Ya Ha Tinda Elk Project

Annual Report 2016 - 2017

Submitted to:
Parks Canada, Alberta Environment and Parks
& Project Stakeholders

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ACKNOWLEDGEMENTS

We thank Parks Canada staff Blair Fyten, Jesse, Whitington, 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, James Spidell 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), Dr. Bryan Macbeth, Mark Benson, Eric Knight, 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 FUNDING

This work would not have been possible without the financial and in-kind support from: Parks Canada, National Science Foundation (NSF, USA, Grant DEB 1556248), Natural Sciences and Engineering Research Council (NSERC), Alberta Conservation Association, Alberta Environment and Parks, Minister's Special License-Hunting for Tomorrow, 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 International – 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

Martin, H., Hebblewhite, M., K. MacAuley, M. Flowers, J.E. Berg, E. Spilker, J. Killeen, and E. Merrill. 2016. Ya Ha Tinda elk and predator study: Annual report 2016-2017. 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 population up to Summer 2017 (Section I). The report also includes summaries of 3 subprojects within our overall project; preliminary results from our study of elk calf survival (Section 2), results of a predator scat distribution and diet study (Section 3), preliminary results from intensive and extensive camera trapping (section 4), results of a new parasitology study (section 5). We also summarize scientific and public communication in the last 5 years in section 6.

Based on aerial winter counts, the Ya Ha Tinda elk population may be stabilizing after a population decline from ~ 2,200 in the late 1990's to ~400-500. Up until 2013, there were no differences in survival or recruitment rates of migrant and western elk. Part of the stabilization of the elk population may be driven by higher calf survival of the relatively new phenomenon of eastern migrants. Migratory elk that migrate to the Dogrib burn and Wildhorse Creek areas.

In winter (Feb-March) 2015, 2016, and 2017, 64, 46, and 20 adult female elk were free-range darted and radiocollared from horseback. Pregnancy rates were high in all 3 years, 94%, 96%, and 94%, respectively. All pregnant elk were collared and fit with vaginal implant transmitters (VITs) in 2015 and 2016 to monitor elk calf survival. In 2017, 14 were recaptured from the previous year, 4 were new captures which were collared, and 2 were released without processing. As of 15 March 2017, a total of 76 elk remained collared, including 46 GPS- and 30 VHF-collared elk. While pregnancy rates in elk were high, calf survival and recruitment continues to be low less than 20 calves:100 cows. Early calf mortality was caused by bears (35%), followed by cougars (14%), and wolves (9%). Preliminary analysis suggests that there is a difference in cause-specific calf mortality and calf survival between residents and eastern migrants.

Based on VITs and/or location of neonatal elk calves in 2013-2016 (n = 153), 12% of females gave birth in Banff National Park, 19% of females gave birth north of the Ranch (e.g., Bighorn Creek cut blocks and along Scalp Creek), 4% gave birth to the south of YHT, 27% of the females gave birth to the east of YHT, and 37% gave birth near YHT. No calves of the 18 pregnant, marked females that migrated into BNP in spring were captured, but VITs of these cows were located later in the summer, and indicated that elk calved along the Panther, Cascade, and Bow valleys in BNP.

Twenty-nine calves (20 residents, 9 eastern migrants) were captured and monitored in May and June 2016. The median birth date for calves (n = 113) born in 2013 – 2016 was 29 May and the mean mass at birth was 17.6 kg (n = 102). 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 29 calves, 3 (10%) were alive as of 15 March 2017. Of the known mortality causes in 2013 - 2017, most were attributed to bears (32%), followed by cougars (13%), and wolves (9%). Spring 2016 was the last summer of radiotagging neonatal elk calves, and PhD Jodi Berg expects to complete her PhD studies in early winter of 2018.

During the summers of 2014-2016, we used scat detection dogs to survey 1,292 km of transects distributed among 57 25-km^2 grid cells. Between both years, we found a total of 1,107 carnivore scats. The carnivore family group with the highest number of scats detected were canids (62%) followed by ursids (30%) and felids (8%). These results are consistent with our long-term data on annual adult female cause-specific mortality, but not our cause-specific neonatal elk calf survival data, which highlights the important role of ursids, especially grizzly bears, in early calf survival.

Elk fecal parasite loads were sampled in summer ranges in 2017 and revealed *Protostrongylid sp., Eimeria sp., Trichuris sp.*, *Dictyocaulus sp., Strongyle spp., Strongyloides sp.,* and *F. magna*. Bighorn sheep had the highest prevalence of parasite infection and cattle and horses did have *Stronglye* parasites. Average intensity of Giant liver fluke, *F. magna* infection was 0.78 eggs/g for western migrants, 2.12 eggs/g for residents, and 5.29 eggs/g for eastern migrants. *F. magna* infection was significantly higher in the eastern migrants than both residents and western migrants but not between residents and western migrants. Our preliminary results suggest that different migratory strategies expose elk to differential parasite loads. Sampling during summer 2018 will expand sampling of ungulate species to include newly released Plains Bison in Banff National Park.

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1.0 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 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 and winter count data from the past 3 years suggests that the population may have stabilized. Further, our past studies of predation risk on elk has focused on wolves (*Canis lupus*), whereas the Ya Tinda is a multi-predator system. 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 2017 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.
(4) camera trapping in extensive and intensive sampling grids.
(5) Parasitology results from summer 2017.

1.1 Population Monitoring

1.1.2 Ground Counts

The highest minimum ground counts of the cow-calf herd in winter were conducted from horseback or the ground 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 1a. 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 #	Date	Total #	Date	Total #	Date	Total #	Date	Total #
7-Feb-13	335	7-Mar-14	338	9-Feb-15	358	18-Feb-16	350	5-Apr-17	357
12-Feb-13	286	9-Mar-14	333	9-Mar-15	352	20-Feb-16	350	15-Apr-17	332
11-Mar-13	277	10-Mar-14	338	2015 Average	355	22-Feb-16	350	2017 Average	341
14-Mar-13	253	18-Mar-14	332			16-Mar-16	350		
16-Mar-13	263	4-Apr-14	387			29-Mar-16	350		
18-Mar-13	259	6-Apr-14	335			30-Mar-16	350		
19-Mar-13	282	7-Apr-14	256			2016 Average	350		
26-Mar-13	236	8-Apr-14	286						
27-Mar-13	274	10-Apr-14	322						
2013 Average	273.9								

1.1.2 Winter Aerial Surveys

No summer aerial surveys were conducted in 2016, and results from summer surveys in 2017 will be summarized in the next annual report. In winter 2016/17, a total count of 391 elk (including 376 in the cow-calf herd, 1 bulls, and 14 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.

1.1.3 Summer Aerial Surveys

On July 13 and 14, Hans Martin, Blair Fyten and Resource Conservation staff conducted two early morning summer surveys of summer range following previous surveys conducted in the 80's by Luigi Morgantini, 2003/04 by Mark Hebblewhite, 08/9 by Holger Spaedtke, and 11/12 by Scott Eggeman (Hebblewhite 2006). The goal was to understand the distribution of radiocollared and uncollared elk on summer ranges to test for long-term changes in summer range distribution.

Table 1b displays results of the survey. A total of 278 elk were counted, 15 of which were located in the upper Bow Valley near Hector Lake, another 13 of which were counted in the front ranges of the Red deer, Cascade, and Panther valleys inside BNP, 202 were counted in the areas surrounding the Ya Ha Tinda Ranch, and 58 which were counted east of the mountains near Wildhorse creek and the Dogrib fire. Radiocollars were observed in all groups, but there were three radiocollared elk that were not seen on surveys, but located using aerial telemetry. Figure 1a displays the location and waypoints corresponding to group size in Table 1.

Formal analyses of changes in distribution between the 4 main areas flown – upper bow, front ranges, ranch, and wildhorse – have not been conducted, accounting for detection and changes in radiocollar distribution. However, preliminary analyses suggest the proportion of elk residing in BNP during summer has stabilized or slightly declined since the most recent summer surveys conducted by Eggeman in 2011/12. In contrast, the number of elk summering east of the ranch has increased to ~ 20% (naïve estimate) since 2011/12. Moreover, our estimates obtained by aerial surveys roughly correspond to estimates of summer range occupancy from our radiocollared sample.

Table 1b. Summer aerial elk survey results from July 13 and 14, 2017, for the Ya Ha Tinda summer range.

Waypoint	Date	Time	Count	Visual	Classification	Collars	Area
078	13-Jul-17	6:46:21	1	No	Cow	1-Or78	Outflow Bow Lake
077	13-Jul-17	6:40:19	3	Yes	Unknown	1-Yl129	South of Bow Lake
076	13-Jul-17	6:28:06	12	Yes	Unknown	1	Hector lake
084	13-Jul-17	9:18:31	1	No	Cow	Or-60	Peters creek
080	13-Jul-17	8:53:00	2	Yes	1 spike 1 cow		McConnough creek
081	13-Jul-17	9:03:55	5	Yes	4 cow 1 calf	Or-51	Tyrrell flats
088	14-Jul-17	6:30:09	4	Yes	bulls		Elkhorn summit
089	14-Jul-17	6:45:05	1	No	Cow	Or66	Red Deer side of Elkhorn
085	13-Jul-17	9:41:30	2	Yes	1 bull 1 cow	Or-65	Red Deer River
095	14-Jul-17	7:52:40	2	Yes	bulls		Hat Mtn, Ya Ha Tinda
086	13-Jul-17	9:58:31	13	Yes	10 cow 3 calves	Yl 168, Or56	Cascade River
096	14-Jul-17	7:53:46	1	Yes	cow		Boulder creek
094	14-Jul-17	7:45:26	15	Yes	10 bulls 5 cows	1	Hat Mtn
093	14-Jul-17	7:30:32	157	Yes	Unknown		Ya Ha Tina Main Pasture
091	14-Jul-17	7:13:44	2	Yes	Unknown		Ribbon Flats
097	14-Jul-17	9:19:02	11	Yes	2 bulls 6 cows 3 calves		Dogrib burn
098	14-Jul-17	9:23:07	47	Yes	Unknown	Yl -159	Dogrib burn

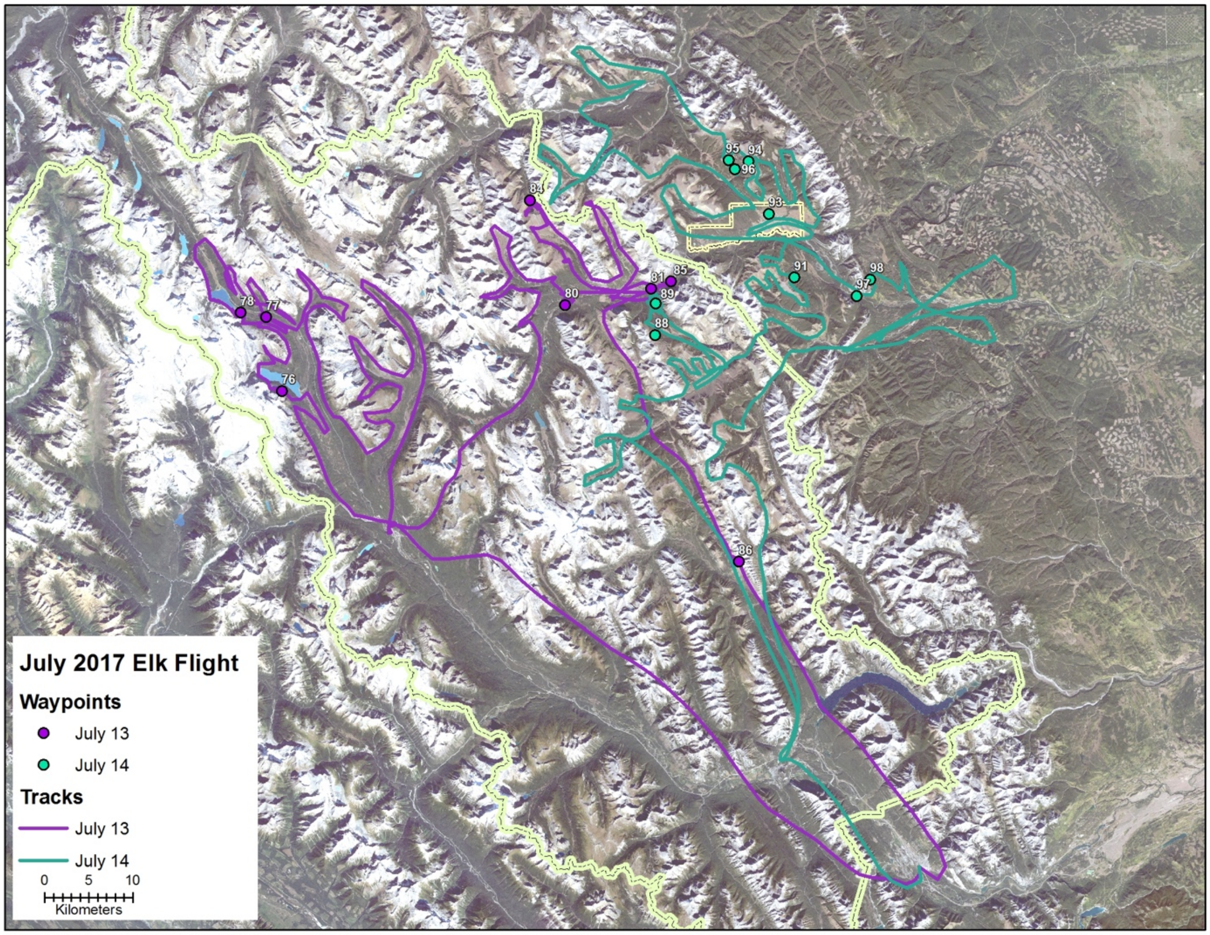

Fig. 1a. Summer aerial surveys flown on July 13 and 14 showing location and waypoints corresponding to group size in Table 1.

