evidence from predators or other causes of death, such as disease or weather. In 2013 - 2016, of known causes of death, bears were responsible for the majority (Fig. 19, Appendix II-4).

Of the 34 calves captured and tagged in 2015, 14 were still surviving as of 15 March 2016 (Appendix II-4). Five of these calves belonged to resident cows, while 9 were born to eastern migrants. It is likely that 1 additional calf is still alive, but its tag was ripped out and found on the ground with no evidence of carcass or predation.

Fig. 17. Calf mortalities in the Ya Ha Tinda elk herd, Alberta, Canada, in 2013 - 2016 were investigated as quickly as possible to determine cause of death based on sign from predators, disease, or weather. *Photo credits: Laura Burns*

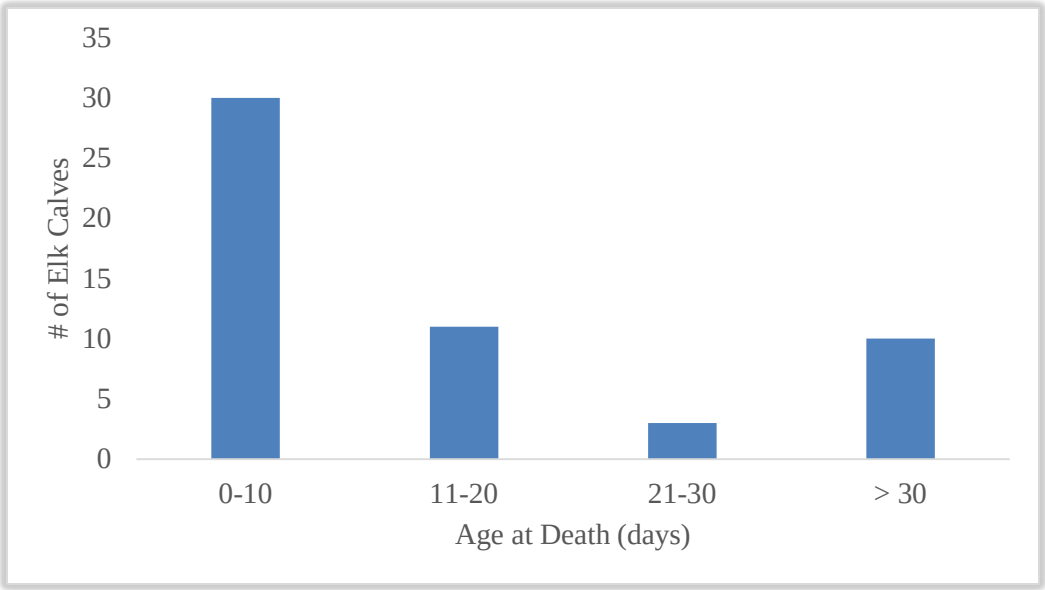


Fig. 18. Age at death of elk calves (*n* = 54) in the Ya Ha Tinda elk herd, Alberta, Canada, in 2013 - 2016.

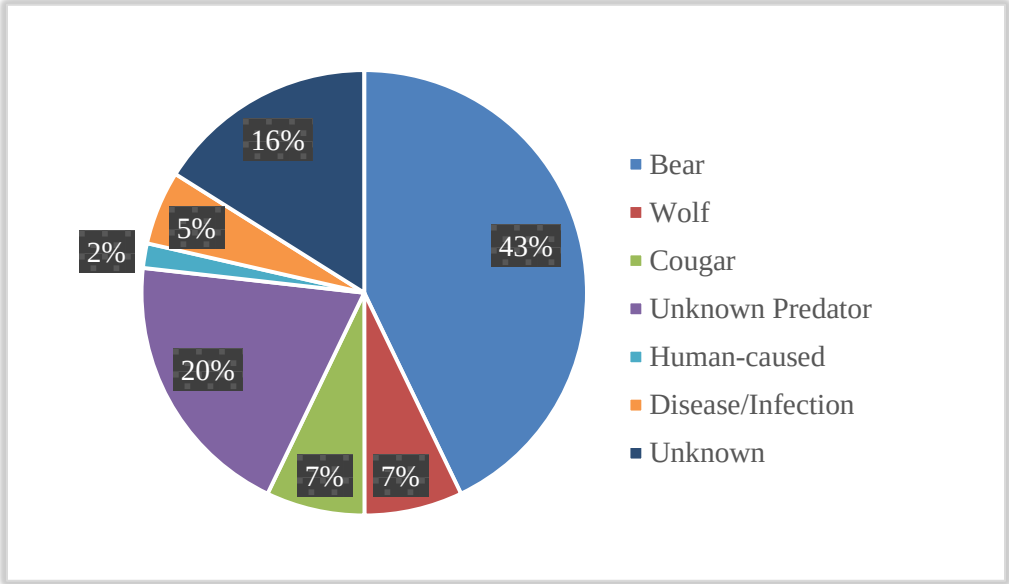


Fig. 19. Causes of death of elk calves (*n* = 56) in the Ya Ha Tinda elk herd, Alberta, Canada, in 2013 - 2016. Note that chart ignores differences in timing of the different causes of mortality (i.e., predation by bears tends to occur earlier in the neonatal period compared to that of other predators).

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 2015 and characteristics (location, slope, elevation, canopy cover, tree density, vegetation, and hiding cover) were measured (Fig. 20). 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.

