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

Central Selkirks Subpopulation

Central Kootenay 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

Central Selkirks caribou are a subpopulation of southern mountain (SM) caribou, an ecotype of woodland caribou federally designated as *Threatened* under the *Species at Risk Act*. SM caribou currently occur in 38 subpopulations 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 are further organized into 24 Local Population Units (LPUs), which reflect subpopulations that were historically contiguous. Central Selkirks caribou are part of the Central Kootenay 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 Central Selkirk subpopulation is situated in the Central Selkirk Mountains of southeastern BC (Fig. 1). The subpopulation's range encompasses the Nakusp and Duncan habitat cores, which at times were considered separate populations (e.g. Wittmer et al. 2005*a*) but this division is no longer warranted as aerial surveys over the last five years have consistently found caribou between the two units (DeGroot 2016). The Nakusp core is located in the Central Selkirk Mountains east of Upper Arrow Lake and the town of Nakusp. Its eastward extent encompasses Trout Lake and northward it extends to Glacier Galena Bay and the Beaton Arm of Upper Arrow Lake. The Duncan core encompasses the watershed of the Duncan River above the Duncan Reservoir in the Bugaboo Mountains, extending north to the boundary of Glacier National Park.

2.2 HABITAT AND BEHAVIOUR

The Southern group of SM caribou undertake seasonal migrations to cope with deep snowfall that dictates changes in forage availability. Across their distribution, this migratory behaviour can vary among subpopulations, particularly with respect to habitat use in early winter (Simpson et al. 1997). Potential explanations for this variation relate to differences in regional topography and snowfall (depth and timing of consolidation).

Central Selkirk caribou appear to have a migratory strategy that is intermediate to caribou residing in the North Columbia Mountains (e.g. the Columbia North subpopulation) and those residing in the South Selkirks (L. DeGroot, *personal communication*). In general, Central Selkirk 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 may descend to closed-canopied forests within the lower ESSF and Interior Cedar-Hemlock (ICH) zones, but the magnitude of this elevational descent appears to vary among individuals. For example, among nine individuals recently fitted with GPS radio-collars in March 2017, only four descended to 1000-m for one week in May while all other animals remained above 1600-m (L. DeGroot, *personal communication*). In summer and fall, caribou occur in the alpine-ecotone and even ascend into alpine areas. With the onset of snow in late fall and early winter, caribou may 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 Central Selkirk 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 potentially 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 the mid-1990s, the Central Selkirk subpopulation has had surveys every 1-3 years to estimate population size (Fig. 2). Starting in 1994, the minimum number of animals was estimated to be 148. From 1996-2002, a radio-telemetry study allowed for estimation using mark-resight methods (reviewed in Hamilton 2004). The first year using mark-resight methods yielded an estimate of 268 caribou, the highest estimate over the last two decades. Over the next six years, the population declined although 95% confidence intervals around point estimates were wide. From 2004 to 2012, the population remained relatively stable, varying between 76 and 102 animals (reviewed in DeGroot and Furk 2012). After 2012, the population began declining again with the most recent survey in 2017 estimating the minimum number alive to be 29 (DeGroot 2017). This recent decline has also been marked by low rates of calf recruitment (Fig. 3). Because no Central Selkirk caribou have been radio-collared during this recent decline, the proximate cause of apparently lowered caribou survival is unknown. To further understand movement patterns and mortality causes of Central Selkirk caribou, nine individuals were collared in March 2017.

