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

Columbia South

Subpopulation

Revelstoke-Shuswap
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

Columbia South caribou are a subpopulation of southern mountain (SM) caribou, an ecotype of woodland caribou that is federally designated as *Threatened* under the *Species at Risk Act*. SM caribou currently occur in 38 subpopulations that are distributed across the southern two-thirds of British Columbia and west-central Alberta with one subpopulation extending into the northern portions of Idaho and Washington (Environment Canada 2014). These subpopulations have been further organized into 24 Local Population Units (LPUs), which reflect subpopulations that were historically contiguous. Columbia South caribou are part of the Revelstoke-Shuswap LPU. They are also considered part of the Southern group of SM caribou (Designatable Unit 9; COSEWIC 2011). Among mountain-dwelling caribou, the Southern group are unique because of their reliance on arboreal lichen as a primary forage source during winter (Rominger et al. 1996, COSEWIC 2011) and they have evolved distinct seasonal migration patterns in response to deep snowfall within the region (Kinley et al. 2007). Within British Columbia, the Southern group is currently *Red-listed* due to sustained declines across their distribution.

2.1 DISTRIBUTION

The Columbia South subpopulation is situated within the North Columbia Mountains in the southeastern portion of the province (Fig. 1). The 1691 km^2 range primarily lies east of Lake Revelstoke and encompasses most of Mt. Revelstoke National Park and northern portions of Glacier National Park (Wittmer et al. 2005*a*). The Columbia South range is bordered to the north by the Columbia North and Central Rockies ranges, to the west by the Frisby-Boulder-Queest range, and to the south by the Trans-Canada Highway.

2.2 HABITAT AND BEHAVIOUR

Columbia South caribou undergo two seasonal migrations with respect to elevation (Apps et al. 2001, Kinley et al. 2007). In mid to late winter when snow packs are consolidated, caribou occur at high elevations, foraging on arboreal lichens (*Bryoria spp*.; Serrouya et al. 2007) in old-growth, relatively open subalpine fir stands at the alpine-forest ecotone. These open woodland and parklands stands occur within the upper limits of the Englemann Spruce – Subalpine Fir (ESSF) biogeoclimatic zone (Meidinger and Pojar 1991). In spring, caribou descend to closed-canopied forests within the lower ESSF and Interior Cedar-Hemlock (ICH) zones. In summer and fall, caribou return to the alpine-ecotone and even ascend into alpine areas. With the onset of snow in late fall and early winter, caribou descend back into the lower ESSF and ICH until sufficient snow accumulation and consolidation allows them to return to higher elevations and complete the annual migratory cycle.

This bimodal cycle of elevational migration creates temporal variation in predation risk for Columbia South caribou, particularly since landscape disturbance has increased the abundances of alternate prey (e.g. moose) and their predators (e.g. wolves) within valley bottoms. By using lower elevation forests during spring and early winter, caribou decrease their spatial separation from wolves and thus incur increased predation risk during these time periods (Stotyn 2008, Apps et al. 2013).

2.3 POPULATION SIZE AND TREND

Since 1975, population sizes have been estimated for areas containing portions of the current Columbia South range and estimates up to 1993 are reviewed McLellan et al. (1994). During the past 25 years, estimates of population size indicate that Columbia South caribou underwent a sharp decline in numbers during the late 1990s and early 2000s (Fig. 2). In 1994, the population was estimated to be 114 animals and by 2002, the population

had declined by 70% to 34 animals. In 2003, an experimental reduction in moose abundance was initiated within portions of the subpopulation's range in attempt to stabilize caribou numbers (Serrouya et al. 2015*b*). This management action, however, had limited success - in contrast to the Columbia North subpopulation, which appeared to stabilize – as Columbia South caribou have continued to decline over the last decade, with the most recent survey (2016) counting four caribou. Note that population estimates prior to 2002 were derived from mark-recapture methods using radio-collared animals while subsequent estimates represent the minimum number alive. Since 1994, the annual percentage of calves in the population has been variable (Fig. 3) although the 2016 survey observed no calves. Given its very small population size and lack of recent juvenile recruitment, the Columbia South is in imminent danger of extirpation and, indeed, may be functionally extirpated depending on the demographic composition of the remaining animals (i.e. the number of males and females).

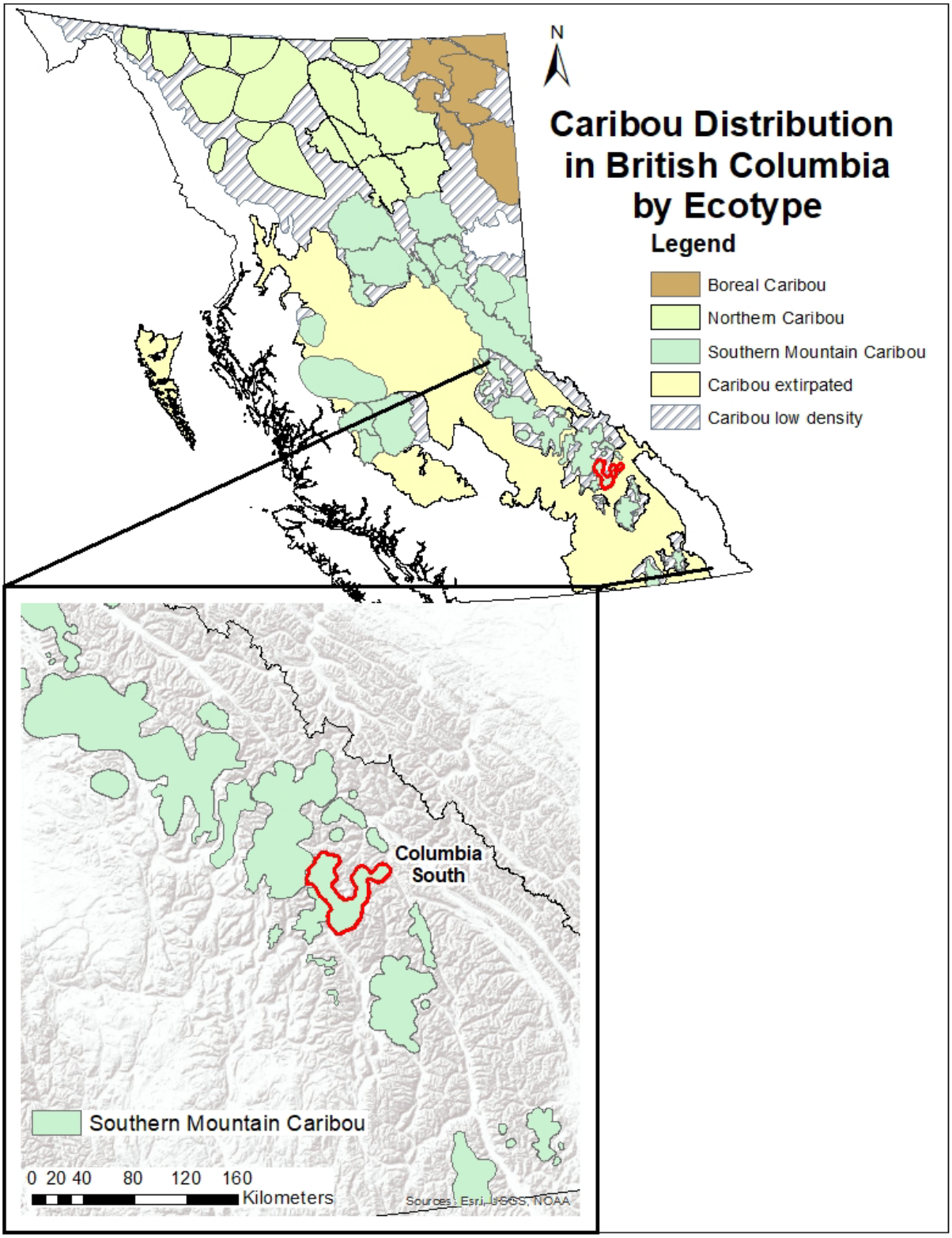

Figure 1: The geographical location of the Columbia South subpopulation of southern mountain caribou. The 1691 km^2 range (inset: red outline) is situated within the Kootenay Region of southeastern British Columbia.

