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

South Selkirks Subpopulation

Southwest 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

South 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. South Selkirks caribou are part of the Southwest 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 South Selkirks subpopulation is situated within the South Selkirk Mountains in the southeastern portion of the province (Fig. 1). The current range of this subpopulation extends into northern Idaho and Washington, which constitutes the most southerly extent of caribou in North America. Historically, South Selkirks caribou ranged as far south as Salmon, Idaho but population declines over the last century have resulted in significant range retraction (Wiles 2017). This retraction has been particularly acute over the last five years as caribou occurrences south of the U.S.- Canada border have been rare with only one documented occurrence since 2011 (Wiles 2017).

The current BC portion of the range covers an area of 1296 km^2 and is bordered by Kootenay Lake to the north and east. Compared to other SM subpopulations, the South Selkirks range is relatively isolated with the closest subpopulation being Purcells South, whose range boundary is ~ 25-30 km to the east. The next closest subpopulation is the Central Selkirks, which is situated ~ 70 km to the north.

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).

Within the South Selkirks, caribou remain at relatively high elevations year-round, inhabiting old growth forests and parkland areas within the forest-alpine ecotone (Freddy and Erickson 1972, Kinley et al. 2007). This behaviour is likely linked to the comparatively drier climatic conditions in the South Selkirk Mountains compared to the deeper snow conditions found in other mountain ranges within BC's Interior Wet Belt (Simpson et al. 1997). With lower amounts of snowfall, South Selkirks caribou are able to forage on shrubs and ground lichens in early winter before switching to arboreal lichens when the snowpack has consolidated in mid- to late-winter (Kinley et al. 2003). This behaviour likely reduces seasonal variation in spatial overlap with predators compared to subpopulations that seasonally descend to lower elevations (Stotyn 2008).

2.3 POPULATION SIZE AND TREND

In the late 1800s, South Selkirks caribou were considered abundant, possibly numbering in the hundreds (Wiles 2017). By the 1950s, however, estimates of population size varied between 25 and 100 individuals, though these estimates were derived from ground-based track surveys and expert opinion (Freddy and Erickson 1972, Wiles 2017). In the early 1980s, sustained population declines of South Selkirks caribou reduced the herd to an estimated 25-30 animals, prompting their listing as *Endangered* under the United States *Endangered Species Act* in 1984. Because of this small population size, the South Selkirks range was augmented three times between 1987 and 1990, receiving a total of 60 translocated caribou (Compton et al. 1995; see *Section 4.5.3 Translocation* below). An additional 43 caribou were translocated between 1996 and 1998 (Almack 2000).

Since 1991, aerial surveys have been conducted annually except for one missed year in 2001 (reviewed in (DeGroot 2017). From 1991 to 2010, the population varied between 33 and 51 animals (mean = 42). After 2010, the population began to decline sharply with the most recent survey in 2017 counting 11 caribou. Trends in calf recruitment (survival to ~ 8-10 months of age) since 1991 have also suggested a declining population as the percentage of calves in the population (geometric mean from 1991 to 2017: 10.3%) has generally been below levels associated with population stability (~ 15%; Bergerud 1996). DeGroot (2017) suggested that the recent decline in caribou numbers correlates with an increasing wolf population in the South Selkirk region (see *Section 3.1 Predation* below).