1.1.3 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
Summer	2016	377	0	9	0.37	1.02	0.003	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	2.01	0.003	0.009
Winter	2014/15	372	0	12	0.78	1.86	0.003	0.008
Winter	2015/16	375	0	12	0.75	1.52	0.003	0.006
Winter	2016/17	375	0	7	0.54	1.18	0.002	0.005

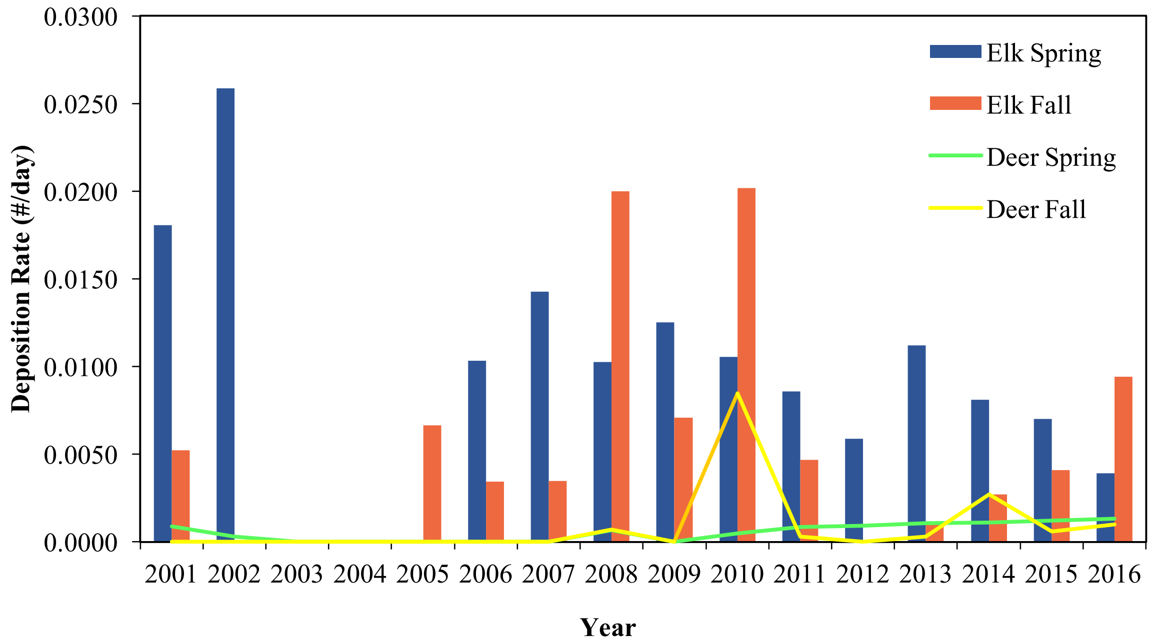

Fig.1b. Changes in deposition rates (#/day) averaged across plots surveyed every year (*n* = 29) over time from winter 2000/01 to summer 2016; pellet groups counts were conducted at the Ya Ha Tinda ranch, Alberta, Canada.

1.2 Adult Elk Capture and Handling 2017

In February and March, 2017, 20 elk were free-range darted and immobilized (Fig. 3). Fifteen of the elk were recaptures from previous years and one VHF collar was replaced with an Iridium GPS collar while the rest of the collars (scheduled to fall off in winter 2017) condition were checked but left on the elk. Four elk were new captures and were fitted with Iridium GPS collars. Hair and blood samples were taken from all elk and body condition and chest girths were measured. The animals were kept on oxygen during the immobilization and vitals were monitored. Blood samples were sent to Biotracking, inc. for pregnancy analysis using BioPRYN's placental Pregnancy-Specific Protein B test (PSPB). Seventeen of the 18 elk (94%) were pregnant. All elk that were captured for the first time were ear-tagged in both ears and a vestigial canine tooth was removed for aging after blocking the nerve with Lidocaine. As a result of winter capture efforts, the YHT elk herd entered spring 2017 with a total of 76 collars (approximately 26-28% of the total adult female population), in the herd.

Fig. 3. Parks Canada and research staff chemically immobilizing elk on horseback to capture adult female elk and estimate pregnancy rates.

1.3 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 3). 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 and 2016, we located western migrants and any missing elk throughout the summer with the help of Parks Canada employees.

Fig. 4. Hans Martin locating migratory elk using VHF radio telemetry.

Table 3. 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	671	30	22	46	302,691	6,580
Average	85	1,261	70	20	14	88,102	5,057
Totals	1,269	18,908	1,053		216	1,321,537	

1.4 Elk Demography

1.4.1 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).

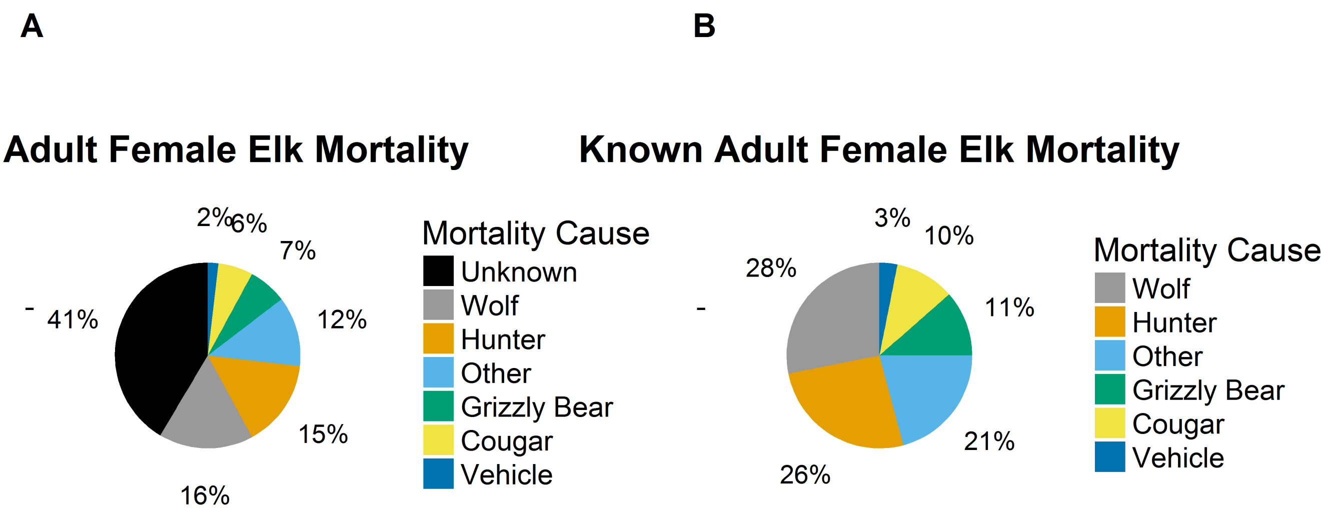

Fig. 5. Mortality causes for radio-collared adult female elk (*n* = 154) from 2002 –March 2016 in the Ya Ha Tinda elk population, Alberta, Canada. (A) Shows all mortalities, including unknowns (*n* = 154), and (B) shows only known-causes of mortality (*n* = 91).

1.4.2 Winter and Summer 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 (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 skilled observers at very close range, as body size of yearling females is variable and there is considerable risk of misclassification (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). We follow statistical methods of Hebblewhite (2006, Appendix 1B). We calculated the standard error in Y_{ij} assuming errors were binomially distributed following (Czaplewski et al. 1983).

Table 4. 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
2016	2063	17	1643	279	0.170	0.008
Average	1969.36	17.4286	1587.36	247.357	0.1565	0.011

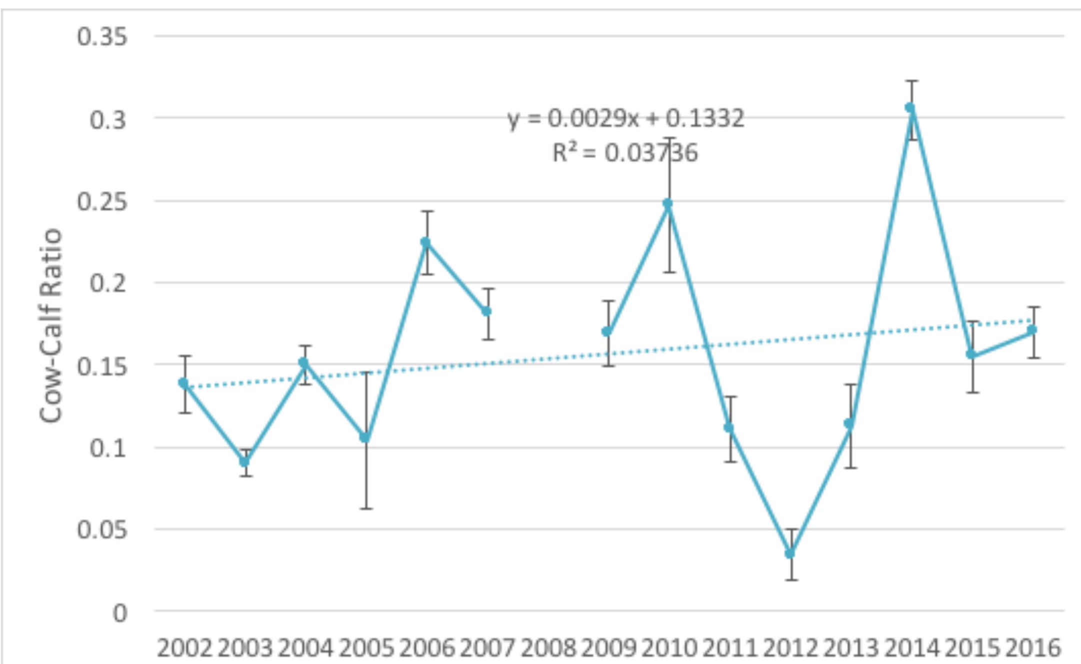

Fig. 6. Calf:cow ratio data in late winter (1 Feb. – 30 Apr.) from 2002 - 2016 for the Ya Ha Tinda elk herd, Alberta, Canada. Adult female total includes female yearlings.

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
2016	907	46	616	161	0.261	0.016
Average	1736.7	96.8	1293.93	298.133	0.23213	0.0124

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	--	--
2016	42	0.38	5	0.26	--	--

[a] as reported by Parks Canada in November 2013

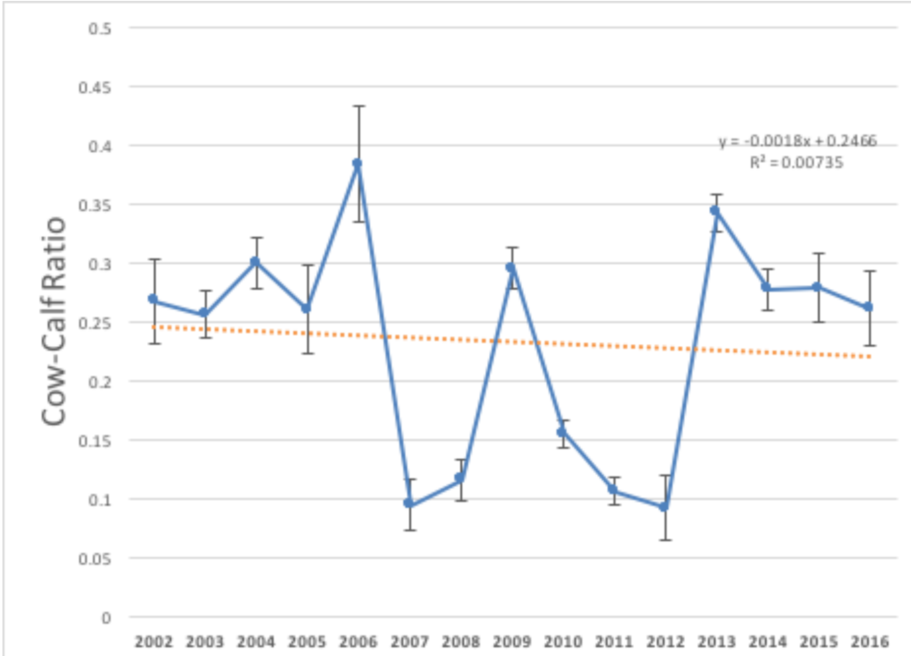

Fig. 7. Calf:cow ratio data in summer (1 June – 31 Aug.), Ya Ha Tinda elk herd, Alberta, Canada. Adult female total includes female yearlings.