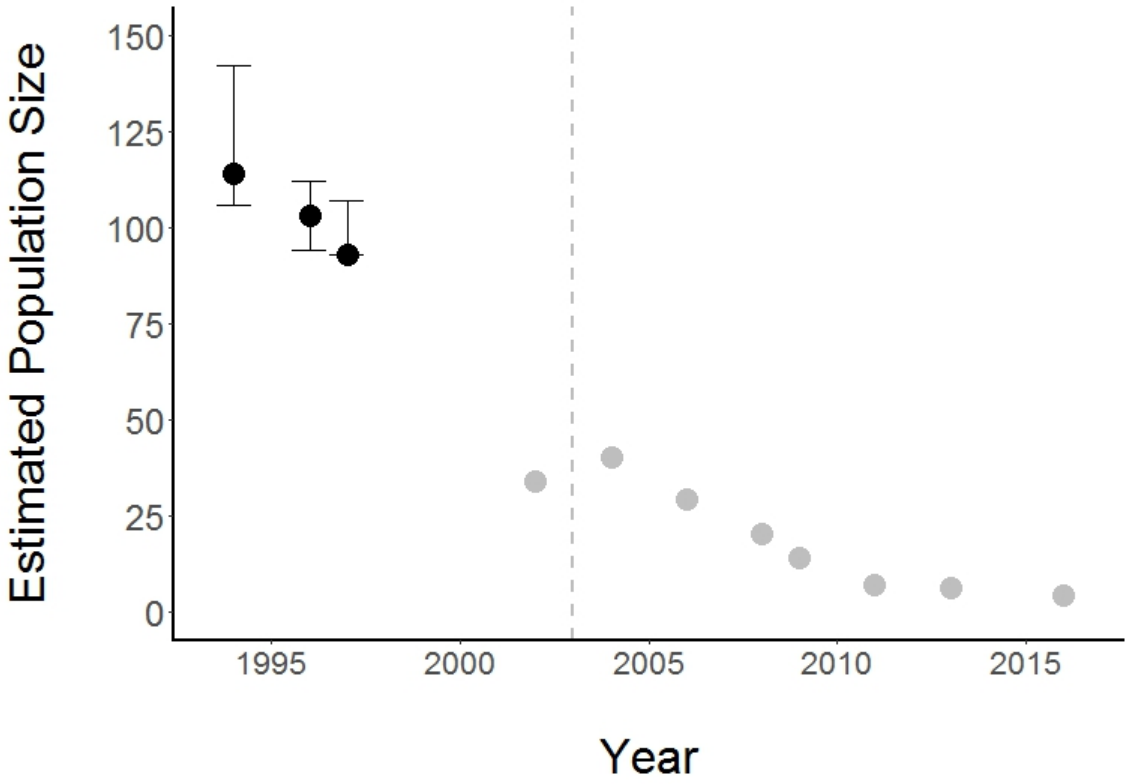

Figure 2: Estimates of population size by year for the Columbia South subpopulation of southern mountain caribou in southeastern British Columbia. Estimates with 95% confidence intervals (black circles) were derived from mark-recapture methods while those without (grey circles) were estimates of the minimum number alive (estimate includes observations of animals and track networks). Vertical dashed line indicates the onset of an experimental moose reduction program within this subpopulation's range.

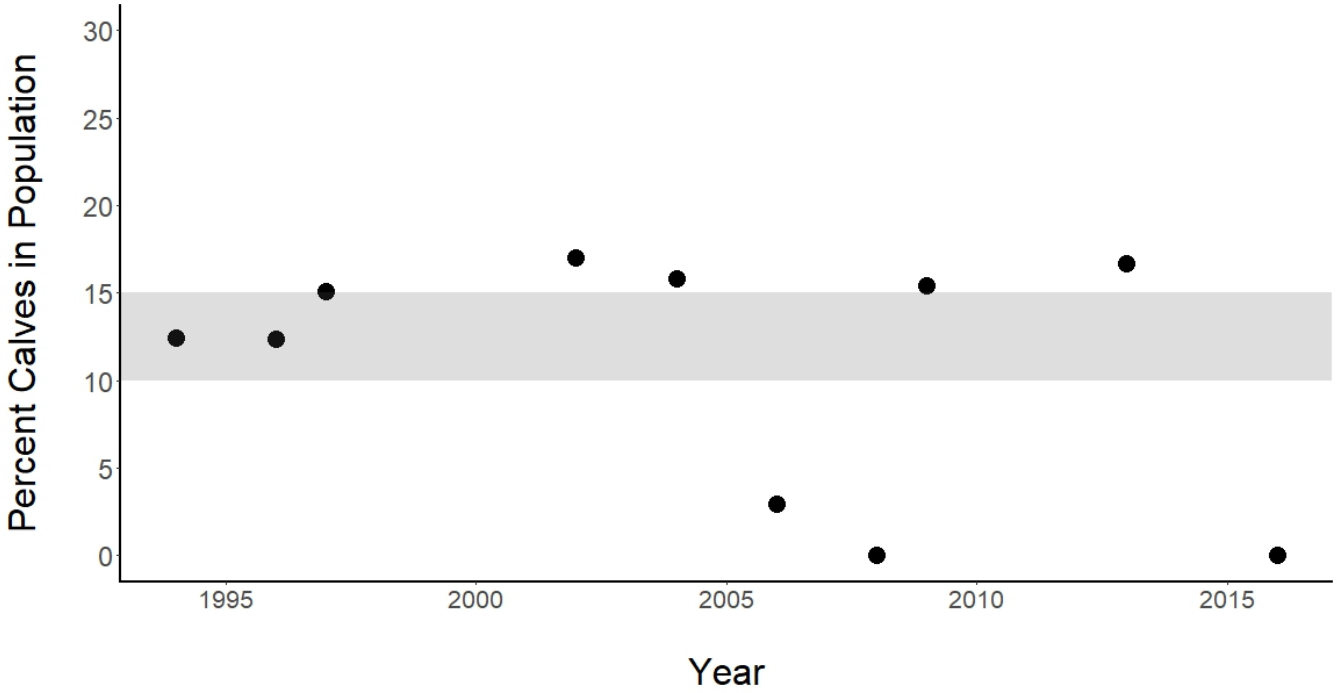

Figure 3: Annual estimates of the percentage of calves in the Columbia South subpopulation of southern mountain caribou in southeastern British Columbia. Estimates were derived from aerial surveys conducted during the late winter and thus calves are counted when they are ~8-10 months old. Horizontal grey bar represents the percentage generally associated with stable populations (Bergerud 1996, Environment Canada 2008).