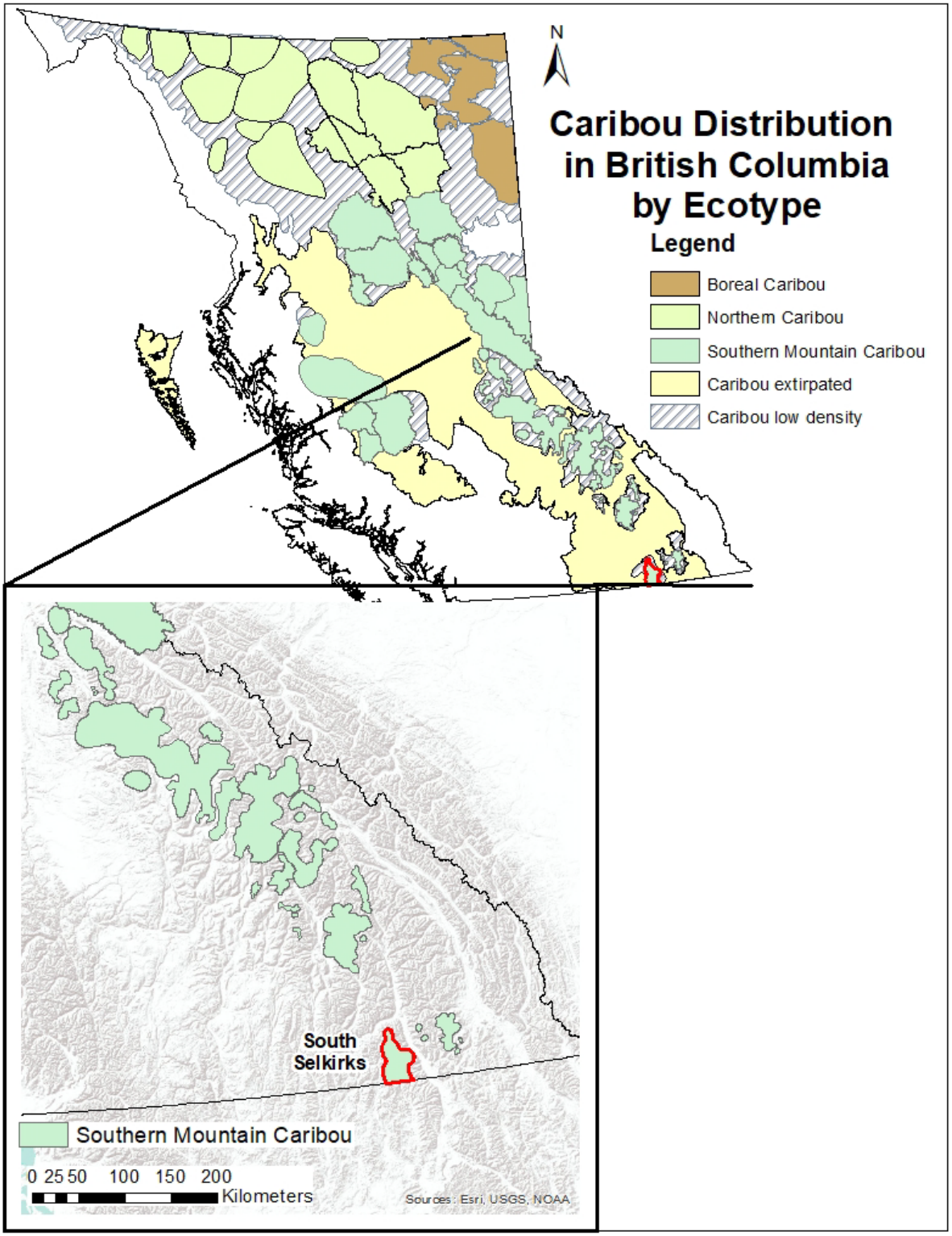

Figure 1: The geographical location of the South Selkirks subpopulation of southern mountain caribou. The subpopulation's range is situated in the southwestern portion of the Kootenay Region. Note that the range of this subpopulation extends into northern Idaho and Washington but only the British Columbia portion (1296 km^2) is shown (inset: red outline).

