WOLF AND COYOTE PREDATION ON LIVESTOCK IN NORTHEAST ALBERTA COUNTIES WITH AND WITHOUT PREDATOR BOUNTIES: SPRING AND SUMMER 2017

by

Gilbert PROULX, Alpha Wildlife Research & Management, 229 Lilac Terrace, Sherwood Park, Alberta, T8H 1W3, Canada. Email: gproulx@alphawildlife.ca
Sadie PARR, Wolf Awareness Inc., 21-514 Anderson Road, Golden, British Columbia, V0A 1H1, Canada. Email: sadieparrwolfpact@gmail.com

January 2018

INTRODUCTION

In Alberta, bounties to control wolves (*Canis lupus*) and coyotes (*Canis latrans*) have been implemented since 2007 to allegedly minimize livestock depredation. Recently, over a 5-year period, more than 1,400 wolves and 25,000 coyotes were killed by bounty hunters in the province (Proulx and Rodtka 2015). Although bounties are known to be an ineffective management practice (Theberge 1973; Melchoir *et al.* 1987; Cluff and Murray 1995), they are maintained by some Alberta municipalities to ostensibly reduce livestock depredation by wolves and coyotes. However, there are no data ascertaining the municipalities' claims that livestock is an important prey item in the diet of wolves and coyotes. The persistence of bounties in rural regions appears to be based on unfounded perceptions rather than scientific evidence.

In spring and summer 2016, we studied the food habits of wolves and coyotes in 1 bounty area including 2 counties, e.g., Two Hills and St. Paul, and in 1 area without bounties (control) overlapping the Counties of Strathcona, Lamont and Beaver in central Alberta (Proulx and Parr 2017). In the bounty area, we found that cattle remains in coyote scats were less frequent in spring than in summer, and corresponded to 5.4% and 18% of all food items, respectively. We were only able to find and collect a few wolf scats in spring (n = 10 in spring and 1 in summer); 30% of the spring scats contained cattle remains and were collected in areas where the wolves had access to cattle carcasses (Proulx and Parr 2017). The frequency of coyote scats with cattle remains in the bounty area did not differ significantly (P>0.05) from that observed in the control area where no scats were found with cattle remains. Surprisingly, cattle remains were more frequent in scats collected in June than in those collected in April. Our field observations suggested that coyotes likely fed on animals that died from natural causes and were left on the landscape. We could not draw a conclusion on the impact of wolves on livestock, because we were unsuccessful in locating wolf scats despite covering several hundred kilometers of rural roads and trails in the bounty zone. The occurrence of coyote and wolf scats with cattle remains occurred in very specific areas in spring and in summer.

Our 2016 findings did not correspond to expectancies based on Acorn and Dorrance's (2010) report, which suggested that livestock losses to wild canids are highest in the spring, coinciding with increased depredation events during birthing seasons for calves (increased vulnerability) and canids (increased energy demands). The presence of cattle remains in coyote scats were not higher in spring than in summer. Most scats with cattle hair came from the same localized areas, suggesting that scavenging may have occurred over time after livestock died naturally and was disposed on the landscape, as there were no reported livestock losses to predators during this period that we were able to determine when speaking with fieldmen and local residents. Finally, wolf scats were scarce, suggesting that wolf feeding activities on farmland were limited in space and time. The first year of our study suggested that livestock was not an important prey item for coyotes and wolves. However, because livestock predation could be related to yearly fluctuation in natural prey, we recommended that our study be repeated in spring and summer 2017 to ascertain our conclusions.

As in 2016, we hypothesized that cattle remains would be: (H_1) frequent in wolf and coyote scats collected in spring (April); (H_2) infrequent in summer (June) scats; and (H_3) wolf and coyote scats with livestock remains would be present throughout the bounty study area.

STUDY AREA & METHODS

Our investigation was conducted in 2 study areas: 1) a 6,000-km^2 bounty area overlapping the Counties of Two Hills and Saint Paul; and 2) an approximate 1,000-km^2 control area overlapping the County of Strathcona, Lamont and Beaver where there are no bounties (Figure 1). In the bounty area, we focused

our search for scats along roads near grazing areas, wildlife reserves, and agriculture areas with woodlots. In the control area, most of the search occurred along trails and roads in or near Cooking Lake-Blackfoot Provincial Recreation Area, and agricultural roads in the Lamont and Strathcona Counties. In 2011, the total combined number of cattle and calves for the Saint Paul and Two Hills Counties was an estimated 127,646; with 46,127 (36%) calves under the age of 1 year (Alberta Agriculture and Rural Development 2014). In the control area, there were approximately 50,484 cattle and calves; 15,622 (31%) of these were calves under 1 year of age (Alberta Agriculture and Rural Development 2014).

