Provincial Caribou Recovery Program
Herd Planning Disclaimer

The following herd plans are a result of Phase One planning and are an incomplete product. Additionally, the documents are 'living' reports and will be updated regularly as Phase Two progresses.

Phase Two planning is currently underway for some herds however still at its early stages of development; many plans reflect this as they are in different stages along their scheduled project continuum.

One of the cornerstone guiding principles to the Caribou Recovery Program (the Program) is to use consistent, fact-based approaches for all woodland caribou herds in the province. The Program has refined and adopted a new format to herd planning that will effectively:

- ❖ Provide a consistent approach to managing all woodland caribou herds in BC
- ❖ Recognize the unique circumstances of each herd
- ❖ Build from current (legacy) caribou management plans
- ❖ Consider First Nations' and stakeholder interests and ideas
- ❖ Be included in larger regional plans

Completed herd plans will describe the status of each herd, and the threats faced by that particular herd. The plans will take note of previous actions, and actions that are planned to take place in the future. As we implement the herd plans, the Program will carefully monitor to which extent and magnitude the caribou respond, and modify its actions as accordingly. Herd plans will help us document our decisions and discuss issues with First Nations and with stakeholders.

Phase One consisted of:

- ✓ Status of herd or sub-population
- ✓ Identified threats
- ✓ Literature
- ✓ Previous work completed

Phase Two will consist of input from:

- Engagement with Indigenous communities
- Provincial Caribou Science Team
- Stakeholders
- Decision-support tools

WOODLAND CARIBOU PLAN

Wolverine Subpopulation

Omineca Local Population Unit

BRITISH COLUMBIA

Recommended Citation:

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EXECUTIVE SUMMARY

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1 BACKGROUND

1.1 INTRODUCTION TO THE PROGRAM

2 POPULATION DESCRIPTION

Wolverine caribou are a subpopulation of the Northern Group of Southern Mountain Caribou, also called Designatable Unit 7 or DU7 (Environment Canada, 2014). This ecotype of woodland caribou is currently federally designated as *Threatened* under the *Species at Risk Act*. Provincially it is Blue listed by the BC Conservation Data Center and is listed as "Identified Wildlife" under the *Forest and Range Practices Act* (FRPA).

2.1 DISTRIBUTION

The Wolverine subpopulation of caribou is located in the Omineca Mountains approximately 250 km northwest of Prince George, B.C (Figure 1). The 10,300 km^2 area is west of the Williston Reservoir and is bordered by the Osilinka River, Takla Lake, the Nation Lakes, and the eastern slopes of the Wolverine Range. Elevations range from 675 meters to 2000 meters above sea level (Klaczek, 2017; Hansen & Paterson, 2016). Adjacent caribou subpopulations are Chase to the north, Takla to the southwest, and Scott to the southeast.

2.2 HABITAT AND BEHAVIOUR

The Wolverine subpopulation of caribou typically feed on terrestrial lichens in low elevation pine forests during the early winter season with most caribou moving to feed on terrestrial lichens on high elevation wind swept ridges during late winter. Arboreal lichens are also used when available (Hansen & Paterson, 2016).Calving typically occurs at high elevations with continued high elevation use throughout the summer, congregating on high elevation post rut ranges during the fall (Brumovsky & McNay, 2015; McNay, et al., 2008; Klaczek, 2017). Annual migration distances may be up to 120 km, but could be considerably less depending on availability of seasonal resources. Use of low elevation habitat is generally avoided as much as possible due to the increased predation risk (McNay, et al., 2008).

2.3 POPULATION SIZE AND TREND

Regular monitoring of the Wolverine caribou subpopulation began in the early 1990's (Klaczek, 2017). Hansen (2016) reports a stable population between 2007 and 2016 with estimates ranging between 341 and 381 caribou, however, recent a survey in 2018 now suggests the Wolverine subpopulation is declining (Table 1; Klaczek 2018). Results from recent monitoring of radio-collared female caribou over the past 2 years suggests that adult female survival (average = 0.81, ± 0.08 SE, 2016-2018; Klaczek 2018) was below the average rate observed during the late 2000s (average = 0.88; 2007-2010; Serrouya et al. 2017) when corrected population estimates suggested the Wolverine subpopulation remained roughly stable (McNay et al. 2010). Calf recruitment has averaged 13.2% since 2007, below the 15% rate that is thought to be required for a stable population (Bergerud, 1996; Bergerud, 1988; Bergerud, 1992).

Table 1. Caribou counts and population estimates in the Wolverine caribou subpopulation area since 2007. Adapted from (McNay, et al., 2010) (Hansen & Paterson, 2016)

Year	Population Count	Population Estimate	% of calves	Reference
2007	356	375	15	Giguere and McNay 2007
2008	349	381	14	Giguere and McNay 2008
2008	340	349	14	Giguere and McNay 2008a
2009	253	378	11	McNay *et al.* 2009
2010	230	341	13	McNay *et al.* 2010