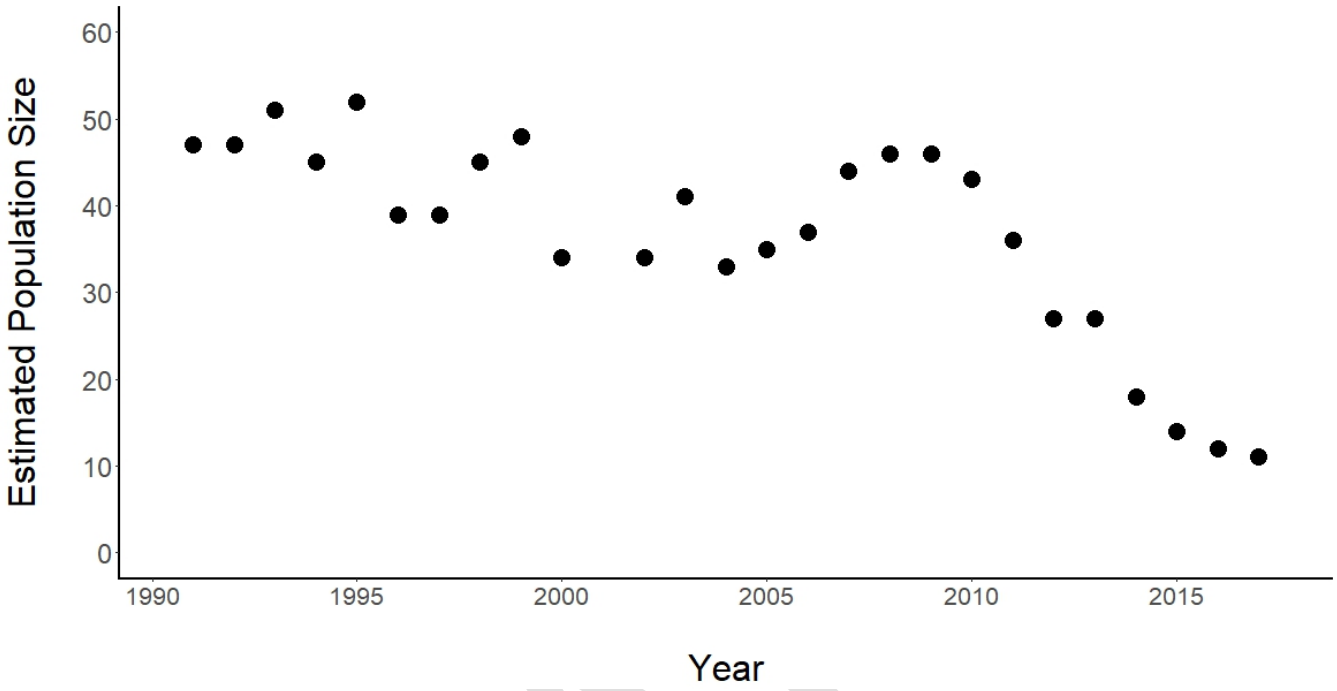

Figure 2: Estimates of population size by year for the South Selkirk subpopulation of southern mountain caribou in southeastern British Columbia. All estimates represent the minimum number alive (estimate includes observations of animals and track networks). Surveys after 2005 were conducted using both helicopter and fixed wing aircraft (DeGroot 2017).

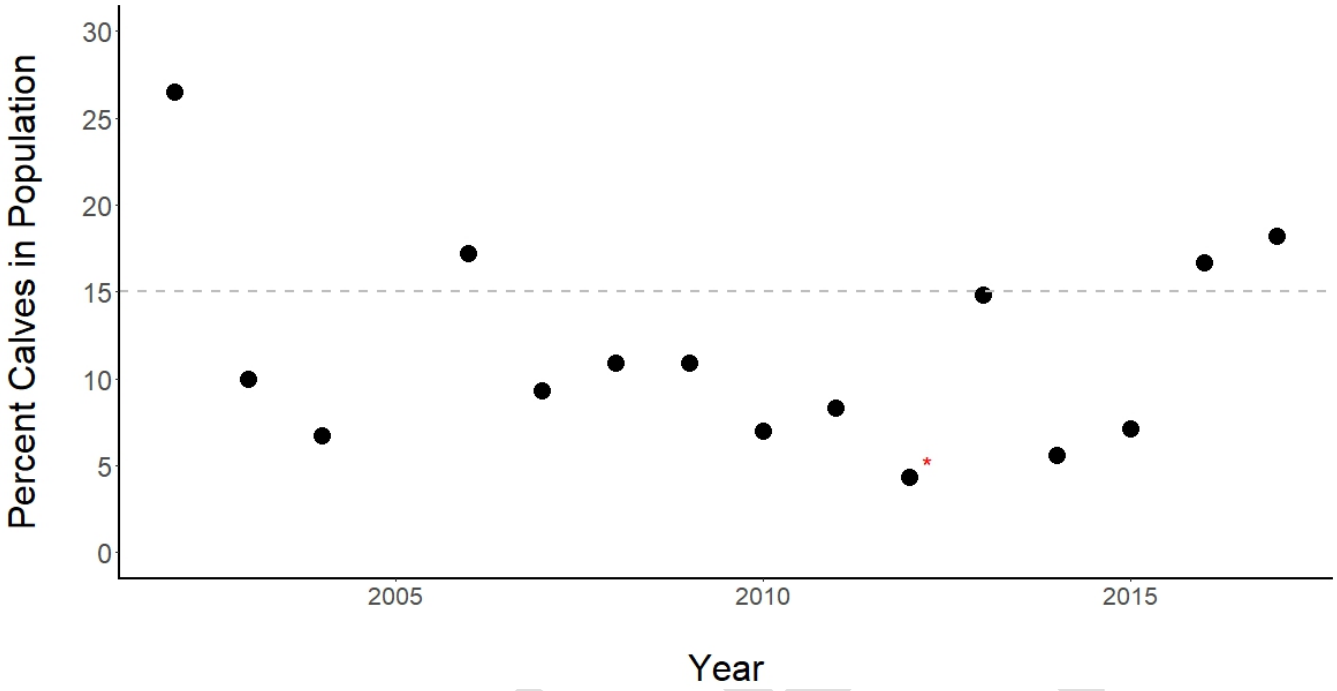

Figure 3: Annual estimates of the percentage of calves in the South Selkirks subpopulation of southern mountain caribou in southeastern British Columbia. Estimates were derived from aerial surveys conducted during the late winter and thus calves are counted when they are ~8-10 months old. Horizontal dashed line represents the percentage generally associated with stable populations (Bergerud 1996). Note that in 2012 (red asterisk) four caribou were not classified as adults or calves (DeGroot 2017).