Table 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
2017	17	18	0.944
Total	**418**	**484**	**0.861**

1.4.3 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). In February and March, 2017, 17 of 18 elk (94%) that were tested for PSPB were pregnant. Pregnancy rates appear to have increased over the past decade, perhaps consistent with reduced density and reduced competition for forage. Future analyses by the current PhD student, Hans Martin, will test for these changes.

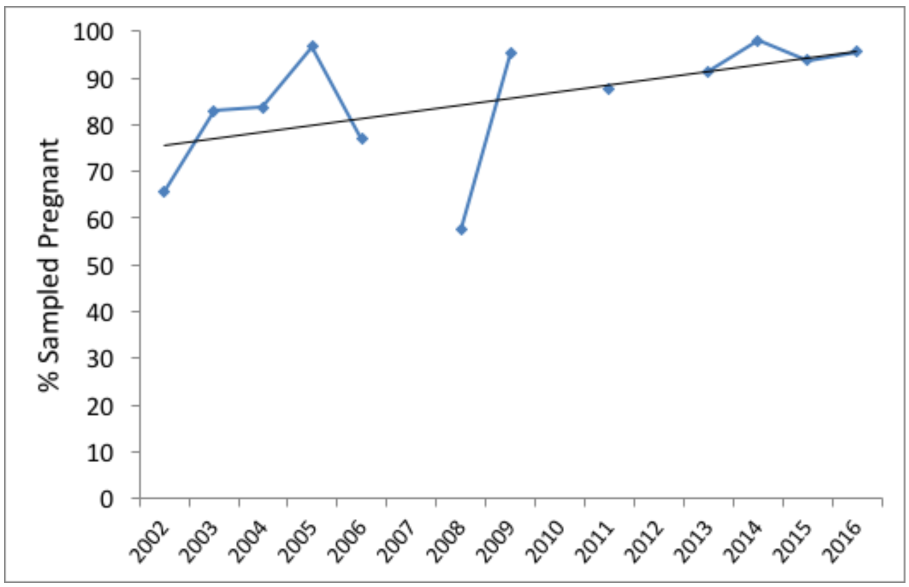

Fig. 8. Pregnancy rates in late winter across all years except 2007 and 2010 for the Ya Ha Tinda elk herd, Alberta, Canada.

2.0 CALF CAPTURES AND MONITORING

Jodi Berg, University of Alberta

2.1 Calving Areas

We determined the distribution of calving locations of adult female elk wintering on the Ya Ha Tinda ranch using vaginal implant transmitters (VITs) or location of neonatal calf capture locations between 2013 - 2017. Of these, 12% of cows gave birth in Banff National Park, 19% of cows gave birth to the north of the Ya Ha Tinda (YHT) ranch, mostly in the Bighorn Creek cut blocks and along Scalp Creek, 27% of cows gave birth to the east of YHT, 37% of cows gave birth in the vicinity of the ranch, and 4% gave birth to the south of the ranch (Fig. 13).

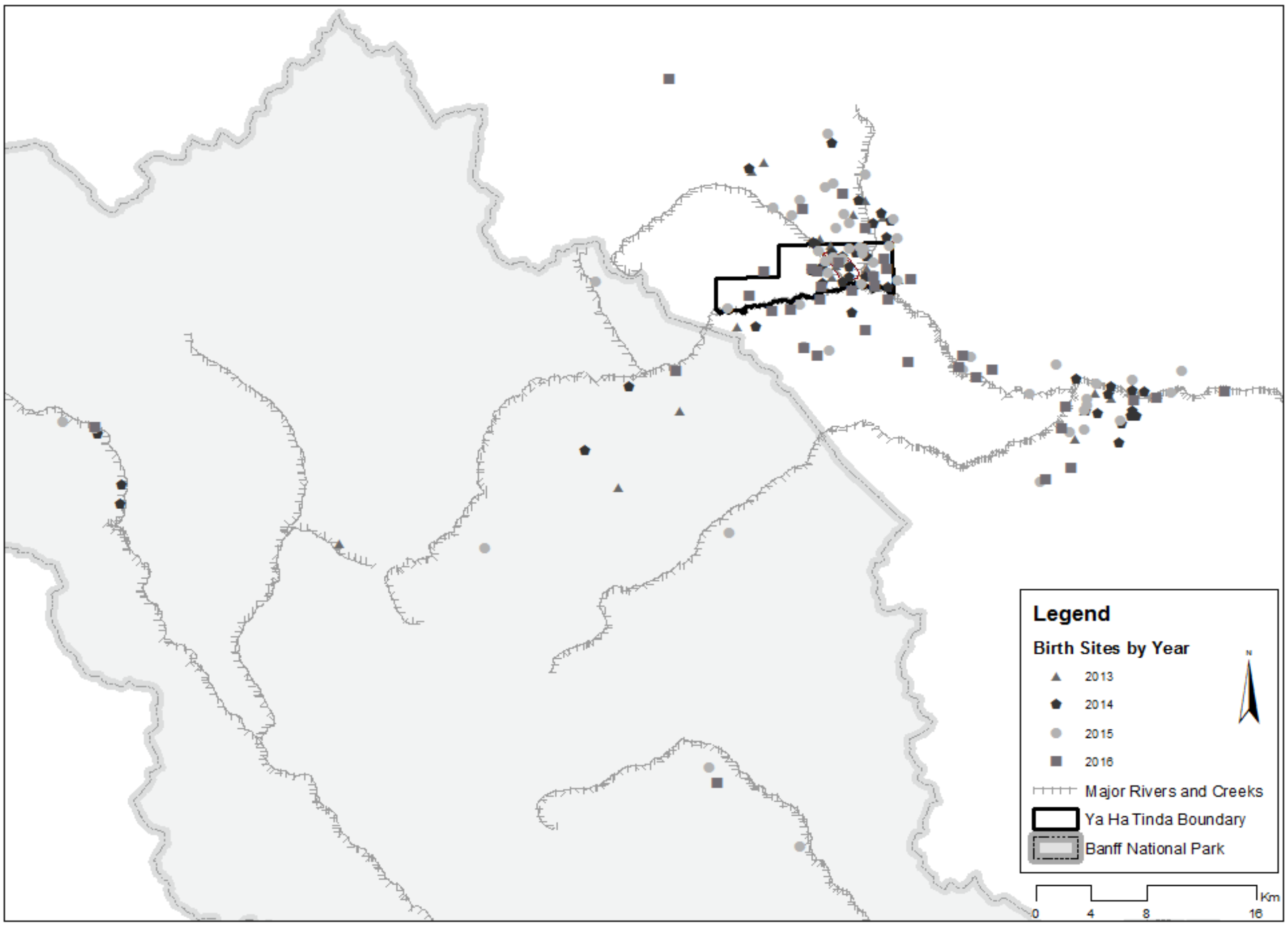

Fig. 13. Birth sites of elk calves located through use of vaginal implant transmitters (VITs) and/or neonatal elk calves in the Ya Ha Tinda elk herd, Alberta, Canada, 2013 – 2016. Based on known locations (n = 153), 12% of cows gave birth in Banff National Park, 19% of cows gave birth to the north of the Ya Ha Tinda (YHT) ranch, mostly in the Bighorn Creek cut blocks and along Scalp Creek, 27% of cows gave birth to the east of YHT, 37% of cows gave birth in the vicinity of the ranch, and 4% gave birth to the south of the ranch.

2.2 Calf Capture Effort 2016

In May and June, 2016, 29 elk calves (20 residents, 9 eastern migrants) calves were captured from the ground and subsequently ear-tagged. We were unable to capture 15 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, 2015-2016, in the Ya Ha Tinda elk herd, Alberta, Canada. *Photo credits: Celie Intering*

2.3 Timing of Calving

The median date of birth for calves born in 2013 – 2016 (n = 147) 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 – 2016 was 17.7 ± 2.1 kg (n = 76; Fig. 16).

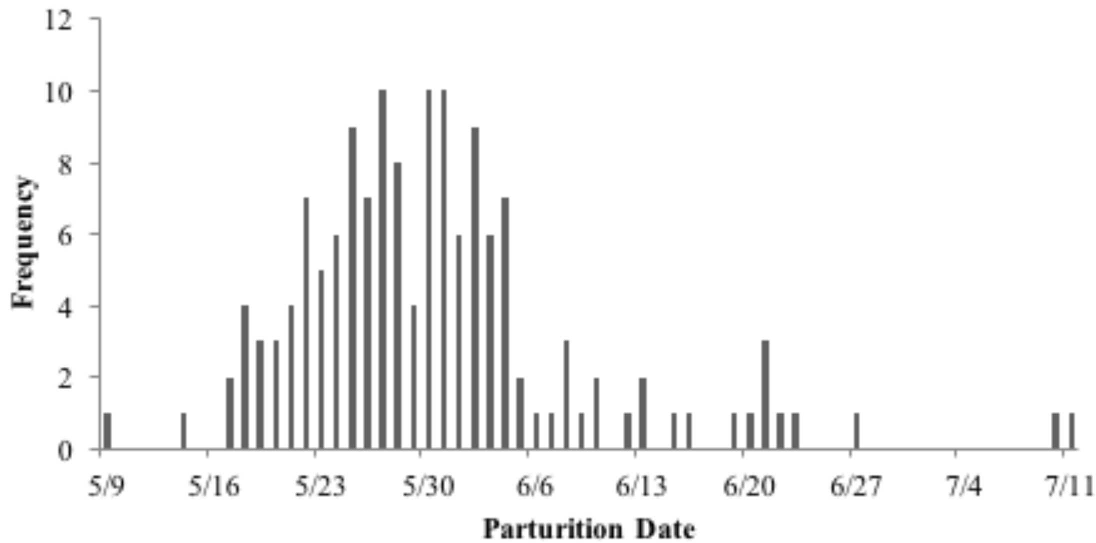

Fig. 15. Parturition dates (n = 147) determined through vaginal implant transmitters (VITs) or through age estimation of opportunistically caught calves in the Ya Ha Tinda elk herd, Alberta Canada, 2013-2016.

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). 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).

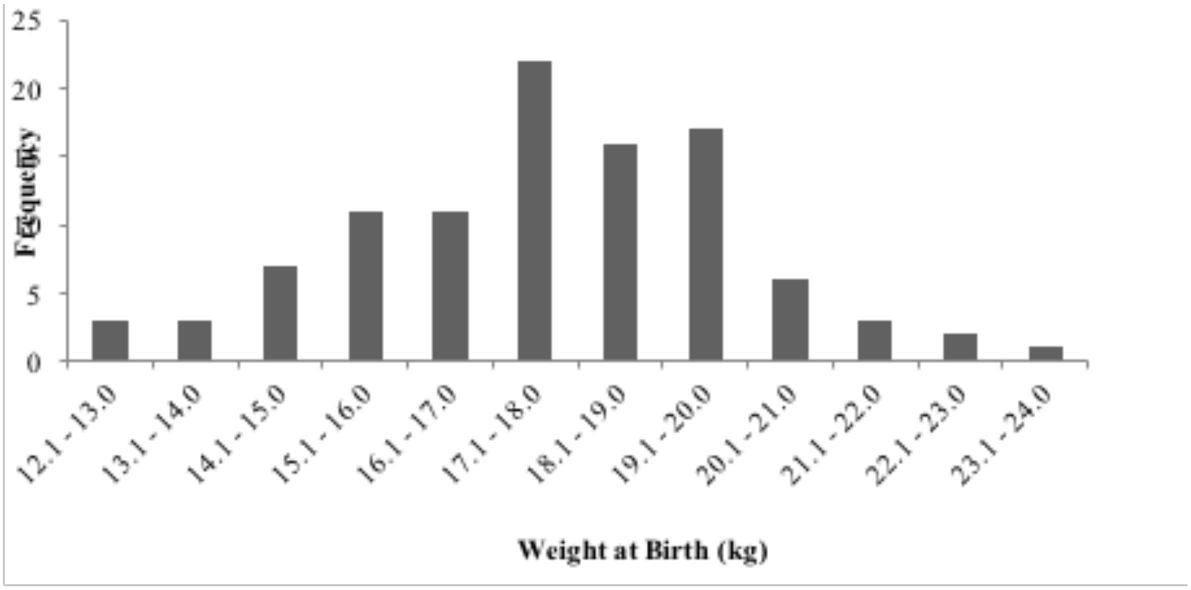

Fig. 16. Weights at birth (kg) for elk calves captured (n = 102) in the Ya Ha Tinda elk herd, Alberta, Canada, 2013 – 2016. We used the estimated daily growth rate of the calves to back-calculate weight at birth from weight at capture.