Figure 1. Location of study areas.

Scat collection and analyses

Wolf and coyote scats were collected along dirt roads and trails crossing agricultural-wilderness areas during 8-20 April (spring sample; calving period), and 5-9 June (summer sample; wolf and coyote pup rearing period). Although the size of each feces varies with individual animal age, as well as food habits, the differentiation of scats was based on the experience of the authors, the presence of coyote or wolf tracks near scats, and the following diameter sizes: ≥18-<25 mm for coyotes, and ≥25 mm for wolves (Weaver and Fritts 1979; Green and Flinders 1981; Reed *et al.* 2004).

Scat locations were recorded with a GPS unit (Garmin model 76S; Garmin International Inc., Olathe, Kansas, USA). Scats were dated, bagged, and kept frozen until they were autoclaved at the University of Calgary at 130ºC for 30 min, to eliminate the danger of any parasite transmission to the analyst,

particularly that of the granular tapeworm (*Echinococcus* spp). Scat analyses were conducted at the Alpha Wildlife Research & Management laboratory in Sherwood Park, Alberta. Scats were soaked overnight in a mild water-bleach solution, washed through a sieve, and oven-dried at 75°C (Proulx 2016). Hairs from scats were treated with methyl salicylate (Fisher Scientific, Fair Lawn, New Jersey, USA) and examined with a microscope to identify cuticular scales and the medulla configuration (Moore *et al.* 1974). Hairs were identified to species. Bone remnants and teeth were used to ascertain the identification based on hair examinations. Feathers were identified to family level using Chandler (1916) and Day (1966). Arthropods were identified to order level.

Food items were classified into 12 categories: small mammals (rodents and insectivores), beaver, porcupine, snowshoe hare, carnivores, boar, wild ungulates, bison, cattle, birds, arthropods, and vegetation. For the purpose of this study, however, food analyses related to scats with or without cattle remains.

Contents of scats were presented both as percentage of occurrence (PO; percentage of total scats in which an item was found) and relative percentage of occurrence (RPO; number of times a specific item was found as percentage of all items found). Although PO indicates how common an item is in the diet, RPO provides a better indication of the relative frequency with which each item is consumed because it accounts for more than 1 of a given item being found in a scat (Ackerman *et al.* 1984). Percent volume of remains of each food item in scats were estimated visually to the nearest 5% (McDonald and Fuller 2005).

The frequencies of scats with cattle hair in spring and summer, within and between areas, were compared with Fisher Exact Probability test (Siegel 1956). Mean volumes of cattle hair in spring and summer scats collected in the bounty area were compared with a Student-*t*-test for unequal variances (Dixon and Massey 1969).

RESULTS

Scat collection

In our second year, we collected 164 coyote (89 in spring and 75 in summer) and 11 wolf (5 in spring and 6 in summer) scats in the bounty study area. In the control area, we collected 99 coyote (40 in spring and 59 in summer) and 12 wolf (5 in spring and 7 in summer) scats (Tables 1 and 2).

Scat analysis – Wild food items

Coyotes – In both seasons and all study areas, small mammals were the most frequent food item with the highest mean volume of remains/scat (Table 1). In the bounty area, scat analyses revealed that snowshoe hares and wild ungulates were important food items in spring; wild ungulate and arthropod remains were frequent in summer. In the control area, the frequency and mean volume of wild ungulate remains was similar in spring and summer. Beaver and bison remains were found in spring only; the presence of arthropod and vegetation in scats was recorded in summer only. Bird remains were more prevalent in summer (Table 1).

Wolves – Only a few scats were found in the bounty and control areas (Table 2). In spring, small mammals, snowshoe hares and wild ungulates were the main prey in the bounty area. In summer, arthropod remains were more frequent, and no snowshoe hare remains were found. In the control area, small mammals and snowshoe hares were the most important prey (Table 2).

Scats with cattle remains

Coyotes – Cattle remains represented 4.7% of all spring food items. In summer, their RPO increased to 8.4%. Mean volumes of cattle remains were relatively low, i.e., 5.6% and 11%, in spring and summer, respectively. There was only 1 scat with cattle remains in the control area, representing 2.2% of all food items. We found no cattle remains in summer scats collected in the control area.