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, 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, 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*.

In the early 1970s, predation was not considered to be a significant mortality factor for South Selkirk caribou with road kill and illegal hunting considered more important (Freddy and Erickson 1972). By the late 1980s, research on resident and translocated caribou found predation by cougars to be the dominant cause of known mortalities among radio-collared females (Compton et al. 1995, Apps et al. 2013). This trend continued through the mid-2000s (Apps et al. 2013). Prior to the mid-2000s, wolf predation was rare as wolves had been functionally extirpated from southeastern BC in the 1960s (Mowat 2007). However, over the last 20 years wolves have been recolonizing southeastern BC and consequently have begun to impact South Selkirk caribou. Of six caribou radio-collared in 2014, at least two have been predated by wolves and the recent population decline of South Selkirk caribou appears to coincide with an increasing wolf population in the area (DeGroot 2016). The high rate of decline in caribou numbers over the last five years further suggests that wolf predation is additive to cougar predation.

Other potential predators of South Selkirk caribou include grizzly bears, black bears, and wolverine. Bear predation has had a smaller impact on South Selkirk caribou compared to more northerly subpopulations (e.g. Columbia North). From 1985-2006, 117 caribou were fitted with radio-collars for various periods and during this time only two mortalities were attributed to bears (Apps et al. 2013). Grizzly bear density is considered to be low in the South Selkirks (< 23 bears / 1000 km^2; Mowat 2007, Mowat et al. 2013) and, consequently, is closed to hunting. Formal estimates of black bear density are unavailable for the South Selkirks. The drier climate of the South Selkirks suggests that black bear density should be lower compared to densities in the wetter North Columbia Mountains (Mowat et al. 2005).

Wolverine abundance is also relatively low in the South Selkirks. In 2012, a genetic mark-recapture study estimated a population size of 7-13 individuals (Kortello and Hausleitner 2012), which was similar to the 7-14 animals estimated by Lofroth and Ott (2007) using a habitat-based model. This low abundance of wolverines has translated into low impacts on adult caribou as no mortalities attributed to wolverine predation were recorded for South Selkirk caribou radio-collared (n = 117) between 1985 and 2006 (Apps et al. 2013). Wolverines, however, may have higher impact on caribou populations through their predation of neonate calves (Gustine et al. 2006) and proximate causes for low rates of calf recruitment within the South Selkirk subpopulation are not well understood.

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, 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). Nevertheless, because food limitation generally acts as a density-dependent mechanism (i.e. decreasing food with increasing animal density), it is unlikely to have driven the South Selkirks population to its current small size (n = 11).

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).

From the early 1900s to the 1970s, logging significantly impacted the South Selkirks range with old-growth forests progressively harvested from lower to higher elevations (Johnson 1976, Allen 1999). This period coincides with suspected population declines of South Selkirks caribou (Spalding 2000). In the 1970s, logging practices in the South Selkirks changed from clear cutting to partial cutting in an effort to protect caribou habitat (Stevenson and Hatler 1985*a*). In the last two decades, logging has been dramatically reduced in the South Selkirks caribou range (see *Section 4.1.1 Habitat Protection* below) and the amount of late seral forest appears to be increasing (Allen 1999, Wiles 2017). The *Mountain Caribou Recovery Implementation Plan*, released in 2007, severely restricted logging within high-suitability winter habitat and protected >95% of core habitat within the South Selkirks range (L. DeGroot, *personal communication*). Outside of these cores, small areas of logging and brush clearing still occur within lower elevation forests.

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).

Mining activities have impacted the South Selkirks range. From the early 1900 to the 1960s, the John Bull mine operated within a central portion of core caribou habitat in an area still used by remaining South Selkirks caribou (L. DeGroot, *personal communication*). Recently, a new company purchased the rights to the John Bull mine and is set to begin new test drilling, although all planned work is to be completed within the existing footprint.

There is also an extensive history of mining in the Salmo River Watershed on the eastern side of the South Selkirks range. Over the last 150 years, approximately 600 mines have operated for various periods within this region (Heinbuch 2000). The vast majority of these mines are abandoned although there is at least one galena mine currently operating near Ymir, BC on the fringe of caribou core habitat (L. DeGroot, *personal communication*).