2.4 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). Of the 29 calves captured and tagged in 2016, 3 were still surviving as of 15 March 2017 (Fig. 20). One of these calves belonged to resident cows, while two 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***

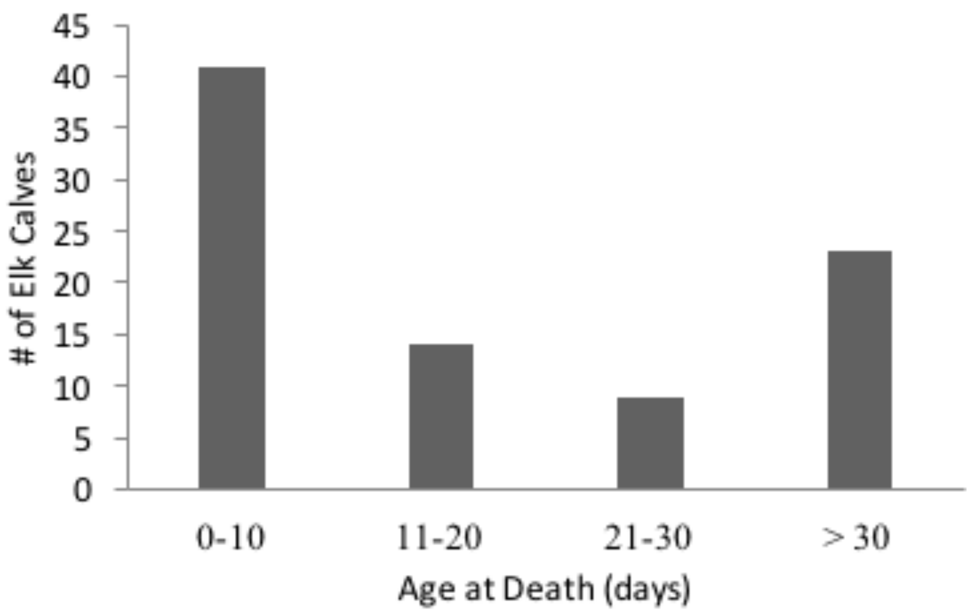

Fig. 18. Estimated age at death of elk calves (n = 105) in the Ya Ha Tinda elk herd, Alberta, Canada, 2013 - 2016.

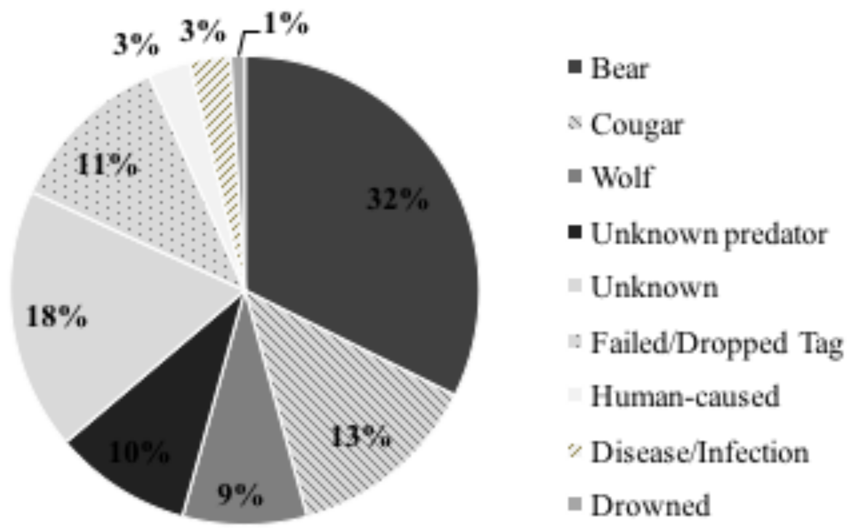

Fig. 19. Causes of death of elk calves (n = 105) in the Ya Ha Tinda elk herd, Alberta, Canada, 2013 - 2016. Note that chart ignores differences in timing of the different causes of mortality (i.e., predation by bears tends to occur earlier in the neonatal period compared to that of other predators).

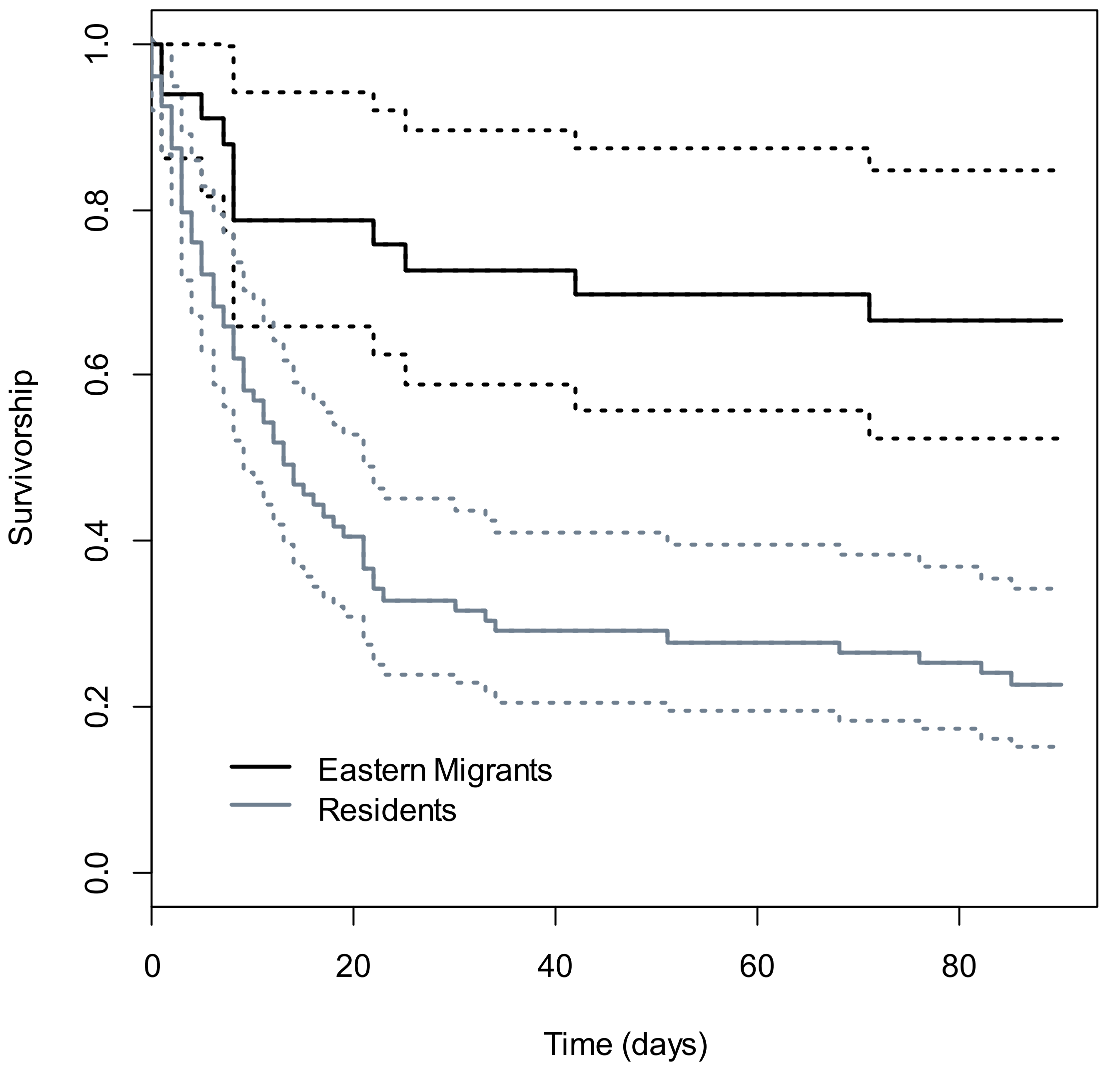

Fig. 20. Kaplan-Meier survival curves for elk calves (n = 112) born to resident (n = 79) or eastern migrant (n = 33) adult cows in the Ya Ha Tinda elk herd, Alberta, Canada, 2013 – 2016. Individuals who survived were right-censored at t = 90 days. The difference in survival was statistically significant ($\chi^2_1 = 16.7$, $p < 0.0001$).

3.0 PREDATOR SCAT SURVEYS AND ELK PREDATION RISK

Kara MacAulay, Eric Spilker, Jodi Berg – University of Alberta

As part of the long-term studies of the Ya Ha Tinda (YHT) elk herd, we have shown that elk respond to wolf predation risk and that may be contributing to overall population decline and shifts in migratory patterns. However, wolf populations have declined in the YHT area, and the YHT elk population is subject to predation by a community of predators. As a result, we expanded our studies to estimate predator distribution centered on the winter range areas by conducting dog-based, predator scat surveys. The goal of this component of the study was to derive species-specific predator risk maps as inputs into habitat selection and movement studies of elk, and in the process, assess potential spatial interactions among predators.

We used specially trained scat dogs in the summers of 2014-2016 to locate predator scats within a 5x5-km grid used for remote camera surveys in and adjacent to the YHT. The scat locations were used to derive scat-based resource selection functions (RSFs) for 4 major predator groups. We then compared the use of RSFs to 1) data from the remote cameras (see **Section 4.0**), and 2) the combination of the 2 datasets for predicting where elk predation events (kill sites) have occurred. Although predator locations can indicate the potential for predation risk, the occurrence of predators in the area may not be sufficient to predict actual predation risk.

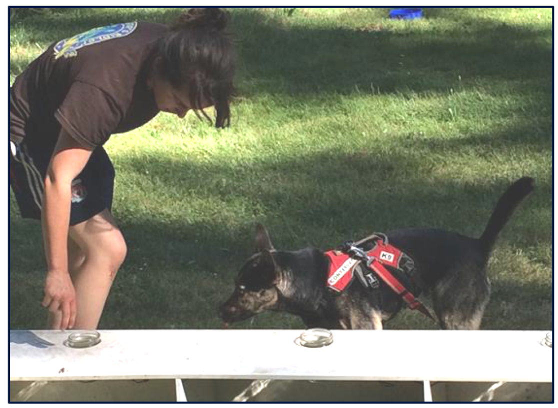

Fig. 21. Detection dog training at Conservation Canines, University of Washington. The dog must indicate which jar contains scat. *Photo credit: Eric Spilker*.

3.1 Scat Surveys

Four dog handlers and 4 dogs were used for scat surveys. The detection dogs were trained following similar procedures used to train drug and explosive detection dogs (Fig. 21). We used a 5 x 5-km grid-based sampling design and surveyed 48 cells from 2 July to 12 September 2014, 7 July to 15 September 2015 and 31-July to 30 August 2016 with different routes within each cell surveyed between years. In 2015 and 2016, we surveyed an additional nine 5 x 5-km cells that covered the northern portion of the proposed area for bison reintroduction in BNP (Fig. 22). Dog handlers and their dogs walked transects that covered different habitat types in individual cells as determined by examining satellite imagery. Survey transects were divided equally among human use trails, animal trails and off trail to avoid sampling biases based on predator travel behaviour. We also collected scats opportunistically (i.e. without dogs) from 2014-2016. Scats collected in 2013 were used only as out-of-sample samples and will be used to assess the RSF models to predict occurrence.

When a scat was detected, a GPS location was recorded and scats were 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 (adapted from Wasser et al. 2004).