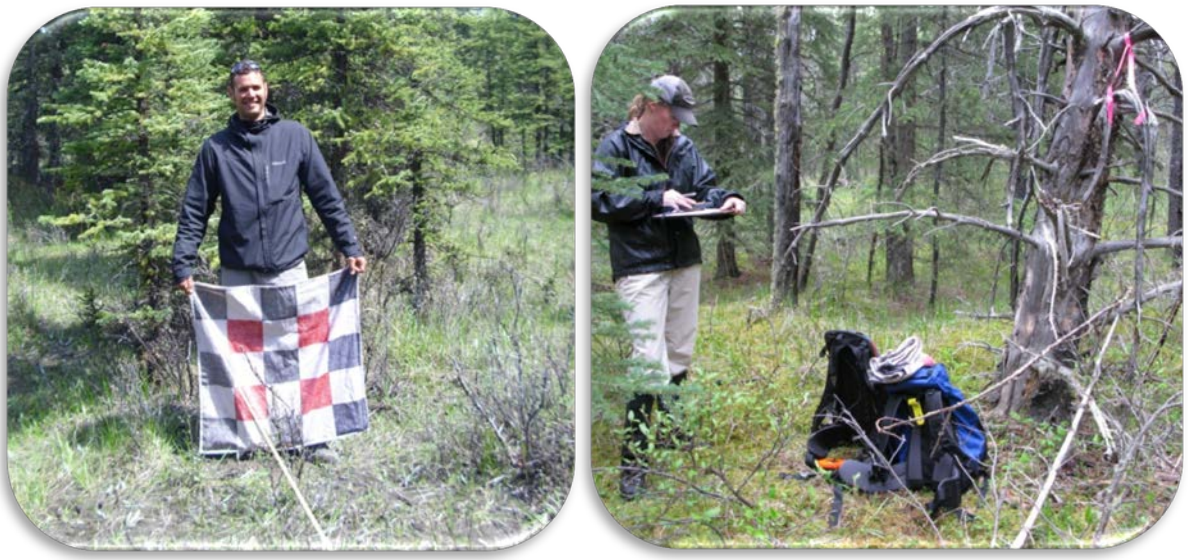


Fig. 20. Birth and bed sites, and 1 random site for each, of calves captured in the Ya Ha Tinda elk herd, Alberta, Canada, were visited in 2013 - 2015 and canopy cover, slope, elevation, calf hiding cover, and shrubby vegetation, and tree density were measured. *Photo credits: Jodi Berg and Marion Calandra*

SECTION III: Carnivore Scat Surveys

Recognition that large predators play a key role in trophic dynamics of ecosystems has led to a greater emphasis in their conservation and management across North America (Estes et al. 2011). Increasingly, research is showing that not only the direct killing, but also the risk of predation has considerable impact on prey species as they navigate a "landscape of fear" (Laundré et al 2001, Tolon et al. 2009). In particular, predation risk from large carnivores has been shown to shape ungulate habitat selection, grouping dynamics, and anti-predator behaviours (Gustine et al. 2006, Vanak et al. 2013, Robinson and Merrill 2013).

Studies of the Ya Ha Tinda elk herd in the eastern slopes of the central Rocky Mountains of Alberta have shown that elk respond to predation risk and predators may be having widespread effects on the prey community that range from overall population decline to losses in migratory behaviour. Elk migrating into Banff National Park have been found to have access to higher-quality forage but are also exposed to high wolf-caused mortality (Hebblewhite and Merrill 2011). However, wolves (*Canis lupus*) are only one of the major predators on elk and elk calves in summer so we expanded our studies to address the community of predators in this area, including black bears (*Ursus americanus*), grizzly bears (*Ursus arctos*), cougars (*Puma concolor*), lynx (*Lynx canadensis*), and coyotes (*Canis latrans*) in and around the Ya Tinda Ranch (Fig. 21).

Building on pilot work conducted by Jodi Berg in 2013, we used specially trained scat dogs in the summers of 2014-2015 to locate predator scats in and adjacent to the Ya Ha Tinda. The scat contents will be analyzed as part of a new MSc thesis project and are not presented in this report. Data described in this report will be used to meet the following research objectives as part of Eric Spilker's MSc thesis.

Study Objectives

1) Sample the scat of large carnivores including black bears, grizzly bears, wolves, coyotes, cougars, and lynx in the study area.
2) Use scat locations to model individual species resource selection functions (RSF) of each carnivore species based on landscape features and the presence of other predator's scats as a surrogate for predation risk to ungulates.
3) Adjust relative abundance estimates for each grid cell with observations of each species collected by remote trail cameras within the same sampling grid cell (Steenweg et al. 2013).
4) Use the predictions of the species-specific RSFs to assess the evidence for the spatial segregation of carnivores.
5) Build separate RSF models of locations of species-specific kill sites of adult elk (2002-2016) and calf elk (2013-2016) using final predator RSF models as predictor variables for determining risk to elk.

In this report we present preliminary summaries of sampling scat (#/km) across the study area. Further analyses will be presented as the completion of an MSc thesis in December 2016.

Fig. 21. Dog/handler team surveying scats at high elevation at the Ya Ha Tinda, AB. *Photo credit: Eric Spilker*.

Methods

Four dog handlers and 4 dogs (Shrek, Chester, Sampson, Rounder) were used for scat surveys. Three of the dogs (Shrek, Chester, Sampson) were trained at Conservation Canines, an established detection dog training facility at the Center for Conservation Biology at the University of Washington, and the other (Rounder) was trained under guidance by Conservation Canines. The detection dogs were trained following similar procedures used to train drug and explosive detection dogs (Fig. 22). Three of the dogs were handled only by their individual handlers and one dog (Shrek) was handled by 2 different handlers in different years.

Scat Surveys. After conducting a pilot study in 2013, we used a 5 x 5-km grid-based sampling design and surveyed 48 cells from 2 July to 12 September 2014 and from 7 July to 15 September 2015 with different routes within each cell surveyed between years. In 2015, we also surveyed an additional nine 5 x 5-km cells that covered the northern portion of the proposed Panther-Dormer drainages of the core area for bison reintroduction. 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. Handlers would rest dogs frequently so as to avoid over-exerting the dog and thus compromising the dog's scenting ability. We did not survey under very hot conditions (>25°C), high winds, or heavy precipitation because these conditions have been shown to significantly reduce a dog's scenting ability (Reed et al. 2011).

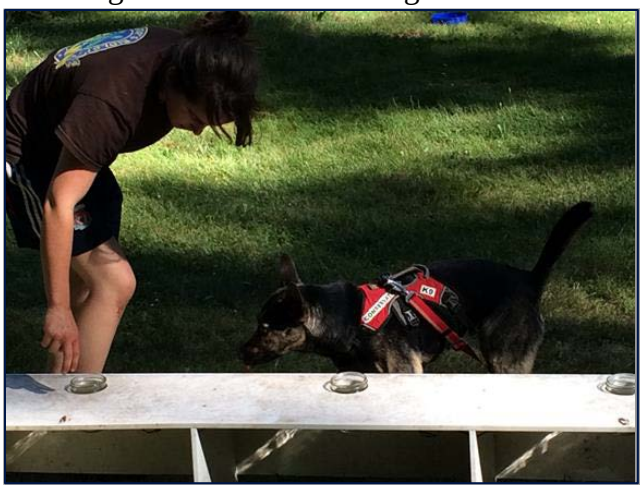


Fig. 22. Detection dog training at Conservation Canines, University of Washington. One of the six jars on the apparatus contains a coyote scat. The dog must correctly indicate which jar it is in. *Photo credit: Eric Spilker*.