Mining has also occurred in the western portion of the range. Currently, there are two to three rock quarries operating in the Porcupine Creek drainage within the Nature Conservancy of Canada's Darkwoods property (L. DeGroot, *personal communication*). One of these quarries is near the site for a proposed maternal pen for South Selkirks caribou (see *Section 4.5.1 Maternal Penning* below).

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 South 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).

There are no clean energy projects within the South Selkirks caribou range. Meteorological testing for wind farms were proposed about a decade ago on a number of ridges within the South Selkirk Mountains but these permits were subsequently cancelled (L. DeGroot, *personal communication*). Hydroelectric dams are present along major waterways adjacent to the South Selkirks range (e.g. Bonnington Falls dam near Nelson, the Boundary Dam on the Pend Oreille River) and two major powerlines running east to west bisect the middle of range (https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/accounts-billing/electrical-connections/bchydro-transmission-systems-map.pdf).

3.3.1.5 Other

There are currently no other major forms of industrial development within the South 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).

In the South Selkirk Mountains, conflicts between snowmobiles and caribou date back to the 1970s (Layser 1974). Among backcountry recreation activities within the South Selkirk range, snowmobiling ranked as "moderate-high" in terms of its probable threat to caribou (Simpson and Terry 2000). Within the British Columbia portion of the range, impacts from snowmobiling are likely much reduced since the release of the *Mountain Caribou Recovery Implementation Plan* in 2007, which closed snowmobiling within caribou core areas. Enforcement of this regulation, however, remains an issue (DeGroot 2017). In Idaho and Washington, snowmobiling is closed on approximately 97,000 ha of U.S. Forest Service land, although these closures continue to be challenged in court (Wiles 2017).

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*).

Currently, there does not appear to be any heli- or cat-skiing companies operating within the South Selkirk caribou range (L. DeGroot, *personal communication*) and future impacts are estimated to be low or non-existent because many potential heli-skiing areas do not overlap with caribou habitat (Simpson and Terry 2000). One heli-skiing company out of South Slocan, BC (Snowwater Heliskiing) does have a small tenure on Three Sisters within the South Selkirks range but in recent years there has been no evidence of this tenure being used (L. DeGroot, *personal communication*). Similarly, a cat-skiing company operating out of the community of Ymir, BC has applied for tenures on the Darkwoods reserve and Mount Elise but these applications have not been approved.

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 South Selkirks range though the extent of these trails and their intensity of use has not been explicitly quantified.

3.3.2.4 OTHER

South 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 and the popularity of this sport has increased significantly in the last decade. In particular, Stagleap Provincial Park is a popular for backcountry skiing and this area is heavily used during the winter by South Selkirks caribou.

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 South Selkirks range are minimal but agricultural areas in the adjacent valleys have likely had high influence on this subpopulation's population dynamics. The Creston Valley on the range's eastern boundary is a major agricultural area and known to support high populations of white-tailed deer and elk (Robinson and Clarke 2007*a*, Szkorupa and Mowat 2010, Stent and Clarke 2011), which in turn support higher populations that incidentally prey on caribou. Agriculture and urbanization also exists in the Nelson and Salmo areas and to a lesser extent along the Highway 6 / U.S. Highway 31 corridor.

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).

Among SM caribou, the South Selkirk subpopulation has a relatively high mortality risk from highways. The subpopulation's range is bisected by Highway #3 in British Columbia with a 7-km stretch of this highway travelling through a key habitat core situated on Kootenay Pass. Since 2009, at least four caribou have been killed from vehicular collisions (Wiles 2017), which given the herd's small size constitutes a high demographic impact. An additional factor contributing to caribou-vehicle collisions is the use of winter road salt, which attracts caribou to the highway. Despite steps taken to reduce caribou-vehicle collisions, including increased highway signage and the placement of salt licks away from the highway, the geographic location of the highway dictates that it will remain an area of high mortality risk for caribou.

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 South Selkirks range, the most prevalent forms of linear features are secondary roads associated with forestry (estimated length = 1956 km; density = 0.31 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 South Selkirks is relatively low. This low density, however, still constitutes an elevated predation risk for South Selkirks caribou. Using data from the South 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 South Selkirks caribou during the early 20th century (Spalding 2000). In the U.S., the subpopulation was legally protected from hunting in 1913 and licensed hunting was closed in British Columbia in 1957 (Wiles 2017). Currently, First Nations subsistence hunting is likely rare.

