

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

Purcells South Subpopulation

Southeast Kootenay
Local Population Unit



BRITISH
COLUMBIA

Recommended Citation:

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EXECUTIVE SUMMARY

DRAFT

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1 BACKGROUND

1.1 INTRODUCTION TO THE PROGRAM

2 POPULATION DESCRIPTION

Purcells South 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. Purcells South caribou are part of the Southeast 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 Purcells South subpopulation occurs within the southern extent of the Purcell Mountains in the southeastern portion of the province (Fig. 1). This subpopulation was once part of a larger, continuous population inhabiting the entirety of the Purcell Mountains range (Stevenson and Hatler 1985, Spalding 2000). By the late 1990s and early 2000s, this range had contracted significantly and the once continuous population had fragmented, leaving two extant subpopulations, Purcells South and Purcells Central (Wittmer et al. 2005a). The Purcells Central subpopulation is now considered extirpated (Environment Canada 2014).

The current range (~ 772 km²) of Purcells South consists of five core areas (Wittmer et al. 2005a) and is bordered by the St. Mary's River to the north, Kootenay Lake to the west, the Moyie River drainage to the east and Highway #3 to the south. This distribution represents the most southeastern extent of SM caribou. Among SM subpopulations, the Purcells South range is relatively isolated with the closest subpopulation being the South Selkirks, whose range boundary is ~ 25-30 km to the west. The next closest subpopulation is the Central Selkirks, which is situated ~ 85 km northwest.

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).

Purcells South caribou remain at relatively high elevations year-round (Apps and Kinley 2000), a behaviour similar to caribou in the South Selkirk subpopulation but distinct from those subpopulations located in the northern mountains of BC's Interior Wet Belt (Simpson et al. 1997). The ability to remain at high elevations year round is likely linked to the comparatively drier climatic conditions in the South Purcell Mountains (Simpson et al. 1997, Kinley and Apps 1999). With lower amounts of snowfall, Purcells South 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

Since 1993, the Purcells South subpopulation has received consistent annual to biennial aerial surveys to estimate its population size (Fig. 2). The highest estimate occurred in 1995 ($n = 77$) after which the population underwent a steep decline until 2000 (reviewed in DeGroot 2017). This decline was attributed to increasing cougar predation ultimately facilitated by increasing landscape disturbance (Kinley and Apps 2001). Over the last decade, the population has varied between 10 and 20 animals. The most recent survey in 2017 estimated 15 to 16 caribou (DeGroot 2017a). The relative stability of the Purcells South population over the last decade is likely driven by high survival of adult females as calf recruitment (survival to ~ 8-10 months of age), as represented by the percentage of calves in the population (geometric mean since 2000: 9.8%), has generally been below levels associated with population stability (e.g. 15%, Bergerud 1996; Fig. 3). Indeed, this low rate of recruitment may be preventing the population from increasing beyond its current size.