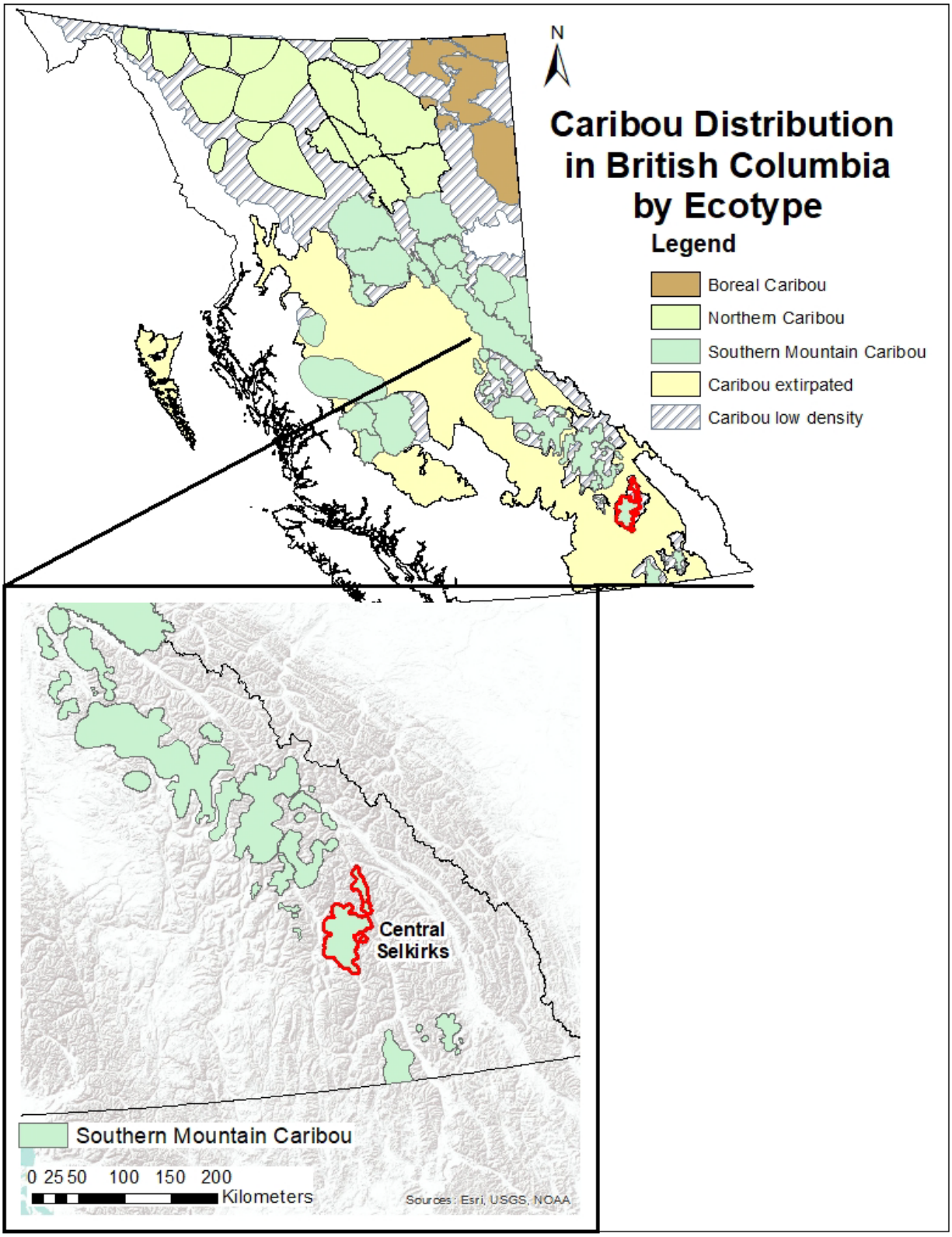

Figure 1: The geographical location of the Central Selkirks subpopulation of southern mountain caribou. The 2788 km^2 range (inset: red outline) is situated within the Kootenay Region of southeastern British Columbia.