When a scat was detected, a GPS location was recorded. 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). Dogs often would alert on weathered, unidentifiable and often unrecoverable scats (Fig. 23), which we ignored because we considered these to have been deposited previous to our sampling timeframe of interest. We assumed such scats were encountered evenly across the study area and did not bias our sampling.

Fig. 23. Example of scat fragments that detection dogs would alert on that were not collected as data points. This example shows a fragment that would be large in the range of unconsidered scats: dogs would also alert on several remnant hairs or discoloured substrate. *Photo credit: Eric Spilker*

Dog handlers recorded the suspected species of the scat based on the physical appearance. In particular, we used the scat diameter measurement ranges and physical descriptions of Elbroch (2003), Weaver and Fritts (1979), and Rezendes (1992) for identification guidelines (Appendix III-1). To verify scat identification, we swabbed a subset of the scats for DNA using latex gloves and 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. Due to the low amplification success rate of scats that are not fresh (Piggott 2005), only samples that appeared to have mucus present that would yield DNA were sampled (n=272). The toothpicks were then placed in breathable coin envelopes and stored at room temperature to aid in desiccation necessary for preserving the DNA structure (Waits and Paetkau 2005).

DNA will be analyzed using the Qlagen QlaAmp Mini Stool Kit (Qiagen Inc., Valencia, CA) to extract DNA. Once extracted, the 16S ribosomal ribonucleic acid (rRNA) mitochondrial gene (Johnson & O'Brien 1997) will be analysed and compared with existing known samples for species identification. DNA samples have been sent to Wildlife Genetics International (Nelson, BC) for analysis.

Results

Scat Surveys. During the summers of 2014 and 2015, we surveyed 1057-km (18.5 ± 9.0 mean ± SD, range 2.1 – 26.2 km/cell across both years) and recorded data on a total of 1259 scats (Fig. 24, Appendix I-2). The carnivore family group with the highest number of scats that we detected were canids (62%), followed by ursids (30%) and the fewest scats detected were felids (8%). Our

measure of relative abundance category by study cell reflected this with canids having the greatest number of study cells with a "high detection" ranking and the fewest cells with a "no scats detected" ranking.

Maps of Raw Scat Counts. As a preliminary exploration of the data, we plotted the average relative abundance of scats (#/km) across the 2 years within 5 x 5-km cell by species (Fig. 25). We used all data, which assumed we identified species correctly; adjustments to our results will be made once the DNA analysis is completed. Classes of relative abundance for each species were determined by examining the frequency histogram of scats for each species. 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 scats/km for canids and ursids; and, (1) no scat detected, (2) low scat detection: 0.001 - 0.099 scats/km, (3) medium scat detection: 0.010 - 0.199 scats/km and (4) high scat detection: >0.200 scats/km for felids.

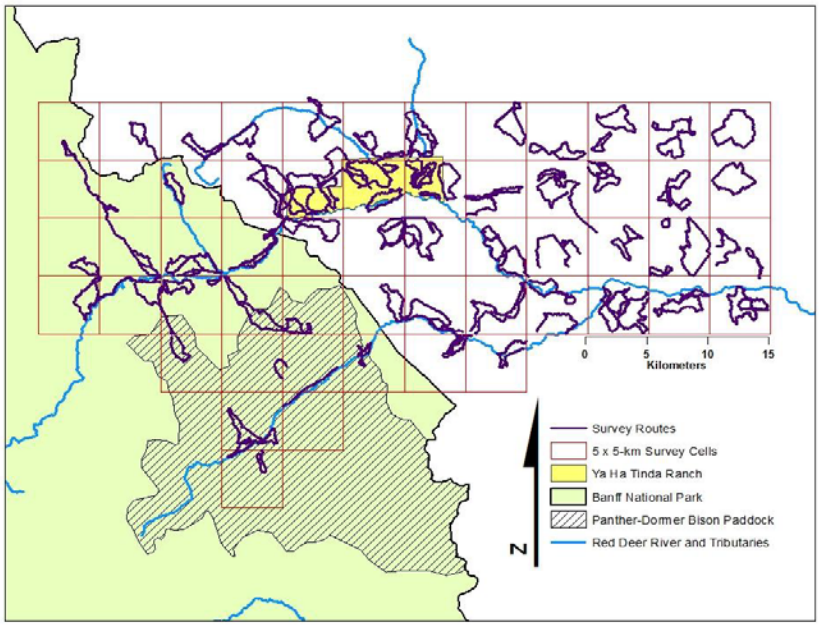
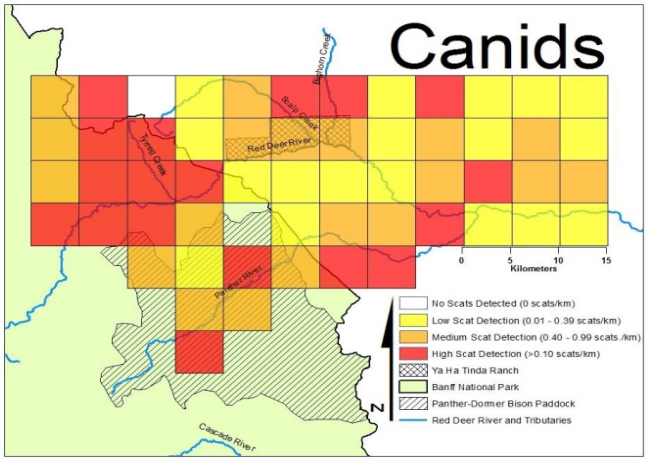


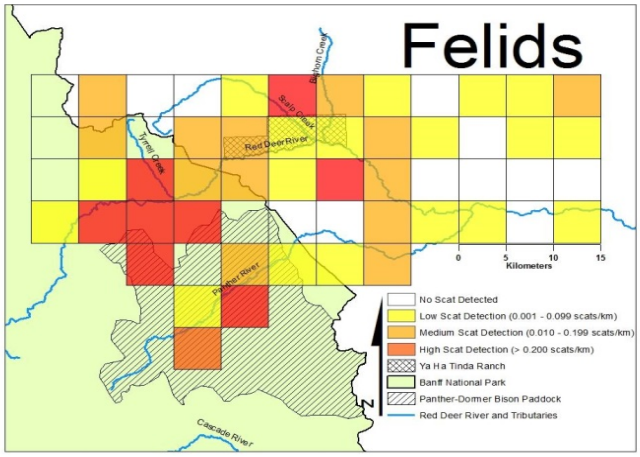
Fig. 24. Grid-based sampling design composed of 5 x 5-km cells and routes used to survey for scat of large carnivores in 2014 and 2015, Alberta, Canada.