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 and Boyce 2009, Festa-Bianchet et al. 2011, Environment Canada 2014). 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, effects of human activities and climate change have led to unsustainable rates of predation (McLoughlin et al. 2003, Wittmer et al. 2005*b*, 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 separates 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

Increasing rates of predation are the primary proximate cause of population decline in most woodland caribou herds (McLoughlin et al. 2003, Wittmer et al. 2005*b*, Apps et al. 2013). Increasing predation has been attributed to changes in the abundances and distributions of predators and alternate prey in response to human-mediated landscape alteration and climate change (Seip 1992, Latham et al. 2011*b*, Apps et al. 2013, DeMars and Boutin 2018). Hypothesized mechanisms relating increased predation to landscape alteration and climate change are detailed under *Section 3.3 Human Activities* and *Section 3.6 Climate Change*.

For Columbia South caribou, predation was a primary driver of population decline during the late 1990s and early 2000s (Wittmer et al. 2005*b*) and it was the dominant cause of mortality among radio-collared adult females monitored for various periods between 1985 – 2006 (Apps et al. 2013). By the mid-2000s, Stotyn et al. (2007) suggested that the proportion of deaths attributed to predation in the North Columbia Mountains, which includes the Columbia South range, had increased by 28% compared to the previous decade.

The primary predators of Columbia South caribou are bears (grizzly and black), wolves, cougars and wolverines (Wittmer 2004, Stotyn 2008, Apps et al. 2013). From 1992 – 2007, cougars accounted for the highest proportion of predation-related caribou mortalities within the Columbia South range (Apps et al. 2013), which mirrored an increasing trend in cougar predation within the entire North Columbia Mountains system over the last three decades (Simpson and Woods 1987, Flaa and McLellan 1999, Stotyn et al. 2007).

Wolf predation seemed to be rare prior to 2000 (Flaa and McLellan 1999, Stotyn et al. 2007) but has since become an increasingly important source of caribou mortality in the North Columbia Mountains (Stotyn et al. 2007, Apps et al. 2013, Serrouya et al. 2017*b*). This rise in wolf predation likely reflects an increasing wolf population responding to increasing moose populations (Serrouya et al. 2011, 2017*b*). Predation from wolverines has also occurred in the Columbia South subpopulation (Lofroth et al. 2007, Stotyn et al. 2007, Apps et al. 2013); however, given the low densities of wolverine (Lofroth and Krebs 2007), this mortality source is not likely a primary cause of recent declines in caribou populations.

3.2 FOOD LIMITATION

Spatiotemporal changes in the quality and quantity of food resources can influence the dynamics of caribou populations by directly affecting survival and reproductive rates (Parker et al. 2009). Woodland caribou are generally associated with old-growth habitats and food limitation may occur if such habitats are converted to early seral habitats (i.e. younger forest), which are avoided because of increased predation risk (Fortin et al. 2013, Serrouya et al. 2017*a*). Such avoidance behaviours may also result in caribou restricting their annual movements, leading to over-grazing of seasonal areas (Heard and Zimmerman 2017). Climate change may further affect food availability and quality; for example, an increase in rain-on-snow events may limit forage availability by increasing the probability of icing (Hansen et al. 2011).

For SM caribou, including the Columbia South subpopulation, evidence to date suggests that food limitation is not a primary factor in recent populations declines (Wittmer et al. 2005*b*, McLellan et al. 2012). Such evidence, however, does not preclude any food limitation effect. For example, risk-sensitive foraging in highly altered landscapes may increase predation risk for caribou if such behaviour causes them to become more predictable in time and space or more clumped in their distribution (Fortin et al. 2013, DeMars et al. 2016). Food limitations may also result in smaller calves, which could have increased predation risk (Adams et al. 1995). Determining the magnitude of such food limitation effects, however, is difficult in a high predation environment because predation may occur before effects on body condition become evident (Boutin and Merrill 2016).

3.3 HUMAN ACTIVITIES

Human activities within and adjacent to caribou range are believed to be a primary driver of current declines in woodland caribou populations (Wittmer et al. 2007, Environment Canada 2008, Sorensen et al. 2008, Johnson et al. 2015) . Such activities can impact caribou populations through multiple mechanisms including direct habitat loss, displacement from preferred habitats (Seip et al. 2007) and indirectly increasing predation (Apps et al. 2013, DeMars and Boutin 2018). This section focuses on impacts associated with industrial activities, recreational activities and other activities such as agriculture and roads.

3.3.1 INDUSTRIAL

Industrial activities include forestry, mining, oil & gas development and clean energy.

3.3.1.1 FORESTRY

Woodland caribou are an old-growth forest dependent species (Bergerud 2000) and are therefore affected by forestry practices. Logging of old-growth forests can result in direct habitat loss and an increase in the extent of early seral (or young) forest, which can increase the abundance and alter the distribution of other ungulates (e.g. moose) and their predators, potentially leading to increased caribou predation (Serrouya et al. 2011, 2015*b*).

Cutblocks can further increase predation risk for caribou if behavioural avoidance of these areas causes caribou to become more clumped in their distribution (Schaefer and Mahoney 2007, Fortin et al. 2013).

Forestry practices are thought to have had a significant impact on Columbia South caribou, primarily by directly and indirectly increasing predator abundances. [INSERT SENTENCES ON HISTORY OF FORESTRY PRACTICES WITHIN THE NORTH COLUMBIA MOUNTAINS]. By the 1990s and early 2000s, an increased extent of early seral forest from logging resulted in a significant increase in moose populations within the North Columbia Mountains (Serrouya and Poole 2007, Serrouya et al. 2011). Rising moose populations resulted in increasing wolf populations, subsequently leading to increasing wolf predation of caribou (Wittmer et al. 2005*b*, Apps et al. 2013). Cutblocks along with climate change may have also facilitated an increase in deer populations (Serrouya et al. 2015*b*, Dawe and Boutin 2016), resulting in higher cougar numbers and increasing caribou predation from cougars (Furk et al. 2008). Bear populations may have also been enhanced by an increasing extent of early seral forest, potentially leading to increasing predation from bears (Schwartz and Franzmann 1991). Linear features associated with forestry practices may have further increased predation risk from each of these predators by increasing the probability of caribou-predator encounter (Apps et al. 2013, Tigner et al. 2014, Serrouya et al. 2017*a*, DeMars and Boutin 2018*;* see also *Section 3.3.3.3 Linear Features* below).

[WOULD BE NICE TO HAVE A CURRENT ASSESSMENT OF FORESTRY IMPACTS HERE E.G. FOREST STAND AGES OR DISTRIBUTION OF CUTBLOCK EXTENT AND/OR CUTBLOCK AGES].

3.3.1.2 Mining

Impacts from mining primarily relate to direct habitat loss. The effective amount of habitat loss, however, can extend well beyond its physical footprint due to behavioural avoidance of areas surrounding mine infrastructure (Polfus et al. 2011, Johnson et al. 2015). As noted previously, impacts that limit the spatial distribution of caribou can potentially lead to increased predation risk (Fortin et al. 2013, DeMars et al. 2016). Related infrastructure such as roads may further increase predation risk by increasing predator hunting efficiency and facilitating predator movement into caribou habitat (Latham et al. 2011*a*, DeMars and Boutin 2018).