2016	258	362	12	Hansen *et al.* 2016
2018	249	266	15	Klaczek 2018

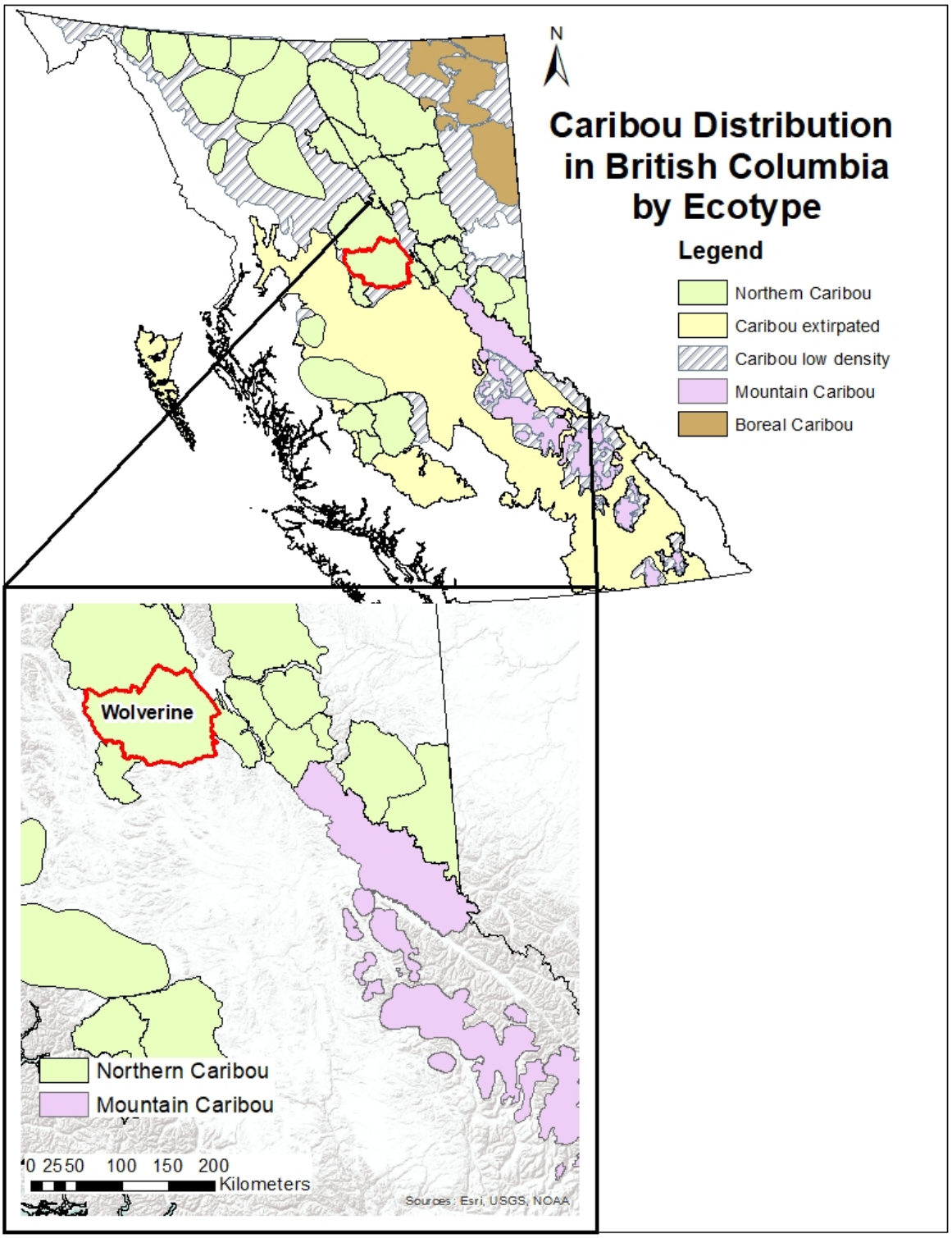

Figure 1. Caribou distribution in BC by ecotype . The Wolverine subpopulation is outlined in red.

3 THREATS AND LIMITING FACTORS

Current declines in woodland caribou populations have been ultimately attributed to direct and indirect effects of human activities and climate change (Vors & Boyce, 2009; Environment Canada, 2014; Festa-Bianchet, et al., 2011). These effects have resulted in lowered rates of adult female survival and/or juvenile recruitment, two demographic rates that have high influence on caribou population dynamics (DeCesare, et al., 2012). For most populations, these effects have led to unsustainable rates of predation (McLoughlin, et al., 2003; Wittmer, et al., 2005b; Apps, et al., 2013). Compared to other ungulates, caribou are particularly vulnerable to increasing predation because they have low reproductive rates (Bergerud, 2000). To reduce predation risk, caribou generally occur at low densities and have evolved to live in low productivity habitats that spatially separate them from other ungulates and their generalist predators (Bergerud, 1992). Effects from human activities and climate change likely compromise this spacing strategy by changing the abundance and spatial distribution of these other ungulates and predators, increasing the likelihood of caribou-predator encounters and consequently increasing predation rates (Festa-Bianchet, et al., 2011).

The federal *Recovery Strategy* for SM caribou (Environment Canada, 2014) identified a number of threats potentially affecting caribou populations and their habitat. These threats, in descending order of importance, included: predation, industrial activities, roads and other linear features, recreational activities, natural disturbances (e.g. fire), hunting, climate change and parasites and diseases. This section follows a similar approach, discussing these threats – and others – though their order does not reflect their relative importance to a specific population. Note that while threats are discussed individually, they are not mutually exclusive as they may interact and their effects on caribou population dynamics are likely cumulative (Sorensen, et al., 2008; Johnson, et al., 2015).