In spring, there was no significant difference in the RPO of scats with cattle remains between the bounty and control areas (Fisher test = 0.67, $P>0.05$). In summer, however, the difference in the RPO of scats with cattle remains was significantly higher in the bounty area than in the control area (Fisher test, $P = 0.01$).

There was no significant difference in the RPO of scats with cattle remains in spring and summer in the bounty (Fisher test = 0.41, $P>0.05$) and control (Fisher test = 0.38, $P>0.05$) areas. In the bounty area, the mean volume of cattle remains in scats was similar in spring and summer ($t_{54} = 0.39$, $P>0.05$).

Wolves – We did not collect wolf scats with cattle remains.

Distribution of coyote scats with cattle remains in the bounty area

Spring - Scats with cattle remains were found in 2 different areas (Figure 2). Location 1 (2 coyote scats) corresponded to a trail leading to the St. Paul Grazing Area – there were no cows or calves in the field at this time of year. Three coyote scats with cattle remains were found in Location 2, an area where fields are interspersed with woodlots. Location 2 corresponds to Location 4 in 2016 where a cow that had died of natural causes was left on the range by the producer (Proulx and Parr 2017).

Summer – Scats with cattle remains were found in 3 locations (Figure 3). Five scats were collected in Location 1, which corresponded to an area where forests had been recently logged and replaced with fields. In Location 2, 3 scats with cattle remains were found on a trail leading to the St. Paul Grazing Area. One scat was found in Location 3.

DISCUSSION

The small number of wolf scats collected in spring and summer, and the absence of cattle remains in these scats, suggests that wolves are not abundant and their impact on livestock is minimal. This is in agreement with Morehouse *et al.* (2018) who reported a very low number of claims in the Two Hills-St. Paul area.

H_1

This study shows that, in spring, the relative frequency of cattle remains in coyote scats in the bounty area did not differ from that observed in the control area where only 1 scat was found with cattle hair. Coyote feeding on cattle in the bounty study area was negligible at this time of year. The low frequency of scats with cattle hair in the Two Hills-St. Paul study area was not the result of bounties. If this was the case, the number of coyote scats with cattle hair would have been much larger in the control area where cows, calves, and coyotes coexist and there are no bounties. Therefore, we reject H_1, which suggests that cattle remains would be frequent in wolf and coyote scats collected in spring.

H_2

Although the RPO of scats with and without cattle remains was similar in spring and summer in the bounty area, the frequency of scats with cattle remains was higher in summer than in spring. We therefore reject H_2, which suggests that cattle remains would not be frequent in summer. As in 2016, the concentration of scats in specific areas suggests that coyotes fed on livestock in specific areas where carcasses had been left on the land.

H_3

In our study, many of the scats with cattle remains came from the same collection areas. Across most of the bounty study area, coyote scats did not contain cattle remains. Therefore, we reject H_3 and conclude that the occurrence of coyotes feeding on livestock was not widespread in the bounty study area.

Table 1. Frequencies and volumes of food items by season in coyote scats in bounty and control areas, Alberta, Canada, 2017 (PO: percentage of occurrence; RPO: relative percentage of occurrence; PV: percent volume; SD: standard deviation).