Within the Columbia South range, there is one gold mining project operating at the confluence of Carnes and McKinnon Creeks. Work on this project, known as the J &L Property, has been mostly exploratory with work to date primarily confined to underground drilling (http://minfile.gov.bc.ca/Summary.aspx?minfilno=082M++003).

3.3.1.3 Oil and Gas

Landscape alteration from oil and gas exploration and extraction can affect caribou populations through direct habitat loss and by indirectly increasing predation. As with other industrial impacts, avoidance behaviours by caribou can increase the effective extent of habitat loss (Dyer et al. 2001, Vistnes and Nellemann 2008) and limit the spatial distribution of caribou, potentially increasing predation risk (Fortin et al. 2013, DeMars et al. 2016). Oil and gas impacts may further increase predation risk by facilitating the expansion of alternate prey (e.g. white-tailed deer) into caribou range (Dawe and Boutin 2016). Linear features associated with oil and gas development may also increase predation risk by enhancing predator hunting efficiency and facilitating predator movement into caribou range (Dickie et al. 2017, DeMars and Boutin 2018; see also *Section 3.3.3.3 Linear Features* below).

There are currently no impacts from oil and gas development within the Columbia South range.

3.3.1.4 CLEAN ENERGY

Infrastructure related to clean energy production (e.g. hydroelectric facilities, wind power) can impact caribou populations through mechanisms similar to other industrial developments. Caribou may avoid such infrastructure with the degree of avoidance dependent on the degree of human activity (Mahoney and Schaefer 2002, Colman et al. 2013). Such avoidance can alter seasonal migration patterns (Mahoney and Schaefer 2002), which can result in negative demographic impacts (Bolger et al. 2008). Power lines associated with energy development can also increase predation risk for caribou because these features create relatively permanent early seral habitat that is favorable to other ungulates (e.g. moose, white-tailed deer) and provide movement corridors for predators (Latham et al. 2011*a*, Dickie et al. 2017).

The Revelstoke hydroelectric dam spanning the Columbia River is the major clean energy development within the Columbia South range. This dam affects Columbia South caribou through the creation of Lake Revelstoke although caribou are known to swim across the lake (R. Serrouya, *personal communication*).

There are no wind power developments within the Columbia South range.

3.3.1.5 OTHER

There are currently no other major forms of industrial development within the Columbia South caribou range.

3.3.2 RECREATION

Recreational activities conducted within caribou range 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). This section considers impacts related to snowmobiling and backcountry skiing as well as other activities such as hiking and mountain biking.

3.3.2.1 SNOWMOBILE

Among winter recreational activities, snowmobiling appears to have the highest impact on caribou, in part because the preferred areas for this activity overlap with the preferred winter habitat of caribou (Simpson and Terry 2000). Snowmobiling has been shown to displace caribou from preferred areas and the intensity of displacement – both in space and time – can depend on the intensity of snowmobile use (Simpson and Terry 2000, Seip et al. 2007). Snowmobiling may further induce physiological stress, potentially affecting individual fitness and population dynamics (Freeman 2008). Compacted trails from snowmobiles may also facilitate movement of predators into winter habitats of caribou, thereby increasing predation risk (Droghini and Boutin 2017).

Within caribou ranges north of Revelstoke, which includes the Columbia South range, impacts from snowmobiling were rated as high by Simpson and Terry (2000). During an aerial survey to census caribou in Columbia South, Furk et al. (2011) noted high levels of snowmobile activity at Sale Mountain and Keystone Creek / Standard Basin. Given the increasing popularity of snowmobiling and recent technological advances, impacts from this activity likely continue to be high.

3.3.2.2 HELI-SKI / CAT-SKI

Heli- and cat-skiing can have similar mechanistic effects on caribou populations as snowmobiling though the degree of impacts is considered to be lower, primarily because skiing generally occurs on slopes steeper than those preferred by caribou (Simpson and Terry 2000). Also, best management practices such as skiing at least

500-m away from observed caribou may reduce caribou-skier encounters (Huebel 2012) although the lack of compliance with these practices remains an issue (L. DeGroot, *personal communication*).

As with snowmobiling, impacts from heli-skiing were rated as high in caribou ranges north of Revelstoke by Simpson and Terry (2000). In 2008, best management practices for ski operators were implemented to reduce conflicts with caribou (Hamilton and Pasztor 2009), which may have resulted in lowered spatial displacement of caribou (Huebel 2012). The increased popularity of heli- and cat-skiing since 2000, however, suggests that impacts from these activities are still high within the Columbia South range. There are currently two heli-skiing companies operating within the Columbia South range (C. Legebokow, *personal communication*).

3.3.2.3 Summer Recreation

Recreational activities in the snow-free seasons can also impact caribou populations. Trails associated with off-road vehicles, hiking, mountain biking and horseback riding may facilitate predator movements into summer habitats used by caribou, potentially increasing predation risk (Whittington et al. 2011). Human presence on hiking trails may also induce physiological stress, though this response may attenuate if humans are not perceived as a predation threat (Lesmerises et al. 2017). All of these activities occur within the Columbia South range though the extent of these trails and their intensity of use has not been explicitly quantified.

3.3.2.4 Other

Columbia South caribou may also be impacted by backcountry skiing (i.e. ski touring). Simpson and Terry (2000) rated this activity's threat to caribou as low because of its non-motorized nature. However, as with other activities, its degree of impact is related to its intensity of use and the popularity of this sport has increased significantly in the last decade. Within the Revelstoke area, a recent increase in backcountry skiing has been noted within Mt. Revelstoke and Glacier National Parks, which are encompassed by the Columbia South range (Furk et al. 2011).

3.3.3 Other

This section considers other forms of human activity potentially impacting caribou populations, including agriculture, major highways linear features and hunting.

3.3.3.1 Agriculture

Agriculture can impact caribou populations through a number of mechanisms. First, conversion of forested areas to agriculture can result in direct habitat loss and avoidance behaviours by caribou may increase the extent of loss beyond the physical footprint (Vistnes and Nellemann 2008). Second, agricultural areas are generally favourable to alternate prey (e.g. deer and elk), potentially increasing their populations and those of predators, which ultimately may increase predation rates of caribou. Third, agriculture could increase the likelihood of disease and parasite transmission among domesticated animals, alternate prey and caribou although such links have not been established within British Columbia caribou herds (Vors and Boyce 2009, Martin et al. 2011).

There are no agricultural impacts within the Columbia South caribou range.

3.3.3.2 Major Highway Corridors

Major highways can constitute a direct source of mortality (i.e. road kill) for caribou and may further alter or impede caribou movements (Leblond et al. 2013). Although road kill of caribou is generally rare, it can become an increasingly important mortality source for small populations (Kinley and Apps 2001). With respect to movement impacts, the relative permeability of highways to caribou movement is inversely related to traffic

volumes (Leblond et al. 2013) and, as such, major highways with high traffic may lead to population fragmentation (Apps and McLellan 2006).

The Columbia South caribou range is impacted by two major highway corridors. The highest in terms of traffic volume is the Trans-Canada Highway, which runs along the ranges south and eastern borders. The other highway is Highway 23, which connects Revelstoke to the Mica Dam and generally has low traffic volume. Both highways can potentially impact Columbia South caribou during seasonal periods when these animals are at low elevations and along valley bottoms.