3.1 PREDATION

Multiple GPS and radio telemetry studies throughout BC have indicated that the dominant, proximal cause of woodland caribou mortality is predation (Wittmer, et al., 2013). Woodland caribou have evolved with their predators and have persisted despite millennia of predation. Their impact on woodland caribou populations has increased due to the result of three dominant processes: apparent competition mediated by increased alternative prey abundance (Hebblewhite, et al., 2007), apparent competition mediated by expanding alternative prey distribution (Wittmer, et al., 2007; DeCesare, et al., 2009; Latham, et al., 2011b), and enhanced predator access to woodland caribou habitat mediated by roads and other industrial developments (James & Stuart-Smith, 2000; Latham, et al., 2011a).

More generally, Bergerud (2007) has calculated that wolf densities greater than 6.5 wolves/1000 km^2 will result in woodland caribou declines. Wolf surveys have not been conducted for the Wolverine caribou subpopulation so the wolf densities and distribution are unknown. However in regards to eight confirmed mortalities of collared caribou from 2016-2018, six were determined to be predation by wolves, one may have had wolverine involvement with no evidence of wolves, and one fell off a cornice (Klaczek, 2017). (Klaczek 2018). Previous studies have also documented wolf predation as the primary cause of mortality (McNay et al. 2010).

3.2 While not specific to the Wolverine caribou subpopulation, studies have demonstrated that bears negatively impact calf recruitment and may impact adult survival (Adams, et al., 1995; Wittmer, et al., 2005a). Cougars are not thought to be major predators of caribou in northern BC (Wittmer, et al., 2005a). Food Limitation

Lichens form the main part of caribou's winter diet, while in the summer a variety of vegetation is consumed. A comprehensive study of mountain caribou using bone marrow fat of deceased collared caribou suggests that population declines are linked to excessive predation, not body condition (McLellan, et al., 2012). However the result of supplemental feeding on the nearby Kennedy Siding subpopulation suggests that caribou movements to reduce predation risk may reduce food intake and therefore lower nutritional condition (Heard & Zimmerman, 2017). In the Wolverine range, health assessments conducted during captures in 2016 and 2017 suggested that most caribou were in good body condition in late-winter. Additionally, bone marrow samples collected at kill sites suggest that wolverine caribou were generally are in good body condition (n = 2 caribou; Klaczek unpublished data).

3.3 Human Activities

3.3.1 Industrial

3.3.1.1 Forestry

Woodland caribou are an old-growth forest dependent species (Bergerud, 2000) hence forest management affects their distribution and populations. Although some populations live seasonally in treeless, alpine ecosystems, all spend some of the year in forests. For this reason, forestry will affect woodland caribou populations. Forestry effects include very general "habitat loss" that reduces the amount of old-growth forest, to reduction in forest-based food resources, to creating more, early seral forest habitat for apparent competitors such as deer and moose (Simpson & Woods, 1987; Cichowski, 1989; Seip, 1990; Stevenson, 1991). Factors such as the type of forest (Cichowski, 1989) and the size of cutblocks (Edmonds & Bloomfield, 1984) play a role in the effect of forestry practices on woodland caribou populations.

Within the Wolverine caribou subpopulation boundaries large scale clearcut forest harvesting began after the construction of the WAC Bennet dam and the subsequent formation of the Williston reservoir in the late 1960's (Brumovsky & McNay, 2015; Terry & Wood, 1999). This harvesting was initially concentrated in the south-east corner (Terry & Wood, 1999). By the mid 1990's the harvesting had expanded to all sides of the subpopulation's periphery and by the early 2000's was taking place adjacent to the boundaries of Omineca Provincial Park which is near the center of the subpopulation's range (Google Earth, 2017).

In the past decade the mountain pine beetle (MPB) infestation has impacted areas within the Wolverine subpopulation boundaries. Subsequent salvage logging has significantly increased the number of roads and cutblocks within caribou habitat, especially within the low elevation pine-lichen forests (MFLNRO LNG, 2015; Google Earth, 2017). For example, new cutblock roads and clear cuts are expanding into the squawfish platuea and areas north Klawi Lake. Recent aerial survey data and telemetry locations collected from GPS collared caribou have provided additional information on late-winter use within the low elevation forests in these areas. During the March 2017 survey, a total of 110 caribou, at least 1/3 of estimated population, were within pine-lichen stands in these area (Klaczek 2017). Further, in 2016 and 2017 new clear cuts and cut-block roads were

established within the southern portion of the Wolverine range with cut block roads extending within a few hundred meters of where caribou use subalpine and alpine habitats throughout the year.

3.3.1.2 MINING

Mine sites deter caribou both for the activities that occur there when they are active as well as for the habitat they destroy. Mines have a 2 km ZOI when they are active, but this shrinks to the physical footprint of the mine site when mines are dormant, inactive or abandoned (Polfus, et al., 2011). This physical footprint usually includes linear features such as roads, which increase predator travel efficiency, thus increasing the predation risk to the caribou (Latham, et al., 2011a; DeMars & Boutin, 2017).

