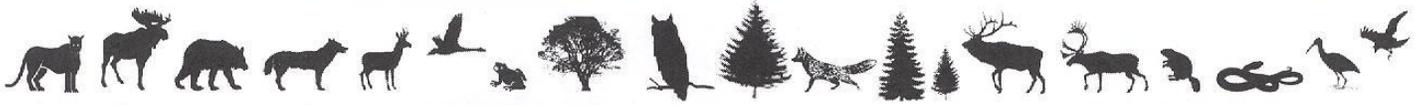

CANADIAN WILDLIFE BIOLOGY & MANAGEMENT



CWBM 2017: Volume 6, Number 2

ISSN: 1929-3100

Point to Ponder

The Impact of Wolf Predation on Western Canada Boreal Woodland Caribou Populations: A Critical Review of the Evidence

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Abstract

The boreal woodland caribou (*Rangifer tarandus*), which is listed as threatened by COSEWIC since 2002, is found across Canada but its status is deteriorating due to habitat loss, fragmentation, and degradation, predation, weather, starvation, diseases and parasites, accidents, and human hunting, poaching and recreational activities. Nonetheless, in the last 2 decades, predation by wolves (*Canis lupus*) has been identified as the proximal factor causing the decline of caribou populations in western Canada. However, some selected scientific references that were used to justify wolf culling programs reported that predation by wolves represented <15% of boreal caribou mortalities. In my preliminary study of wolf food habits in January-February 2012 in northwestern Saskatchewan, the relative percentage occurrence of caribou in wolf scats was 5.8%. My findings were in agreement with previous studies that found that the boreal woodland caribou was not an important food item for wolf. In Alberta, government biologists and some academics have argued that reducing wolf populations would save the boreal woodland caribou. My review of the evidence here shows that the impact of wolf predation on the sustainability of boreal woodland caribou populations has been overstated. Instead of scapegoating wolves for the demise of boreal woodland caribou populations, wildlife managers should implement a comprehensive caribou recovery program aimed at conserving, restoring, expanding and connecting critical habitats across landscapes.

Key Words: Habitat Conservation, Predation, Wolf, Woodland Caribou.

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The woodland caribou (*Rangifer tarandus caribou*) is a widely distributed species in Canada. On the basis of their behaviour and ecology, woodland caribou populations are sub-divided into 3 ecotypes: 1) the northern mountain ecotype in Yukon, Northwest Territories and northwestern British Columbia; 2) the southern mountain ecotype in British Columbia and Alberta; and 3) the boreal ecotype in the Northwest Territories, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, and Newfoundland and Labrador (Government of Canada 2017). The boreal ecotype has the most extensive range area in Canada but, like the other 2 ecotypes, its status is deteriorating. It was designated threatened in May 2000; its status was re-examined and confirmed in May 2002 (Environment Canada 2012a).

Many factors may impact on boreal caribou populations: habitat loss, fragmentation, and degradation, predation, weather, starvation, diseases and parasites, accidents, and human hunting, poaching and recreational activities (Thomas and Gray 2002). Most experts agree that habitat is the ultimate long-term cause of boreal woodland caribou decline across its range (Edmonds 1988; Cumming 1992; Weclaw and Hudson 2004; Proulx *et al.* 2016). However, in the last 2 decades, predation by wolves (*Canis lupus*) has been identified as the proximal factor causing the decline of caribou populations in western Canada. In Alberta, Schneider *et al.* (2010) suggested that conducting a 50-year wolf control program, with the assumption that wolf control would result in an annual boreal woodland caribou population increase of 10%, would be more economical than restoring habitats. Festa-Bianchet *et al.* (2011) argued that, in the short-term, boreal woodland caribou populations may be maintained by reducing mortality caused by predation, namely wolves. Environment Canada (2012a) also suggested that predator control (e.g., wolf) may be an option to recover boreal caribou populations. However, the implementation of a wolf-culling program in western Alberta (Hervieux *et al.* 2014), which involved the killing of more than 800 wolves over 7 years, failed to increase or stabilize the Little Smoky boreal caribou population (Proulx and Brook 2017; Proulx *et al.* 2017). If wolves were the proximate factor for the decline of boreal caribou, why did the western Alberta culling program fail to generate a caribou population growth? Is predation only 1 of many factors, or has the impact of wolves on caribou populations been oversold? Is it possible to save boreal caribou populations, even in the short-term, by simply killing wolves? Is the promotion of wolf culling programs distracting us from a comprehensive caribou conservation approach focusing on a series of synergetic factors causing the decline of boreal caribou populations?