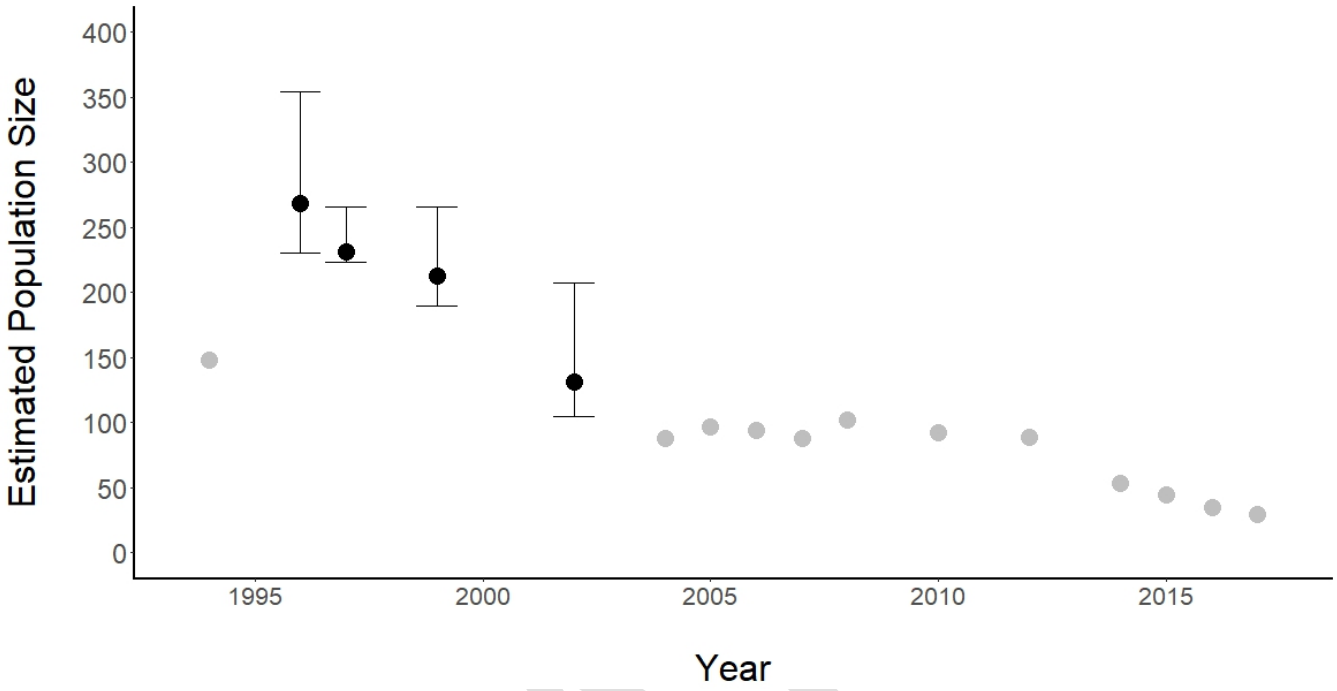

Figure 2: Estimates of population size by year for the Central Selkirks subpopulation of southern mountain caribou. Estimates with 95% confidence intervals (black circles with 95% confidence intervals) were derived from mark-recapture methods while those without (grey circles) were estimates of the minimum number alive (estimate includes observations of animals and track networks).

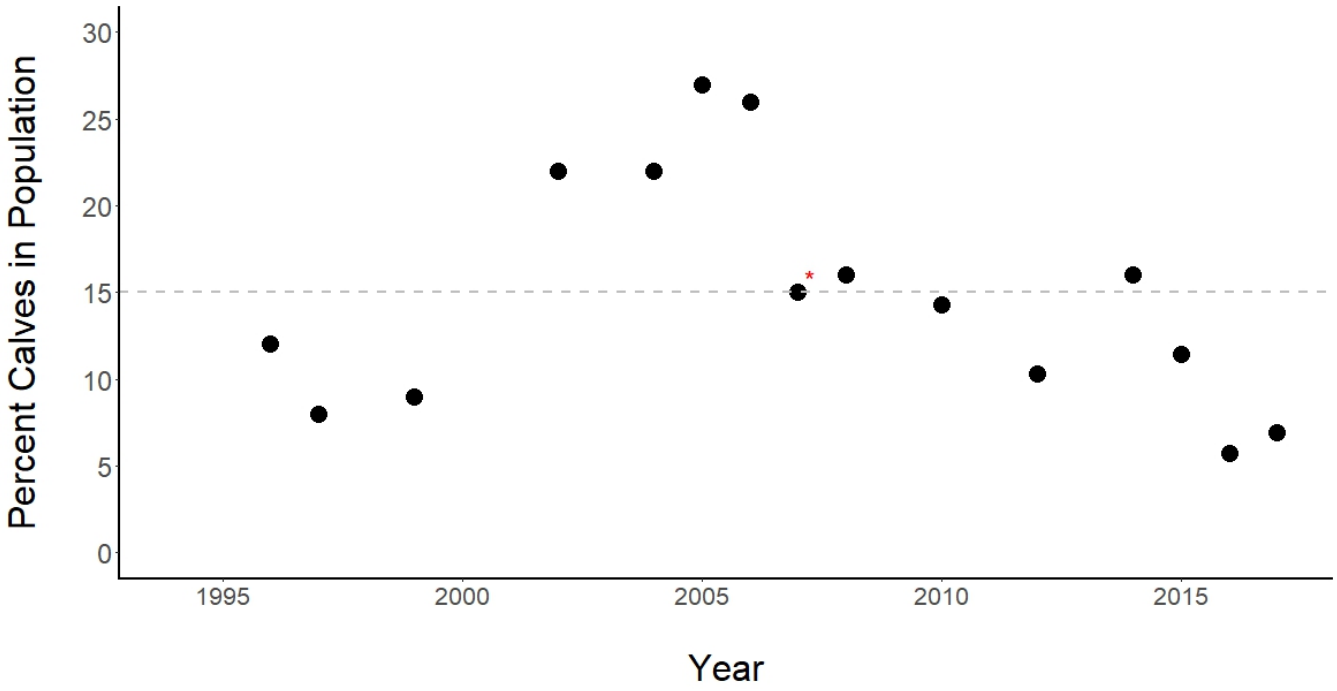

Figure 3: Annual estimates of the percentage of calves in the Central Selkirks subpopulation of southern mountain caribou in southeastern British Columbia. Estimates were derived from aerial surveys conducted during the late winter and thus calves are counted when they are ~8-10 months old. Horizontal dashed line represents the percentage generally associated with stable populations (Bergerud 1996). Note that in 2007 a small proportion of caribou observed on survey were not classified and thus the estimate for this year (red asterisk) represents a minimum.