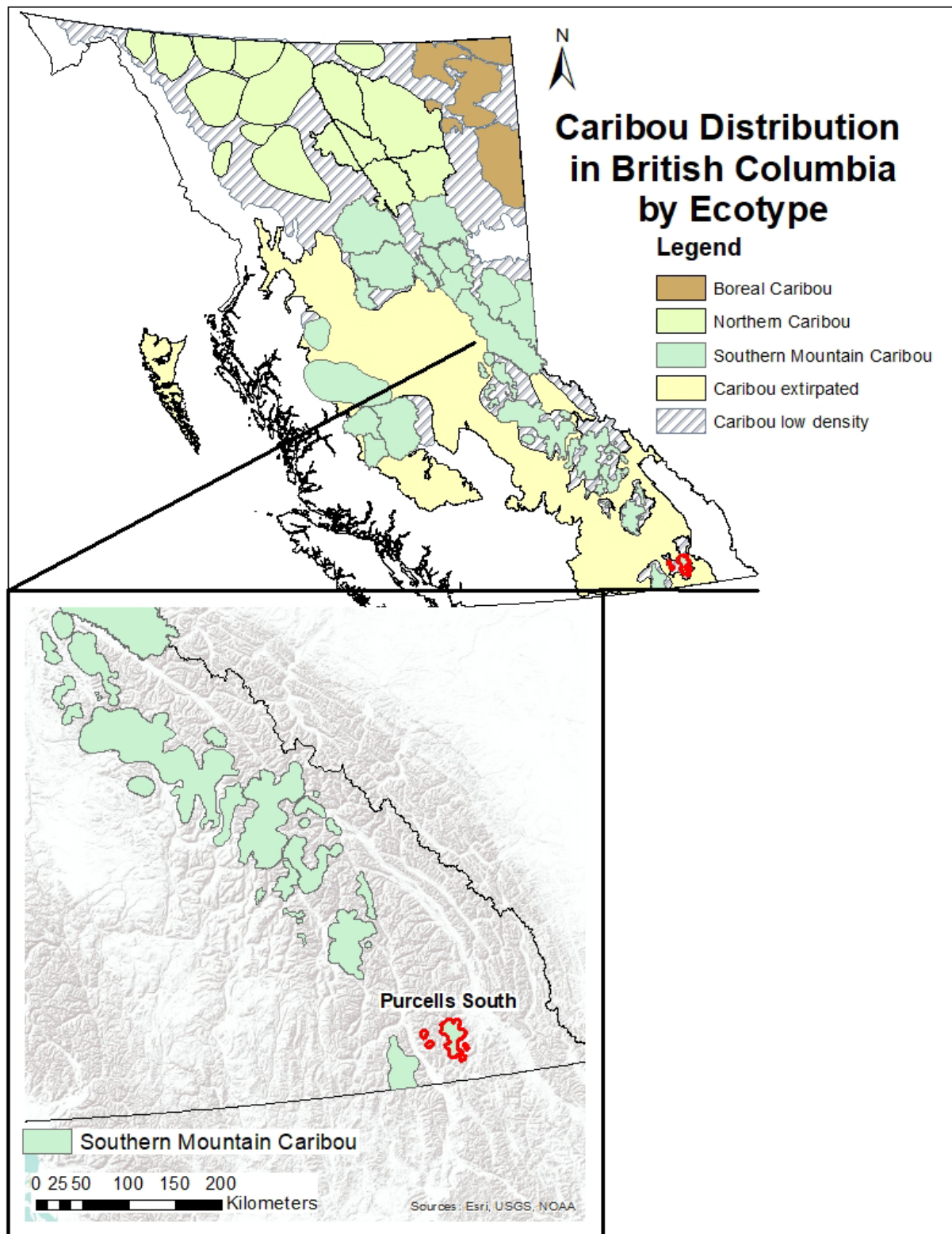


Figure 1: The geographical location of the Purcells South subpopulation of southern mountain caribou. The subpopulation's range ($\sim 772 \text{ km}^2$) is situated in the southeastern portion of the Kootenay Region and consists of five core areas.

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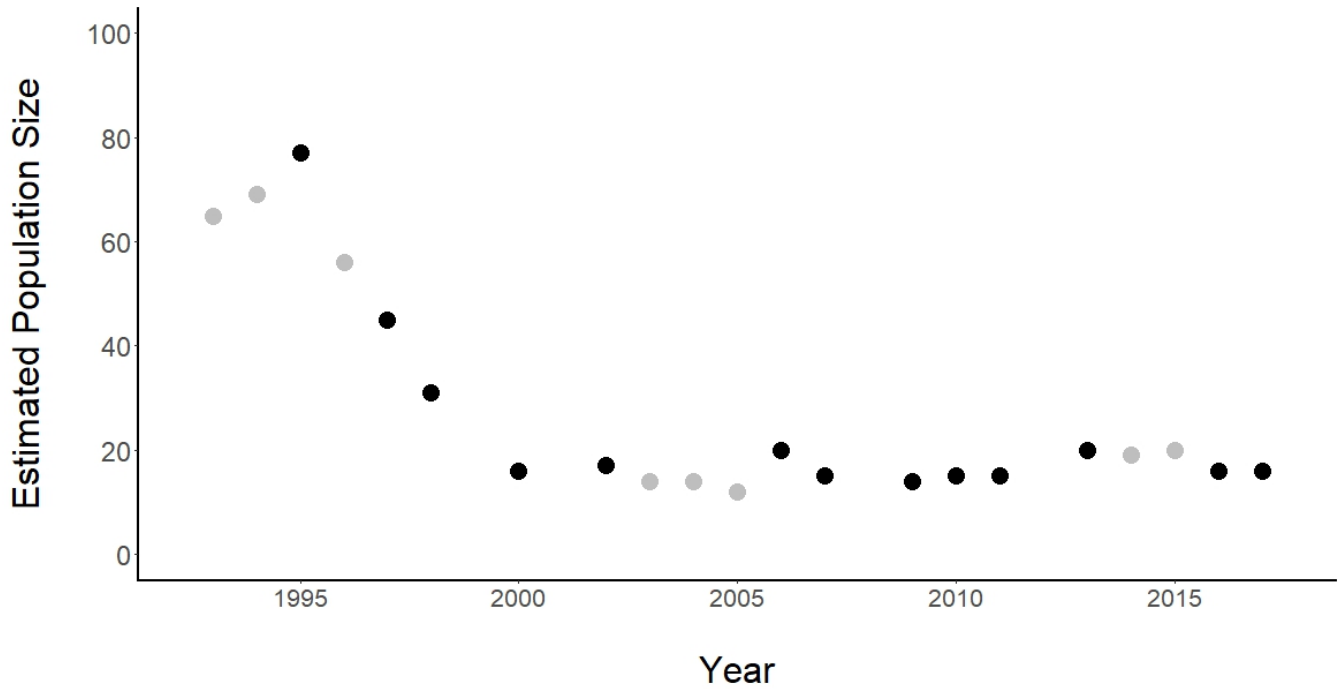