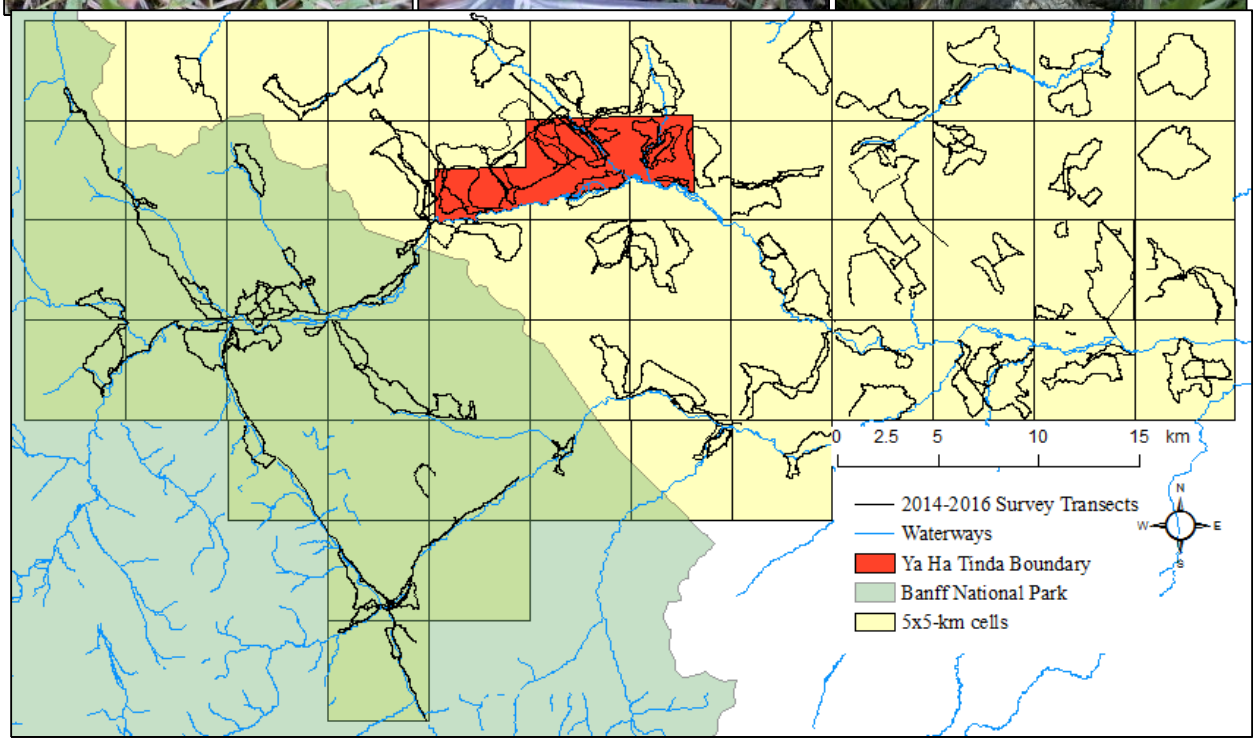

Fig. 22. Map of transects sampled with scat detection dogs from 2014-2016 across 57 5x5-km cells encompassing the summer distribution of the Ya Ha Tinda elk.

Dog handlers recorded the suspected species of the scat based on the physical appearance using scat diameter measurement ranges and physical descriptions. We swabbed a subset of the scats for DNA using non-finished to verify species error rates with non-finished toothpicks. 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). During the summers of 2014-2016, we surveyed 1,292-km (18.5 ± 9.0 mean ± SD, range 2.1 – 26.2 km/cell across all years) and recorded data on 1107 scats.

3.2 Scat Analysis

To identify the predator species, we analyzed all scats collected <100-m apart (n=647) through fecal hair DNA analysis to identify the predator species. Hairs (n~40) were soaked for 24 hours in a 3µl:100mL Sunlight dish detergent solution and rinsed with hot water. DNA will be extracted using Qiagen DNeasy Tissue Kit, and species presence will be confirmed via a partial sequence analysis of a hypervariable region of the mitochondrial 16S rRNA gene (WGI, pers. comm). This method is time-effective, but only reports the primary species present. We expect DNA results from WGI in January 2018.

To identify the diet content of the scat (i.e., prey species ID), we selected a subset of scats (n=300) for macroscopic analysis. We selected ~50 scats from each predator species (the method is very time consuming), with equal sampling from each spatial segment of the summer Ya Ha Tinda elk herd (defined in Section 1.5). Scats were autoclaved at 120°C for 60 minutes to kill endoparasites, then washed with warm water to remove dirt and debris. We randomly selected 20 hairs and identified each to species and age-class using reference keys that differentiate various microscopic characters for species (Fig. 23). Identification accuracy is verified by “blind trials” to ensure adequate skill in sample identification. We present preliminary findings based on results from wolf (n=40) and cougar (n=16), bear (n=102) and coyote (n=16) scats macroscopically analyzed.

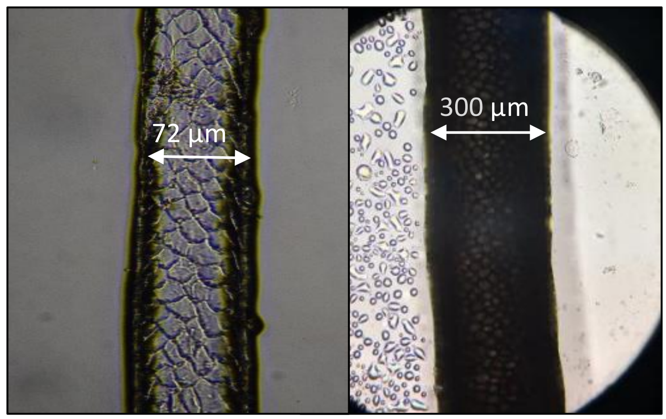

Fig. 23. Microscopic characteristics (left to right: cuticle scale pattern, medulla) used to differentiate between prey hairs. *Photo credit: Kara MacAulay*

Preliminary analyses show that ungulates comprise the highest proportion of cougar (0.70), wolf (0.67), coyote (0.60) scats, while vegetation dominates bear scats (0.96; Fig 8). Within ungulates, juveniles are proportionally more frequent in bear (0.98), wolf (0.83), and coyote (0.70) scats than adults. Cougar scats had roughly equal proportions of adult and juvenile ungulate prey items.

3.3. Spatial Predation Risk Models

3.3.1 Resource selection functions.

In all species, the chosen top selection models were better supported than both their respective null models and the full candidate model. Bears selected against conifer forest areas, for areas with cutblocks and of high NDVI, steeper slopes, areas further from vehicle-permitted trails and roads, and for use of vehicle-restricted trails, particularly with increased distance from vehicle-permitted trails (Table 9). Wolves selected to be near waterways, in areas with less slope, further from vehicle-permitted trails and on vehicle-restricted trails. Coyotes selected for areas with increase proportion of shrub cover, decreased slope, areas further from vehicle-permitted trails, and use of vehicle-restricted trails. Finally, cougars selected for areas with less conifer forest cover and higher edge density. Maps of predicted selection values standardized within species (Fig. 24).

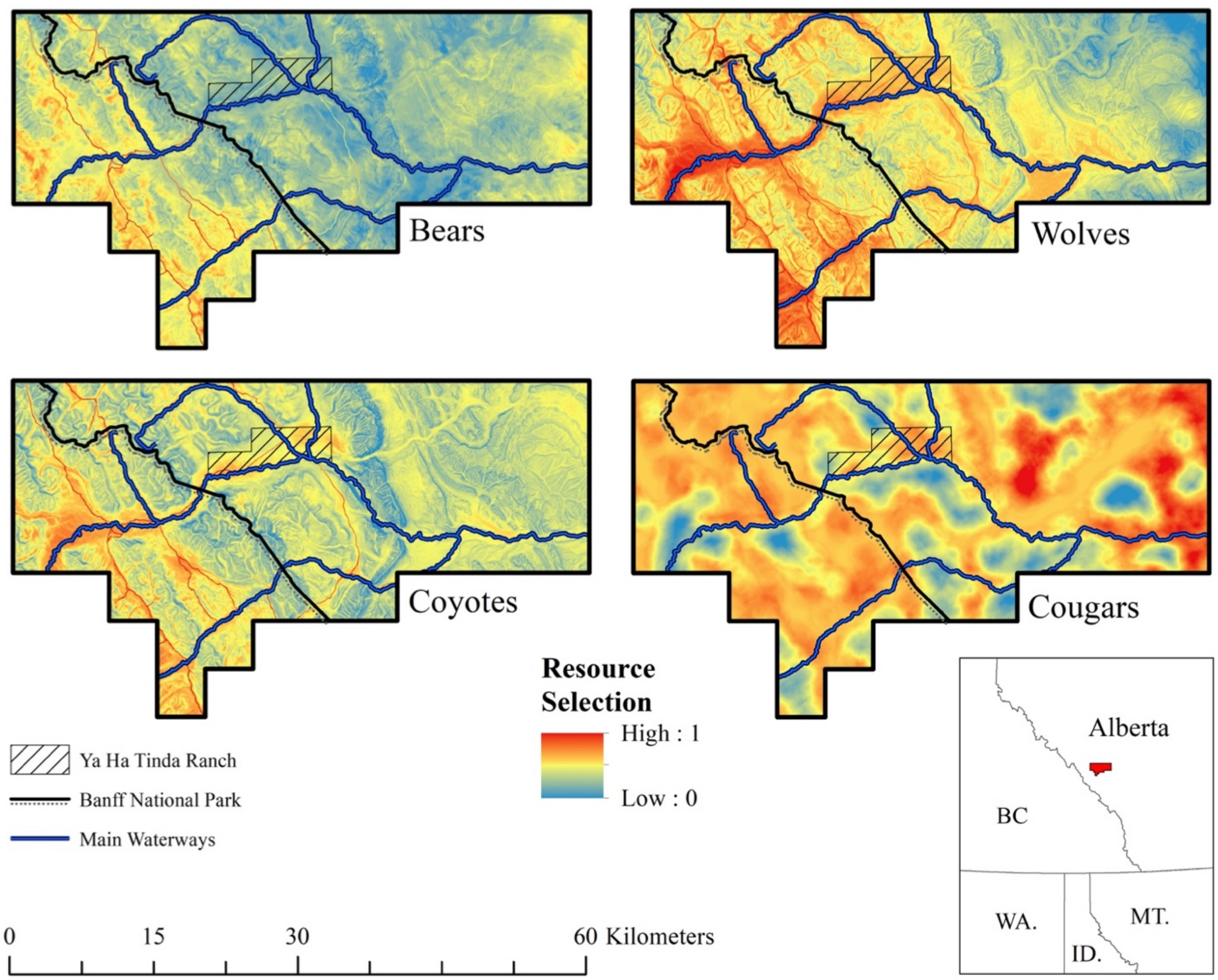

Fig. 24. Prediction of the scat-based RSF values for bears, wolves, coyotes and cougars near and adjacent to the Ya Ha Tinda, east slopes of the Rocky Mountains, Alberta.

Table 9. Resource Selection Function beta coefficients (β), upper and lower 95% confidence interval (CI), based on AIC_c for the top RSF models for 4 carnivores, east slopes of the Rocky Mountains, Alberta, Canada.

Species	Variable	β	95% CI Lower	Upper
Bears	Conifer forests	-0.71	-0.19	-1.23
	Cutblocks	0.84	0.23	1.45
	NDVI	0.0002	0.00007	0.00033
	Slope	0.02	0.2	0.4
	VR trail use[a]	0.86	0.41	1.31
	Distance to VP trail/road[b]	0.00005	0.00003	0.00007
	VR trail use*Distance to VP trail/road	0.00005	0.00001	0.00009
Wolf	Distance to water	-0.0001	-0.00005	-0.00015
	Cutblocks	-2.47	-0.46	-4.48
	Slope	-0.04	-0.02	-0.06
	VR trail use[a]	1.29	0.99	1.59
	Distance to VP trail/road	0.00005	0.00004	0.00006
Coyote	Shrub	2.63	0.21	5.05
	Slope	-0.05	-0.02	-0.08
	VR trail use[a]	1.62	1.27	1.97
	Distance to VP trail/road	0.00006	0.00004	0.00008
Cougar	Conifer	-1.92	-0.46	-3.38
	Edge	8.39	1.12	-15.66

[a] Vehicle-restricted trails, a categorical variable where on-trail=1, off-trail=0.
[b] Vehicle-permitted trails and roads.