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. An assessment of threat importance is contained in Table X. 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 decline in most woodland caribou populations (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 2017). 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 Central Selkirks caribou, increasing predation has been implicated as a main driver of population declines observed over the last two decades. Among radio-collared caribou (n = 39) monitored from 1995 – 2006, predation accounted for six of the nine mortalities where the cause of death could be determined (15 total mortalities, 6 causes unknown; Apps et al. 2013). Of these predation-caused mortalities, four were attributed to bears, one was attributed to cougar and one was caused by wolverine.

The recolonization of the Central Selkirks by wolves (Mowat 2007) has likely played a role in recent population declines of caribou. Initial predator surveys conducted in 2007 estimated a minimum population size of 30 wolves (Gaynor et al. 2007). While this survey did not formally estimate wolf density, this minimum number combined with the size of the Central Selkirks caribou range (2788 km^2) suggests that wolf densities at the time exceeded those associated with caribou population stability (e.g. $\leq$ 6.5 wolves / 1000 km^2; Bergerud and Elliot 1986). Subsequent surveys have suggested a decline in wolf numbers (23 – 27 wolves in 2009, van Oort et al.

2010; 12 in 2014, Clarke et al. 2014; and 9 in 2016, Clarke et al. 2016). These declines, however, may not equate to population stability of caribou as wolf predation may be additive to other predation sources (e.g. bears and cougars), potentially resulting in overall predation rates that are still high enough to drive caribou population decline.

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, 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 leading to over-grazing may result in lowered rates of pregnancy, parturition, and over-winter survival (Parker et al. 2009, Heard and Zimmerman 2017), which cumulatively can lower population resilience to other limiting factors such as predation. 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 2017). 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, a reduction in lichen availability (Stevenson 1979) 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). 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).

The Central Selkirks range has been impacted by logging practices. In 2003, Wilson and Hamilton (2003) estimated that > 8.4% of caribou range had been disturbed by either logging or fire between 1960 – 2000. The highest rate of forest disturbance occurred during the 1990s, which coincides with a period of sustained population decline for Central Selkirks caribou (Fig. 2). Wilson and Hamilton (2003) noted that the overall loss of caribou habitat with high suitability was negligible over this time period because the small amount of logging and/or burning within this habitat type was counterbalanced by forest regeneration. However, logging outside of caribou core habitat can still exert influence caribou demographics by altering the abundances of alternate prey and their generalist predators (Seip 1992, Wilson 2009).

Since the release of the *Mountain Caribou Recovery Implementation Plan* in 2007, logging has been severely restricted within high-suitability winter habitat and has resulted in the protection of >95% of currently demarcated core habitat within the Central Selkirks range (L. DeGroot, *personal communication*). Recent data from radio-collared animals, however, suggests that the delineation of caribou core habitat need to be revisited to include areas in Upper Halfway River drainage, Lake Creek and possibly the west side of Duncan Lake (L. DeGroot, *personal communication*).

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 2017).

The Central Selkirk Mountains have an extensive history of mining activities, as evidenced by relic mining roads and a few ghost towns. Current mine impacts include the MAX molybdemun mine located just south of the community of Trout Lake. This mine has a relatively small footprint as it is predominantly underground and traffic volumes associated with the mine are low as only one to two truckloads leave the mine per week. Exploration for potential new mines continues in the Central Selkirks with active exploration occurring on Great Northern Mountain and in the Gaynor Creek area (L. DeGroot, *personal communication*).

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. 2016, DeMars and Boutin 2017; see also *Section 3.3.3.3 Linear Features* below).

There are currently no significant impacts from oil and gas development within the Central Selkirks 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. 2016).

Two hydro dams are located adjacent to the central Selkirks range. The Duncan Dam is an earth-filled dam spanning the Duncan River and lies south of the Duncan habitat core. This dam was constructed to control water flow within the Columbia River Basin and has no power generation facilities. The Hugh Keenleyside dam spans the Columbia River 12 km north of Castlegar and its construction formed the Arrow Lakes reservoir on the western boundary of the Nakusp core. Power lines associated with this dam's power generating facility do not traverse the Central Selkirks caribou range.

There are no other clean energy facilities located within Central Selkirks range.

3.3.1.5 OTHER

There are currently no other major forms of industrial development within the Central Selkirks 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 degree 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).

Among backcountry recreation activities within the Central Selkirks range, snowmobiling ranked as "high" in terms of its probable threat to caribou (Simpson and Terry 2000). In the early 2000's, Wilson and Hamilton (2003) identified 344 km of trails and 324 km^2 of areas that were used by snowmobilers either on a daily or weekly basis. Within the Trout Lake area, snowmobile areas receiving daily use fell within areas known to be used by Central Selkirks caribou during the early winter.