Figure 2: Estimates of population size by year for the Purcells South subpopulation of southern mountain caribou in southeastern British Columbia. All estimates represent the minimum number alive (estimate includes observations of animals and track networks). Grey circles represent years with incomplete surveys (i.e. not a complete census; DeGroot 2017).

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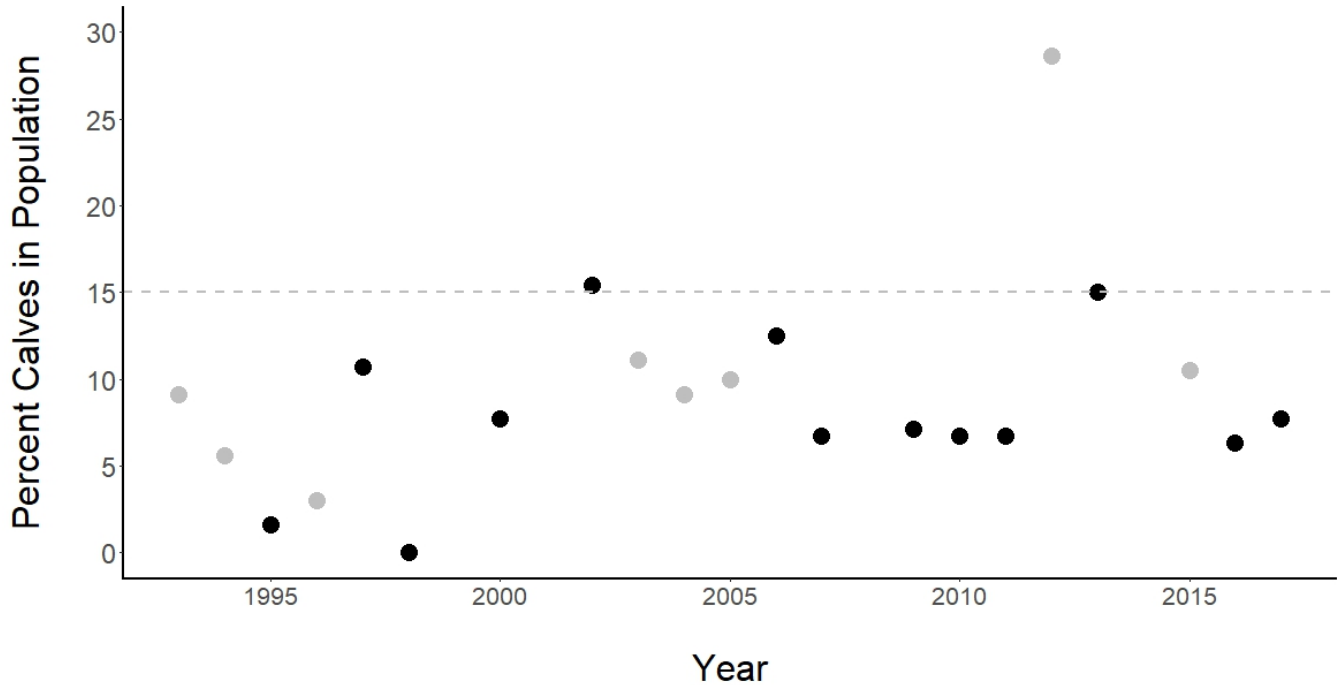