Mineral exploration has and continues to occur within the subpopulation range, especially in the south-west quadrant (MFLNRO LNG, 2015). This exploration has not resulted in any significant mining operations.

Placer mining also continues to occur throughout much of the area, but most notably along the Manson and Germansen rivers (MFLNRO LNG, 2015). Placer tenures overlap approximately 3% of the herd range.

3.3.1.3 OIL AND GAS

The potential impacts on caribou of oil and gas development would likely be similar but possibly more extensive than mining. However currently the oil and gas potential is low in this area. A proposed gas transmission line would cross this area; more details are in the linear corridor section below.

3.3.1.4 CLEAN ENERGY

Clean energy projects could include large hydroelectric dams and reservoirs, smaller run of the river hydroelectric projects, wind farms, and solar power generating projects.

Research in southern British Columbia correlated hydroelectric development with declines in caribou populations (Simpson, 1987b). The WAC Bennett dam built for electricity generation in the last 1960's created the Williston Reservoir, which is adjacent to but not within the Wolverine caribou subpopulation's boundaries. This reservoir may have impacted connectivity with the caribou subpopulations to the east.

There are no current run of the river hydroelectric, wind, or solar power generating installations or proposals in the Wolverine subpopulation area.

3.3.1.5 OTHER

No other forms of industrial development are currently planned or underway within the Wolverine subpopulation area.

3.3.2 RECREATION

Recreational activities can impact caribou populations by displacing individuals into sub-optimal habitats (Seip, et al., 2007), increasing stress levels (Freeman, 2008) and / or facilitating predator movement into caribou habitat (Whittington, et al., 2011). Unnecessary movements can deplete critical fat reserves, potentially decreasing the likelihood of successful parturition and calf rearing the following summer and potentially decreasing the ability to avoid predators (Seip, et al., 2007). Additional winter movements may also increase the amount of exposure to steep terrain, increasing the risk of mortality due to avalanches (Simpson, 1987a; Seip, et al., 2007).

3.3.2.1 SNOWMOBILE

Snowmobile use appears to be low within the Wolverine caribou subpopulation boundaries. The Recovery Plan for Northern Caribou Herds in North-central British Columbia (McNay, et al., 2008) displays 18 common snowmobiling areas; none of these are located within the Wolverine subpopulation range.

3.3.2.2 HELI-SKI /CAT SKI

There are no commercial helicopter or snowcat skiing operators within the Wolverine caribou subpopulation boundaries (HeliCat Canada, 2017).

3.3.2.3 OTHER

Backcountry skiing, snowshoeing, ATV use, hiking, mountain biking, and other similar activities could also stress or displace caribou from preferred habitat. However due to the remote location of the Wolverine caribou subpopulation these activities are likely not significant.

3.3.3 OTHER

3.3.3.1 AGRICULTURE

Agricultural development can impact caribou populations in several ways. These include the direct losses of habitat as forests are converted to fields and the supplementation of natural food sources for alternate prey such as elk and deer potentially increasing their populations, which in turn may support increased numbers of predators, increasing the predation risk to the caribou. In addition, domestic livestock could harbour diseases and parasites. Transmission to caribou has not been established within British Columbia (Martin, et al., 2011; Vors & Boyce, 2009).

There are no significant agricultural developments within or adjacent to the Wolverine caribou subpopulation area.

3.3.3.2 HIGHWAY CORRIDORS

Direct mortality from collisions with vehicles is the most obvious threat when highways pass through caribou habitat. Less obvious threats include direct loss of habitat along highway right of ways; fragmentation of habitat, especially if traffic volumes form a crossing barrier (Apps & McLellan, 2006); the maintenance of permanent early seral along highway edges supporting alternate prey and therefore predators; improved travel efficiencies for predators increasing predation risk; and improving human access for recreational use.

There are no highway corridors through the Wolverine caribou subpopulation however there are several all-season gravel roads and a network of forestry roads that could support some of the potential impacts listed above.

3.3.3.3 LINEAR FEATURES

Linear features could include roads as mentioned above but could also include powerlines, pipelines, railways, and seismic lines. These features often result in direct loss of habitat, create permanent early seral conditions that benefit alternate prey and their predators, and improve travel and therefore hunting efficiency for predators (DeMars & Boutin, 2017). Avoidance by caribou may extend the area of impact well beyond the physical footprint (Vistnes & Nellemann, 2008).

There are currently no powerlines, pipelines, railways, or seismic lines within the Wolverine caribou subpopulation boundaries. However the proposed Westcoast Connector Gas Transmission project (WCGT) has plans to construct a pipeline through the area (MFLNRO LNG, 2015).

3.3.3.4 HUNTING

Excessive hunting of caribou is likely responsible for the initial declines in populations throughout the southern half of the province (Spalding, 2000). Hunting of caribou has been either eliminated or tightly controlled in the south for several decades. However there remains an open hunting season for 5 point bull caribou in the northern part (Management Unit 7-38) of the Wolverine sub-population from August 15 to October 15 annually (BC Government, 2016a). Compulsory inspection is required for all resident and non-resident caribou harvest. Results from inspections suggest that resident and non-resident harvest rates of caribou are low within the Omineca region. The last recorded bull caribou harvested in the Omineca region was in 2004 (FLRNO compulsory inspection data 1982-2016). While there are some anecdotal reports of First Nation harvest, the number of caribou harvested annually by First Nation's hunters is unknown.