3.3.3.5 POACHING

Poaching (or illegal hunting) was considered to be a primary mortality factor for South Selkirk caribou in the early 1970s (Freddy and Erickson 1972) and incidences of accidental harvest were periodically reported until the 1990s (Wiles 2017). The current impact of illegal hunting is unknown but is likely small as there have been no known cases of poaching within this subpopulation since 1997 (Environment Canada 2014, Wiles 2017).

3.4 NATURAL DISTURBANCE

Caribou populations are subject to impacts from a number of natural disturbances. Being dependent on old-growth forests, caribou are impacted by forest fires. 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 South 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 South Selkirks caribou range has been minimally impacted by fires as areas burned < 50 years ago constitute only 10% of the range. Mountain pine beetle infestations have occurred within the South Selkirk Mountains over the last three decades (Ebata 2003), potentially affecting forage availability, although their current impact on caribou is not known. South Selkirks caribou are also subjected to mortality risk from avalanches though the degree of risk is likely 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 South 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 South Selkirk Mountains (Foreyt and Compton 1991). For SM caribou, including the South 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 South Selkirk subpopulation is situated at the extreme 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.

With only 11 individuals counted in 2017 (DeGroot 2017), the South Selkirks subpopulation has a high risk of negative impacts associated with its small size, including a high probability of extinction within the next ten years (Wittmer et al. 2010). In addition, the subpopulation is highly 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 South 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). In the South Selkirks range, caribou use mid- to high-elevation old-growth forests year round (Kinley et al. 2007). 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 South 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 South Selkirks range, the protection of such habitat is estimated to be 90-95% (L.DeGroot, *personal communication*). The South Selkirks range also contains Stagleap Provincial Park, an area highly used by caribou, and Darkwoods, a 55,000 ha reserve operated by the Nature Conservancy of Canada and also highly used by caribou.

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 South Selkirks range, restoration from logging impacts (e.g. cutblocks) has primarily relied on standard re-planting practices and natural regeneration. In the Darkwoods reserve, there are current efforts focused on deactivating legacy forestry roads (L. DeGroot, *personal communication*).

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

Since 2007, snowmobiling has been closed in many areas of caribou core habitat within the South Selkirks range (L. DeGroot, *personal communication*). Areas of closure may change annually depending on space use by caribou. For example, areas south of Highway #3 and east of Stagleap Provincial Park are now open to snowmobiling because South Selkirks caribou have not used these areas in the past 4-5 years (L. DeGroot, *personal communication*). Direct communication between government and snowmobiling groups has increased compliance with these closures in recent years, although snowmobile tracks continue to be observed in caribou core areas during aerial surveys (DeGroot 2016, 2017).

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). Within the South Selkirks range, impacts from heli- and cat-skiing are currently minimal to non-existent (L. DeGroot, *personal communication*) and direct management of these activities will not be necessary for the foreseeable future given the moratorium on new commercial backcountry recreation tenures within caribou habitats (BC Ministry of Agriculture and Lands 2007).

4.2.3 Summer Recreation

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

4.2.4 Other

Backcountry skiing is a popular activity within Stagleap Provincial Park, an area highly used by South Selkirks caribou. To date, the only restriction on non-motorized winter activities within the park is that dogs are not permitted from November 1 to April 30 to reduce stress on caribou. There are no restrictions on the number of skiers using the park nor are there areas closed to skiing because of potential impacts to caribou.

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 South Selkirks and other Kootenay caribou ranges began in the winter of 2006-2007 (Gaynor et al. 2007). In 2008, the government initiated a program whereby local trappers were provided support and financial incentives to increase trapping of wolves within the South Selkirks and Purcell South ranges (L. DeGroot, *personal communication*). This program was augmented in 2009 by liberalized hunting quotas consisting of no bag limits for wolves within Wildlife Management Units overlapping caribou range. In 2011, the supported trapping program was terminated as it was suspected to be ineffective in controlling wolf populations. In 2014, an estimated 25 wolves were thought to occur within the South Selkirks range and in response the government announced the targeted removal of up to 24 wolves by aerial shooting (BC Ministry of Forests, Lands and Natural Resource Operations 2015). This action resulted in the removal of 11 wolves in the winter of 2014-15 and nine wolves in 2015-16 (DeGroot 2016). The policy was continued in 2016-17 with an additional five animals removed (DeGroot 2017). Because demographic responses in small populations can be highly variable (Caughley 1994), it may take several years to adequately evaluate the effects of the current wolf removal program on South Selkirks caribou (DeGroot 2017).