In the light of all the controversy currently surrounding the implementation of wolf culling programs to recover caribou populations (Suzuki and Moola 2006; Brook *et al.* 2015; Wolf Awareness 2016; Proulx *et al.* 2017), I believe it is important to review some of the peer-reviewed literature that has been instrumental in implementing wolf control programs to recover boreal caribou populations, and to discuss factors that may impact on caribou. Because my studies of boreal caribou populations and habitats have occurred in Saskatchewan and Alberta (Proulx 2013, 2015a; Proulx and Gillis 2017), and the western populations are more closely associated with muskegs than those of eastern Canada (Fortin *et al.* 2017), I focused my paper on western Canada boreal caribou populations.

A review of pre-2012 publications recommending the implementation of wolf culling programs

Papers by Schneider *et al.* (2010), Festa-Bianchet *et al.* (2011) and Environment Canada (2012a) were among the references used by Hervieux *et al.* (2014) to justify their wolf-culling program in the Little Smoky range in western Canada. A few of the scientific papers cited in these publications, however, are irrelevant to boreal caribou populations as they relate to mountain ecotypes. Whereas boreal caribou populations are associated with low-productivity coniferous forests, and black spruce (*Picea mariana*) and tamarack (*Larix laricina*) muskegs (Proulx 2015a), mountain caribou populations inhabit high-productivity upland stands and seasonally move to alpine openings (Environment Canada 2012b). The distribution and habitats of mountain caribou, and their relationships with wolves, differ from those of boreal caribou and therefore datasets relative to the mountain caribou-wolf relationship are not transferable to boreal caribou populations. Nevertheless, references relevant to boreal caribou populations reported that predation by wolves represented <15% of the mortalities (Table 1).

2012 dataset from northwestern Saskatchewan

In 2012, following the publication of Festa-Bianchet *et al.*'s (2011) review, I recorded the distribution of wolves in my northwestern Saskatchewan study area (54° 07' N, 108° 25' W) where I was investigating winter habitat use by boreal caribou of the Primrose-Cold Lake population (Proulx 2013). This boreal caribou population was estimated at 350 animals (Callaghan *et al.* 2011). In January-February, 1 pack of 15 wolves (estimation based on personal observations and discussions with local foresters) inhabited the southern portion of my study area. Caribou inhabited muskegs (particularly those dominated by tamarack, or mixed with black spruce; Proulx 2013). No big game surveys were conducted in the area, but deer (*Odocoileus* spp.) and moose (*Alces alces*) were considered to be very abundant (R. Tether,

Table 1. Canadian references used by Schneider *et al.* (2010), Festa-Bianchet *et al.* (2011), Environment Canada (2012a), and Hervieux *et al.* (2014) to justify recommendations or actions to control wolves in western boreal woodland caribou range. Boreal caribou population sizes are from Callaghan *et al.* (2011).