In 2007, the release of the *Mountain Caribou Recovery Implementation Plan* closed many areas to snowmobiling within caribou habitat cores. Within the Central Selkirks, however, these closures only affected a small proportion

of caribou habitat (Silvercup Ridge and Hamling Lakes; http://www.env.gov.bc.ca/fw/wildlife/snowmobile-closures/). Consequently, revising the extent of closures is a high priority for management (L. DeGroot, *personal communication*).

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*).

Heli- and cat-skiing are increasingly popular activities within the Central Selkirks. In the early 2000's, Wilson and Hamilton (2003) estimated that 52% of the Central Selkirks caribou range was covered by commercial backcountry recreation tenures and that 48% of late winter telemetry locations for caribou were within these tenures. Wilson and Hamilton (2003) also reported that the number of skier-runs in two tenure areas had increased by 85% from 1992-3 to 2001-2. Because of these impacts, heli- and cat-skiing have been ranked "high" in terms of their probable threat to Central Selkirks caribou (Simpson and Terry 2000).

In 2008, best management practices for ski operators were implemented to reduce conflicts with caribou (Hamilton and Pasztor 2009). The popularity of heli- and cat-skiing and the relatively large spatial distribution of commercial recreational tenures, however, suggests that impacts from these activities remain high within the Central Selkirks range.

3.3.2.3 Summer Recreation

Recreational activities in the snow-free seasons can also impact caribou populations. Off-road vehicles trails and those associated with 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 Central Selkirks range though the extent of these trails and their intensity of use has not been explicitly quantified.

3.3.2.4 Other

Central Selkirks 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 (Lesmerises et al. 2018) and the popularity of this sport has increased significantly in the last decade. Since 2012, tracks from backcountry skiers have been recorded on every aerial census of Central Selkirks caribou, particularly within the southwest portion of the Nakusp core (DeGroot and Furk 2012, DeGroot 2014, 2016, 2017).

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).

Agricultural impacts within the Central Selkirks range are minimal although agricultural areas are present along the travel corridor of Highways #6 and #23, particularly near the community of Nakusp. Small areas of agriculture also occur near Meadow Creek on the southwestern boundary of the Nakusp caribou core.

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).

There are three highway corridors potentially affecting Central Selkirks caribou. The corridor with the highest traffic volume contains Highways #6 and #23, which traverse the eastern and southeastern boundaries of the Nakusp caribou core. Highway #6 intersects delineated caribou range north of the community of Nakusp and caribou may potentially interact with the highway when individuals seasonally descend to lower elevations. The Nakusp core is also bisected by Highway #31 near Trout Lake. This highway has generally lower traffic volume but caribou can potentially interact with the highway when travelling between the Lardeau and Duncan mountain ranges. The third highway is Highway #31A connecting the communities of New Denver and Kaslo. This highway lies > 13 km south of the Nakusp core boundary and thus caribou interactions with this highway corridor are likely rare.

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. 2016) and facilitating predator movement into caribou range (Whittington et al. 2011, DeMars and Boutin 2017). 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 Central Selkirks range, the most prevalent forms of linear features are secondary roads associated with forestry (estimated length = 896 km; density = 0.32 km/km^2; data source: https://catalogue.data.gov.bc.ca/dataset/forest-tenure-road-segment-lines), and, to a lesser extent, power lines. Compared to other woodland caribou ranges in western Canada, the density of linear features in the Central Selkirks is relatively low. This low density, however, still constitutes an elevated predation risk for Central Selkirks caribou. Using data from the Central Selkirks subpopulation, Apps et al. (2013) reported that the risk of predation by wolves and cougars increased with increasing road density. The spatial distribution of linear features also factors into predation risk as such features can facilitate predator movement into core caribou habitat, increasing the likelihood of caribou-predator encounters (DeMars and Boutin 2017).

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 SM caribou within the Kootenay region during the early 20th century (Spalding 2000). Harvest of caribou in the Central Selkirks was also rated as "fairly heavy" during the late 1960's and early 1970's (Stevenson and Hatler 1985). Licensed hunting for caribou was closed in the Central Selkirk Mountains in 1972 (Stevenson and Hatler 1985). Currently, First Nations subsistence hunting is likely rare.

3.3.3.5 POACHING

The current impact of illegal hunting is unknown but is likely small due to the relative remoteness of caribou habitat in the Central Selkirk Mountains (Environment Canada 2014); however, given the subpopulation's small size, any illegal take of the herd's remaining animals would have significant demographic impact.

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 Central Selkirk Mountains, the median return interval for forest fires is > 135 years (Courtney Mustaphi and Pisaric 2013). Using forest fire data available to 2015, the Central Selkirks caribou range has been minimally impacted by fires as areas burned < 50 years ago constitute approximately 8% of the range. Mountain pine beetle infestations have occurred within the Central Selkirk Mountains over the last three decades (Ebata 2003), potentially affecting forage availability, although their current impact on caribou is not known. Central Selkirks caribou are also subjected to mortality risk from avalanches though the degree of risk may be lower than for subpopulations residing in more northerly areas of the Interior Wet Belt (e.g. Columbia North) where snowfall is higher and the terrain is generally steeper.