4.3.2 Cougar Management

In the late 1990s and early 2000s, cougar predation was the main cause of mortality for radio-collared caribou in the South Selkirk herd (Apps et al. 2013). Harvest data from 1990-2015 suggests that cougar populations were highest in the early 1990s then declined through the late 1990s and early 2000s (T. Szkorupa, unpublished data). This decline coincides with findings from a demographic study conducted during the same time period (Lambert et al. 2006). Since 2005, harvest data suggest a relatively stable population. From 2011-2015, 21 cougars have been harvested from Wildlife Management Units overlapping the South Selkirks range. Cougars continue to be a primary cause of mortality for South Selkirks caribou, as evidenced by cougar predation of one of the six radio-collared females in 2014 (DeGroot 2016). In response, 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).

4.3.3 Other

There have been no management actions targeted toward other predators (e.g. bears and wolverine) within the South 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, mule deer and moose all occur within the range of South Selkirks caribou and are listed in descending order of relative abundance (Szkorupa and Mowat 2010, Stent and Clarke 2011).

4.4.1 Moose Management

Historically, moose were considered rare in the South Selkirk Mountains (Spalding 1990, Kay 1997) but in recent decades their populations have been expanding, including within southeastern British Columbia (Serrouya et al.

2011). Compared to other caribou ranges in the Kootenay region, current moose abundance is relatively low within the South Selkirk range. From 2000 – 2016, estimated moose densities varied between 0.02 and 0.18 / km2 within Wildlife Management Units overlapping the South Selkirk range (T. Szkorupa, *unpublished data*).

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

4.4.2 Deer Management

For the last 15 years, the South Selkirks has had formal surveys to estimate deer population sizes. Aerial surveys conducted in 2000, 2004 and 2007 suggested growing populations for both mule and white-tailed during this time (Robinson and Clarke 2007*b*). In 2007, estimated population sizes were 1161 and 1675 for mule deer and white-tailed deer, respectively. In 2011, a repeat survey yielded similar estimates (mule deer: 841, white-tailed deer: 1212), suggesting that the populations had stabilized over this four year period (Stent and Clarke 2011).

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 South Selkirk Mountains with their populations increasing over the last half century following repeated translocations to the Kootenay region (Szkorupa and Mowat 2010). This increasing population trend was particularly noticeable during the early 2000s when mid-winter elk populations quadrupled from 2000 to 2011 (~ 200 to ~ 800 animals), although relatively low calf: cow ratios recorded in 2011 suggested that population may have reach its ecological carrying capacity (Stent and Clarke 2011).

There has been no active management of elk in the context of caribou conservation within the South 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 South Selkirk subpopulation. However, given the critically low population size of South Selkirks caribou, maternal penning is being proposed for the spring of 2018 with a pen being constructed at high-elevation (~1700 m) within the Darkwoods reserve.

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 South 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).

Since the 1980s, the South Selkirks subpopulation has been augmented six times with translocated caribou. The first three augmentations occurred from 1987-1990 with a total of 60 animals translocated (24 in 1987, 24 in 1988 and 12 in 1990; Compton et al. 1995). For these translocated caribou, the weighted 5-year average survival was 74% with annual survival ranging from 65 to 94%. An additional 43 caribou were translocated between 1996 and 1998 (19 in 1996, 12 in 1997 and 11 in 1998; Almack 1998). Survival of these caribou varied among the three cohorts (uncensored survival to 2000 for the 1996 cohort = 21%, 1997 cohort = 38%, 1998 cohort = 81%; Almack 2000). In general, translocation efforts to the South Selkirks range provided temporary increases in population size but declines continued a few years after due to lowered survival among translocated caribou (Warren et al. 1996, Almack 2000, Wiles 2017).

4.5.4 Other

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

4.6 Stewardship/Outreach

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4.7 Research

Prior to the 1980s, there was limited information on the ecology of SM caribou with the few studies conducted relying aerial and ground surveys, expert opinion and incidental sightings reported by the public (Stevenson and Hatler 1985*b*). 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 South Selkirks caribou, initial observational studies began in the 1950s (review in Almack 2000) but one of the first studies investigating their abundance, habitat use and movements was conducted by Freddy and Erickson (1972) in the early 1970s. Because of its small population, suspected declining population trend and importance as a trans-boundary herd, research on South Selkirks caribou ecology and demography continued through the 1970s (e.g.

Johnson 1976) and 1980s (e.g. Rominger and Oldemeyer 1989). Research and monitoring using radio-collared animals began in the mid-1980s (Servheen and Lyon 1989). Data from these animals refined existing knowledge on habitat selection (Rominger and Oldemeyer 1989, Servheen and Lyon 1989) and identified landscape factors affecting survival rates and population demography (Apps et al. 2013).