On-going Analyses

- Revise scat species identification as per DNA analyses results.
- Use scat locations to model individual species resource selection functions (RSF) of each carnivore species based on landscape features and the presence of other predator's scats as a surrogate for predation risk to ungulates.
- Adjust relative abundance estimates for each grid cell with observations of each species collected by remote trail cameras within the same sampling grid cell (Steenweg et al. 2013).

- Assess mapped predictions of the final wolf, grizzly, and cougar RSF models with existing RSF models from other studies made with GPS and telemetry data collected in the same/nearby areas.
- Use the predictions of the species-specific RSFs to assess the evidence for the spatial segregation of carnivores.
- Build separate RSF models of species-specific kill sites of adult elk (2002-2016) and calf elk (2013-2016) using final predator RSF models as predictor variables for determining risk to elk.





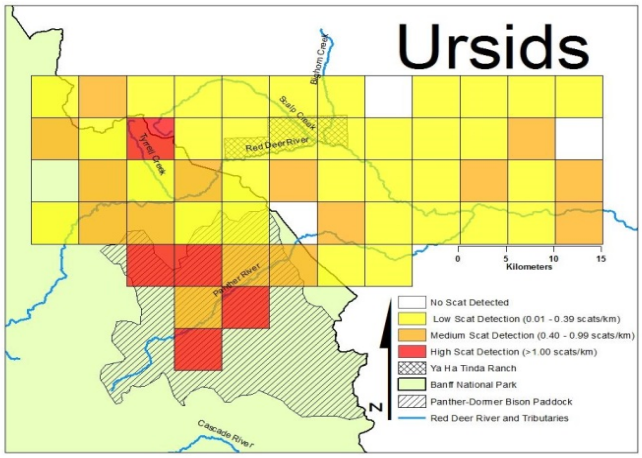


Fig. 25. Relative abundance of scats (#/km) detected by scat dogs along transects in each cell in 2014 and 2015.

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Appendix I-1. 2013 - 2016 YHT winter elk capture information.

Date	Animal ID	Method	Blood	Hair	Tooth	Preg Check	Pregnant	VIT	Collar
17/Feb/2013	OR76	Ground Dart	Yes	Yes	Yes	Yes	No	No	VHF
18/Feb/2013	OR77	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 3300
17/Feb/2013	OR78	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 4400
18/Feb/2013	OR79	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 3300
18/Feb/2013	OR80	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 4400
18/Feb/2013	OR81	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 4400
19/Feb/2013	OR82	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 3300
2/Mar/2013	OR83	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 4400
2/Mar/2013	OR84	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 4400
4/Mar/2013	OR85	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 4400
4/Mar/2013	OR86	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Mortality; see incident report
4/Mar/2013	OR87	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	ATS GPS
5/Mar/2013	OR88	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 4400
5/Mar/2013	OR89	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 4400
5/Mar/2013	OR90	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	ATS GPS
5/Mar/2013	OR91	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	VHF
6/Mar/2013	OR92	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 7000
7/Mar/2013	OR93	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 7000
7/Mar/2013	OR94	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 7000
8/Mar/2013	OR95	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	VHF
8/Mar/2013	OR96	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	VHF
22/Mar/2013	OR41	Ground Dart	Yes	Yes	Yes	Yes	Yes	Yes	Lotek GPS 4400
22/Mar/2013	OR97	Ground Dart	Yes	Yes	Yes	Yes	No	No	Lotek Lifecycle satellite
22/Mar/2013	OR98	Ground Dart	Yes	Yes	Yes	No	No	No	Lotek Lifecycle satellite
22/Mar/2013	OR99	Ground Dart	Yes	Yes	Yes	No	No	No	Lotek Lifecycle prototype
23/Mar/2013	OR100	Ground Dart	Yes	Yes	Yes	No	No	No	Lotek Lifecycle prototype
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

Date	Animal ID	Method	Blood	Hair	Tooth	Preg Check	Pregnant	VIT	Collar
25/Feb/2014	OR39	Ground Dart	Yes	No	No	Yes	Yes	Yes	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	VHF
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

Date	Animal ID	Method	Blood	Hair	Tooth	Preg Check	Pregnant	VIT	Collar
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
10/Feb/2015	YL109 (OR35)	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400
10/Feb/2015	YL110 (OR29)	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400
11/Feb/2015	YL107	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 3300
11/Feb/2015	YL111 (OR6)	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400 ARGOS
11/Feb/2015	YL112 (OR38)	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 3300
11/Feb/2015	YL113 (OR31)	Ground Dart	YES	YES	NO	YES	YES	YES	VHF
11/Feb/2015	YL114 (BL274)	Ground Dart	YES	YES	NO	YES	YES	YES	VHF
12/Feb/2015	YL115 (OR34)	Ground Dart	YES	YES	NO	YES	YES	YES	VHF
12/Feb/2015	YL116 (OR83)	Ground Dart	YES	YES	NO	YES	YES	YES	VHF
12/Feb/2015	YL117 (OR3)	Ground Dart	YES	YES	NO	YES	YES	YES	VHF
12/Feb/2015	OR91	Ground Dart	YES	YES	NO	YES	NO	NO	VHF
13/Feb/2015	YL118 (OR8)	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400
13/Feb/2015	OR89	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400
13/Feb/2015	YL119 (BL245)	Ground Dart	YES	YES	NO	YES	YES	YES	VHF