Moose, deer, elk, and goat hunting continue within the Wolverine caribou sub-population range (BC Government, 2016a). While reduction in alternative prey can be beneficial to woodland caribou, active hunting in their winter range may also contribute to accidental death by hunters who misidentify their prey. The specific impact to the Wolverine caribou sub-population is unknown. Moose density appears to have declined in the Wolverine range over the last decade (McNay et al. 2010; Anderson et al. 2017).

3.4 NATURAL DISTURBANCE

Caribou populations are subject to impacts from a number of natural disturbances. Being dependent on old-growth forests, caribou are impacted by forest fires. In northern and boreal habitats, it takes 80 years for a forest to recover from a fire to become caribou habitat again. In addition the early seral habitat created post-fire may facilitate population increases in alternate prey and their predators. Although caribou are likely adapted to the natural forest fire regime within and adjacent to their ranges, effects of forest fire may act cumulatively with human-mediated disturbances to negatively impact caribou demography (Sorensen, et al., 2008). Caribou may also be affected by insect or disease outbreaks that affect forest stand condition. For example, mountain pine beetle outbreaks can highly impact old-growth pine stands, affecting lichen availability (Cichowski & Haeussler, 2015) – a primary forage resource for caribou – and increasing the likelihood of fire (Lynch, et al., 2006). For mountain-dwelling caribou, avalanches constitute another type of natural disturbance that can potentially impact demography, though under normal conditions their importance as a mortality should be small unless population sizes are small (Hebblewhite, et al., 2007; Seip & Cichowski, 1996).

The magnitude of the annual impact of wildfires on the Wolverine caribou subpopulation's habitat, and the change in this impact due to a warming climate, has not been calculated. Similarly salvage forest harvesting in response to the recent mountain pine beetle outbreak is also a concern that is not well quantified (MFLNRO LNG, 2015) .

3.5 PARASITES AND DISEASES

Caribou can be impacted by a range of native and introduced diseases and parasites (Bergerud, et al., 2008; Schwantje, et al., 2014). Disease and parasite outbreaks can limit caribou populations by affecting survival and reproductive rates (Albon, et al., 2002; Klein, 1991) and effects of disease and parasites may interact with other limiting factors such as predation and nutrition. Threats from disease and parasites are predicted to increase with climate change (see *Section 3.6* below), particularly if spatial overlap between caribou and other ungulate species increases (Bradley, et al., 2005; Dobson, 2009; Kutz, et al., 2005). For example, increasing expansion of white-tailed deer into caribou range may increase the prevalence of meningeal worm in caribou, a parasite that is highly pathogenic to caribou and whose usual host is white-tailed deer (Anderson, 1972).

Health monitoring of wolverine caribou was initiated in 2016 when blood and fecal samples were collected from live animals during capture. The objective of health assessment was to determine impacts from parasites and diseases, however, results were not available to be included in this report. Evidence to date from an extensive study involving the mountain caribou ecotype suggests that mortality from natural causes (i.e. diseases and nutrition) is low (McLellan, et al., 2012; Apps, et al., 2013) and diseases and parasites are not thought to be a major driver of current declines in populations of southern mountain caribou (Environment Canada, 2014).

3.6 Climate Change

Climate change can potentially exert numerous effects on caribou population dynamics. Warmer winters may impact forage availability by increasing icing events and / or causing poor snow conditions that limit the ability of caribou to access lichens (Hansen, et al., 2011). A warming climate may also change the abundances and distribution of alternate prey and their generalist predators, potentially increasing rates of caribou predation (Latham, et al., 2011b; Dawe & Boutin, 2016). Climate change may alter the spatial and temporal distribution of insects, diseases and parasites, potentially affecting individual fitness and population dynamics (Bradley, et al., 2005). Changes to the natural disturbance regime (e.g. fire interval, fire intensity, avalanche frequency) may further impact caribou through mechanisms outlined in *Section 3.4*.

There is no specific information on how climate change may be affecting the Wolverine subpopulation of caribou, although the mountain pine beetle infestation described above has likely been exacerbated by warmer winters (COSEWIC, 2014).

3.7 Small Population Size Effects

Caribou subpopulations that are small and isolated may be subject to negative demographic effects that can occur as a result of their small size (Caughley, 1994). Such effects include inbreeding depression, genetic isolation from population fragmentation (Serrouya, et al., 2012), demographic stochasticity (e.g. all offspring produced are of one sex), environmental stochasticity (e.g. the population is extirpated by a random natural disturbance such as an avalanche; (Hebblewhite, et al., 2010)), and Allee effects (e.g. lowered demographic performance with decreasing population size; (Courchamp, et al., 1999)). For group-living ungulates such as caribou, McLellan et al. documented a predation-mediated Allee effect where the predation rate may increase with declining population size because group size declines at a faster rate than the number of groups in the population and the number of groups dictates the rate of caribou-predator encounters (McLellan, et al., 2010).