Food item	**Two Hills & Saint Paul**						**Control**					
	Spring			**Summer**			**Spring**			**Summer**		
	PO (*n*) *n = 89*	**RPO (*n*) *n = 107***	**Mean PV (SD)**	**PO (*n*) *n = 75***	**RPO (*n*) *n = 107***	**Mean PV (SD)**	**PO (*n*) *n* = 40**	**RPO (*n*) *n* = 45**	**Mean PV (SD)**	**PO (*n*) *n* = 59**	**RPO (n) *n* = 73**	**Mean PV (SD)**
Small mammals (insectivores & rodents)[a]	65.2 (58)	54.2 (58)	59.3 (46.8)	41.3 (31)	29 (31)	29.4 (39.9)	67.5 (27)	60 (27)	60.8 (46.2)	67.8 (40)	54.8 (40)	58.1 (45.3)
Beaver[b]	3.4 (3)	2.8 (3)	1.9 (10.3)	1.3 (1)	0.9 (1)	1.3 (11.5)	2.5 (1)	2.2 (1)	2.5 (15.8)	-	-	-
Porcupine[c]	1.1 (1)	0.9 (1)	0.2 (2.1)	-	-	-	-	-	-	-	-	-
Snowshoe hare[d]	20.2 (18)	16.8 (18)	17.6 (37.3)	6.7 (5)	4.7 (5)	5.3 (20.8)	17.5 (7)	15.5 (7)	17.5 (38.5)	11.9 (7)	9.6 (7)	11.8 (32.5)
Carnivores[e]	4.5 (4)	3.7 (4)	3.7 (18.3)	9.3 (7)	6.5 (7)	8.2 (27.3)	-	-	-	3.4 (2)	2.7 (2)	2.5 (14.5)
Wild boar[f]	1.1 (1)	0.9 (1)	1.1 (10.6)	-	-	-	-	-	-	-	-	-
Ungulates[g]	9 (8)	7.5 (8)	5.3 (19.8)	18.7 (14)	13.1 (14)	13.7 (31.4)	10 (4)	8.9 (4)	6.5 (20.8)	8.5 (5)	6.8 (5)	8.5 (28.1)
Bison[h]	-	-	-	-	-	-	2.5 (1)	2.2 (1)	1.5 (9.5)	-	-	-
Cattle	5.6 (5)	4.7 (5)	5.6 (23.2)	12 (9)	8.4 (9)	11 (31.1)	2.5 (1)	2.2 (1)	2.5 (15.8)	-	-	-
Birds[i]	7.9 (7)	6.5 (7)	5.7 (21)	10.7 (8)	7.5 (8)	5.3 (18..6)	10 (4)	8.9 (4)	8.8 (27.5)	27.1 (16)	21.9 (16)	18.1 (32.9)
Arthropods[j]	1.1 (1)	0.9 (1)	0.01 -	26.7 (20)	18.7 (20)	18.7 (36.8)	-	-	-	1.7 (1)	1.4 (1)	0.03 -
Vegetation	1.1 (1)	0.9 (1)	0.06 -	16 (12)	11.2 (12)	7 (19.2)	-	-	-	3.4 (2)	2.7 (2)	0.8 (4.7)
Total		**100 (107)**	**100**		**100 (107)**			**100 (45)**	**100**		**100 (73)**	**100**

[a]Shrew (*Sorex* spp.);; deer mouse (*Peromyscus maniculatus*); meadow vole (*Microtus pennsylvanicus*); prairie vole (*Microtus ochrogaster*; red-backed vole (*Myodes gapperi*); northern pocket gopher (*Thomomys talpoides*); house mouse (*Mus musculus*; least chipmunk (*Tamias minimus*); northern flying squirrel (*Glaucomys sabrinus*); red squirrel (*Tamiasciurus hudsonicus*); Richardson's ground squirrel (*Urocitellus spermophilii*).

b Beaver (*Castor canadensis*); [c]Porcupine (*Erethizon dorsatum*); [d]Snowshoe hare (*Lepus americanus*)

[e]Weasels (*Mustela* spp.); striped skunk (*Mephitis mephitis*); black bear (*Ursus americanus)*; coyote (*Canis latrans*); red fox (*Vulpes vulpes*); cougar (*Puma concolor*).

[f]Wild boar (*Sus scrofa);* [g]Deer (*Odocoiles* spp.); moose (*Alces alces*); elk (*Cervus canadensis*); [h]Bison (*Bison bison*)

[i]Anatidae, Columbidae, Passeridae, Phasianidae, Rallidae. [i]Coleoptera.

Table 2. Frequencies and volumes of food items by season in wolf scats in bounty and control areas, Alberta, Canada, 2017 (PO: percentage of occurrence; RPO: relative percentage of occurrence; PV: percent volume; SD: standard deviation).