Ecotypes		Predation
Mountain	Boreal	Proportion of caribou population lost to wolf predation
Edmonds 1988 (both ecotypes) Little Smoky boreal population ≈80		- 6 (25%) out of 24 radio-collared caribou belonging to adjacent mountain and boreal caribou populations were consumed by wolves. - 1 out of 31 (about 12% of estimated population of 250 animals – sum of mountain and boreal population estimates) non-collared caribou found dead was killed by wolves. This would correspond to <1% of the population. - 2 (2.2%) out of 92 wolf scats contained caribou remains.
	McLoughlin <i>et al.</i> 2003 Population: 1550-2000	58 (17.5%) of 332 radio-collared adult females killed by predators over a 10-year period. Accurate estimates of population sizes did not exist. The impact of wolf predation on the caribou populations could not be estimated, but it was <17%. Most mortalities occurred from April to October. Note – this study includes Stuart-Smith <i>et al.</i> 's (1997) and James and Stuart-Smith's (2000) studies reported below.
Seip 1990		12.5% of the adult population in 2 study areas. When wolves were present and uncontrolled, calf survival was 2.5%. When wolves were absent and reduced through control, calf survival was 39%.
	Stuart-Smith <i>et al.</i> 1997 Population: 450-650	13.8% of radio-collared caribou (adult females: 5%/yr; adult males: 14%/yr). It was assumed that wolves were the major source of mortality.
	Rettie and Messier 1998 Population: Unknown	7.5% of radio-collared adults. Caribou mortality sites were typically inspected several weeks after death.
	Schaefer <i>et al.</i> 1999 Population: 97	2/3 of all deaths of an unknown number of >1-yr-old radio-collared females. No data on the proportion of caribou lost for the whole population.
	James and Stuart-Smith 2000 Population ≥450	5.1% (5/98 radio-collared caribou). From 1994 to 1997, 76 wolf predation sites (18 moose, 20 deer, and 38 unknown) were found while locating 23 radio-collared wolves. No identifiable caribou kill sites were found by following radio-collared wolves.
Hayes <i>et al.</i> 2003		Wolf predation strongly limited recruitment of a caribou population, but high recruitment was also observed in a caribou population without wolf reduction. No evidence that adult survival of caribou improved when wolf numbers were reduced. Woodland caribou declines may be linked to falling moose abundance.
Wittmer <i>et al.</i> 2005		Unknown proportion lost to wolves. Wolves and bears were the major predators in northern populations; cougar (<i>Puma concolor</i>), bears, and wolverine (<i>Gulo gulo</i>) were the major predators in southern populations.

regional biologist, personal communication, 2012) as they were protected from hunting in Meadow Lake Provincial Park and Cold Lake Air Weapons Range.

A random stratified approach was used to locate transects averaging ≥1-km long and ≥1-km apart that crossed all habitat types. Transects were traversed on snowshoes and because it was not possible to consistently determine if animal crossings were made by the same animals, all wolf tracks were tallied. The distance travelled in each habitat type was used to determine the proportions of habitat types in the overall survey. Such proportions were used to estimate the expected frequency of wolf tracks in each habitat type,

i.e., the distribution of tracks according to the availability of habitats surveyed if animals were randomly using all habitats. This expected frequency of wolf tracks per habitat type was compared to the frequency of tracks observed in each habitat type during the snowshoe surveys. Habitat use (i.e., observed vs. expected frequency of track encounters) was tested with Chi-square statistics with Yates correction (Zar 1999). More details about transects and methodology are available in Proulx (2013).

I recorded 38 wolf tracks. The analysis of their distribution indicated that wolves frequented muskegs that were preferred by caribou, and mixed (coniferous or coniferous-

deciduous) and deciduous stands, according to their availability ($\chi^2 = 4.6$, 50.2, $df = 2$, $P > 0.05$). In caribou habitats, wolf tracks were present in the ecotones (100-m transition zone) between the muskegs and the upland forests. Although caribou could be found in ecotones and some upland stands adjacent to preferred muskegs (Proulx 2013), wolves were following deer and elk (*Cervus canadensis*) tracks (Proulx 2013; unpublished observations).

I also collected 50 wolf scats (>25 mm diameter, Reed *et al.* 2004), mostly from the southern portion of my study area, and analysed them as per Proulx (2016). For each food item, I determined the relative percentage of occurrence (RPO; number of times a specific item was found as percentage of all food items found), which I multiplied by mean prey mass to estimate the biomass of each food item in wolf diet (Proulx 2016). I used average weights of 375 kg for adult moose, 75 kg for adult deer, 300 kg for elk, 140 kg for caribou, and 1.3 kg for snowshoe hare (*Lepus americanus*) (Naughton 2012). In January-February 2012, caribou were found in 5.8% (RPO) of prey items (i.e., 3 out of 52 prey items) and provided 8.5% of biomass in wolf diet. This was slightly higher than elk with a 1.9% RPO and 6.1% biomass. Deer had a 21.2% RPO contributing 16.6% of biomass in wolf diet. Moose had a lower RPO (17.3%) but contributed 68.1% biomass. Finally, snowshoe hares had the highest RPO (53.8%), but the lowest biomass (0.7%) in wolf diet.