4 Management History

4.1 Habitat

Concerns on maintaining caribou habitat in the Wolverine caribou subpopulation area began after large adjacent areas were flooded by the creation of the Williston Reservoir in the late 1960's (Wood & Terry, 1999). The Omineca Mountains Woodland Caribou Project was initiated in 1991 to determine the population status, seasonal movements, habitat selection, and distribution of caribou west of the Williston Reservoir (Terry & Wood, 1999). This project ran until 1997.

In 2003 the British Columbia government initiated the Northern Caribou Recovery Implementation Group (NCRIG) for North Central British Columbia. Between 2003 and 2006 this group developed a recovery action plan for four caribou subpopulations including the Wolverine subpopulation. The NCRIG recommended

managing forest harvesting and other consumptive development in area based clusters 50 km ^{2} in size, where a percentage of clusters over a certain age class would be maintained (McNay, et al., 2008).

4.1.1 PROTECTION

Initial habitat protection as Ungulate Winter Range (UWR) focussed on low elevation winter range and was calculated to protect 54,988 ha or 11% of the Wolverine subpopulation area from forest harvesting (McNay & Hamilton, 2010) in (Brumovsky & McNay, 2015) (MFLNRO LNG, 2015). In addition 132,296 ha of mostly high elevation winter range has been protected from industrial uses within Omineca Provincial Park since 2001 (MFLNRO LNG, 2015). In 2016, 26,229 ha of core high elevation winter range, was added to the UWR as no harvest; 80,960 ha less than recommended by the federal Recovery Strategy for Woodland Caribou (BC Government, 2016b).

Non staking reserves?

4.1.2 ENHANCEMENT AND RESTORATION

Caribou habitat enhancement and restoration relates both to recreating or improving habitats for caribou seasonal range as well as managing linear disturbances (roads, seismic lines, pipelines, transmission rights of way) to prevent facilitated predator access (Alberta Woodland Caribou Recovery Team, 2005; Dickie, et al., 2017; Dickie, et al., 2016). As well, habitat enhancement and restoration must be accompanied by protection to be effective (Schneider, et al., 2010). Restoration of caribou habitat takes place naturally through succession from early seral stages to mature and old forest. Standard silviculture practices could aid this process. Further habitat enhancement and / or restoration has not taken place within the Wolverine caribou subpopulation area.

4.2 PREDATORS

4.2.1 WOLF MANAGEMENT

Population surveys for wolves have not been carried out within the Wolverine caribou subpopulation area. Wolves are managed as general open seasons through the provincial hunting regulations. The limit on the number of wolves harvested per person annually (annual bag limit) for the Wolverine caribou subpopulation area (Management Units (MUs) 7-28 and 7-38) was increased from 3 to unlimited (no bag limit) in 2012 (BC Government, 2012). Wolves are also trapped by registered trappers for their fur. There is no requirement for compulsory inspection or compulsory reporting of wolves harvested in Region 7 (BC Government, 2016a).

Hunting and trapping does not usually result in the removal of complete packs; remaining pack members can reproduce and recover within one year providing food resources are available. Partial pack removal can also splinter packs, resulting in more wolves as their territorial system is compromised (B. McLellan, pers. comm. 2017). Complete pack removal, usually carried out from a helicopter, would likely be more effective. An aerial wolf cull has not been carried out within Wolverine caribou subpopulation area.

4.2.2 COUGAR MANAGEMENT

Cougar populations are thought to be low within the Wolverine caribou subpopulation area. There is not hunting season for cougar in MU's 7-28 and 7-38 (BC Government, 2016a).

4.2.3 OTHER

Bear and wolverine predation can also have a significant impact on caribou populations (Wittmer, et al., 2005a). However bears and wolverine populations are likely not greater than historic levels, instead grizzly bears and

wolverines themselves may be at risk in some areas (BC Conservation Data Centre, 2017). In addition, as bears are more abundant than caribou and only a small portion of the diet of any one bear would be caribou, a very large number of bears would have to be killed to have an effect (MFLNRO LNG, 2015).

4.3 PRIMARY PREY

Wolves are a major predator of caribou, but other ungulate species, especially moose, are the primary prey of the wolves. If those other prey species are reduced, the wolf population will decline and the rate of wolf predation on caribou will likely be reduced. The effectiveness of this method is supported by preliminary results from two trials in B.C., including the Parsnip herd.

Reduction of moose and other prey species can be achieved by providing increased opportunities for hunters. Implementation of this technique is dependent on the provincial government changing the hunting regulations. Collection of reliable moose population data is desirable prior to and during implementation of moose reduction programs. Moose census methods using stratified random block are well established in B.C.

Reducing moose numbers to benefit caribou is controversial among First Nations and sport hunters who do not want to lose future opportunities to hunt moose. The only potential solution to this conflict is to ensure that there are alternative areas available outside of core caribou ranges where abundant moose populations are maintained to provide moose hunting opportunities. Potential projects to support this approach include Land-use planning processes to identify appropriate moose enhancement areas, and projects to enhance moose-habitat (eg. prescribed burning) in areas outside of caribou range.

Managing the abundance and distribution of other ungulate species (e.g. moose and deer) has been a fundamental recommendation for recovering southern mountain caribou (MCTAC, 2002; Messier, et al., 2004; MCST, 2006; Environment Canada, 2014; Boutin & Merrill, 2016).