Date	Animal ID	Method	Blood	Hair	Tooth	Preg Check	Pregnant	VIT	Collar
13/Feb/2015	OR92	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400
13/Feb/2015	YL120 (BL290)	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400
13/Feb/2015	YL121 (BL250)	Ground Dart	YES	YES	NO	YES	YES	YES	VHF
14/Feb/2015	YL122 (BL244)	Ground Dart	YES	YES	YES	YES	YES	YES	VHF
14/Feb/2015	YL123 (OR7)	Ground Dart	YES	YES	NO	YES	YES	YES	VHF
14/Feb/2015	YL124	Ground Dart	YES	YES	YES	YES	YES	YES	Lotek GPS 4400 ARGOS
15/Feb/2015	OR82	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400
15/Feb/2015	OR81	Ground Dart	YES	YES	NO	YES	YES	YES	VHF
15/Feb/2015	YL127	Ground Dart	YES	YES	YES	YES	NO	NO	Lotek GPS 4400
15/Feb/2015	YL126 (OR20)	Ground Dart	YES	YES	YES	YES	YES	YES	VHF
15/Feb/2015	YL125 (BL286)	Ground Dart	YES	YES	NO	YES	YES	YES	VHF
15/Feb/2015	YL128 (BL261)	Ground Dart	YES	YES	NO	YES	NO	NO	VHF
16/Feb/2015	YL129 (OR11)	Ground Dart	YES	YES	NO	YES	YES	YES	VHF
16/Feb/2015	YL130 (OR9)	Ground Dart	YES	YES	NO	YES	YES	YES	VHF
16/Feb/2015	YL131 (OR32)	Ground Dart	YES	YES	NO	YES	YES	YES	VHF
17/Feb/2015	YL135 (BL222)	Ground Dart	YES	YES	NO	YES	YES	YES	VHF
17/Feb/2015	YL132 (OR2)	Ground Dart	YES	YES	NO	YES	YES	YES	VHF
24/Feb/2015	YL140 (BL257)	Ground Dart	YES	YES	NO	YES	YES	YES	VHF
17/Feb/2015	YL133 (OR87)	Ground Dart	YES	YES	NO	YES	YES	YES	VHF
17/Feb/2015	YL134 (BL262)	Ground Dart	YES	YES	YES	YES	YES	YES	Lotek GPS 4400
18/Feb/2015	YL138 (BL295)	Ground Dart	NO	YES	NO	YES	YES	YES	Lotek GPS 4400
18/Feb/2015	YL139 (BL220)	Ground Dart	NO	YES	YES	YES	YES	YES	Lotek GPS 4400
18/Feb/2015	YL137 (Calf Ellie)	Ground Dart	YES	YES	NO	YES	NO	NO	VHF
18/Feb/2015	YL136 (BL284)	Ground Dart	YES	YES	NO	YES	YES	YES	VHF
19/Feb/2015	YL105	Ground Dart	YES	YES	NO	YES	YES	YES	VHF
19/Feb/2015	OR99	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400
19/Feb/2015	OR52 (OR28)	Ground Dart	YES	YES	NO	YES	YES	YES	VHF
27/Feb/2015	GR513	Ground Dart	YES	YES	YES	YES	YES	YES	Lotek GPS 4400
24/Feb/2015	OR96	Ground Dart	YES	YES	NO	YES	YES	YES	VHF
24/Feb/2015	OR51 (OR19)	Ground Dart	YES	YES	YES	YES	YES	YES	VHF

Date	Animal ID	Method	Blood	Hair	Tooth	Preg Check	Pregnant	VIT	Collar
26/Feb/2015	YL102	Ground Dart	YES	YES	NO	YES	YES	YES	VHF
26/Feb/2015	OR53 (OR22)	Ground Dart	YES	YES	YES	YES	YES	YES	Lotek GPS 4400
26/Feb/2015	OR54 (BL260)	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400
26/Feb/2015	YL100	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400
27/Feb/2015	OR80	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400 ARGOS
27/Feb/2015	OR55 (OR15)	Ground Dart	NO	YES	NO	YES	YES	YES	VHF
1/Mar/2015	OR57 (OR27)	Ground Dart	YES	YES	NO	YES	YES	YES	VHF
1/Mar/2015	OR56 (BL251)	Ground Dart	YES	YES	YES	YES	YES	YES	Lotek GPS 7000 ARGOS
1/Mar/2015	OR88	Ground Dart	YES	YES	NO	YES	YES	YES	VHF
4/Mar/2015	OR97	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek Lifecycle satellite
4/Mar/2015	OR79	Ground Dart	YES	YES	NO	YES	YES	YES	VHF
4/Mar/2015	OR58 (BL292)	Ground Dart	YES	YES	NO	YES	YES	YES	VHF
4/Mar/2015	OR59 (BL259)	Ground Dart	YES	YES	NO	YES	YES	YES	VHF
5/Mar/2015	OR60 (BL288)	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400
5/Mar/2015	OR61	Ground Dart	YES	YES	YES	YES	YES	YES	VHF
5/Mar/2015	OR63 (BL242)	Ground Dart	YES	YES	YES	YES	YES	YES	VHF
5/Mar/2015	YL108	Ground Dart	YES	YES	NO	YES	YES	YES	VHF
7/Mar/2015	OR78	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400 ARGOS
7/Mar/2015	OR66 (BL293)	Ground Dart	YES	YES	NO	YES	YES	YES	VHF
7/Mar/2015	OR65 (BL265)	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 3300
11/Feb/2016	OR100	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400
11/Feb/2016	OR60	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400
11/Feb/2016	YL151 (YL87)	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400
12/Feb/2016	YL152 (YL63)	Ground Dart	YES	YES	YES	YES	YES	YES	Lotek GPS 4400
12/Feb/2016	YL153	Ground Dart	YES	YES	YES	YES	YES	YES	Lotek GPS 4400
12/Feb/2016	YL154	Ground Dart	YES	YES	YES	YES	YES	YES	Lotek GPS 4400
12/Feb/2016	YL107	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400
13/Feb/2016	YL114	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 7000
13/Feb/2016	YL155 (OR16)	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 7000
13/Feb/2016	YL118	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400