The repeated augmentations of the South Selkirks subpopulation has yielded important research as to the viability of this management tool and considerations governing its implementation. Such research has demonstrated that habitat use and survival may vary depending on the ecotype of the translocated caribou (Warren et al. 1996) and that translocation efforts may not be successful long-term if the underlying cause(s) of population decline are not addressed (Compton et al. 1995).

With the South Selkirks subpopulation nearing extinction, future research will need to focus on testing recovery options in an adaptive management framework. Because of the South Selkirks' unique geographic location, such research will be critical in determining whether caribou can be sustained in southern landscapes which currently contain high diversity and abundances of predators and alternate prey.

4.8 MONITORING

Consistent monitoring of caribou populations in the South Selkirks did not begin until the early 1970s when aircraft were used in surveys to estimate population size (Freddy and Erickson 1972, Wiles 2017). Periodic surveys continued through the 1980s (Scott and Servheen 1985) with the frequency of monitoring increasing during the first translocation efforts in the late 1980s (Compton et al. 1995). Since 1991, annual aerial surveys have been conducted to estimate population size and trend (DeGroot 2017).

Radio-collaring of South Selkirks caribou began in the 1980s to assess and monitor space use patterns and to determine causes of mortality (Servheen and Lyon 1989, Compton et al. 1995). From 1985 to 2006, a total of 117 caribou were monitored with radio-collars for various time periods (Apps et al. 2013). Radio-collaring has continued through the 2000s and there are two radio-collared animals within the current population of 11 caribou (DeGroot 2017).

Monitoring of predator populations in the South Selkirks began in 1998 due to high rates of predation among radio-collared caribou (Clarke 2002). Initial monitoring efforts focused on cougars, which were the primary predator of caribou (Apps et al. 2013). By the early- to mid-2000s, predator monitoring expanded to include wolves as their populations were increasing into the South Selkirk Mountains. Since the winter of 2007-2008, predator surveys to assess distribution patterns and relative abundance have been conducted using a combination of ground-based transects and aerial surveys (Gaynor et al. 2007, van Oort et al. 2010). Recently, wolves have also been monitored by radio-collaring of individuals within packs (DeGroot 2016, 2017).

Population monitoring of other ungulate species has also been conducted within the South Selkirk Mountains, though not necessarily in the context of caribou conservation. Since 2000, the Columbia Basin Fish and Wildlife Compensation Program has been monitoring ungulate populations within Wildlife Management Units overlapping the South Selkirk Mountains (Stent and Clarke 2011). The last survey was completed in 2016 (T. Szkorupa, *personal communication*).

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.

The establishment of high populations of deer, elk, and to a lesser extent, moose in the last 50-75 years suggests that the southern Kootenay region has fundamentally changed from the system that historically supported SM caribou. These ecological changes likely reflect the combined influences of climate change, past management actions (e.g. elk translocations) and landscape alteration. Notably, most major valleys within the region have extensive agriculture and urbanization, permanent landscape changes that are generally conducive to high deer and elk populations. Given these biotic and abiotic conditions within the greater landscape, ***attaining self-sustaining status will be challenging for the South Selkirks subpopulation of SM caribou***. Nevertheless, the importance of the South Selkirks subpopulation as a trans-boundary herd is recognized and its continued persistence may be a management priority. For a small and rapidly declining population such as the South Selkirks, multiple management levers will need to be enacted simultaneously to stabilize and recover the population (Boutin and Merrill 2016, Serrouya et al. 2017*b*).

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 South 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.

- 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.
- Continue current restrictions on snowmobiling in all delineated core areas. Maintain current standard operating procedures for heli- and cat-ski operators.

2. *Population Augmentation*

- The South Selkirk herd has been supported previously by translocations but the long-term benefits have been limited, likely because habitat conditions remained unchanged within the South Selkirks range and populations of predators and alternate prey were high (Boutin and Merrill 2016). ***Future 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.
- For maternal penning, the current population size necessitates that most, if not 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.
- If only maternal penning is used, periodic augmentation with 1-2 animals from other populations should be considered to increase genetic diversity.

3. *Management of Other Ungulates*

- Reducing deer, elk and moose densities to levels conducive to caribou persistence will be challenging in the South Kootenays given the collectively high populations of these species. Moreover, severe reductions in the populations of these species may be socially and politically unacceptable. ***Failure to effectively reduce the abundance of these species, however, will likely require the long-term application of predator control to maintain caribou populations within the region.*** If sociopolitical acceptance can be obtained for reducing non-caribou ungulate populations, at least for Wildlife Management Units within and adjacent to caribou range, then setting specific density targets for each species will require relating 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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