3.3.3.3 *Linear Features*

Industrial activities within forested systems are often accompanied by the creation of linear features such as roads, railways, power lines, pipe lines and seismic lines. Such features are thought to increase predation of caribou by increasing predator hunting efficiency (McKenzie et al. 2012, Dickie et al. 2017) and facilitating predator movement into caribou range (Whittington et al. 2011, DeMars and Boutin 2018). Linear features may further contribute to caribou-predator spatial overlap if such features facilitate the movement of alternate prey into caribou range (Dawe and Boutin 2016, Fisher et al. 2017).

Within the Columbia South range, the most prevalent forms of linear features are secondary roads associated with forestry (estimated length = 372 km; density = 0.22 km/km^2; data source: https://catalogue.data.gov.bc.ca/dataset/forest-tenure-road-segment-lines), and, to a lesser extent, power lines from hydroelectric facilities. The prevalence of linear features constitutes an elevated predation risk for Columbia South caribou. Using data from the Columbia South subpopulation, Apps et al. (2013) reported that the risk of predation by wolves and cougars increased with increasing road density.

3.3.3.4 *Hunting*

Historical records indicate that SM caribou have long been hunted by First Nations residing in southeastern BC (Spalding 2000). Following Euro-American settlement of the region in the late 1800s and early 1900s and the subsequent arrival of firearms, excessive harvest was likely a primary factor in suspected population declines of Columbia South caribou during the early 20th century (Spalding 2000). Licensed hunting for caribou has been closed in the Columbia South range for at least two decades. Currently, First Nations subsistence hunting is likely rare.

3.3.3.5 *Poaching*

The impact of illegal hunting (i.e. poaching) is unknown but is likely small (Environment Canada 2014).

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. Areas burned by fire may be avoided for up to 50 years (Dalerum et al. 2007) and the early seral habitat created post-fire may facilitate population increases in predators and alternate prey. 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 and Haeussler 2015, Apps and Dodd 2017) – 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 (Seip and Cichowski 1996, Hebblewhite et al. 2010).

Within the North Columbia Mountains where the Columbia South caribou range is situated, forest fires are infrequent (Johnson et al. 1990, Meidinger and Pojar 1991) and impacts from mountain pine beetle are minimal. During the 1980s, avalanche was the leading cause of mortality of adult mortality (Simpson and Woods 1987). Among radio-collared females (n = 27) monitored in the Columbia South range for various periods between 1985 – 2006, four of 16 mortalities were attributed as accidental, which includes those caused by avalanche (Apps et al. 2013). The extent to which Columbia South caribou are currently affected by avalanches is unknown.

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 (Klein 1991, Albon et al. 2002) 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, Kutz et al. 2005, Dobson 2009). 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).

Impacts from parasites and disease on the population dynamics of Columbia South caribou are not well studied. Evidence to date, however, 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 SM 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 SM caribou to access arboreal lichens (Kinley et al. 2007, 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. 2011*b*, Dawe and 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*.

For Columbia South caribou, potential effects of climate change on their population dynamics are not well understood although the expansion of white-tailed deer populations within the Kootenay region over the last half century may be partially due to climate change effects (Mowat and Kuzyk 2009, Dawe and Boutin 2016).

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. (2010) 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.

With only four individuals counted in 2016 (Serrouya et al. 2016), the Columbia South subpopulation has a high risk of negative impacts associated with its small size, including a high probability of extinction within the near future (Wittmer et al. 2010). Compared to other SM subpopulations situated further south which are highly isolated, the close proximity of the larger Columbia North subpopulation could provide a chance for demographic rescue (i.e. immigration) although documented rates of dispersal between these two ranges are extremely low (van Oort et al. 2011).

4 MANAGEMENT HISTORY

Over the past 15 years, a number of different entities have proposed management actions aimed at recovering SM caribou populations in British Columbia. In 2002, the Mountain Caribou Technical Advisory Committee outlined a strategy that emphasized identifying and protecting critical habitat, monitoring the size and movement of caribou populations, managing predators and managing the populations of other ungulate species (Mountain Caribou Technical Advisory Committee 2002). In 2004, an independent panel reviewing recovery of mountain caribou in the South Columbia Mountains suggested an adaptive management approach emphasizing protection of old-growth forests, population monitoring of caribou, reducing populations of predators and other ungulates, and limiting recreational activities in caribou range (Messier et al. 2004). The Mountain Caribou Science Team issued similar recommendations in 2006 and further suggested potentially augmenting small subpopulations and that habitat protection should promote connectivity among subpopulations (Mountain Caribou Science Team 2006). Three years later, Wilson (2009) outlined actions for managing predators and other ungulates within and adjacent to caribou range, including species-specific density targets. While these documents have collectively added to the understanding of caribou population dynamics and potential recovery actions, they are unified in their recommendations for the following three management actions:

i. Protecting and restoring sufficient habitat for caribou to carry out life history processes and reduce predation risk thereby ensuring long-term population persistence. Habitat protection generally has included managing recreational activities (e.g. snowmobiling and heli-sking) within caribou range.

ii. Managing the populations of other ungulate species.

iii. Managing predator populations.

These actions are also key components in the 2014 federal *Recovery Strategy* and in more recent reviews on management strategies for recovering populations of SM caribou (Environment Canada 2014, Boutin and Merrill 2016, Serrouya and McLellan 2016). Because of continued declines in most subpopulations and their current small population sizes, more direct measures for reinforcing populations – such as maternal penning – have been further suggested (Boutin and Merrill 2016, Serrouya and McLellan 2016). This section reviews management actions undertaken for the Columbia South subpopulation under these four broad categories: habitat management, predator management, alternate prey management, and population reinforcement.

4.1 HABITAT

Protecting and restoring sufficient habitat for caribou to carry out essential life processes and reduce predation risk is fundamental to achieving self-sustaining populations (Environment Canada 2014, Ray et al. 2015). SM caribou require large tracts of undisturbed habitat and have evolved to inhabit old-growth forests, which separates them – both in terms of elevation and horizontal space – from other ungulates and their generalist predators(Seip 1992, Rettie and Messier 2000, Apps et al. 2001). In the Columbia South range, deep annual snowfall dictates that caribou utilize old-growth forests at both high and low elevations, depending on the time of year (Apps et al. 2001). Spatial requirements for SM caribou also extend beyond areas of high use (i.e. habitat cores) and can include "matrix" habitat, of which there are two types (Environment Canada 2014). Type 1 matrix range are areas of relatively low use and such areas may include those used during migration. Type 2 matrix range are areas surrounding seasonal cores where predator-prey dynamics still affect caribou populations.

Impacts to caribou habitat are generally assessed at the range scale in a cumulative effects framework (Environment Canada 2008, 2014). The 2014 federal *Recovery Strategy* suggests that caribou populations have a higher probability of being self-sustaining when their range contains at least 65% undisturbed habitat (Environment Canada 2014). While such quantitative assessments have yet to be conducted for most ranges of SM caribou – including the Columbia South population, management actions have been enacted to protect old-growth forests within caribou range (Serrouya and McLellan 2016).

4.1.1 PROTECTION

Management actions to protect caribou habitat have primarily focused on protecting high-elevation winter habitat. In 2007, the *Mountain Caribou Recovery Implementation Plan* protect 2.2 million hectares within mountain caribou range and increased protection of high-suitability winter habitat from 65 to 95 percent (BC Ministry of Agriculture and Lands 2007). Within Mountain Caribou Planning Unit 3A, which includes the Columbia South range, approximately 188,578 hectares have been protected; however, this extent only covers 60-65% of remaining old-growth forests (Serrouya and McLellan 2016). For Columbia South caribou, much of the remaining unprotected old-growth habitats are low-elevation cedar-hemlock forests, which are valuable to the forest industry and continue to be logged (Serrouya and McLellan 2016). Current government protections, however, have limited logging to where the rate of forest regeneration appears to be exceeding the rate of forest harvest (Serrouya and McLellan 2016). The Columbia South range also has protected areas encompassed by Mount Revelstoke and Glacier National Parks.