Figure 3: Annual estimates of the percentage of calves in the Purcells South subpopulation of southern mountain caribou in southeastern British Columbia. Estimates were derived from aerial surveys conducted during the late winter and thus calves are counted when they are ~8-10 months old. Horizontal dashed line represents the percentage generally associated with stable populations (Bergerud 1996). Grey circles represent years with incomplete surveys (i.e. not a complete census; 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. 2005b, Apps et al. 2013). Compared to other ungulates, caribou are particularly vulnerable to increasing predation because they have low reproductive rates (Bergerud 2000). To reduce predation risk, caribou generally occur at low densities and have evolved to live in low productivity habitats that spatially 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. 2005b, 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. 2011b, 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 mid-1990s and early 2000s, radio-collars were deployed on a sample of female caribou in the Purcells South and Purcells Central subpopulations to investigate causes of mortality (Kinley and Apps 2001, Apps et al. 2013). Seventeen of the 38 animals monitored died during the study period with predation being the leading cause ($n = 10$). Of the predation-related mortalities, six were attributed to cougars, two were by bears, one by wolverine and one by an unknown predator. Kinley and Apps (2001) concluded that a high rate of predation was a primary factor in the rapid population decline observed during this time period.

The recent period of relative stability within the Purcells South subpopulation has coincided with lowered predation rates as no mortalities have been recorded among radio-collared caribou monitored between 2011 and 2015 ($n = 1$ -6 per year; DeGroot 2016). Increasing wolf populations in the Purcell Mountains, however, may constitute an increasing predation risk. While no mortalities have been attributed to wolves in the Purcells South population, wolves have become a primary predator of caribou in the adjacent South Selkirks subpopulation (DeGroot 2017a, b).

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. 2017a). 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. 2005b, McLellan et al. 2012). For the Purcells South subpopulation, none of the mortalities among radio-collared caribou monitored in the mid- to late-1990s were attributed to nutrition or poor body condition (Kinley and Apps 2001, Apps et al. 2013). 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 Purcells South population to its current small size ($n = 14-16$).

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).

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The Purcells South subpopulation has been affected by logging both within and adjacent to its range. Logging was particularly intensive in the 1980s and 1990s (Stevenson 1991). This period slightly precedes the mid- to late-1990s when the Purcells South subpopulation underwent a rapid decline in size (see *Section 2.3 Population Size and Trend* above). Investigations into mortality patterns of South Purcells caribou during this time suggested that caribou residing in landscapes with higher proportions of forest < 40 years old had a higher mortality risk (Kinley and Apps 2001).

In the last two decades, logging has been reduced in core habitats used by Purcells South caribou (see *Section 4.1.1 Habitat Protection* below) and the amount of late seral forest appears to be increasing in at least some SM caribou ranges (Serrouya and McLellan 2016). 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 Purcells South range (L. DeGroot, *personal communication*). Outside of these cores, logging still occurs 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. 2011a, DeMars and Boutin 2017).

There are currently no active mines within the Purcells South range, although there are at least four tenures for metal-based mines (Grieve 2011). The Iron Range property is located ~ 15 km northeast of Creston and exploratory drilling has been conducted there, beginning in the fall of 2010. The Bohan property is located 20 km north of Creston and helicopter-supported exploratory drilling was initiated in 2011. The Lov property is 37 km west of Cranbrook and underwent exploratory drilling in 2011. The Red Lobster tenure has also had exploratory drilling conducted on its property, which is situated 30 km west of Kimberley.

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 Purcells South range.

3.3.1.4 CLEAN ENERGY

Infrastructure related to clean energy production (e.g. hydroelectric facilities, wind power) can impact caribou populations through mechanisms similar to other industrial developments. Caribou may avoid such infrastructure with the degree of avoidance dependent on the degree of human activity (Mahoney and Schaefer 2002, Colman et al. 2013). Such avoidance can alter seasonal migration patterns (Mahoney and Schaefer 2002), which can result

in negative demographic impacts (Bolger et al. 2008). Power lines associated with energy development can also increase predation risk for caribou because these features create relatively permanent early seral habitat that is favorable to other ungulates (e.g. moose, white-tailed deer) and provide movement corridors for predators (Latham et al. 2011a, Dickie et al. 2016).