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 Central Selkirks 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 research in the 1990s suggested that meningeal worm is not known to exist in the Selkirk Mountains, at least in the southern ranges (Foreyt and Compton 1991). For SM caribou, including the Central Selkirks subpopulation, diseases and parasites are not thought to be a major driver of current population declines (Environment Canada 2014, Wiles 2017).

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*.

The Central Selkirk subpopulation is situated at the southern extent of woodland caribou distribution in North America and as such has likely been impacted by effects of climate change. While such effects have not been explicitly quantified, climate is likely to have played a role in the expansion of white-tailed deer into the West Kootenay region (Dawe and Boutin 2016) and the establishment of elk populations (Szkorupa and Mowat 2010). These species likely support higher predator populations, which negatively impact caribou population dynamics by increasing predation rates.

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.

The recent sharp decline in population size has increased the risk of small population size effects for Central Selkirks caribou. With only 29 individuals counted in 2017 (DeGroot 2017), the Central Selkirks subpopulation now has a high probability of extinction within the next ten to twenty years if no management actions are taken (Wittmer et al. 2010). In addition, the subpopulation has become increasingly isolated and the probability of other caribou immigrating to the range (i.e. demographic rescue) is extremely low (van Oort et al. 2011, Serrouya et al. 2012).

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 North 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 Central Selkirk subpopulation under five broad categories: habitat management, recreation and access 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). 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 Central Selkirks population, management actions outlined in the *Mountain Caribou Recovery Implementation Plan* have been enacted to protect old-growth forests within caribou range (BC Ministry of Agriculture and Lands 2007).

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* protected 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 the Central Selkirks range, the protection of such habitat is estimated to be 90-95% although potential revisions include protecting areas in the upper Halfway River and Lake Creek drainages and possibly the west side of Duncan Lake (L.DeGroot, *personal communication*). The Central Selkirks range also contains Lew Creek Ecological Reserve and portions of Goat Range Provincial Park.

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 Central Selkirks 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.

4.2.1 SNOWMOBILE

Compared to other SM caribou ranges, the *Mountain Caribou Recovery Implementation Plan* resulted in only small areal closures to snowmobiles within the Central Selkirks range. These areas are located in the Silvercup Ridge and Hamling Lakes areas (http://www.env.gov.bc.ca/fw/wildlife/snowmobile-closures/). Because snowmobiling continues to be a popular activity in the Central Selkirk Mountains and many snowmobile areas overlap with areas known to be used by caribou (DeGroot 2017), revising the extent of closures is a high priority for management (L. DeGroot, *personal communication*).

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). Compared to other SM caribou ranges further south (i.e. Purcells South and South Selkirks), the Central Selkirk has much higher

impacts from heli- and cat-skiing. In areas such as the Great Northern Mountain and Kimbol Lake, heavy use by skiers may be displacing caribou from preferred winter habitats (DeGroot 2017). In 2002, proposals were made to close some areas to skiing but this action was not supported by industry stakeholders. Despite this lack of support, DeGroot (2017) recommended that select areal closures be given a high management priority to prevent caribou from abandoning areas of high habitat suitability.

4.2.3 SUMMER RECREATION

Currently, there no regulations on summer activities (e.g. off-road vehicles, hiking, mountain biking) within the Central Selkirks caribou range.

4.2.4 OTHER

Backcountry skiing (or ski touring) also occurs within the Central Selkirks. Tracks recorded during aerial surveys to census caribou indicate that most of this activity is focused in the southwest portion of the Nakusp habitat core near Summit Lake and the Kuskanax River drainage (DeGroot 2016, 2017*a*). In general, the intensity of skier use in these areas has been rated as low to medium. Currently there are no restrictions on backcountry skiing within the Purcells 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

In the last two decades, wolves have been recolonizing the southern Kootenay region after being functionally extirpated in the late 1960s (Mowat 2007). Because of potential impacts on caribou, monitoring of wolf populations within the Central Selkirks and other Kootenay caribou ranges began in the winter of 2006-2007 (Gaynor et al. 2007) and surveys to estimate minimum population size within the Central Selkirks have been conducted every 2 – 4 years through 2016 (Clarke et al. 2016). To date, the primary management action targeted toward wolves has been the liberalization of hunting regulations, which eliminated bag limits in caribou areas. Steep declines in population size of Central Selkirks caribou, however, has resulted in the recommendation that more targeted actions (e.g. removal of specific wolf packs) may be necessary to stabilize the caribou population (DeGroot 2017).