4.1.2 ENHANCEMENT AND RESTORATION

Enhancement and restoration activities within ranges of SM caribou have been limited with management actions primarily focused on protecting caribou habitat. Within the Columbia South range, restoration from logging impacts (e.g. cutblocks) has primarily relied on standard re-planting practices and natural regeneration.

4.2 RECREATION AND ACCESS MANAGEMENT

In 2007, the *Mountain Caribou Recovery Implementation Plan* placed a moratorium on new commercial applications for recreational activities occurring within caribou habitats and further closed areas where recreational activities could potentially disturb and displace caribou (BC Ministry of Agriculture and Lands 2007). These restrictions have primarily applied to winter recreational activities such as snowmobiling and heli- / cat-skiing.

The *Mountain Caribou Recovery Implementation Plan* also implemented a five-year moratorium on new commercial backcountry recreation applications and recommended the development of best management practices for commercial backcountry ski operators. These practices, which include maintaining a distance of at least 500-m from observed caribou, were implemented in 2008. At this time, there are seven commercial backcountry ski operations within the Columbia South range.

4.2.1 SNOWMOBILE

Within the Columbia South range, snowmobiling is not permitted within Mount Revelstoke and Glacier National Parks. Snowmobiling closures (1 January – 15 April) also have been enacted in areas around Sale Mountain and Keystone Creek / Standard Basin (http://www.env.gov.bc.ca/fw/wildlife/snowmobile-closures/docs/85x11/snowmobile_closures_85x11_Standard-Peak-Sale-Mtn-Frisby-Ridge.pdf). These closures encompass the majority of high-value habitat within these areas (Serrouya and McLellan 2016). Outside of these closures, snowmobiling continues to be a popular activity in both areas (Serrouya and McLellan 2016).

4.2.2 HELI-SKI / CAT-SKI

The *Mountain Caribou Recovery Implementation Plan* recommended the development of best management practices for commercial backcountry ski operators. These practices, which include maintaining a distance of at least 500-m from observed caribou, were implemented in 2008 (Hamilton and Pasztor 2009). At this time, there are two commercial backcountry ski operations within the Columbia South range (C Legebokow, *personal communication*).

4.2.3 SUMMER RECREATION

Currently, there no regulations on summer activities (e.g. hiking, mountain biking) within caribou range.

4.2.4 OTHER

Backcountry ski-touring has become increasingly popular over the last twenty years. Within Mount Revelstoke National Park, a closure at Mt. Klotz was implemented in 2008 to minimize disturbance to caribou (Serrouya and McLellan 2016). Outside of the national parks, there are no restrictions on ski-touring within the Columbia South range.

4.3 PREDATORS

Actions aimed at managing predators may include liberalizing hunting and trapping quotas (Cluff and Murray 1995), diversionary feeding (Lewis et al. 2017), managing alternate prey (Serrouya et al. 2017*b*), and lethal control (Hervieux et al. 2014). Note that actions such as lethal control are controversial (Boertje et al. 2010, Lute and Attari 2017) and are generally considered short-term strategies used to sustain small and rapidly declining populations until the effects of habitat restoration and protection are realized (Wittmer et al. 2010, Hervieux et al. 2014).

4.3.1 WOLF MANAGEMENT

The primary management action for wolves in the Columbia South range has been an experimental reduction in moose abundance in the Lake Revelstoke valley. This action, initiated in 2003, liberalized moose hunting quotas, primarily to reduce herbivory on cedar plantations, but was subsequently transformed into an experiment to test this action as a recovery option for caribou (Serrouya 2013*a*). Reducing moose populations appeared to be successful as wolf numbers in the study area declined from 25-32 animals in 2007 to 11-17 by 2011 (Serrouya et al. 2015*b*, 2017*b*). Over the subsequent five years, wolf populations appeared to stabilize between ten and fifteen

animals (Bird et al. 2016). This size estimate equates to a summer density of 3.0 – 4.5 wolves / 1000 km^2 (the denominator consisting of the area potentially used by wolves in the snow-free season), which is within the threshold of ≤ 6.5 wolves / 1000 km^2 proposed by Bergerud and Elliot (1986) for caribou populations to be stable. Population responses by caribou to this management action, however, varied among ranges. While the Columbia North population appeared to stabilize, populations in Columbia South and Frisby-Boulder-Queest continued to decline, perhaps due to the small sizes of their starting populations (Serrouya et al. 2015*b*).

4.3.2 Cougar Management

Within the North Columbia Mountains, relative abundances of cougars have been monitored concurrently with wolves since the mid-2000s (Bird et al. 2010, 2016). Between 2006 and 2008, four individuals were radio-collared to assess space use and kill rates (Bird et al. 2010). Active management of cougars for caribou conservation, however, has been limited with only one cougar removed within the Columbia North range and none in Columbia South (L. DeGroot, *personal communication*). With cougar populations thought to be increasing in this system, recent recommendations have suggested more active monitoring of cougar populations and removing those individuals whose space use overlaps with caribou core areas (Serrouya and McLellan 2016).

4.3.3 Other

Within the context of caribou conservation, there have been no other management actions directed at other predators within the Columbia South range.

4.4 Alternate Prey

Managing the abundance and distribution of other ungulate species (e.g. moose and deer) has been a fundamental recommendation for recovering SM caribou (Mountain Caribou Technical Advisory Committee 2002, Messier et al. 2004, Mountain Caribou Science Team 2006, Environment Canada 2014, Boutin and Merrill 2016). Moose are currently the most abundant non-caribou ungulate within the range of Columbia South caribou, with deer and elk occurring at relatively low densities (Szkorupa and Mowat 2010, Serrouya 2013*b*, Poole et al. 2014).

4.4.1 Moose Management

Historically, moose were believed to be absent or at very low densities within the interior rainforests of BC, including the range of Columbia South (Bergerud and Elliot 1986, Spalding 1990, Seip 1992). Over the last 50-75 years, moose populations have increased in these areas, likely due to increasing landscape alteration from human activities (Rempel et al. 1997, Serrouya et al. 2011). By 2003, moose densities in the Lake Revelstoke valley were among the highest recorded in BC (1.58 moose / km^2; Hatter 1999, Poole and Serrouya 2003) and the point estimate of 1650 moose was over five times greater than the number of moose predicted to occur in a pristine landscape (e.g. no human disturbance; Serrouya et al. 2011).

As noted in *Section 4.2.1*, the Lake Revelstoke area underwent an experimental reduction in moose abundance (by liberalizing moose harvest) beginning in 2003 (Serrouya et al. 2015*b*). By 2009, this management action resulted in an approximate 70% reduction in moose abundance. From 2009 - 2013, the moose population was relatively stable at approximately 500 animals (Serrouya 2013*b*). In 2014, the moose population declined to 286 animals, equating to a density of 0.34 / km^2 (Poole et al. 2014). Preliminary results from the 2017 survey, however, have found higher calf: cow ratios than in previous years, suggesting that the population is rebounding (R. Serrouya, *personal communication*). To reduce negative effects on caribou populations stemming from apparent competition with high moose populations, Serrouya & McLellan (2016) have recommended continuing

limited entry hunts for antlerless moose to keep moose populations at their historical carrying capacity (~ 300 animals) within the North Columbia Mountains.