There are no clean energy projects within the Purcells South caribou range. Hydro-electric dams are present along the Columbia and Kootenay river systems, which border or are adjacent to the Southeast Kootenay LPU boundaries.

3.3.1.5 OTHER

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

3.3.2 RECREATION

Recreational activities conducted within caribou range can impact caribou populations by displacing individuals into sub-optimal habitats (Seip et al. 2007), increasing stress levels (Freeman 2008) and / or facilitating predator movement into caribou habitat (Whittington et al. 2011). This section considers impacts related to snowmobiling and backcountry skiing as well as other activities such as hiking and mountain biking.

3.3.2.1 SNOWMOBILE

Among winter recreational activities, snowmobiling appears to have the highest impact on caribou, in part because the preferred areas for this activity overlap with the preferred winter habitat of caribou (Simpson and Terry 2000). Snowmobiling has been shown to displace caribou from preferred areas and the 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).

The Purcells South range has been impacted by snowmobiling since at least the early 2000s (Kinley 2002). In the 2002 aerial census of the range, Kinley (2002) noted very few major ridges or valleys that did not have some degree of snowmobile activity. Among backcountry recreation activities within the Purcells South range, snowmobiling ranked as “high” in terms of its probable threat to caribou (Simpson and Terry 2000). In 2007, the *Mountain Caribou Recovery Implementation Plan* closed snowmobiling within most core areas. Enforcement of this snowmobile closures, however, remains an issue (DeGroot 2016, 2017a).

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*).

There are currently no commercial heli-ski or cat-ski companies operating within the Purcells South range (L. DeGroot, *personal communication*).

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 Purcells South range though the extent of these trails and their intensity of use has not been explicitly quantified. Of note, however, is the Gray Creek Pass road, which bisects the South Purcells range and is open during the snow-free season, allowing relatively easy access to high alpine areas potentially used by caribou in the summer and fall.

3.3.2.4 OTHER

Purcells South caribou may also be impacted by backcountry skiing (i.e. ski touring). Simpson and Terry (2000) rated this activity's threat to caribou as low because of its non-motorized nature. However, as with other activities, its degree of impact is related to its intensity of use and the popularity of this sport has increased significantly in the last decade. Because of the relative remoteness of winter core habitat areas within the Purcell South range, the intensity of ski tracks noted on aerial surveys over the last two years has been rated as low (DeGroot 2016, 2017a).

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 Purcells South 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 western boundary and the East Kootenay Trench adjacent to its eastern boundary are major agricultural areas and known to support high populations of white-tailed deer and elk (Robinson and Clarke 2007, Mowat and Kuzyk 2009, Szkorupa and Mowat 2010, Stent and Clarke 2011), which in turn support higher populations that incidentally prey on caribou.

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).

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There are no major highways traversing through the Purcells South caribou range. Major highways, however, are present just outside of the east, south and west boundaries of Southeast Kootenay LPU and although movement among caribou subpopulations is rare (van Oort et al. 2011), these highways may limit any potential future movements into or out of the Purcells South range (Apps and McLellan 2006).

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 Purcells South range, the most prevalent forms of linear features are secondary roads associated with forestry (density = 0.82km/km^2 ; data source: <https://catalogue.data.gov.bc.ca/dataset/forest-tenure-road-segment-lines>). While this density of linear features is relatively low compared to other woodland caribou ranges (e.g. northeast BC boreal caribou ranges average 4.04 km/km^2 ; DeMars and Boutin 2017), the presence of linear features still constitutes an elevated predation risk for caribou. Using data from the Purcells South range, 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 Purcells South caribou during the early 20th century (Spalding 2000). Licensed hunting for caribou was closed in the South Purcell Mountains in 1972 (Stevenson and Hatler 1985). Currently, First Nations subsistence hunting is likely rare.