Date	Animal ID	Method	Blood	Hair	Tooth	Preg Check	Pregnant	VIT	Collar
14/Feb/2016	YL156	Ground Dart	YES	YES	YES	YES	YES	YES	Lotek GPS 7000
14/Feb/2016	YL157 (OR37)	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400
14/Feb/2016	OR89	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400
14/Feb/2016	YL158 (OR21)	Ground Dart	YES	YES	YES	YES	YES	YES	Lotek GPS 4400
15/Feb/2016	YL112	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 7000
16/Feb/2016	YL159	Ground Dart	YES	YES	YES	YES	YES	YES	Lotek GPS 4400
16/Feb/2016	YL160 (OR12)	Ground Dart	YES	NO	NO	YES	NO	NO	Lotek GPS 4400
16/Feb/2016	YL161	Ground Dart	YES	YES	YES	YES	YES	YES	Lotek GPS 4400
16/Feb/2016	YL133	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 7000
16/Feb/2016	YL162 (Claudine)	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400
17/Feb/2016	YL163	Ground Dart	YES	YES	YES	YES	YES	YES	Lotek GPS 4400
17/Feb/2016	YL164 (BL255)	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 7000
17/Feb/2016	OR54	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400
17/Feb/2016	YL100	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400
18/Feb/2016	YL120	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400
18/Feb/2016	OR65	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400
19/Feb/2016	OR61	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400
19/Feb/2016	YL124	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400
19/Feb/2016	YL115	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400
19/Feb/2016	YL165 (OR17)	Ground Dart	YES	YES	NO	YES	YES	YES	Mortality; see incident report
20/Feb/2016	OR56	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 7000
20/Feb/2016	OR78	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400
20/Feb/2016	OR97	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400
21/Feb/2016	OR99	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400
21/Feb/2016	YL166	Ground Dart	YES	YES	YES	YES	YES	YES	Lotek GPS 4400
21/Feb/2016	YL167 (OR10)	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400
22/Feb/2016	OR52	Ground Dart	YES	YES	NO	YES	NO	NO	Lotek GPS 4400
22/Feb/2016	YL137	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400
22/Feb/2016	YL168	Ground Dart	YES	YES	YES	YES	YES	YES	Lotek GPS 4400
26/Feb/2016	OR66	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400

Date	Animal ID	Method	Blood	Hair	Tooth	Preg Check	Pregnant	VIT	Collar
26/Feb/2016	OR81	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400
26/Feb/2016	YL169	Ground Dart	YES	YES	YES	YES	YES	YES	Lotek GPS 7000
26/Feb/2016	YL170	Ground Dart	YES	YES	YES	YES	YES	YES	Lotek GPS 4400
27/Feb/2016	YL134	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400
27/Feb/2016	YL171	Ground Dart	YES	YES	YES	YES	YES	YES	Lotek GPS 4400
27/Feb/2016	YL172	Ground Dart	YES	YES	NO	YES	YES	YES	Lotek GPS 4400S

Appendix I-2. 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 I-3. 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 I-4. Calf birth sites determined by location of VITs and/or newborn calf in the Ya Ha Tinda elk herd, 2013 – 2015.

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	Western	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

Cow ID	Migratory Status	VIT Frequency	Date VIT Retrieved	General Birth Site	Birth Site Easting	Birth Site Northing	Calf Captured?	Calf ID	Calf Surviving?
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	23-Jul-14	BNP	580797	5719396	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		

Cow ID	Migratory Status	VIT Frequency	Date VIT Retrieved	General Birth Site	Birth Site Easting	Birth Site Northing	Calf Captured?	Calf ID	Calf Surviving?
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
UNK	Resident	N/A	N/A	YHT	UNK	UNK	Y	YP14	N
untagged	Resident	N/A	N/A	YHT	UNK	UNK	Y	YF14	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
GR513	Western	155.703	28-Aug-15	BNP	596363	5689234	N		
OR51 (OR19)	Western	152.682	1-Aug-15	BNP	591263	5713091	N		
OR52 (OR28)	Eastern	155.733	24-May-15	East of YHT	623437	5723834	Y	YR15	Y
OR53 (OR22)	Eastern	153.063	N/A	N/A	N/A	N/A	N/A		
OR54 (BL260)	Resident	155.544	31-May-15	North of YHT	595791	5737283	Y	RW15	N
OR55 (OR15)	Western	155.064		UNK	UNK	UNK	N		
OR56 (BL251)	Western	152.562	28-Aug-15	BNP	589784	5695183	N		

Cow ID	Migratory Status	VIT Frequency	Date VIT Retrieved	General Birth Site	Birth Site Easting	Birth Site Northing	Calf Captured?	Calf ID	Calf Surviving?
OR57 (OR27)	Eastern	155.053	31-May-15	East of YHT	615057	5725962	Y	RB15	Y
OR58 (BL292)	Resident	155.463	27-May-15	YHT	599541	5733969	Y	YO15	Y
OR59 (BL259)	Eastern	152.782	29-May-15	East of YHT	619764	5721646	Y	RI15	Y
OR60 (BL288)	Western	155.413	20-Jul-15	BNP	581546	5732200	N		
OR61	Resident	155.193	8-Jun-15	YHT	598297	5733791	Y	SS15	N
OR63 (BL242)	Resident	155.210	14-Mar-15	YHT	597809	5734572	N	No ID	N
OR65 (BL265)	Resident	152.722		South of YHT	UNK	UNK	N		
OR66 (BL293)	Resident	152.940	1-Jun-15	North of YHT	596411	5738460	N		
OR78	Western	152.943	13-Sep-15	BNP	542737	5721577	N		
OR79	Resident	155.293	1-Jun-15	YHT	600802	5734856	Y	YI15	Y
OR80	Resident	155.234	19-Jun-15	North of YHT	599082	5736350	Y	RY15	Y
OR81	Eastern	155.153	2-Jun-15	East of YHT	617288	5723271	Y	E115	N
OR82	Resident	152.602	28-May-15	YHT	601090	5734803	N		
OR88	Resident	152.641	2-Jun-15	YHT	602889	5734950	N		
OR89	Western	155.253		BNP	UNK	UNK	N		
OR92	Eastern	155.272	2-Jul-15	East of YHT	617069	5722437	Y	RU15	Y
OR96	Resident	153.032	10-Jun-15	YHT	603517	5732358	Y	RP15	Y
OR97	Resident	155.314	24-Jun-15	North of YHT	598253	5739418	N		
OR99	Resident	155.562	7-Jun-15	YHT	598879	5734094	Y	RC15	N
YL100	Resident	152.802	30-May-15	YHT	601737	5733728	Y	RL15	UNK - dropped tag?
YL102	Resident	155.353	5-Jun-15	YHT	591173	5730230	Y	I115	N
YL105	Resident	152.841	10-Jun-15	North of YHT	603469	5735541	Y	K115	N
YL107	Resident	155.914	24-May-15	North of YHT	599999	5736695	Y	YS15	N
YL108	Resident	155.582	25-May-15	YHT	598427	5732898	Y	BM15	N
YL109 (OR35)	Eastern	153.330	13-May-15	East of YHT	620577	5724783	N		
YL110 (OR29)	Resident	155.113	6-Jul-15	YHT	596379	5730522	Y	RM15	N
YL111 (OR6)	Eastern	155.504	N/A	N/A	N/A	N/A	N/A		
YL112 (OR38)	Resident	155.014	2-Jun-15	YHT	601744	5732683	Y	RV15	N
YL113 (OR31)	Resident	153.003	28-May-15	North of YHT	601000	5734427	Y	RR15	N