4.4.2 Deer Management

While mule deer have been historically present at low densities in the North Columbia Mountains, white-tailed deer have only recently expanded into the area in the last 50 years (Armleder et al. 1994, VerCauteren 2003). Deer populations can exhibit high year-to-year variability dependent on winter severity (Dawe et al. 2014, Fisher et al. 2017) and such fluctuations can impact caribou populations. In the late 1990s, an extreme winter caused deer populations to crash and over the subsequent 2-3 years caribou populations in North Columbia Mountains rapidly declined, presumably due to prey-switching by cougars (Serrouya et al. 2015*b*).

In 2010, expanding white-tailed deer populations prompted more liberalized hunting quotas (bag limit of two antlerless deer) in the Kootenay region (Region 4). These quotas, however, were reduced in 2016 (bag limit of one antlerless deer). Recent recommendations for managing caribou in the North Columbia Mountains have suggested that liberal hunting quotas be continued to maintain white-tailed deer at low densities (Serrouya and McLellan 2016).

No active management has been implemented to reduce mule deer populations in the North Columbia Mountains.

4.4.3 Other

Elk populations are generally considered to be small in the North Columbia Mountains and have not been subject to active management in the context of caribou conservation.

4.5 Population Reinforcement

To bolster small populations, management actions may include population reinforcement. Such measures include maternal penning, captive breeding, and translocation. Population reinforcement techniques are generally considered to be highly invasive, logistically difficult and expensive (Hayek et al. 2016).

4.5.1 Maternal Penning

Maternal penning is a captive-rearing technique where wild female caribou are captured in late-winter and confined to a predator-proof pen within their range to give birth (Hayek et al. 2016). Females and calves are retained in the pen for at least four weeks post-parturition. The main objective of maternal penning is to increase calf survival during the neonate period when predation rates are generally highest (Adams et al. 1995, Pinard et al. 2012). To effectively improve caribou population dynamics, the success of maternal penning depends on the proportion of the female population penned, the survival of penned females and calves post-release, and the survival of wild females and calves.

In 2014, maternal penning was initiated within the Nortth Columbia Mountains. Ten females from the Columbia North subpopulation were penned in 2014 followed by 18 in 2015, 12 in 2016, and 12 in 2017. Preliminary results from the project's first three years have been mixed. Only two of nine calves released the first year survived until ten months of age while nine of 15 calves survived the second year. In the third year (2016), only four of the eleven calves born survived to March 2017 with four calves dying in the pen prior to release (Revelstoke Caribou Rearing in the Wild Society 2017). Based on the project's first two years of results, Serrouya and McLellan (2016) concluded that while penning had a net benefit on calf recruitment in 2015, the

overall effect on the Columbia North subpopulation was limited (i.e., no increase in population growth rate) because the proportion of the population penned was small.

Maternal penning has not yet been used within the Columbia South range.

4.5.2 CAPTIVE BREEDING

Captive breeding is defined by Hayek et al. (2016) 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". To date, captive breeding of caribou has not been implemented as a management tool for conserving wild caribou populations.

There have been no captive breeding efforts undertaken for the Columbia South subpopulation.

4.5.3 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 South America and are reviewed in Bergerud and Mercer (1989) and Hayek et al. (2016).

There have been no translocations of other caribou into the Columbia South subpopulation.

4.5.4 OTHER

There have been no other forms of population reinforcement implemented for the Columbia South subpopulation.

4.6 STEWARDSHIP/OUTREACH

[NO IDEA WHAT TO PUT HERE....]

4.7 RESEARCH

Prior to the 1980s, there was limited information on the ecology of SM caribou with the few studies conducted relying on aerial and ground surveys, expert opinion and incidental sightings reported by the public (Stevenson and Hatler 1985). Over the last 40 years, however, a significant body of research has emerged from the North Columbia Mountains that has greatly increased the understanding of caribou behaviour and population dynamics. Within an area encompassing the Lake Revelstoke valley and portions or the current Columbia South range, the first study using radio-collared animals (n = 13) began in the winter of 1981 (Simpson and Woods 1987). This study assessed seasonal habitat use and movement of caribou, estimated population size and composition, and determined causes of mortality. From 1992-1998, radio-collaring of caribou (n = 47) in the North Columbia Mountains continued within an emphasis placed on evaluating population demography (e.g. population size and trend, survival rates, pregnancy rates and adult female-calf ratios) and causes of mortality (Flaa and McLellan 1999). During this time, populations in the Lake Revelstoke area were considered stable and the leading cause of mortality was avalanches. Radio-collar data from this period were also used to refine knowledge of habitat selection and evaluate occupancy patterns within the North Columbia Mountains (Apps et al. 2001, Apps and McLellan 2006).

In the late 1990s, suspected population declines of caribou in the Lake Revelstoke region prompted further studies. Wittmer et al. (2005*a*) continued using radio-collar data collected through 2002 to investigate population dynamics and provided the first delineation of current subpopulation ranges, including that of Columbia South.

These assessments also documented that predation was now the leading cause of adult female mortality (Wittmer et al. 2005*b*). Further research established links between human-mediated landscape alteration and increasing caribou predation (Wittmer et al. 2007, Apps et al. 2013).

Starting in 2003, the North Columbia system was subject to the first landscape-level experiment aimed at testing a potential management action for stabilizing and recovering caribou populations. This innovative study used an adaptive management approach to assess whether reducing populations of alternate prey (i.e. moose) could stabilize declining caribou populations (Serrouya et al. 2015*b*). For the Columbia North subpopulation, this management action appeared to be successful in stabilizing their numbers (Serrouya et al. 2015*b*), likely because it indirectly reduced wolf numbers (Serrouya et al. 2017*b*). For other smaller caribou subpopulations in the system (e.g. Columbia South), results were less promising as these populations continued to decline. Ongoing monitoring will be necessary to more fully evaluate the long-term efficacy of this approach.

The North Columbia Mountains continues to be a leader in testing recovery options for caribou, as evidenced by the recent initiation of the maternal penning project within the Columbia North range (Serrouya et al. 2015*a*). Suggested directions for future, adaptive management-based research include testing the simultaneous application of multiple management actions for stabilizing small and rapidly declining populations (Boutin and Merrill 2016, Serrouya and McLellan 2016).

4.8 MONITORING

Monitoring of caribou populations in the North Columbian Mountains has been ongoing since the mid-1970s. (Simpson and Woods 1987, Flaa and McLellan 1999, Serrouya et al. 2016). Over this time period, aerial surveys have been conducted every 1- 3 years to estimate population size, trend and composition. Although the Columbia South range was only formally delineated in the early 2000s (Wittmer et al. 2005*a*), estimates of population size and juvenile recruitment dating back to 1994 are available from previous survey data (McLellan et al. 2006, Serrouya et al. 2016; see also *Section 2.3 Population Size and Trend)*. Rates of adult female survival have also been monitored intermittently via radio-collaring studies conducted in the 1980s, 1990s and 2000s (Flaa and McLellan 1999, Wittmer et al. 2005*a*, Serrouya et al. 2017*b*).