Food item	**Two Hills & Saint Paul**						**Control**					
	Spring			**Summer**			**Spring**			**Summer**		
	PO (*n*) *n* = 5	**RPO (*n*) *n* = 6**	**Mean PV (SD)**	**PO (*n*) *n* = 6**	**RPO (*n*) *n* = 6**	**Mean PV (SD)**	**PO (*n*) *n* = 5**	**RPO (*n*) *n* = 6**	**Mean PV (SD)**	**PO (*n*) *n* = 7**	**RPO (n) *n* = 7**	**Mean PV (SD)**
Small mammals (insectivores & rodents)[a]	60 (3)	50 (3)	60 (54.8)	33.3 (2)	33.3 (2)	33.3 (51.6)	40 (2)	33.3 (2)	39 (53.4)	28.6 (2)	28.6 (2)	28.6 (48.8)
Beaver[b]	-	-	-	-	-	-	-	-	-	-	-	-
Snowshoe hare[c]	40 (2)	33.3 (2)	36 (46.5)	-	-	-	40 (2)	33.3 (2)	40 (54.8)	42.9 (3)	42.9 (3)	42.9 (53.5)
Carnivores[d]	-	-	-	-	-	-	20 (1)	16.7 (1)	20 (44.7)	14.3 (1)	14.3 (1)	14.3 (37.8)
Ungulates[e]	20 (1)	16.7 (1)	4 (8.2)	33.3 (2)	33.3 (2)	33. 3 (51.6)	-	-	-	14.3 (1)	14.3 (1)	14.3 (37.8)
Cattle	-	-	-	-	-	-	-	-	-	-	-	-
Birds[f]	-	-	-	-	-	-	-	-	-	-	-	-
Arthropods[g]	-	-	-	33.3 (2)	33.3 (2)	33.3 (51.6)	-	-	-	-	-	-
Vegetation	-	-	-	-	-	-	20 (1)	16.7 (1)	1 (2)			
Total		100 (6)	100		100 (6)	100		100 (6)	100		100 (7)	

[a]Shrew (*Sorex* spp.);; deer mouse (*Peromyscus maniculatus*); meadow vole (*Microtus pennsylvanicus*); prairie vole (*Microtus ochrogaster*; red-backed vole (*Myodes gapperi*); northern pocket gopher (*Thomomys talpoides*); house mouse (*Mus musculus*; least chipmunk (*Tamias minimus*); northern flying squirrel (*Glaucomys sabrinus*); red squirrel (*Tamiasciurus hudsonicus*); Richardson's ground squirrel (*Urocitellus spermophilii*).

b Beaver (*Castor canadensis*); [c]Snowshoe hare (*Lepus americanus*);

[d]Weasels (*Mustela* spp.); striped skunk (*Mephitis mephitis*); black bear (*Ursus americanus)*; coyote (*Canis latrans*); red fox (*Vulpes vulpes*); cougar (*Puma concolor*).

[e]Deer (*Odocoiles* spp.); moose (*Alces alces*); elk (*Cervus canadensis*);

[f]Anatidae, Columbidae, Passeridae, Phasianidae, Rallidae. [g]Coleoptera.