4.3.2 COUGAR MANAGEMENT

Compared to more southern caribou ranges (e.g. Purcells South and South Selkirks), cougar predation historically has had a small impact on Central Selkirks caribou with only one incidence of cougar predation being documented among 39 radio-collared caribou monitored during the 1990s and early 2000s (Apps et al. 2013). As part of the predator monitoring program initiated in the Central Selkirks in 2006-2007, cougar tracks have been recorded during surveys to estimate wolf abundance (Gaynor et al. 2007). The initial survey estimated a

minimum of three cougars in the Central Selkirks study area. By 2014, the estimated minimum number alive had risen to 10 -11 (Clarke et al. 2014). To reduce potential cougar impacts on caribou populations, hunting quotas for cougars in the Kootenay region have been liberalized in Wildlife Management Units overlapping caribou core habitats (two bag limit, one otherwise; female quota removed in 2014). Currently, there are no radio-collared cougars in the Central Selkirks to assess potential spatial overlap with caribou. To date, there have been no other management actions focused on managing cougars within caribou range (e.g. targeted removal of individuals preying on caribou).

4.3.3 OTHER

There have been no management actions targeted toward other predators (e.g. bears and wolverine) within the Central Selkirks caribou range.

4.4 PRIMARY 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). White-tailed deer, elk, moose and mule deer and all occur within the range of Central Selkirks caribou and are listed in descending order of relative abundance (Stent et al. 2009, Szkorupa and Mowat 2010).

4.4.1 MOOSE MANAGEMENT

Historically, moose were considered rare in the Central Selkirk Mountains (Spalding 1990, Kay 1997) but in recent decades their populations have been expanding, including within southeastern British Columbia (Serrouya et al. 2011). Data from the most recent aerial survey suggests that moose density is still relatively low within the Central Selkirks compared to other caribou ranges in the Kootenay region (0.12 / km2, Stent et al. 2009; 0.34 / km^2 in the North Columbia Mountains; > 0.20 / km^2 for WMUs within or near the South Purcells).

There has been no active management of moose in the context of caribou conservation within the Central Selkirks range.

4.4.2 DEER MANAGEMENT

No formal estimates for deer population sizes exist for the Central Selkirks. A habitat selection study suggested that deer, especially mule deer, were more abundant in the region than elk and moose based on track transects conducted during the winter of 2001-2002 (Poole et al. 2003). Since that study, harvest data suggests that white-tailed deer abundance has increased in the region as kill rates over the past decade have been three times higher for white-tailed deer versus mule deer (T. Szkorupa, *unpublished data*).

In response to expanding white-tailed deer populations within the Kootenay region, the government introduced liberalized hunting quotas including an antlerless season with a two bag limit implemented in 2012 (BC Ministry of Forests, Lands and Natural Resource Operations 2016). Note that these regulations were not implemented in the context of caribou conservation *per se*. In 2016, the antlerless bag limit was reduced to one due to suspected declines in white-tailed deer populations, particularly in the south Kootenay.

4.4.3 OTHER

Elk are also present within the Central Selkirk Mountains with their populations increasing over the last half century following repeated translocations to the Kootenay region (Szkorupa and Mowat 2010). Current estimates of elk population size within and adjacent to the Central Selkirks caribou range are primarily generated from expert opinion due to a lack of survey data (Szkorupa and Mowat 2010). Combining estimates of winter elk population size cited within Szkorupa and Mowat (2010) for Central Selkirk WMUs yields a population estimate of approximately 1000 elk.

There has been no active management of elk in the context of caribou conservation within the Central Selkirks range.

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.

To date, maternal penning has not been used to reinforce the Central Selkirk subpopulation.

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 Central Selkirk 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 North America and are reviewed in Bergerud and Mercer (1989) and Hayek et al. (2016).

There have been no translocation efforts undertaken for the Central Selkirk subpopulation.

4.5.4 OTHER

There have been no other forms of population reinforcement implemented for the Central Selkirks subpopulation.

4.6 STEWARDSHIP/OUTREACH

[NO IDEA WHAT TO PUT HERE....LEAVING THIS FOR GOVERNMENT FOLKS TO FILL IN]

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 Kootenay region that has greatly increased the understanding of caribou behaviour and population dynamics (e.g., Flaa and McLellan 1999, Kinley and Apps 2001, Wittmer et al. 2005*b*, 2007, Serrouya et al. 2015*b*).

For Central Selkirks caribou, insights into population size and distribution prior to the 1990s were limited to field observations, expert opinion and interviews (Stevenson and Hatler 1985). In the mid-1990s, a five-year radio-collaring study was initiated in the Central Selkirk Mountains to better understand local caribou ecology. This effort resulted in seasonal habitat suitability models and the first attempt to delineate caribou habitat for management purposes (Hamilton and Wilson 2003). This study also resulted in one of the first attempts to quantify the effects of backcountry recreation on caribou behaviour (Wilson and Hamilton 2003). Investigations of mortality sites of radio-collared caribou contributed to understanding dominant causes of mortality within the Central Selkirks (Apps et al. 2013).