Cow ID	Migratory Status	VIT Frequency	Date VIT Retrieved	General Birth Site	Birth Site Easting	Birth Site Northing	Calf Captured?	Calf ID	Calf Surviving?
YL114 (BL274)	Eastern	155.523	22-May-15	East of YHT	624188	5725458	Y	YG15	Y
YL115 (OR34)	UNK	155.822		UNK	UNK	UNK	N		
YL116 (OR83)	Resident	152.902	2-Jun-15	North of YHT	599620	5737380	N		
YL117 (OR3)	Resident	155.482	6-Aug-15	South of YHT	596728	5727335	N		
YL118 (OR8)	Eastern	155.853	29-May-15	East of YHT	613139	5723702	Y	BP15	Y
YL119 (BL245)	Resident	155.612	4-Jun-14	North of YHT	603197	5737032	Y	RT15	Y
YL120 (BL290)	Resident	152.621	1-Jun-15	North of YHT	594422	5737896	Y	RQ15	N
YL121 (BL250)	Resident	155.371		North of YHT	UNK	UNK	N		
YL122 (BL244)	Eastern	155.032	8-Jun-15	East of YHT	617110	5720984	Y	RX15	Y
YL123 (OR7)	Eastern	155.070	N/A	N/A	N/A	N/A	N/A		
YL124	Resident	152.663	27-May-15	YHT	597806	5734578	Y	RE15	N
YL125 (BL286)	Resident	152.822	14-Jun-15	North of YHT	601156	5740447	N		
YL126 (OR20)	Eastern	155.093	19-May-15	East of YHT	608884	5726471	Y	YN15	Y
YL129 (OR11)	Western	155.133	31-May-15	BNP	545091	5721105	N		
YL130 (OR9)	Eastern	155.973	27-Jun-15	East of YHT	608258	5725560	Y	G115	Y
YL131 (OR32)	Mixed	155.333	18-Jul-15	BNP	573503	5711951	N		
YL132 (OR2)	Resident	155.643	7-Jun-15	YHT	600891	5732040	Y	RO15	N
YL133 (OR87)	Resident	155.762	28-May-15	YHT	600022	5734776	Y	RK15	N
YL134 (BL262)	Eastern	152.743	12-Jul-15	East of YHT	613906	5716968	N		
YL135 (BL222)	UNK	155.944	N/A	N/A	N/A	N/A	N/A		
YL136 (BL284)	Eastern	155.433	28-May-15	East of YHT	616081	5720801	Y	L115	N
YL138 (BL295)	Eastern	155.672	24-Aug-15	North of YHT	598451	5743519	N		
YL139 (BL220)	Eastern	155.592	23-Jun-15	East of YHT	617308	5722831	N		
YL140 (BL257)	Eastern	152.922	28-May-15	East of YHT	617973	5724442	Y	YH15	N
Untagged	Resident	N/A	N/A	YHT	UNK	UNK	Y	RJ15	N
Untagged	Resident	N/A	N/A	YHT	UNK	UNK	Y	RN15	N

Appendix I-5. 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.

Appendix II-1. Calves captured in May and June, 2013-2015, on the Ya Ha Tinda Elk Project.

Calf ID	Frequency	Cow ID	Birth Site Easting	Birth Site Northing	Capture Date	Capture Site Easting	Capture Site Northing	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

Calf ID	Frequency	Cow ID	Birth Site Easting	Birth Site Northing	Capture Date	Capture Site Easting	Capture Site Northing	Estimated Age at Capture (hrs)
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
BM15	149.262	YL108	598427	5732898	20-May-15	598439	5732908	3.5
BP15	148.922	YL118 (OR8)	613139	5723702	25-May-15	613153	5723700	3
E115	152.503	OR81	617288	5723271	2-Jun-15	617288	5723271	2.5
G115	149.682	YL130 (OR9)	608258	5725560	27-Jun-15	608273	5725530	3.5
I115	152.313	YL102	591173	5730230	6-Jun-15	591172	5730029	20
K115	149.262	YL105	603469	5735541	10-Jun-15	603498	5735554	4.5
L115	149.763	YL136 (BL284)	616081	5720801	28-May-15	616081	5720801	4.5

Calf ID	Frequency	Cow ID	Birth Site Easting	Birth Site Northing	Capture Date	Capture Site Easting	Capture Site Northing	Estimated Age at Capture (hrs)
RB15	148.582	OR57 (OR27)	615057	5725962	31-May-15	615057	5725962	1
RC15	149.513	OR99	598879	5734094	1-Jun-15	598879	5734094	2.5
RE15	152.042	YL124	597806	5734578	27-May-15	592340	5730343	11
RI15	149.252	OR59 (BL259)	619764	5721646	29-May-15	619812	5721790	19
RJ15	148.872	untagged	UNK	UNK	30-May-15	600355	5733217	12
RK15	148.938	YL133 (OR87)	600022	5734776	28-May-15	599988	5734661	16
RL15	148.522	YL100	601737	5733728	30-May-15	601737	5733728	3.75
RM15	148.368	YL110 (OR29)	596379	5730522	4-Jun-15	596580	5730406	10.5
RN15	148.703	untagged	UNK	UNK	29-May-15	601341	5734650	6
RO15	148.341	YL132 (OR2)	600891	5732040	28-May-15	600891	5732040	3
RP15	148.982	OR96	603517	5732358	10-Jun-15	603370	5732259	5
RQ15	148.743	YL120 (BL290)	594422	5737896	1-Jun-15	594483	5737823	11
RR15	149.461	YL113 (OR31)	601000	5734427	30-May-15	600451	5736755	104.5
RT15	149.482	YL119 (BL245)	603197	5737032	4-Jun-15	603294	5737226	18.5
RU15	149.602	OR92	617069	5722437	3-Jun-15	617055	5722417	2
RV15	152.400	YL112 (OR38)	601744	5732683	2-Jun-15	601744	5732683	3
RW15	152.200	OR54 (BL260)	595791	5737283	31-May-15	595203	5737216	20.5
RX15	149.622	YL122 (BL244)	617110	5720984	8-Jun-15	617110	5720984	2.5
RY15	152.582	OR80	599082	5736350	19-Jun-15	599088	5736412	5.5
SS15	149.853	OR61	598297	5733791	9-Jun-15	598307	5733661	30.5
UN08	N/A	OR63 (BL242)	597809	5734572	N/A	N/A	N/A	0
YG15	149.092	YL114 (BL274)	624188	5725458	22-May-15	624349	5725574	25
YH15	149.422	YL140 (BL257)	617973	5724442	21-May-15	618033	5724432	12
YI15	149.012	OR79	600802	5734856	1-Jun-15	600243	5734939	22
YN15	149.111	YL126 (OR20)	608884	5726471	19-May-15	608840	5726644	23.5
YO15	149.333	OR58 (BL292)	599541	5733969	27-May-15	599541	5733969	5.5
YR15	149.132	OR52 (OR28)	623437	5723834	24-May-14	623485	5723842	11
YS15	149.853	YL107	599999	5736695	22-May-15	599999	5736695	4