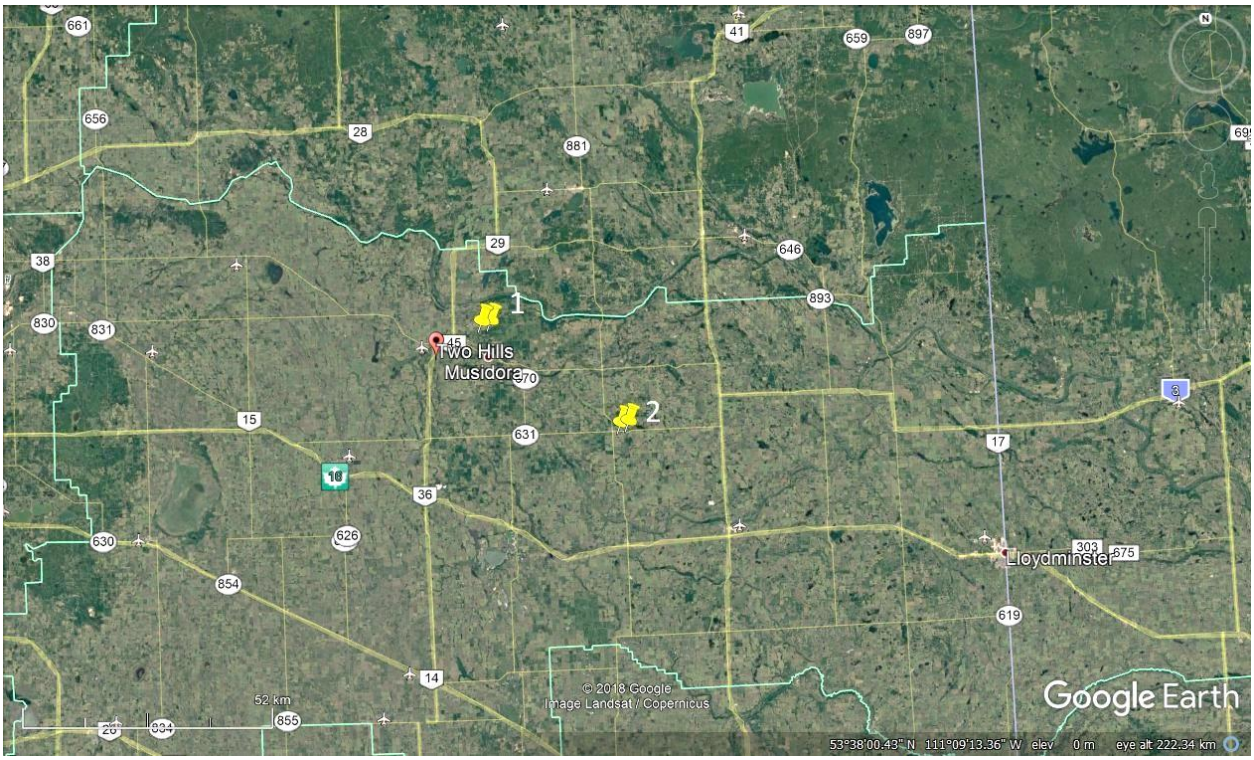

Figure 2. Location of scats (yellow pushpins) with cattle remains in the bounty area, spring 2017.

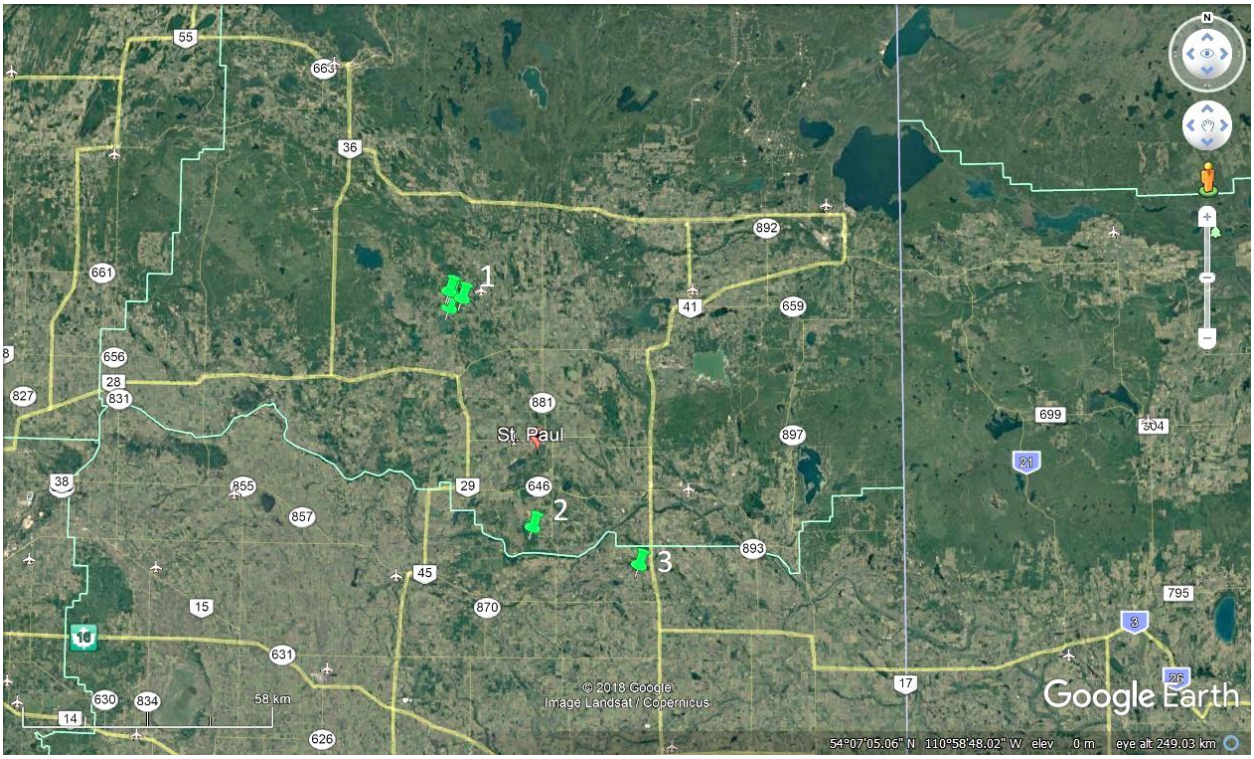

Figure 3. Location of scats (green pushpins) with cattle remains in the bounty area, summer 2017.