3.3.3.5 POACHING

In the early 1970s, poaching (or illegal hunting) was considered to be a primary mortality factor for caribou in the adjacent South Selkirk range and as such was likely a threat to Purcells South caribou (Freddy and Erickson 1972, Stevenson and Hatler 1985). The current impact of illegal hunting is unknown but is likely small due to the remote areas that they inhabit (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 caribou core areas of the South Purcell Mountains, the median return interval for forest fires is 200+ years with surrounding lower elevation forests have an interval of 100 – 200 years (Gray and Blackwell 2005). Using forest fire data available to 2015, areas burned < 50 years ago constitute ~16% of the Purcells South caribou range. Mountain pine beetle infestations have likely occurred within the Purcells South Mountains over the last three decades (Ebata 2003), potentially affecting forage availability, although their current impact on caribou is not known. Purcells South 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. During the radio-collaring studies conducted in the 1990s, none of the caribou mortalities investigated were attributed to avalanche (Kinley and Apps 2001, Apps et al. 2013).

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 Purcells South caribou are not well studied. Evidence to date, however, suggests that mortality from natural causes (i.e. diseases and nutrition) is low (McLellan et al. 2012, Apps et al. 2013). Among the 38 Purcells South caribou monitored in 1990s, none of the recorded mortalities ($n = 17$) were attributed to disease (Kinley and Apps 2001, Apps et al. 2013). For SM caribou, diseases and parasites are not thought to be a major driver of current population declines (Environment Canada 2014).

3.6 CLIMATE CHANGE

Climate change can potentially exert numerous effects on caribou population dynamics. Warmer winters may impact forage availability by increasing icing events and / or causing poor snow conditions that limit the ability of SM caribou to access arboreal lichens (Kinley et al. 2007, Hansen et al. 2011). A warming climate may also change the abundances and distribution of alternate prey and their generalist predators, potentially increasing rates of caribou predation (Latham et al. 2011b, 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 Purcells South 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 East Kootenay region (VerCauteren 2003, Dawe and Boutin 2016) and decreasing winter severity may contribute to high populations of elk (Forchhammer et al. 1998, Szkorupa and Mowat 2010). High populations of both 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 14-16 individuals counted in 2017 (DeGroot 2017a), the Purcells South subpopulation has a high risk of negative impacts associated with its small size, including a high probability of extinction within the next ten to twenty 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 (Apps and McLellan 2006, van Oort et al. 2011).

4 MANAGEMENT HISTORY

Over the past 15 years, a number of different entities have proposed management actions aimed at recovering SM caribou populations in British Columbia. In 2002, the Mountain Caribou Technical Advisory Committee outlined a strategy that emphasized identifying and protecting critical habitat, monitoring the size and movement of caribou populations, managing predators and managing the populations of other ungulate species (Mountain Caribou Technical Advisory Committee 2002). In 2004, an independent panel reviewing recovery of mountain caribou in the 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:

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- 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 Purcells South 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 Purcells South range, caribou use mid- to high-elevation old-growth forests year round (Apps and Kinley 2000). 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 Purcells South 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 Purcells South range, the protection of such habitat is estimated to be 90-95% (L.DeGroot, *personal communication*). The Purcells South range also contains Kianuko Provincial Park, an area frequently used by caribou (DeGroot 2009, 2013, 2016), and Lockhart Creek 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 Purcells South range, restoration from logging impacts (e.g. cutblocks) has primarily relied on standard re-planting practices and natural regeneration.

4.2 RECREATION AND ACCESS MANAGEMENT

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

4.2.1 SNOWMOBILE

Since 2007, snowmobiling has been closed in many areas of caribou core habitat within the Purcells South range (L. DeGroot, *personal communication*). Areas of closure may change annually depending on space use by caribou. Direct communication between government and snowmobiling groups has increased compliance with these closures in recent years. For example, a *Memorandum of Understanding* between the Cranbrook Snowmobile Club and the provincial government resulted in shared stewardship roles whereby both parties participated in boundary marking and monitoring compliance (BC Ministry of Forests, Lands and Natural Resource Operations 2015). These measures have significantly reduced snowmobile usage in caribou core areas, although snowmobile tracks continue to be observed in these areas during recent aerial surveys (DeGroot 2016, 2017a).