Appendix II-2. 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): _____
_____
_____
Collect Hair!!! **Double Check Freq!!!** **Remove Blindfold!!!**

Appendix II-3. Mean measurements (range) taken on elk calves captured in the Ya Ha Tinda herd in 2013 - 2015.

			Standard Measurements						
			millimeters					centimeters	
	Age Class	**# of Calves**	**Navel Diam.**	**Incisor Inside**	**Incisor Middle**	**Incisor Outer***	**Hoof Growth Line to Hair Line**	**Chest Girth**	**Right Hind Leg**
A	Newborn - 1 day	69	13.5 (8.1 - 27.0)	0.7 (0.0 - 4.6)	3.1 (0 - 8.6)	3.7 (1.0 - 6.1)	11.0 (0.0 - 19.0)	60.9 (41.0 - 76.0)	41.5 (31.0 - 46.0)
B	2-4 days	8	12.1 (7.1 - 19.1)	2.4 (0.6 - 4.4)	5.0 (2.2 - 6.7)	5.1 (4.4 - 5.6)	11.7 (8.9 - 14.3)	61.4 (47.5 - 69.1)	41.1 (38.4 - 42.9)
C	5-7 days	2	8.0 (7.4 - 8.5)	4.1 (3.4 - 4.8)	6.2 (4.1 - 8.2)		10.1 (7.1 - 13.0)	70.4 (70.0 - 70.8)	43.0 (42.0 - 44.0)
D	8+ days	1	12.6	6.2	8		9.5	68	43

* measured in 2015 only; n = 31 for age class A and n = 2 for age class B

Appendix II-4. Detected elk calf mortalities on the Ya Ha Tinda Elk Project, 2013 - 2016.

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
UN01	N/A	18-Jun-13	619861	5724902	> 1	<10	Unknown predator
UN02	N/A	9-Jun-13	601424	5732514	0.25	7	Unk. - pred. or human-caused
UN03	N/A	8-Oct-13	599092	5733038	< 1	130	Human-caused
UN08 (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	Unknown 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
UN07 (YL102)	N/A	31-May-14	601142	5732678	< 0.5	< 0.5	Bear

Calf ID	Frequency	Date Found	Easting	Northing	Est. Time Since Death (days)	Estimated Age (days)	Cause of Death
YQ14	149.834	5-Jun-14	595688	5732024	2	UNK	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
UN06 (BL268)	N/A	22-Jun-14	620638	5722423	< 1	0.5	Bear
BM15	149.262	2-Jun-15	598522	5732877	7	6	Bear
E115	152.503	17-Aug-15	621299	5722510	UNK	70	Unk. pred.
I115	152.314	12-Jun-15	590783	5730863	1	7	Unk. pred. - likely bear
K115	149.262	19-Jun-15	603004	5733748	< 1	8.5	Bear
L115	149.763	28-Jan-16	600430	5732979	UNK	245	Unknown
RC15	149.513	16-Jun-15	596077	5734390	1	13	Unk. pred. - likely cougar
RE15	152.042	12-Oct-15	601485	5734811	UNK	720	Unknown
RJ15	148.872	7-Jun-15	600048	5732944	5	9	Bear
RK15	148.938	5-Jun-15	600902	5734075	< 1	9	Bear
RL15	148.522	15-Feb-16	600047	5734203	UNK	260	Unknown - dropped tag?
RM15	148.368	11-Jul-15	599738	5736655	UNK	30	Bear
RN15	148.703	2-Jul-15	598868	5735994	< 1	34	Cougar
RO15	148.341	28-Jun-15	605109	5729692	17	14	Unk. pred. - likely wolf
RQ15	148.743	15-Jun-15	594558	5738073	1	14.5	Bear
RR15	149.482	15-Oct-15	603295	5735017	UNK	139	Unknown
RV15	152.400	7-Jun-15	599828	5733127	2	5.5	Bear
RW15	152.200	15-Jun-15	594558	5738073	1	15.5	Bear
SS15	149.853	12-Jun-15	599153	5734048	1	3	Bear
UN09 (OR63)	N/A	14-Mar-15	597809	5734572	< 1	0	Aborted
YH15	149.422	2-Jul-15	612118	5724454	< 0.5	42.5	Bear
YS15	149.853	24-May-15	599967	5736564	1	2	Bear

Appendix III-1: Scat characteristics used for field identification.

Species	Diameter (cm)	Shape	Other Characteristics	Reference
Grizzly Bears	> 5	Highly varied, often tubular and unsegmented, or in piles of loose, unformed pellets	Often contains vegetation	Rezendes 1992
Black Bears	3.2 – 7.0			
Wolves	1.4 – 4.8	Cord-like, well tapered at one end	Often contain large bone fragments and high hair content	Thompson 1952, Weaver and Fritts 1979
Coyotes	1.4 – 3.3		Often contain bone fragments and high hair content. Berries and other vegetation sometimes present	Rezendes 1992
Cougars	2.5 – 3.8	Well segmented, not tapered	Rarely contains bones	Elbroch 2003,
Lynx/bobcat	1.6 – 1.9			Rezendes 1992

Appendix III-2: Scat collection data by predator family group.

Predator Group	Percent of total scats detected (%)	Scats detected/ km of transect	SD	Range
Canid	62	0.80	0.64	0 – 2.93
Ursid	30	0.46	0.51	0 – 2.25
Felid	8	0.10	0.10	0 – 0.40