My findings were in agreement with Wasser *et al.* (2011) and Latham *et al.* (2013) who reported that caribou were infrequent in wolf scats in winter, i.e., 11% and 7.4%, respectively, and provided little in terms of biomass in wolf diet. Although based on a small sample of scats collected during 1 winter, my investigation suggested that wolf prefer feeding on moose and deer. Caribou was not an important food item. Also, from 2009 to 2012, I snowshoed over 60 km of transects across the range of this boreal caribou population and found wolf-killed deer, elk, moose and snowshoe hares, but no caribou. Finally, in January 2017, Proulx and Gillis (2017) surveyed 126 km of transects through the northern range of the same caribou population. As in previous studies (James and Stuart-Smith 2000; Whittington *et al.* 2005), they found that seismic exploration lines, paved roads and compacted snow trails were used by wolves; however, they did not record wolves hunting in muskegs.

Was the impact of wolves on boreal caribou populations oversold?

In the past, it has been argued that changes in the forest age structure may compromise the ability of caribou to avoid other prey species and their predators because young forests support higher densities of alternate ungulate species such as

moose (Rempel *et al.* 1997; Wiwchar and Mallory 2012) that in turn support higher predator densities and wolf size, leading to increased predation on caribou (Bergerud and Elliot 1986; Seip 1992). However, data show that caribou are not an important food item of wolves. Would a <15%-predation rate threaten a caribou population? It would likely threaten a population that has dwindled to a few animals, or when the females fail to reproduce. However, the majority of boreal caribou populations encompass hundreds of animals (Table 1) and $\geq 85\%$ of the adult females usually are pregnant (Stuart-Smith *et al.* 1997; Rettie and Messier 1998; McLoughlin *et al.* 2003). In the Little Smoky range where the population is relatively small (≤ 80 animals; Callaghan *et al.* 2011), it is unlikely that wolf predation compromised the caribou population. In fact, aerial surveys indicated that the population increased from 43 in the late 1990s to 74 in 2003 in the absence of any wolf control program (ASRD/ACA 2010). Obviously, predation did not impede the population from increasing in numbers, even though it was a slow growth. After killing nearly 1,000 wolves during a 7-year period, Hervieux *et al.* (2014) failed to generate growth in the Little Smoky caribou population. Clearly, something other than predation interfered with the growth of the population.

While methodological limitations and non-replicated treatments likely impacted on the ability of researchers to properly evaluate the mechanism of caribou population declines (Hayes *et al.* 2003; Brown *et al.* 2007; Proulx *et al.* 2017), I believe that wolves have been wrongly singled out as the proximate factor for the decline of boreal caribou populations. There is no doubt that wolves are opportunistic predators and they will kill caribou or any other prey they may encounter while hunting moose or deer. However, past researchers have not demonstrated that wolves caused the decline of boreal caribou populations. In the Little Smoky range, no studies have shown that wolves were limiting the caribou population. There were no recent studies on food habits, rates of predation or wolf densities (M. Besko, Director, Wildlife Management, Alberta, 8 February 2017, personal communication). As is the case for many other populations, conjectures about wolves impacting on caribou populations have been qualitative, anecdotal, and prejudicial (Proulx *et al.* 2017). Hebblewhite *et al.* (2006) also recognized that future research was needed on some of the assumptions underlying predator-prey models including multi-prey wolf numeric responses, wolf kill-rates of caribou, and caribou mortality by other predators.