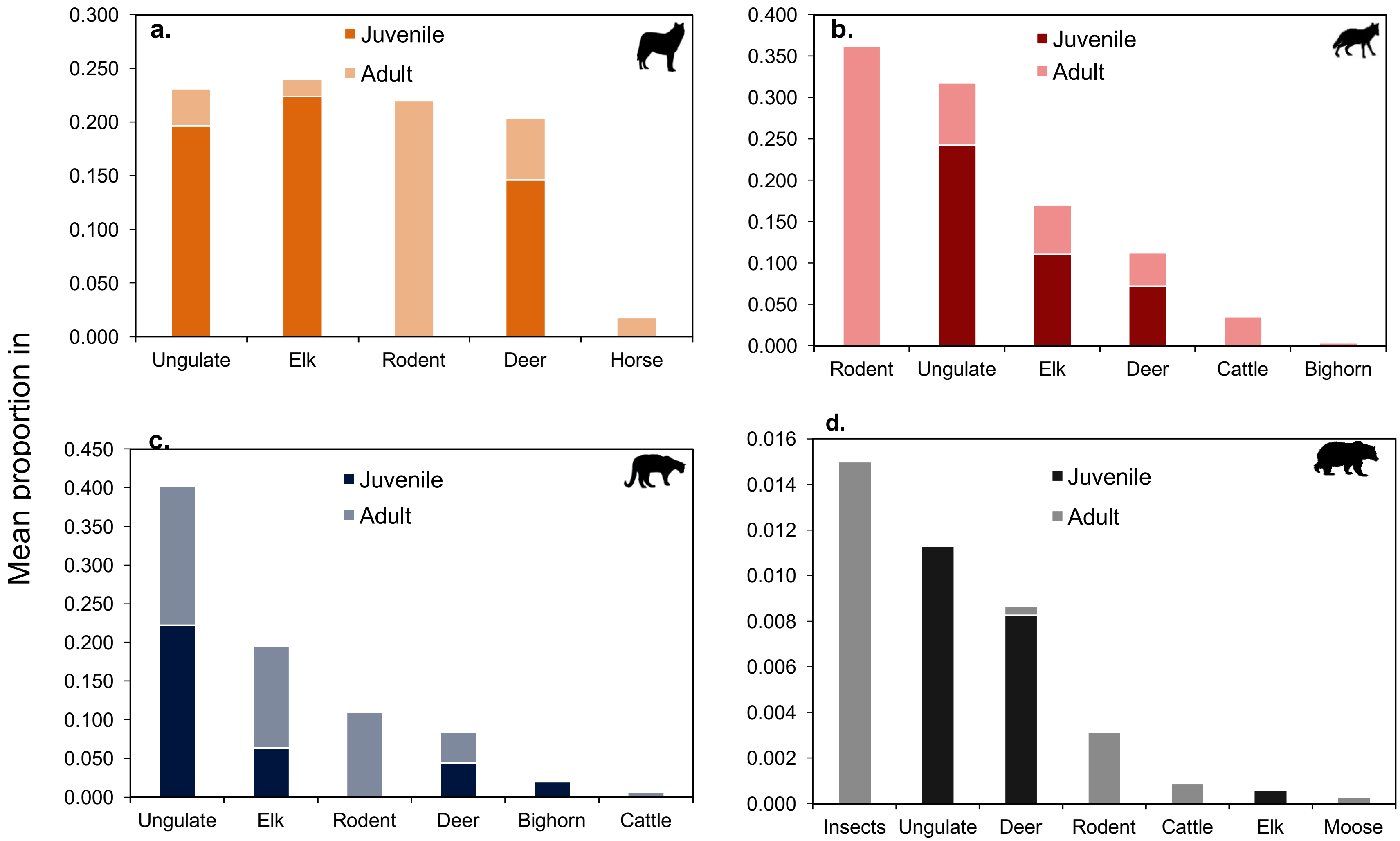

Fig 25. Mean proportion of prey items (excluding vegetation) in scats from four predator species from the Ya Ha Tinda region of central Alberta: (a) wolf (n=40), (b) coyote (n=16); (c) cougar (n=16) and (d) bear (n=102). Grizzly bear and black bear scats were combined due to a small sample size. "Ungulate" refers to hairs that could not be analyzed further to species due to poor hair quality.

4.0 MONITORING DISTRIBUTION OF PREDATOR AND PREY USING CAMERA TRAPS

Mitch Flowers, Eric Spilker – University of Alberta
Hans Martin, Mateen Hessami, Robin Steenweg – University of Montana

Since the Ya Ha Tinda Elk and Predator Project has assisted in the development and maintenance of the Banff, Kootenay, and Yoho National Parks Remote Camera Wildlife Monitoring Projects resulting in numerous publications and advancements in camera trapping methodology (Steenweg et al. 2016). The Ya Ha Tinda Elk and Predator Project maintains ~30 long-term remote camera traps (Fig. 26) on the Ya Ha Tinda Ranch and adjacent provincial lands. This sampling design is consistent with and extends the Parks Canada camera trapping grid with at least 1 camera within each 10x10km grid cell. Cameras were deployed in 2013/14, and again continuously in summer of 2016 to the present.

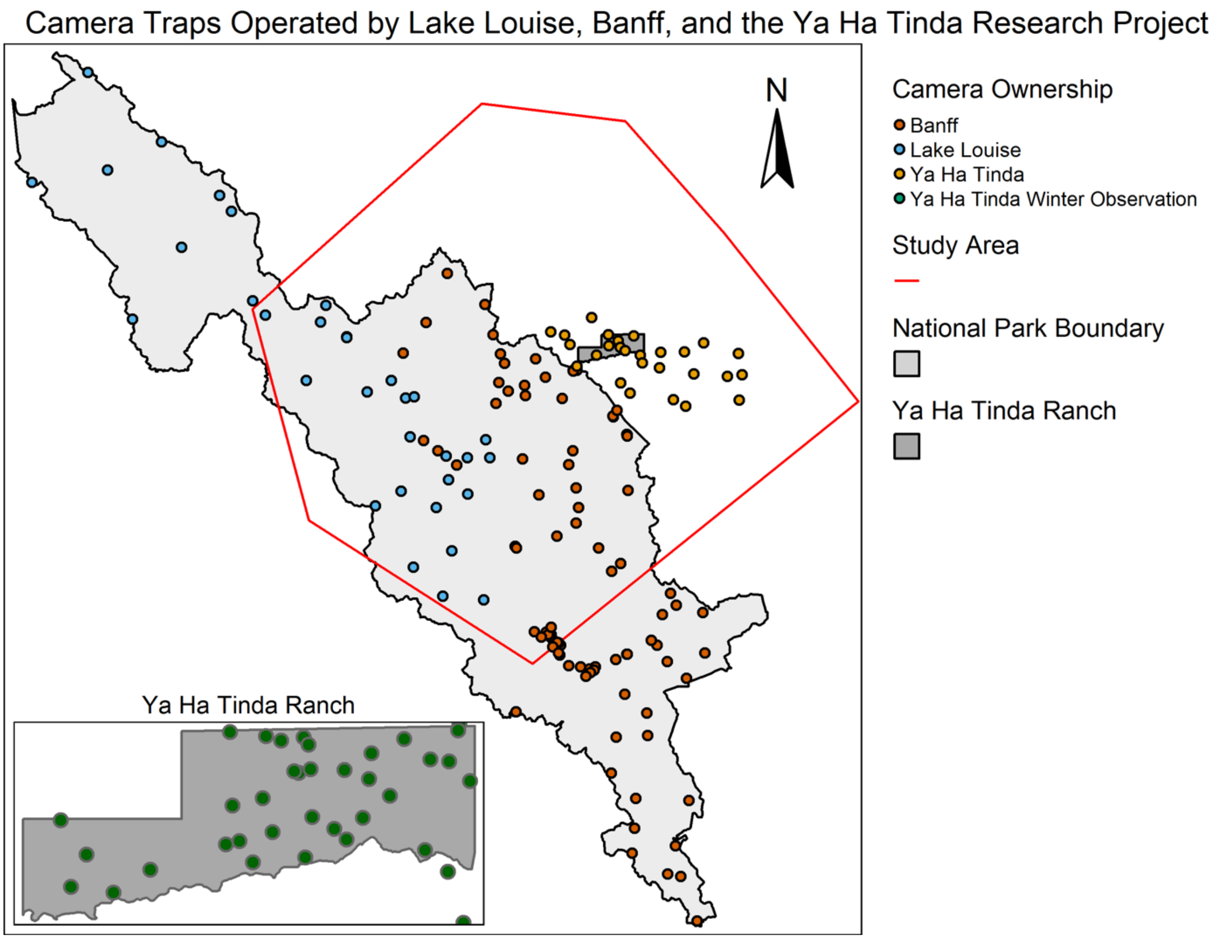

Fig. 26. The collaborative camera trap effort between the Ya Ha Tinda Elk and Predator Research project and Parks Canada.

In addition, for a short time period of 2 years, Mitchell Flowers (MS student at University of Alberta) has deployed an additional ~ 30 camera in a more intense camera trapping grid (2.5 km^2, Fig .27). The goals of this MS project are to test finer-scale behavioral interactions between wolves and elk just on the YHT winter range during both winter and summer.

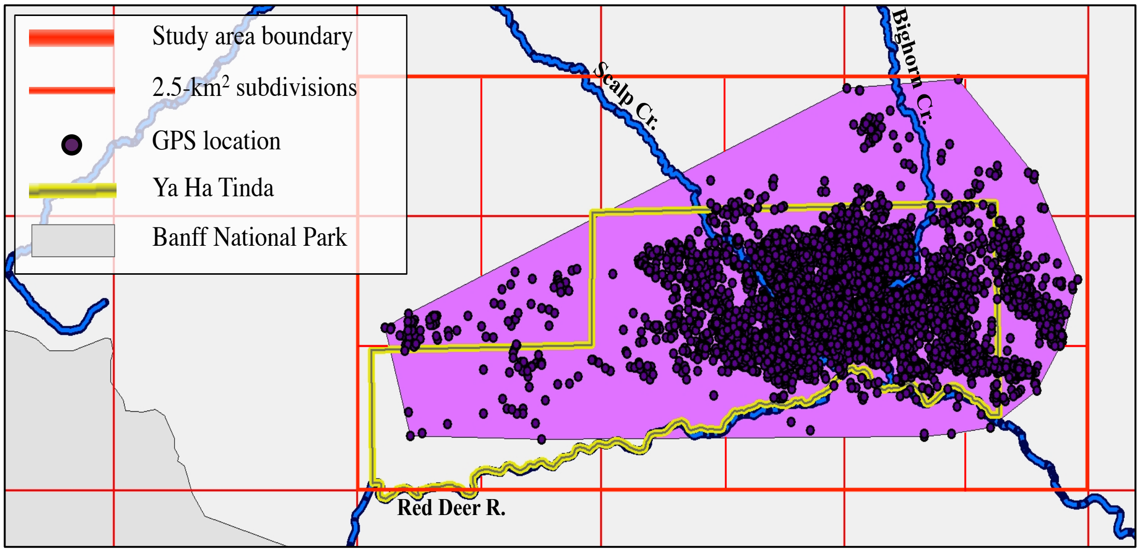

Fig. 27. Study area and sampling grid for remote-camera distribution across a 2.5-km^2 grid at the Ya Ha Tinda, along the eastern slopes of the Rocky Mountains, Alberta. The elk winter range was defined using the GPS locations of adult female elk on the winter range.

4.1 Image Classification

Camera data has been analyzed using the same Timelapse software (Greenberg and Goudin 2012) used by Parks Canada, enabling easy integration of our data into the Parks Canada databases. Events were defined as any consecutive sequence of images of the same species. For wolves and cougars, sequences separated by at least 5 minutes will be considered independent, regardless of whether the same individuals are being photographed. This definition was chosen specifically for the analysis of predator imagery because heightened use (*i.e.* high number of events) of an area can result from intense use by a single individual or moderate use by several. Image sequences of all other species will be assigned a threshold of 10 minutes, in accordance with current classification protocols for Parks Canada (Hunt and Bourdin, 2016). Elk events separated by more than 10 minutes are not be considered a new event if there are other individuals present beyond the camera's field of detection throughout consecutive sequences.

4.2 Preliminary Results –Extensive 10x10km^2 Sampling Grid

Wildlife observation data from the initial 2014-2015 deployment of remote cameras in the extensive, 10km^2 grid have been conducted by graduate students at the University of Montana (Robin Steenweg) and University of Alberta (Kara MacAulay, Eric Spilker). Data collection during this initial period was summarized by Steenweg (2016), and independently reported to Parks Canada in the final report for multispecies monitoring in the Canadian Mountain National Parks.

Since being re-deployed in June 2016, we have been collecting 10,000s of thousands of new images and classifying these data using the TIMELAPSE database system. For example, from June 2016 to March 2017, 2,485 events were captured by remote cameras on the Ya Ha Tinda of which 1,603 events were of wild animals. A total of 2,609 individual wild animals were photographed using the camera traps. We will continue to work with Banff National Park Ecologist Jesse Whittington to analyze the data from both our extensive and intensive camera trap surveys.

4.2.1 Intensity of use

During 2014-2015, across the 10km^2 grid study area, wolf events/active camera days averaged almost 4x as many as bears, 5x as coyotes and 10x as cougars across the 2 year (Table 10, Fig.26). Bears and wolves were detected at least once at about twice as many cameras as coyotes and cougars, and cameras with at least one event of coyotes and cougar were more clumped (Table 10). Terrain-based least cost polygons sizes around cameras (n=54) averaged 26.4+12.73 km^2 (Fig. 26).

Table 10. Mean, standard error (SE), maximum (Max) intensity of use (IU), number and percent of cameras within at least one event, contagion of index reflecting aggregation of cameras sites with at least one event by predator groups, east slopes of Rocky Mountains, Alberta, Canada, IU is based events on remote camera (n=54) from 1 May – 30 June combining data across 2014 and 2015. Different superscripts indicate significant differences between species.