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

4.2.4 OTHER

Backcountry skiing has become an increasingly popular in recent years and tracks from this activity have been recorded in caribou core areas during recent aerial surveys of the Purcells South range (DeGroot 2016, 2017a). Where encountered, the intensity of usage based on track observations has generally “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. 2017b), 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 Purcell South 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 Purcell South and the South Selkirks 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 (WMUs) overlapping caribou range. In 2011, the supported trapping program was terminated as it was suspected to be ineffective in controlling wolf populations. While there has not been any caribou mortalities attributed to wolves over the last 15 years, suspected increases in wolf numbers likely threatens Purcell South caribou and thus more direct management of wolves may be necessary to recover the Purcell South caribou population (Bird et al. 2011, DeGroot 2017a).

4.3.2 COUGAR MANAGEMENT

Cougar predation was a primary factor in population declines of the South Purcell caribou herd during the late 1990s and early 2000s (Kinley and Apps 2001, Apps et al. 2013). To reduce cougar populations within and adjacent to caribou range, hunting quotas for cougars in the Kootenay region have been liberalized in WMUs overlapping caribou core habitats (two bag limit, one otherwise; female quota removed in 2014). The exception to this management action is WMU 4-20, which overlaps the northern portion of the Purcell South range and historically has received relatively high hunting pressure. Although evaluating the efficacy of this management action is difficult without rigorous population surveys, data indexing catch-per-unit-effort suggest a relatively stable cougar population since 2000 (moving 5-year average of 2-3 kills / 100 hunter-days; T. Szkorupa, *unpublished data*). From 2011 to 2015, 57 cougars were harvested from WMUs 4-05, 4-06, and 4-20. During the same period, no mortalities of radio-collared South Purcell caribou have been attributed to cougar predation (DeGroot 2016).

4.3.3 OTHER

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

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4.4.1 MOOSE MANAGEMENT

Historically, moose were considered rare in the South Purcells Mountains (Spalding 1990, Kay 1997) but in recent decades their populations have been expanding, including within southeastern British Columbia (Serrouya et al. 2011). Estimates of moose density for specific game management units that span parts of the South Purcell caribou range include 0.77 / km² for WMU 4-05 (survey year 2005), 0.21 – 0.90 / km² for WMU 4-06 (survey years 1997 and 2008; Stent and Poole 2008), and 0.47 / km² for WMU 4-20 (survey year 2006; T. Szkorupa, *unpublished data*). In recent years, hunting has been restricted to bulls only within these WMUs with a general season for spike-fork bulls and limited entry hunts for any sized bull (~ 15 bulls / WMU).

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

4.4.2 DEER MANAGEMENT

Formal estimates of population size for mule and white-tailed deer specific to the Purcells South caribou range are lacking; however, the range is located in the drier, southeastern portion of the Kootenay region where deer populations are considered to be highest (Mowat and Kuzyk 2009). The few surveys conducted on WMUs adjacent to the Purcells South range seem to confirm that deer are relatively abundant in the area; for example, Mowat and Kuzyk (2009) suggested an estimate of 2000+ mule deer for WMU 4-06 based on aerial survey data from (Robinson and Clarke (2007)). For white-tailed deer, Mowat and Kuzyk (2009) reported densities ranging from 0.7-7 deer / km² in survey blocks near the Creston valley and within WMUs 4-02, 4-03, 4-20, 4-21 and 4-22.

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. In recent years, mule deer hunting has been restricted to mature males only (e.g. ≥ 4-point bucks).

4.4.3 OTHER

Purcells South caribou reside next to two of the largest populations of elk in the Kootenay region (Szkorupa and Mowat 2010). On the eastern side of the Purcells South caribou range, the southern East Kootenay Trench had an estimated elk population of ~ 7500 in 2013 (Stent and Phillips 2013), which was down from an estimated 14,120 animals in 2010 (Szkorupa and Mowat 2010). On the range's west side, the Creston valley had an estimated elk population of 1230 in 2010 (Szkorupa and Mowat 2010). It is unknown to what extent there is seasonal spatial overlap between Purcells South caribou and surrounding elk populations.

There has been no active management of elk in the context of caribou conservation within the Purcells South range. Currently, elk hunting is restricted to bulls only within WMUs overlapping and adjacent to caribou 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).

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4.5.1 MATERNITY 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 Purcells South 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 Purcells South subpopulation.