In Alberta, caribou conservation strategies basically correspond to wolf killing programs. While it is believed that killing wolves will increase caribou populations (Boertje *et*

al. 1996; Hayes *et al.* 2003; Boutin 2017), any reduction of predator or competitor populations should also result in an increase of boreal caribou populations. Controlling bears (*Ursus* spp.) would likely reduce calf mortality (Rettie and Messier 1998; Latham *et al.* 2011; Pinard *et al.* 2012) and therefore contribute to population growth. Decreasing densities of moose, and thus provoking a decline in the density of predators, may also result in an increase in the survival of caribou (Serrouya *et al.* 2017). Eliminating beavers (*Castor canadensis*) would likely decrease incidental caribou kills by wolves in spring and summer (Latham *et al.* 2013). Destroying predators and their prey to increase boreal caribou populations is a simplistic and relatively inexpensive approach employed by some managers hoping for a short-term victory for their single-species management program. The notion of killing predators and prey, and destroy an entire wildlife community, to save a species at risk is not coherent with contemporary ecosystem and biodiversity conservation principles (Proulx and Brook 2017).

I believe that wolf killing programs were oversold, and such programs are misleading the public and the scientific community by shrouding the real cause of the decline of boreal caribou populations – habitat loss and disconnection. On the subject of limiting factors on caribou populations, Leopold and Darling (1953) stated: “We cannot agree with the viewpoint...that the game program must be directed towards controlling the action of predators, both men and wolves, rather than improving the range. To ignore range limitations for caribou is to ignore the crux of the problem”. Hindsight indicates that Leopold and Darling were right. Habitat loss and disconnection is the ultimate factor impacting on the survival of boreal caribou populations (Donovan *et al.* 2017). One may kill all the wolves and alternate prey of an ecosystem, and farm caribou in an enclosure in order to save the species (Alberta Government 2016) but without functional and accessible habitat, caribou are unlikely to persist over the long term. Boreal woodland caribou are now faced with climate change involving the drying of peatlands, and the “icing” of winter ranges where interludes of mild weather result in the formation of crusted snow and basal ice that restricts access to forage (Tyler 2010; Proulx 2015a). Where muskegs have been disconnected, caribou must venture on roads and through upland forests where they may be killed by predators or become victims of accidents (Proulx, personal observations). Human activities and infrastructures are the cause here, not the wolves.

Caribou are capable of adapting and coexisting in areas affected by human development provided that adequate habitat exists (Weclaw and Hudson 2004; O’Brien *et al.* 2006). By maintaining and interconnecting black spruce-

tamarack muskegs and adjacent lichen-rich pine (*Pinus* spp.) stands, caribou can find food and security from adverse weather, predation, competition from other ungulates and accidents. The plea from wildlife professionals to conserve boreal woodland caribou habitat is based on scientific evidence, not on speculations or prejudices (Proulx *et al.* 2017). Developing a caribou recovery program based on habitat conservation is addressing the ultimate factor responsible for the decline of boreal caribou populations, and will solve issues associated with proximal mortality factors. Habitat conservation has been recommended by a plethora of wildlife biologists. Nearly 30 years ago, Edmonds (1988) recommended habitat conservation to ensure the future of the Little Smoky caribou population. Her recommendation was echoed by Cumming (1992), Weclaw and Hudson (2004), O’Brien *et al.* (2006), Proulx (2015a), Proulx and Powell (2016), and many others. We should no longer postpone the implementation of habitat conservation programs with the excuse that some caribou populations are presumably unsustainable, or their current range is highly fragmented and it may take another 40 years to bring back large intact forests. Caribou will persist if, and only if, we act now by conserving and further improving their habitats, and eliminating or at least minimizing habitat loss and alteration caused by industry (Proulx 2015b).

In conclusion, I believe that wolf predation on boreal woodland caribou was oversold by government agencies and some academics. Instead of scapegoating wolves for the demise of boreal woodland caribou populations, wildlife managers should implement a comprehensive caribou recovery program aimed at conserving, restoring, expanding and connecting critical habitats across landscapes (Proulx *et al.* 2017).

ACKNOWLEDGEMENTS

I thank Associate Editor Pauline Feldstein and 2 anonymous referees for their comments on an earlier version of this manuscript.

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Received 11 September 2017 – Accepted 24 October 2017