MANAGEMENT IMPLICATIONS

Our 2017 findings support our 2016 conclusions that livestock is not an important prey item for wolves and coyotes inhabiting the Two Hills-St. Paul bounty study area (Proulx and Parr 2016). Nevertheless, a few wolves and more than 2,600 coyotes are killed every year in the St. Paul and Two Hills Counties, and annual bounty payments amount to $ 25,000 and $ 20,000, respectively (Proulx and Parr 2016). While there is little evidence that wild canids prey upon livestock, particularly in spring, the maintenance of bounties may be counter-productive. Indeed, previous research has shown that removing resident wild canids may actually result in an increase in conflicts with livestock due to subdivision of existing territories, and an increase in canid densities through compensatory reproduction and colonization (Ballard and Stephenson 1982; Brainerd *et al.* 2008; Wielgus and Peebles 2014). The constant removal of local canids could eventually lead to greater depredation due to a constant reallocation of territories and high levels of reproduction and immigration, in areas where lethal interventions occurred and in neighboring farms (Santiago-Avil *et al.* 2018). For wolves, socially fractured packs that have lost members to bounties may be less capable of effectively hunting wild prey, and forced to survive on whatever can be obtained. Also, coyote and wolf immigrants and dispersers could become accustomed to cattle meat as part of their diet because producers leave carcasses where they can be accessed by scavengers (Proulx and Parr 2017).

In conclusion, our 2017 study ascertains our 2016 findings that livestock is not an important food item of coyotes and wolves in spring and summer in the Two Hills-St. Paul bounty study area. On the basis of our findings, and the low number of compensation claims in these counties (Morehouse *et al.* 2018), the implementation of bounties in these counties is unjustified and should be discontinued.

ACKNOWLEDGEMENTS

We thank the Naturalist Clubs of Fort Saskatchewan, Buffalo Lake, and Calgary, Lush Cosmetics, the Animal Welfare Foundation of Canada, Patagonia-Environmental Grants Fund of Tides Foundations, the Fitzhenry Family Foundation, and Community Foods for their financial support. We also thank Keith Kornelsen and Elden Kozak, Fieldmen of St. Paul and Two Hills Counties, respectively, who provided us with valuable information for our collection of scats. and Victor Robinson, who discussed our findings and shared his extensive experience as the Operator of the St. Paul Grazing Lease. Finally, we are grateful to the Canid Ecology Lab at the University of Calgary, Department of Geography, especially Dr. S. Alexander and PhD candidate Victoria Lukasik for facilitating the autoclaving of the scats.

LITERATURE CITED

Acorn, R. C., and M. J. Dorrance. 2010. Coyote predation of livestock. Alberta Agriculture and Rural Development, Edmonton, Alberta, Canada.

Ackerman, B. B., F. G. Lindzey, and T. P. Henker. 1984. Cougar food habits in southern Utah. Journal of Wildlife Management 48: 147-155.

Alberta Agriculture and Rural Development. 2014. 2011 census of agriculture for Alberta. Her Majesty the Queen in Right of Alberta (Alberta Agriculture and Rural Development), Edmonton, Alberta, Canada.

Ballard, W. B., and R. O. Stephenson. 1982. Wolf control – Take some and leave some. Alces 18: 276-300.

Brainerd, S. M., H, Andrén, E. E, Bangs, E. H. Bradley, J. A. Fontaine, W. Hall. Y. Iliopoulos, M. D. Jimenez, E. A. Jozwiak, O. Liberg, *et al.* 2008. The effects of breeder loss on wolves. Journal of Wildlife Management 72: 89-98.

Chandler, A. C. 1916. A study of the structure of feathers with reference to their taxonomic significance. Zoology (California) 13: 243-266.

Cluff, H. D., and D. L. Murray. 1995. Review of wolf control methods in North America. Pages 491-504 *in* L. N. Carbyn, S. H. Fritts, and D. R. Seip. 1995. Ecology and conservation of wolves in a changing world. Canadian Circumpolar Institute, University of Alberta, Edmonton, Alberta, Canada.

Day, M. G. 1966. Identification of hair and feather remains in the gut of stoats and weasels. Journal of Zoology 148: 201-217.