Since the early 2000s, populations of moose and wolves in the North Columbia Mountains have also been monitored due to their influence on caribou population dynamics (Serrouya et al. 2015*b*, 2017*b*). For moose, an aerial survey to estimate moose population size and composition was conducted in the winter of 2002-2003 prior to the moose reduction experiment (see *Section 4.3.1 Moose Management*). From 2003-2014, annual estimates of moose population size were obtained through a combination of aerial surveys and pellet transects (Serrouya 2013*b*, Poole et al. 2014). A further aerial survey was conducted in the winter of 2017 (R. Serrouya, *personal communication*).

Increased wolf predation during the early-to-mid-2000s prompted the monitoring of wolf populations within the North Columbia Mountains during the mid-2000s. Surveys were initiated in 2007 and completed annually through 2012 then every two years thereafter (reviewed in Bird et al. 2016). Estimates of population size are based on a combination of animal observations and snow track surveys conducted from both the air and on the ground.

Expanding deer populations within the North Columbia Mountains has also prompted their monitoring in the context of caribou conservation. To date, monitoring has primarily relied on hunter harvest data, specifically catch-per-unit-effort indices (Serrouya et al. 2015*b*).

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*b*, 2017*b*). 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 require limits on these activities, which will invoke socioeconomic costs (Schneider et al. 2011). Limiting recreational activities such as snowmobiling and skiing within caribou range will likely create further socioeconomic costs. 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, 2012).

In many caribou ranges, reducing the current densities of other ungulate species will be fundamental to conserving caribou (Serrouya et al. 2015*b*). Lowered populations of big-game species such as moose and white-tailed deer 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*b*), 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

[LEAVING THIS FOR THE RELEVANT GOV FOLKS....]

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

The Columbia South subpopulation is at high risk of extirpation in the near future given its current small population size. Stabilizing and recovering this subpopulation will require the simultaneous deployment of multiple management actions. Because current declines of SM caribou populations are ultimately driven by landscape alteration, a core tenet of this action plan is the protection and restoration of suitable caribou habitat. Protecting and restoring habitat, however, is a long-term process as disturbed areas may take decades to recover to old-growth conditions conducive to caribou persistence. Interim management actions aimed at addressing the "symptoms" of landscape alteration (e.g. altered predator-prey dynamics) will therefore be necessary to stabilize Columbia South and population augmentation may be required to lower the risk of extirpation, at least until the effects of habitat protection and restoration are realized (Schneider et al. 2010, Wittmer et al. 2010). Such interim actions should be considered complementary to – and not replace – habitat protection and restoration as part of a comprehensive recovery plan.

Habitat protection and restoration will also be necessary for Columbia South to ultimately achieve self-sustaining status, which is a key objective contained in the federal *Recovery Strategy* for SM caribou (Environment Canada 2014) (Environment Canada 2014). The *Recovery Strategy* defines a population to be self-sustaining when it "demonstrates stable or positive population growth over the short term (≤20 years), and is large enough [> 100 individuals] to withstand random events and persist over the long term (≥50 years), without the need for ongoing active management intervention" (Environment Canada 2014). Attaining self-sustaining status can only be achieved by restoring the range conditions conducive to population persistence.

Effectively implementing the recommended actions to reach recovery objectives will require adaptive management. This approach involves using known information to select actions predicted to achieve a desired outcome, monitoring the response of such actions, then modifying management plans in response to new information. Having an adaptive approach will in part be necessary because the recommended management actions are generally linked. For example, reducing the amount of early seral habitat should result in a reduction of non-caribou ungulates, which in turn should result in a reduction of predators, thereby reducing the need for active predator control. Continued monitoring of population size and trend in caribou, other ungulates and predators will be necessary to effectively evaluate management actions.

Recommended Actions

1. *Caribou Habitat Protection*

- Conduct a cumulative effects assessment to quantify anthropogenic and natural disturbance within the Columbia South range. This assessment should include identifying disturbances that are permanent (e.g. highways, rural developing) and those that are likely to regenerate (e.g. cut blocks, fires). Quantifying disturbance impacts within caribou range will be necessary to inform the development of meaningful management targets for protecting and restoring caribou habitat.
- Increase protection of old-growth forests to 100% in delineated core areas.
- Maintain matrix conditions conducive to low populations of non-caribou ungulates and their predators. The extent of Type 1 and 2 matrix range and potential disturbance thresholds within these areas will be defined by the federal recovery process, in consultation with provincial agencies and relevant stakeholders; thus, more specific recommendations are deferred at this time.
- Close snowmobiling in all delineated core areas. Maintain current standard operating procedures for heli- and cat-ski operators.

2. *Population Augmentation*

- The current small size of the Columbia South subpopulation (minimum number alive = 4 in 2016) puts it at high risk for extirpation in the near future. Reducing this risk will require population augmentation by translocation, captive breeding and/or maternal penning. Note that augmentation efforts will likely have limited success if they are not implemented as part of a comprehensive management program that includes habitat protection, control of predators and alternate prey.
- If translocation is considered, donor caribou should be of the same ecotype (i.e. from the Southern group of SM caribou). Because many SM caribou herds are also small and declining, the number of potential donor herds is limited.
- Maternal penning should be considered in conjunction with translocation. The current small population size necessitates that all females should be penned. Doing so, however, has inherent risk because unforeseen catastrophes within the pen could potentially extirpate the entire population. Undertaking maternal penning will require careful consultation with experts in maternal penning and wildlife veterinarians.
- Given its current small population size, augmentation with 1-2 animals from other populations on a periodic basis should be considered to increase genetic diversity.

3. *Management of Other Ungulates*

- Continue management of moose populations to maintain densities at < 0.3 / km^2. This threshold is based on estimates of wolf-prey density relationships in the literature. For example, (Messier's (1994) numeric response model predicts that for wolves to be < 6.5 / 1000 km^2 – Bergerud and Elliot's (1986) threshold for caribou population stability – moose densities need to be < 0.13 / km^2. Wilson (2009) used Fuller's (1989) prey biomass equation to estimate moose densities of < 0.3 / km^2 for wolves to be < 6.5 / 1000 km^2. Bergerud (1996) has similarly suggested that caribou populations cannot persist when moose densities exceed 0.2 – 0.3 / km^2. These various approaches all suggest that caribou populations are more likely to persist in systems where moose density is < 0.3 / km^2. Moose, however, are not the only prey species for wolves in the

Kootenays. In multi-prey systems, Fuller's (1989) equation may be the most useful for defining targets for multiple ungulate species.

The extent of moose management should be expanded to include all Wildlife Management Units overlapping with caribou core areas and Type 1 and 2 matrix range.

- Liberalize white-tailed deer hunting to reduce densities and limit further expansion. Potential actions could include a mid-winter hunt for both sexes. The extent of this program should be expanded to include all Wildlife Management Units overlapping with caribou core areas and Type 1 and 2 matrix range.

4. *Predator Management*

- Continued monitoring and periodic active control of wolf populations when necessary to maintain densities at < 3 wolves / 1000 km^2 in caribou core areas and Type 1 and 2 matrix range.
- Conduct targeted removal of individual cougars spatially overlapping with caribou. Identifying such individuals may require a dedicated monitoring program (e.g. remote camera) or maintaining a sample of radio-collared caribou to determine causes of mortality.

8.1 Short Term (Within 6-12 Months)

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8.2 Medium Term (Within 12-24 Months)

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8.3 Long Term (Within 24-48 Months)

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