4.3.1 MOOSE MANAGEMENT

Moose density during the winter of 2016-2017 was calculated at 0.21 moose / km^2; lower than the figures of 0.27, 0.30, and 0.41 from 1999, 2006, and 2013 respectively (Hengeveld & Corbould, 1999; Walker, et al., 2006; McNay & Giguere, 2013; Anderson, et al., 2017). Low snow depths in 2016 - 2017 may have played a role in the low density recorded as the moose may have been more spread out, however the distribution of collared moose suggests that this would only partially account for the difference (Anderson, et al., 2017). A density below 0.2 moose / km^2 is considered low in British Columbia (MMTT, 2015).

Hunting moose in MU's 7-28 and 7-38 is managed through a combination of general open seasons and limited entry hunts (BC Government, 2016a). There have not been changes to hunting management of moose for caribou recovery purposes (M. Klaczek, pers. comm., 2017).

4.3.2 DEER MANAGEMENT

Both mule deer and white tail deer are present within the Wolverine caribou subpopulation area, however at low densities (M. Klaczek, pers. comm., 2017). There is a general open season for both white tail and mule deer bucks (BC Government, 2016a).

4.3.3 OTHER

Elk are observed and there is a 6 point bull elk general open hunting season (BC Government, 2016a) however they are thought to be in low densities and have not been surveyed (M. Klaczek, pers. comm., 2017).

4.4 POPULATION REINFORCEMENT

4.4.1 MATERNITY PENNING

Maternal penning to increase calf recruitment is a tool that has not been used with the Wolverine caribou subpopulation. It is not a viable tool for caribou populations over 100 animals (MFLNRO LNG, 2015). Penning requires a minimum of 60% of the female population penned and an annual female survival rate greater than 85% to be effective (DeMars, 2017). The number of females that would have to be penned to produce a significant increase to recruitment rates would be cost prohibitive.

4.4.2 CAPTIVE BREEDING

Captive breeding is defined as "keeping and selectively breeding caribou in captivity, usually at an ex-situ facility, over a relatively long period of time with the purpose of releasing individuals back into the wild" (Hayek, et al., 2016). To date, captive breeding of caribou has not been implemented and is not in the plans as a management tool for conserving wild caribou populations.

There have been no captive breeding efforts undertaken for the Wolverine caribou subpopulation.

4.4.3 TRANSLOCATION

Translocation refers to the movement of individuals from one population (or subpopulation) to another (Hayek, et al., 2016). Numerous translocation efforts for caribou have taken place across North America (Bergerud & Mercer, 1989; Hayek, et al., 2016).

There have been no translocations of caribou into the Wolverine caribou subpopulation.

4.4.4 OTHER

Predator exclusion fencing or other forms of population reinforcement have not been implemented for the Wolverine caribou subpopulation.

4.5 RECREATION

4.5.1 SNOWMOBILE

Snowmobile use is not permitted in the Wolverine mountain range within Omineca Provincial Park (BC Parks, 2017). The use of snowmobiles for hunting purposes between March 31 and November 30 is prohibited. There are currently no other restrictions on snowmobile use within the Wolverine subpopulation boundaries.

4.5.2 HELI SKI / CAT SKI

The helicopter and cat skiing industry is guided by best management practices. However there are no commercial helicopter or snowcat skiing operators within the Wolverine caribou subpopulation boundaries (HeliCat Canada, 2017).

4.5.3 Summer Recreation

The year round use of ATV's for hunting purposes in the northern portion of the subpopulation range (Management Unit (MU) 7-38) is prohibited. In addition all vehicles except for commercial and trapping related vehicles are prohibited from using elevations above 1450 meters year round in MU 7-38 (BC Government, 2016a).

4.6 Stewardship/Outreach

Stewardship Management Agreements are in place for many caribou subpopulation areas that also experience high recreational snowmobile use. Considerable outreach efforts at industry trade shows, snowmobile retailers, etc. may also be undertaken. The Wolverine caribou are not at high risk of displacement from preferred habitat by recreational activities so this area is not part of these stewardship or outreach activities.

4.7 Research and Monitoring

There have been decades of research into caribou biology and conservation. This body of work has informed scientists and policy makers of the key factors that contribute to caribou population dynamics, important threats and potential solutions. Key findings have been the proximate role of predation and apparent competition in caribou population fluctuations and the ultimate role of habitat destruction in caribou population declines. While these factors are well understood in a broad sense, ongoing research is necessary to fine tune caribou responses to ecological stimuli and human disturbance.

In the range of the Wolverine caribou subpopulation research and monitoring began in 1991 with collaring of caribou to determine the distribution, seasonal movements, habitat selection patterns, and population status (Wood & Terry, 1999) . Similar research continued until 2010 (Hengeveld & Wood, 2000; Johnson, et al., 2001; Johnson, 2002; Johnson, et al., 2004; Zimmerman, et al., 2002; Lance, 2002; Giguere & McNay, 2007; Giguere & McNay, 2008; McNay, et al., 2008; McNay, et al., 2010). In 2016 the BC Government reinitiated monitoring and research with the deployment of 30 GPS satellite collars and subsequent aerial surveys (Klaczek, 2017). The GPS satellite collars transmit mortality notification within 12 hours allowing prompt investigation, greatly improving accurate determination of mortality causation.