With the caribou population rapidly declining in the Central Selkirks, future research will need to focus on testing recovery options in an adaptive management framework. Understanding the dominant cause(s) of current population decline will be critical to developing effective management strategies (Caughley 1994). To that end, nine caribou were fitted with GPS radio-collars in March 2017 to determine primary causes of mortality (DeGroot 2017).

4.8 MONITORING

Consistent monitoring of caribou populations in the Central Selkirks did not begin until 1992 when a radio-collaring study was initiated to better understand space use patterns and habitat selection (Hamilton and Wilson 2003). Two years later, the first aerial census was conducted to estimate population size and composition and such surveys have been conducted every 1-2 years through 2017 (DeGroot 2017). The initial radio-collaring study, which used VHF radio-collars, extended until 2003. Since this study's termination, no further radio-collars were deployed until March 2017 when nine individuals were captured and fitted with GPS radio-collars. The objective of this recent collaring program is to assess the causes of mortality currently driving population declines.

Monitoring of predator populations in the Central Selkirks began in 2007 (Gaynor et al. 2007) due to high rates of predation among radio-collared caribou (Apps et al. 2013) and the re-colonization of the Kootenay region by wolves (Mowat 2007). Predator track surveys were repeated in the winters of 2007-08, 2008-09, 2013-14 and 2015-16 (Clarke et al. 2016). These monitoring efforts have primarily focused on estimating the minimum population size of wolves although cougar tracks are also recorded. To date, there has been no radio-collaring of wolves or cougars in the Central Selkirk Mountains.

Population monitoring of other ungulate species has also been conducted within the Central Selkirk Mountains, though not necessarily in the context of caribou conservation. In 1999, a radio-collar study of mule deer was

initiated in the central West Kootenay and the study area covered portions of the Central Selkirks caribou range (Poole et al. 2003). In 2008, an aerial survey was conducted in portions of the Central Selkirks range to estimate the population size of moose (Stent et al. 2009). Ungulate populations are also monitored by harvest data and catch-per-unit-effort indices (T. Szkorupa, unpublished data).

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, elk, 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, elk 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

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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 stated recovery goal in the federal *2014 Recovery Strategy* for SM caribou is to achieve self-sustaining populations in all LPUs within their current distribution (Environment Canada 2014). In this document, a population is 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". Attaining self-sustaining status can only be achieved by restoring the range conditions conducive to population persistence.

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. Recently, the Central Selkirks subpopulation has undergone a steep decline in population size and the current trajectory suggests that these caribou will be extirpated before the effects of habitat protection and restoration are realized. Urgent actions are therefore needed to halt the decline and begin recovery. Such management actions should be viewed as interim and are aimed at addressing the "symptoms" of landscape alteration (e.g. altered predator-prey dynamics). These interim actions should be considered complementary to – and not replace – habitat protection and restoration as part of a comprehensive recovery plan. P***ublic support for other management actions may be limited if meaningful progress on the protection and restoration of caribou habitat cannot be demonstrated.***

Adaptive management will be required to effectively implement the recommended actions to reach recovery objectives. 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 Central Selkirks 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. Revise core areas based on recent telemetry data and aerial survey observations. These data have suggested extending protection to include a small hole in the upper Halfway River drainage.
- 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.
- Revise current restrictions on snowmobiling, heli-skiing and cat-skiing. These activities continue to have high overlap with core winter habitat for caribou. Maintain current standard operating procedures for heli- and cat-ski operators.

2. *Population Augmentation*

- The current population size of the Central Selkirk caribou herd makes it an ideal candidate for maternal penning, particularly if high rates of neonatal mortality are a contributing factor to population decline. In general, given the current population size, penning appears to be demographically most effective when > 60% of the female population is penned. However, prior to penning this high of a proportion, extensive consultations with past and existing maternal penning projects should be undertaken and a first year pilot study using a smaller number of individuals should be conducted.
- To maximize the demographic benefits of penning, ensure the implementation of other management strategies (see below) to enhance juvenile and adult female survival outside of the pen.

3. *Management of Other Ungulates*

- Because the Central Selkirks contain established populations of deer, elk and moose, specific density targets for each species will require relating estimated ungulate biomass to desired predator densities (e.g. < 3 wolves / 1000 km^2; see Fuller's (1989) equation for defining targets for multiple ungulate species). Such modelling of species-specific targets will also need to consider management objectives for big game hunting.

4. *Predator Management*

- Continued monitoring and periodic active control of wolf populations when necessary to maintain densities at < 3 wolves / 1000 km^2 in 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 traps) or maintaining a sample of radio-collared caribou to determine causes of mortality.

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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