Dixon, W. J., and F. J. Massey, Jr. 1969. Introduction to statistical analysis. McGraw-Hill Book Company. New York, New York, USA.

Floyd, T. J., L. D. Mech, and P. A. Jordan. 1978. Relating wolf scat content to prey consumed. Journal of Wildlife Management 42: 528-532.

Gililand, R. L. 1995. Predation impacts and management strategies for reducing coyote damage to cattle. Symposium Proceedings – Coyotes in the Southwest: a compendium of our knowledge. Paper 32. Available at: http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1031&context=coyotesw . Accessed March 28, 2017.

Green J. S., and J. T. Flinders. 1981. Diameter and pH comparisons of coyote and red fox scats. Journal of Wildlife Management 45: 765-767.

Knowlton, F. F., E. M. Gese, and M. M. Jaeger. 1999. Coyote depredation control: an interface between biology and management. Journal of Range Management 52: 398-412.

McDonald, J. E., and T. K. Fuller. 2005. Effects of spring acorn availability on black bear diet, milk composition, and cub survival. Journal of Mammalogy 86: 1022-1028.

Melchoir, H. R., N. F. Johnson, and J. S. Phelps. 1987. Wild furbearer management in the western United States and Alaska. Pages 1115-1128 *in* M. Novak, J. A. Baker, M. E. Obbard, and B. Malloch, editors. Wild furbearer management and conservation in North America. Ontario Trappers Association, North Bay, Ontario, Canada.

Moore, T. D., L. E. Spence, and C. E. Dugnolle. 1974. Identification of the dorsal guard hairs of some mammals of Wyoming. Bulletin No. 14, Wyoming Game and Fish Department, Cheyenne, Wyoming, USA.

Morehouse, A. T., J. Tigner, and M. S. Boyce. 2018. Coexistence with large carnivores supported by a predator compensation program. Environmental Management https://doi.org/10.1007/s00267-017-0994-1.

Proulx, G. 2016. American badger predation on Richardson's ground squirrels in southwestern Saskatchewan, Canada. Pages 219-236 *in* G. Proulx and E. Do Linh San, editors. Badgers: systematics, ecology, behaviour and conservation. Alpha Wildlife Publications, Alberta, Canada.

Proulx, G., N. MacKenzie, B. Proulx, K. MacKenzie, and K. Walsh. 2009. Relationships among predators, prey and habitat use in southern Saskatchewan, 2008. Alpha Wildlife Research & Management Ltd. report submitted to Saskatchewan Agriculture Development Fund, Regina, Saskatchewan.

Proulx, G., and S. Parr. 2017. Wolf and coyote predation on livestock in northeast Alberta counties with and without predator bounties: a progress report. Alpha Wildlife Research & Management and Wolf Awareness progress report, Sherwood Park, Alberta, Canada.

Proulx, G., and D. Rodtka. 2015. Predator bounties in Western Canada cause animal suffering and compromise wildlife conservation efforts. Animals 5: 1034-1046.

Reed, J. E., R. J. Baker, W. B. Ballard, and B. T. Kelly. 2004. Differentiating Mexican gray wolf and coyote scats using DNA analysis. Wildlife Society Bulletin 32: 685–692.

Reynolds, J. C., and N. J. Aebischer. 1991. Comparison and quantification of carnivore diet by faecal analysis: a critique, with recommendations, based on a study of the fox *Vulpes vulpes*. Mammal

Review 21: 97-122.
Santiago-Avila, F. J., A. M. Cornman, and A. Treves. 2018. Killing wolves to prevent predation on livestock may protect one farm but harm neighbors. PLoS ONE 13(1): e0189729. https://doi.org/10.1371/journal.pone.0189729
Shivik, J. A. 2004. Non-lethal alternatives for predation management. Sheep & Goat Research Journal, 19: 64-71.
Siegel, S. 1956. Nonparametric statistics for the behavioral sciences. . McGraw-Hill Book Company. New York, New York, USA.
Theberge, J. B. 1973. Death of a legislative fossil: Ontario's wolf and coyote bounty. Ontario Naturalist 13 (3): 32-37.
Weaver, J. L., and S. H. Fritts. 1979. Comparison of coyote and wolf scat diameters. Journal of Wildlife Management 43: 786-788.
Wielgus, R. B., and K. A. Peebles. 2014. Effects of wolf mortality on livestock depredation. PLos ONE 9, e113505.