	Mean IU			Cameras with ≥1 event		
	$\bar{x}$	SE	Max	No.	(%)	Contagion index
Bear	0.033[b]	0.04	0.19	48	89	73.12
Wolf	0.112[a]	0.23	1.52	46	85	71.68
Coyote	0.020[c]	0.04	0.25	28	52	48.94
Cougar	0.009[c]	0.02	0.12	22	41	49.74

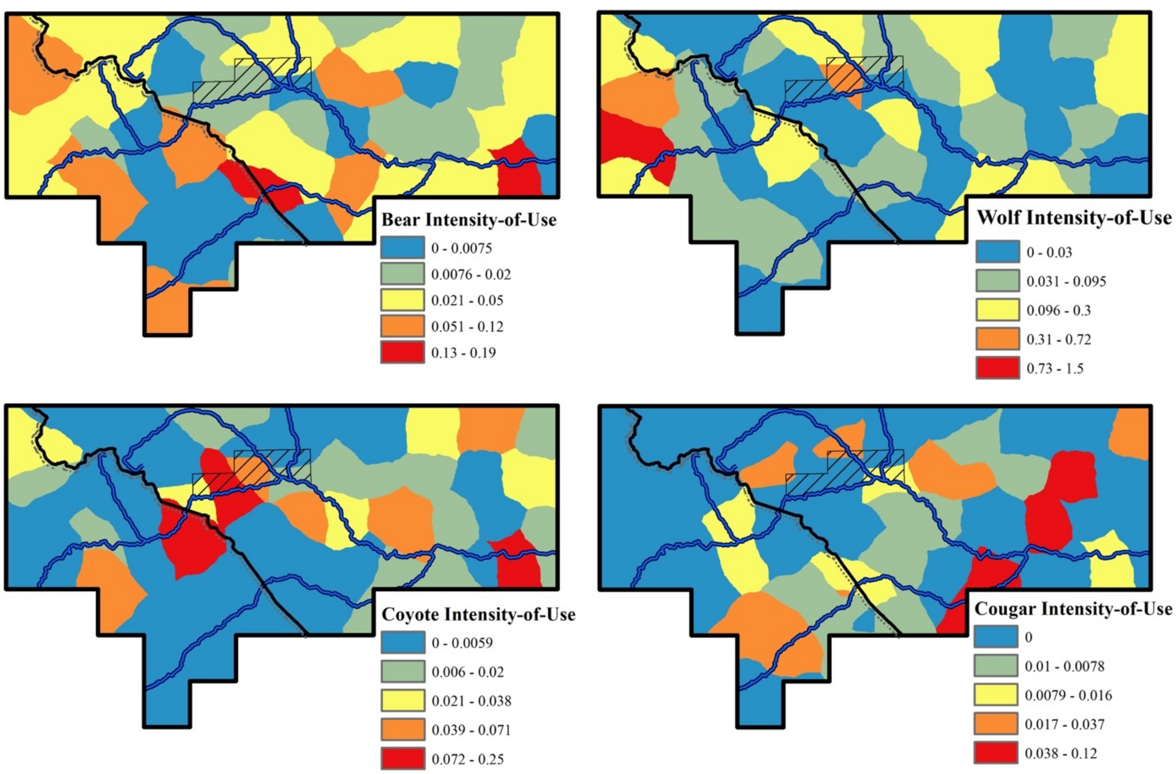

Fig. 28. Intensity of use (IU) derived from camera events (detections /active camera days) of 4 species of carnivores with terrain-based least cost polygons, east slopes of the Rocky Mountains, Alberta.

4.3 Preliminary Results – Intensive 5x5km^2 Grid

During 9 Feb to 20 May 2016 we had 37 functioning in the intensive 5km^2 grid, elk were the most frequently detected species across all cameras, with 209 events occurring at 28 locations (Table 10). Wolves were detected less often than elk, but at 4 times as many cameras as cougars, with 53 events across 18 locations. Coyotes were also detected at several cameras (n=12), Grizzly (n=3) and black bear (n=1) events were rare and only occurred between 22 April and 24 May. Wolf events appeared to occur in clusters at 1 to 3-week periods, whereas there was a steady increase in elk detections that may reflect consistent elk use at the camera sites (Figure 28).

Overall, wolf and coyote activity was highest among areas west of Scalp Creek, whereas elk were most often detected in the central grasslands east of Scalp Creek (Fig. 28 - 30). Reduced use of areas northeast of the ranch by wolves at night (Fig. 29, 30) resembled previous patterns of wolf-use derived from telemetry data. All cougar events occurred north of the ranch property in more rugged areas. Horse riders (87%) were the dominant source of human activity at camera sites and occurred on a regular basis throughout the winter.

Table 12. Number of cameras that captured each focal species and total number of events across all cameras. Event counts for each species are averaged across all cameras in the study area and only those cameras that captured each species at least once during the winter of 2016 (mean [no./day] ± standard deviation [SD]).

			Across all cameras		***Across cameras w/ ≥ 1 event***	
Species	***No. cameras w/ events***	***Total events***	***Mean***	***SD***	***Mean***	***SD***
Elk	28	209	5.81	6.7	7.46	6.7
Wolf	18	53	1.39	2.1	2.83	2.2
Coyote	12	42	1.17	2.4	3.5	2.3
Cougar	4	10	0.26	1.2	2.5	3.0
Grizzly bear	2	3	--	--	--	--
Black bear	1	1	--	--	--	--
Humans	14	65	1.81	4.1	4.64	5.6

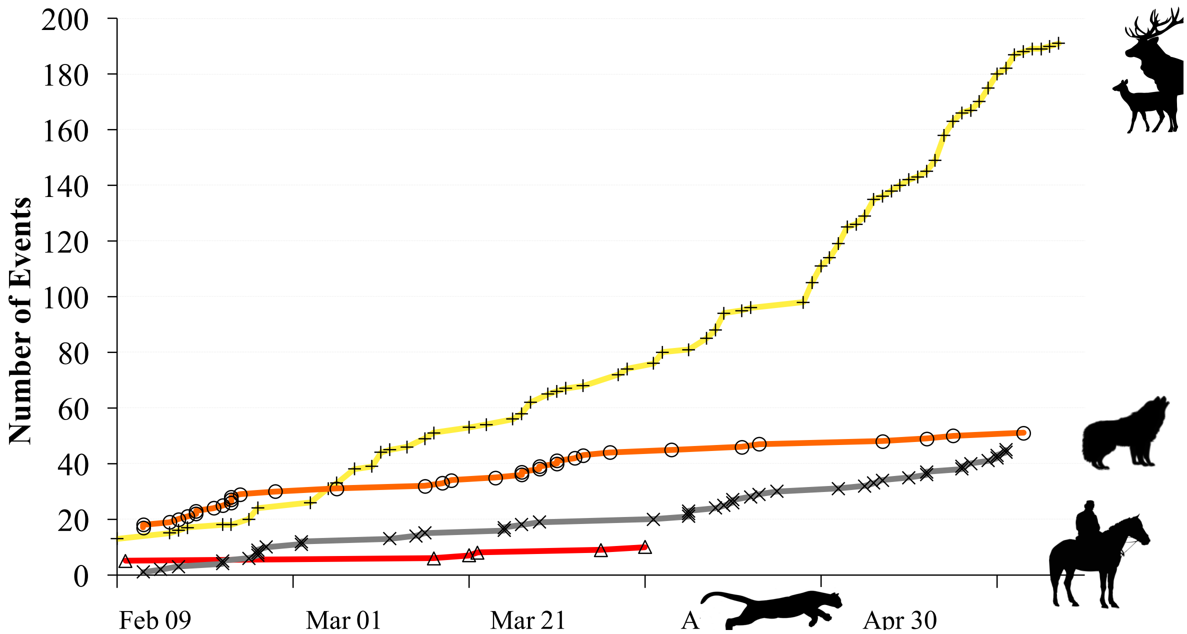

Fig. 29. Cumulative number of independent events for each focal species showing temporal patterns of use at the Ya Ha Tinda. Counts are based on photographs obtained during winter from all cameras (n=37) that were functioning from 9 Feb to 25 May of 2017.

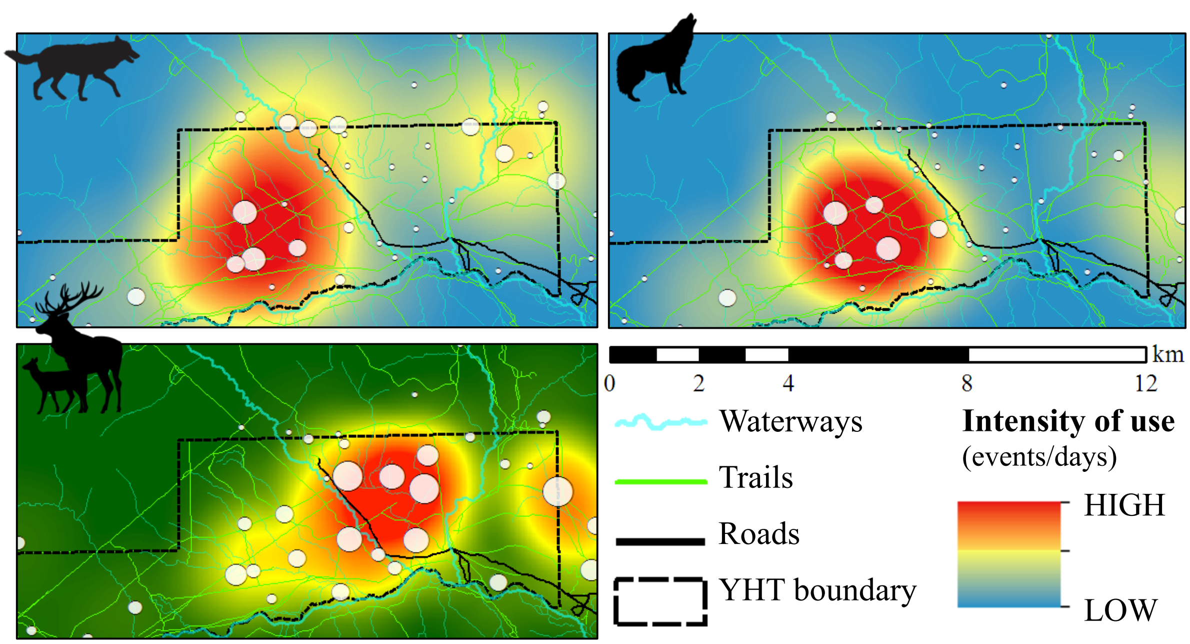

Fig. 30. Spatial distribution of wolf and elk (bottom left) activity from January to May 2017, as shown by intensity-of-use (events/active sampling days). Wolf events are separated by day (top left) and night (top right). Smoothed kernels for intensity-of-use were derived using the Kernel Density tool in ArcMap v.10.3 with a search radius of 3 km.

5.0 ARE THERE COSTS OF SHIFTING MIGRATION LINKED TO PARASITISM?

Jacalyn Normandeau (University of Alberta)
Dr. Susan Kutz (Collaborator, University of Calgary)

Many studies of ungulate populations focus on forage-predation interactions, but parasites can be as important in affecting mortality (Pybus et al. 2016, Mysterud et al. 2016, Pruvot et al. 2016). Parasites affect host body condition reproduction and longevity in ungulates, but the interaction between migration and parasite levels is not well understood. Here, we test whether there are differences between migrant and resident elk at the YHT. In summer 2017, we conducted a pilot study that compared parasite loads and diversity among herd-segments. We predicted that (1) elk migrating into BNP would have *lower* parasite levels than resident elk because they have high quality forage and are not concentrated in summer, whereas (2) elk that migrated east of YHT would have *higher* parasite loads than both Banff migrants and residents because they are concentrated in human-mediated refuges and may have lower food quality making them more susceptible to parasite infections. We also collected samples from other ungulates in the study to compare parasite loads of elk, cattle, deer, bighorn sheep, and feral horses on allopatric ranges to determine similarity in parasites to assess inter-species transmission potential.

During summer 2017, we radiotracked collared elk in each of the 3 herd segments at 6-week intervals (n=3 times) from May-September with the goal of collecting ~30 fresh samples/segment/interval (Fig. 31). We collected fresh samples after observed elk groups had moved away or from game trails following telemetry of collared elk. Giant liver fluke (*Fascioloides magna*) eggs were isolated from pellets using the FlukeFinder sedimentation method (2g of pellets) and examined under a dissecting scope. All other parasites were isolated using the Wisconsin Double-Centrifugation technique (4g of pellets) to float eggs onto slide covers that were examined under a microscope following Edwards and Kutz (2013).

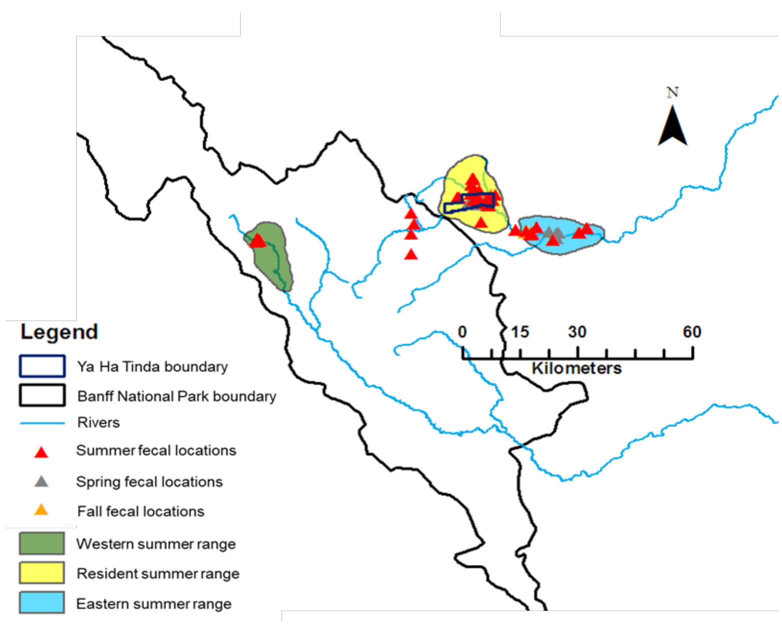

Fig. 31. Location of the study site including the Ya Ha Tinda Ranch, Banff National Park, and allopatric elk summer ranges with locations of samples collected shown as triangles.