5 Implications to Other Wildlife

Management actions focused on conserving caribou will necessarily have impacts on other wildlife species. Caribou require landscapes where densities of other ungulates and predators are low; thus, management actions undertaken for caribou may result in population sizes of moose, deer, and wolf that are much lower than those currently experienced (Serrouya, et al., 2015; Serrouya, et al., 2017). Reducing the populations of these species may occur from either direct management actions (e.g. lethal control) or through environmental changes (e.g. habitat restoration for caribou) that lowers the extent of suitable habitat.

Conserving caribou will likely benefit a myriad of other species co-occurring within old-growth forests. In this context, caribou may be considered an "umbrella" species (Bichet, et al., 2016). Such species generally have large spatial requirements and are sensitive to environmental changes, both attributes associated with caribou. Meeting the habitat requirements of caribou will therefore result in the habitat needs of many other species also being met.

6 IMPLICATIONS TO OTHER VALUES

Enacting measures to conserve caribou will likely have impacts on social, political and economic values. Most woodland caribou populations occur in working landscapes managed for natural resource extraction. Conserving caribou in these landscapes will likely require limits on these activities, which will likely invoke socioeconomic costs (Schneider, et al., 2011). To effectively mitigate these impacts while conserving caribou in multi-use landscapes, conservation planning will need to incorporate both economic costs and the biological needs of caribou in a spatially-explicit modelling framework (Schneider, et al., 2011; Schneider, et al., 2012).

In many caribou ranges, reducing the current densities of other ungulate species will be fundamental to conserving caribou (Serrouya, et al., 2015). Lowered populations of big-game species such as moose will result in reduced hunting opportunities. While incorporating hunters in the initial lowering of these populations can be advantageous and seen as a "win-win" (Serrouya, et al., 2015), the long-term suppression of these populations will likely require support from the regional hunting community.

Caribou have evolved a life history strategy that is dependent on large landscapes of intact wilderness (Bergerud, 2000). For many, such landscapes have inherent and intangible value. Intact wilderness also has economic benefits, including climate regulation, sedimentation control and nutrient cycling (Balmford, et al., 2002).

Caribou conservation can also elicit ethical issues. For many small and rapidly declining populations, management actions may include direct control of predators and other ungulates (Hervieux, et al., 2014). Such actions can elicit considerable controversy and, consequently, require substantial scientific support and justification for their implementation (Boertje, et al., 2010).

7 PARTNERS / NEIGHBOURS

Partners are bodies, currently existing or with strong future potential, that can assist in some aspect of management, such as expertise, financial contribution, in-kind support or moral support.

Neighbours are bodies within in the caribou subpopulation area that are currently not participating in caribou management that could be affected by caribou management, such as local governments, industry tenure holders, and recreation groups. These neighbours could potentially become future partners.

8 RECOMMENDED ACTIONS

Planning

- Re-establishment of collaborative working groups between government (including FLNRO, MOE and programs such as FFT, FES, SFE, FCI, PWFWCP,Moose enhancement), forest licensees, First Nations, others

Population management

- Review general open season for 5 point bulls in MU 7-38
- Determine the extent of First Nation harvest within the wolverine caribou sub-population.

Habitat

- Identify and protect from further forest harvesting post rut aggregation and low-elevation winter ranges habitat.
- Identify and protect from further forest harvesting habitats that may contain edaphic dry pine lichen types.
- Amend existing low elevation UWR 7-007 and 7-015 to include new information
- Determine through research the lichen maintenance success of the 70 / 140 year rotation system in low elevation winter range.
- High elevation winter habitat – is protection adequate??
- Identify critical habitat restoration opportunities (how and where)
- Develop best management practices / standard operating procedures for forest licensees, mineral tenure holders and others working in and around caribou habitat
- Building on the manual lichen restoration pilots conducted the from 2015-2017, helicopter based lichen seeding trials in critical caribou areas with habitat disturbance
- Need to add the caribou calving and migration corridor work
- Need effective connectivity across the range
- Need to fully monitor the moose browse/GWM5 work to determine effectiveness
- Need to be able to address habitat needs at the landscape level. No sense in having bits and pieces if they are not arranged through space and time to be effective at the overall landscape level
- Need to be able to manage roads

Monitoring

- Continue to monitor moose densities every 3 years
- Continue to census caribou population every 3 years
    - Maintain 30 satellite GPS collars on caribou to determine sightability during census flights and to determine causation of caribou mortalities
    - Conduct annual late-winter composition flights to assess calf recruitment.
- Conduct wolf track surveys every 2 years
    - Collar 10 of wolves and maintain this number to monitor track survey accuracy and to determine spatial and temporal overlap with caribou.

Moose management

- Increase moose cow / calf LEH authorizations if moose density becomes greater than 0.2 moose / km^2

Wolf management

- Introduce aerial cull if wolf density is greater than 10? wolves / 1000 km^2.

Anything else??

8.1 Short Term (Within 6-12 Months)

[place holder] (activity, budget)

8.2 Medium Term (Within 12-24 Months)

[place holder] (activity, budget)

8.3 Long Term (Within 24-48 Months)

[place holder] (activity, budget)

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