4.5.3 TRANSLOCATION

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

In March 2012, the Purcells South range was augmented with 19 northern-ecotype caribou from the Level Kawdy herd (Leech et al. 2017). At the time, the Purcells South subpopulation was estimated to consist of 15 individuals and population recovery of was considered to be unlikely without augmentation (Kinley 2010). The project had limited success. By June 2012, three months after release, ten of the 19 translocated caribou had died (Gordon 2012a). Six of these mortalities were attributed to predation (four by cougar, two by wolves), two to accidents, and two from unknown causes. Two other translocated caribou died by September 2012, one from an accident and one from unknown causes (Gordon 2012b). By April 2013, 17 of the 19 translocated caribou had died, eight of which were from predation (Leech et al. 2017). Currently, one of the translocated animals, a bull, may still be alive and residing with one of the resident caribou groups (DeGroot 2017a). Suggested reasons for the low rate of success included: *i*) difficulty in uniting translocated caribou with residents upon release; and, *ii*) increased movements of translocated caribou resulted in their high use of low-elevation habitats, increasing their spatial overlap with cougars (Leech et al. 2017). A planned second augmentation in 2013 did not occur.

4.5.4 OTHER

There have been no other forms of population reinforcement implemented for the Purcells South 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 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. 2005b, 2007, Serrouya et al. 2015b). For the Purcells South subpopulation, more directed research into understanding its ecology began in the 1990s (Kinley and Apps 2001, Kinley et al. 2003, Apps et al. 2013). These studies yielded insight into patterns of space use and habitat selection (Apps and Kinley 2000, Kinley et al. 2007), feeding ecology (Kinley et al. 2003), and survival rates and mortality causes (Kinley and Apps 2001, Apps et al. 2013).

The recent augmentation of Purcells South with translocated caribou has also contributed to the body of literature assessing the feasibility of this management tool (Leech et al. 2017). Recommendations from this research include using donor caribou that have similar genetics and behaviours as those of the recipient population and, where possible, ensuring that donor caribou have been exposed to the same suite of predators expected within the recipient range. This research also involved the radio-collaring of cougars, which yielded insights into the space use and habitat selection of this primary predator within the South Purcell Mountains.

With the Purcells South subpopulation nearing extinction, future research will need to focus on testing recovery options in an adaptive management framework. 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 Purcells South Selkirks did not begin until the early 1990s when aerial surveys to estimate population size, composition and trend (Kinley 2002). During this same time period, radio-collars were deployed on a sample of caribou to evaluate space use patterns (Apps and Kinley 2000), monitor survival rates and assess mortality causes (Kinley and Apps 2001, Apps et al. 2013). Data from these animals informed the delineation of the current range boundary for this subpopulation (Wittmer et al. 2005a). Monitoring of Purcells South caribou has continued intermittently over the last decade, including from 2011 to 2015 where 1-6 resident animals were monitored per year as part of the 2012 translocation effort (see *Section 4.5.3 Translocation* above; DeGroot 2016).

Because of continued concerns of predation risk to Purcells South caribou and the recolonization of southeastern BC by wolves, monitoring of predator populations within the Purcells South range was initiated in the mid-2000s (Gaynor et al. 2007). These surveys use a combination of ground-based transects and aerial surveys to assess distribution patterns and relative abundance (Gaynor et al. 2007, van Oort et al. 2010). Predator monitoring was also incorporated into the 2012 translocation effort. During that year, radio-collars were deployed on seven cougars captured within and adjacent to the Purcells South range. To date, radio-collars have not been deployed on wolves within the Purcells South range.

Population monitoring of other ungulate species has also been conducted within the South Purcell Mountains, though not necessarily in the context of caribou conservation. Over the last decade, aerial and ground-based surveys have been conducted to estimate the abundance and/or composition of moose (Stent and Poole 2008), mule deer (Stent and Szkorupa 2012) and elk populations (Stent and Phillips 2013).

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. 2015b, 2017b). 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. 2015b). 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. 2015b), 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 that 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 Purcells South subpopulation of SM caribou*. For a small population such as Purcell South, *multiple management levers will need to be enacted simultaneously* to recover the population (Boutin and Merrill 2016, Serrouya et al. 2017b).

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 Purcells South range and Southeastern Kootenay LPU. 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.

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- 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

- Recovering the Purcell South herd from its current small population size will likely require population augmentation, either by translocation, maternal penning or both. The previous translocation effort in 2012 had limited success, likely because habitat conditions remained unchanged within the Purcells South 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 km²; 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 km² in Type 1 and 2 matrix range.

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- 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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