Elk fecal parasite levels during collection on the allopatric summer ranges in 2017 included *Protostrongylid sp., Eimeria sp., Trichuris sp., Dictyocaulus sp., Strongyle spp., Strongyloides sp.,* and *F. magna*.

Bighorn sheep had the highest prevalence of parasite infection and cattle and horses did have *Stronglye* parasites but very low prevalence of these parasites in elk of all migrant segments indicates low potential for inter-species transmission. Elk did have a higher prevalence of *F. magna* and both prevalence and intensity were separated by migrant group and sampling period (Fig. 31). Average intensity of *F. magna* infection was 0.78 eggs/g for western migrants, 2.12 eggs/g for residents, and 5.29 eggs/g for eastern migrants. There were significant differences between fluke prevalence in migrant segments during the summer ($\chi^2 = 27.3$, df = 2, p-value < 0.0001) and overall ($\chi^2 = 29.1$, df = 2, p-value < 0.0001) but not in the spring ($\chi^2 = 1.77$, df = 2, p-value = 0.41) and fall ($\chi^2 = 2.74$, df = 2, p-value = 0.25). *F. magna* infection was significantly higher in the eastern migrants than both residents and western migrants but not between residents and western migrants.

The next component of this study will focus on *F. magna*, known to cause mortality in BNP elk (Pybus et al. 2015), by collecting fecal pellets from known, radiocollared individuals to relate infection intensity to hypothesized factors thought to influence *F. magna* loads. Sampling during summer 2018 will expand sampling of ungulate species to include newly released Plains Bison in Banff National Park.

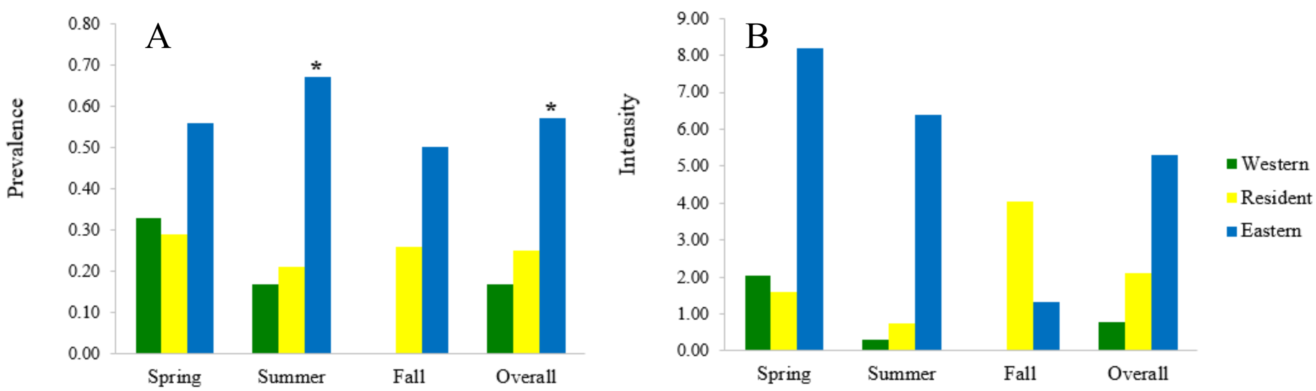

Figure 31. (A) Fluke prevalence (infected animals/all animals) and (B) fluke intensity (number of eggs/g of feces) detected in each elk migrant segment separated by sampling period. Eastern migrants showed significantly higher parasite prevalence (denoted using [*]) than western migrants and residents (Chi-squared test, df=2, p-value < 0.0001).

6.0 SCIENTIFIC COMMUNICATION AND OUTREACH

Scientific Publications & Reports (Last 5 years)

Popular articles:

1. Berg, J., E. Merrill, M. Hebblewhite, and M. Boyce. 2014. Ya Ha Tinda elk herd: Persistence or Doom? Alberta Outdoorsman. Fall 2013: 6-9.
2. MacAulay, K. J Normandeau, and M Boyce. 2017. The Hairy Truth: Investigating predator-prey interactions. Alberta Outdoorsman, Fall 2016: 16-18.

Peer-reviewed articles:

1. Spitz, D.B., Hebblewhite, M. & Stephenson, T.R. 2017. 'MigrateR': extending model-driven methods for classifying and quantifying animal movement behavior. *Ecography,* 40, 788-799.
2. Ahrestani, F. S., M. Hebblewhite, B. Smith, S. W. Running, and E. Post. 2016. Dynamic complexity and stability of herbivore populations at the species distribution scale. Ecology.
3. Eggeman, S. L., M. Hebblewhite, H. Bohm, J. Whittington, and E. H. Merrill. 2016. Behavioural flexibility in migratory behaviour in a long-lived large herbivore. *Journal of Animal Ecology* 85:785-797.
4. Pruvot, M., M. Lejeune, S. Kutz, W. Hutchins, M. Musiani, A. Massolo, K. Orsel. 2016. Better alone or in ill company? The effect of migration and inter-species comingling on *Fascioloides magna* infection in elk. 2016. PLoS ONE 11(7): e0159319.
5. Steenweg, R., M. Hebblewhite, D. Gummer, B. Low, and B. Hunt. 2016. Assessing Potential Habitat and Carrying Capacity for Reintroduction of Plains Bison (*Bison bison bison*) in Banff National Park. PLoS One 11:e0150065.
6. Whittington, J., K. Heuer, B. Hunt, M. Hebblewhite, and P. M. Lukacs. 2014. Estimating occupancy using spatially and temporally replicated snow surveys. Animal Conservation 18:95-101.
7. Hebblewhite, M. 2013. Consequences of ratio-dependent wolf predation on elk population dynamics. Population Ecology 55:511 - 522.
8. Brodie, J., H. Johnson, M. Mitchell, P. Zager, K. Proffitt, M. Hebblewhite, M. Kauffman, B. Johnson, J. Bissonette, C. Bishop, J. Gude, J. Herbert, K. Hersey, M. Hurley, P. M. Lukacs, S. McCorquodale, E. McIntire, J. Nowak, H. Sawyer, D. Smith, and P. J. White. 2013. Relative influence of human harvest, carnivores, and weather on adult female elk survival across western North America. Journal of Applied Ecology 50:295-305.
9. Ahrestani, F. S., M. Hebblewhite, and E. S. Post. 2013. The importance of observation versus process error in analyses of global ungulate populations. Scientific Reports 3:03125.
10. Robinson, B. G and E. H.Merrill. 2013. Foraging-vigilance trade-offs in a partially migratory population: comparing migrants and residents on a sympatric range. *Animal Behaviour* 85:849- 856.

11. Hebblewhite, M and E.H. Merrill. 2012. Demographic balancing of migrant and resident elk in a partially migratory population through forage–predation tradeoffs. *Oikos* 120:1860-1870.
12. Nelson, B., M. Hebblewhite, V. Ezenwa, T. Shury, E.H. Merrill, P.C. Paquet, F. Schmiegelow, D. Seip, G. Skinner, N. Webb. 2012. Prevalence of antibodies to canine parvovirus and distemper virus in wolves in the canadian rocky mountains. *Journal Wildlife Diseases* 48:68-76.
13. Robinson, B. G. and E. H. Merrill. 2012. The influence of snow on the functional response of grazing ungulates. *Oikos*. 164: 265-275.
14. Nelson, B., M. Hebblewhite, V. Ezenwa, T. Shury, E. H. Merrill, P. C. Paquet, F. Schmiegelow, D. Seip,G. Skinner, and N. Webb. 2012. Seroprevalence of canine parvovirus and distemper in wolves in the Canadian Rocky Mountains. Journal of WIldlife Diseases 48:68-78.
15. Goldberg, J. F., M. Hebblewhite, and J. Bardsley. 2012. Consequences of a refuge for the predator-prey dynamics of a wolf-elk system in Banff National Park, Alberta, Canada. Population Ecology 9:e91417.
16. DeCesare, N. J. 2012. Separating spatial search and efficiency rates as components of predation risk. Proceedings of the Royal Society B-Biological Sciences 279:4626–4633.

Completed Graduate Theses: 2 PhD and 7 MSc theses since 2001:

1. Spilker, E. 2018. Spatial predation risk and interactions within a predator community on the Rocky Mountain Eastern Slopes, Alberta. MSc Thesis, University of Alberta, Edmonton, Alberta, Canada.
2. Paoli, Amelie. 2014. Paysage de la peur et effets indirects de la prédation sur la sélection de l'habitat par le wapiti (*Cervus elaphus canadensis*). Diplome de Master 2, Laboratoire de Biometrie et Biologie Evolutive Equipie Ecologie Evolutive des Populations.
3. Smolko, P. 2014. Ekológia parciálne migrujúcich populácií jelena lesného (*Cervus elaphus*). PhD thesis. Technical University of Slovakia, Slovakia.
4. Intering, C. 2013. Linking predation pressure, forage availability and physiography to group size in a partially migratory elk (*Cervus elaphus*) herd. MSc Thesis. Université Jean- Monnet, France.
5. Eggeman, S.L. 2012. Migratory behavior and survival of adult female elk in a partially migratory population. MSc thesis. Unversity of Montana, Montana.
6. Glines, L. M. 2012. Woody plant encroachment into grasslands within the Red Deer River drainage, Alberta. MSc Thesis, University of Alberta, Alberta.
7. Spaedtke, H. R. 2009. Aversive conditioning on horseback: A management alternative forgrassland systems threatened by sedentary elk populations. MSc thesis. University of Alberta, Alberta.
8. Hebblewhite, M. 2006. Linking Predation Risk And Forage Dynamics To Landscape-Scale Ungulate Population Dynamics. PhD thesis. University of Alberta, Alberta.
9. McInenly, L. 2003. Seasonal effects of defoliation on montane rough fescue (*Festuca campestris* rydb.) MSc Thesis, University of Alberta, Alberta.

In-progress Graduate Theses: 2 PhD and 3 MSc in progress

1. Berg, J. Calving ecology of the Ya Ha Tinda elk herd, PhD, University of Alberta. Expected completion: December 2018.
2. Martin, H. Role of migration dynamics of male and female elk in the population dynamics at Ya Ha Tinda. PhD, University of Montana. Expected completion: April 2020.
3. MacAulay, K. Spatial mortality risk for elk in a multi-predator community. MSc, University of Alberta. Expected completion: April 2018.
4. Normandeau, J. Elk contact networks and parasite dynamics. MSc, University of Alberta. Expected completion: April 2019.

Undergraduate Honors Theses since 2013 (11 undergraduate student/intern projects).

1. Hessami, M. 2016. Estimating Migratory-Resident Elk Populations and Juvenile Recruitment Using Remote Cameras in the Canadian Rockies. Honors thesis. University of Montana.
2. Roberge, C. 2016. Does timing of parturition influence elk birth site selection with respect to predation risk? University of Alberta. CICan Internship. Final report
3. Pettit, J. 2016. Third-year Honors Thesis, Density-dependent habitat selection of Ya Ha Tinda elk. University of Alberta.
4. O'Donnell, M. 2017. Seasonal diet variation of wolf packs in east slopes of Alberta. University of Alberta. ICICan Internship. Final report.
5. Colquhoun, S. 2016. Shifting migration: the role of anthropogenic factors and predation in a declining elk herd. Science Horizons Internship. Final report
6. Wilde, M. 2015. Methods to determine human activity and impact in ecosystems. NSERC USRA
7. Cyr, A. 2016. Diet and distribution of predators in relation to a declining elk herd. University of Alberta. Science Horizons Internship. Final report.
8. Bonart, A. 2015. Fourth-year Honors Thesis. Spatial patterns in wolf risk at Ya Ha Tinda via scats. University of Alberta.
9. Skurdal, A. 2015. Fourth Year Honors Thesis. Diversity & overlap in predator diets at Ya Ha Tinda. University of Alberta.
10. Beatty, A. 2015. Third Year Honors Thesis. Effects of scat analysis methods on diets of predators. University of Alberta. Comparison of wolf diets at Ya Ha Tinda, 2005 and 2012. Supported by Parks Canada. Final Report.

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