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

Chase

Subpopulation

Chase

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

Chase caribou are a subpopulation of southern mountain (SM) caribou, an ecotype of woodland caribou that is federally designated as *Threatened* under the *Species at Risk Act*. SM caribou currently occur in 38 subpopulations that are distributed across the southern two-thirds of British Columbia and west-central Alberta with one subpopulation extending into the northern portions of Idaho and Washington (Environment Canada 2014). Within Canada, this distribution coincides with the Southern Mountain National Ecological Area (COSEWIC 2002, Environment Canada 2014). Subpopulations of SM caribou have been further organized into 24 Local Population Units (LPUs), which reflect subpopulations that were historically contiguous. The Chase subpopulation forms its own LPU and these animals are considered part of the Northern group of SM caribou (Designatable Unit 7; COSEWIC 2011). The three groups of SM caribou – Northern, Central and Southern – are differentiated by their winter foraging behaviour and seasonal range use (Environment Canada 2014). Caribou in the Northern group, which are considered the "northern" ecotype in British Columbia (Heard and Vagt 1998), reside in mountainous areas with relatively shallow snow where they predominantly feed on terrestrial lichens within old-growth conifer forests or wind-swept alpine areas during winter. Within British Columbia, the Northern group is currently *Blue-listed* with a conservation status of S2/S3 due to threats from industrial activities and sustained declines in some subpopulations.

2.1 DISTRIBUTION

The range of the Chase subpopulation is found at the northern limit of SM caribou distribution and is situated within the Omineca Mountains in the north-central part of the province (Fig. 1). The 11,747 km^2 range is situated on the boundary of two ecoprovinces, with its northern third lying within the Northern Boreal Mountains and its southern two-thirds occurring within the Sub-boreal Interior. Topography within the range is typified by north-south oriented ridges, with alpine tundra and parkland forests occurring at high elevations and conifer forests (Engelmann Spruce – Supalpine Fir; Boreal White and Black Spruce; Spruce – Willow - Birch) occurring in lower-elevation valleys (Giguere and McNay 2007, McNay 2011). The range is bounded to the east by Williston Lake and the Northern Rocky Mountain Trench. Its northern extent is delineated by the watershed of the Ingenika River, which separates it from the Thutade caribou range. To the west, the range is bounded by the Thutade, Sustut and Driftwood Rivers and to the south, its boundary with the Wolverine range is formed by Ominicetla Creek, the Osilinka River, and the upper watersheds of Wasi and Flegezand Creeks (Giguere and McNay 2007). Note that the boundaries of the Chase range were recently refined with the northeastern corner (718 km^2) of the range's previous extent being incorporated into the newly recognized Thutade range (Sittler et al. 2015). Two protected areas occur within the Chase range, Chase Provincial Park and Sustut Provincial Park and Protected Area.

2.2 HABITAT AND BEHAVIOUR

Mountain-dwelling caribou undergo seasonal range shifts in response to snowfall conditions affecting forage availability (Bergerud 1978, Heard and Vagt 1998). These shifts vary among subpopulations, being affected by such factors as topography, predation risk, and snow characteristics (Seip and McLellan 2008). For the Chase subpopulation, monitoring of 30 radio-collared females from 1991 to 1993 found that caribou generally selected for higher elevation habitats (alpine and subalpine tundra) in late spring, summer and fall then moved into lower elevation conifer forests during the winter and early spring (Wood 1996). Considerable variation, however, may exist among individuals and among years. For example, in late winter, many caribou use wind-swept alpine ridges to access exposed terrestrial lichens whereas other individuals remain below treeline (Wood 1996). The

proportion of the population using alpine areas increases during high snowfall years when cratering for terrestrial lichens becomes difficult in low-elevation forests. When using low-elevation forests, caribou appear to select for pine or spruce dominated stands (Wood 1996, Wood and Terry 1999).

Calving in the Chase range occurs from late-May to mid-June with the majority of calves born during the first week of June (Wood and Terry 1999). Although individual variation exists, most females appear to select calving sites within subalpine parklands and females appear to show relative fidelity to calving areas (Wood 1996, Wood and Terry 1999). During calving, females disperse as individuals before aggregating into small groups later in the summer.

2.3 Population Size and Trend

In the late 1970s, Bergerud (1978) conducted some of the first aerial surveys to estimate caribou population size within the Omineca Mountains. For the 'Lay Range herd', which was situated within the current boundaries of the Chase range, Bergerud (1978) estimated 100+ caribou, which was believed to be a decrease from an estimated 300 caribou 6-7 years earlier. Bergerud (1978) speculated that over-hunting after the construction of the Omineca Resource Road was the cause of the decline.

More formal surveys to estimate caribou population size within the Chase range began in the early 1990s (Table 1). In March 1993, an aerial survey of the Chase and Butler Mountain Ranges counted 396 caribou, including three of six radio-collared individual, with most caribou (90%) found on the Chase Range (Wood 1996). Using the collared animals in a mark-resight framework, the population was estimated to be 690 caribou (95% confidence interval: 396-1085). This estimate likely informed Heard and Vagt's (1998) expert opinion-based estimate of 500-900 caribou for the Chase subpopulation.

The next aerial surveys of the Chase range occurred in the late 1990s and early 2000s. In 1998, an aerial survey recorded 54 caribou, though this survey was biased to moose habitat and caribou were recorded incidentally (Pacific Slope Consulting 1999). In 2000 and 2001, transect-based aerial surveys conducted over high elevation winter range of caribou recorded minimum counts of 126 and 174 caribou, respectively (Zimmerman et al. 2002). In 2002, the survey extent was expanded using a modified stratified random block design where a small portion of the sample units selected (5 of 34) were biased toward those containing radio-collared caribou. This survey, conducted in March, recorded 200 caribou (83 in sample units and 117 encountered incidentally) and derived a sightability-corrected estimate of 575 caribou for the entire range (Zimmerman et al. 2002).

The most recent surveys of the Chase range occurred during the late 2000s. In 2007, Giguere and McNay (2007) used a stratified block design where sample units were progressively selected to ensure coverage of the entire range over successive years. Sample units selected for the 2007 survey covered ~41% of the range. The survey recorded 431 caribou and, after applying a sightability correction factor, estimated the population size to be 561. The next survey occurred in 2009 with the selected sample units covering 35% of the range's area. This survey recorded 399 caribou and a sightability-corrected estimate of 475 (McNay et al. 2009). A follow-up survey was conducted in 2010, covering 41% of the range's area (McNay et al. 2010). This survey recorded a smaller number of caribou, 292, than the previous year and derived a sightability-corrected estimate of 347.

Estimates of juvenile recruitment and adult female survival, two demographic parameters with high influence on caribou population dynamics (DeCesare et al. 2012), have also been recorded for the Chase subpopulation. Juvenile recruitment can be expressed as the percentage of ~9-10 month old calves in the population or as ratio of

the number of ~9-10 month old calves per 100 adult females. For the former, ratios of calves:100 females have been at or above thresholds associated with population stability (28.9 calves: 100 females; Environment Canada 2008) for surveys conducted between 1993 and 2009 (Table 2). In 2010, this ratio dropped to 21 calves, which coincides with a 27% decrease in estimated population size from the previous year (McNay et al. 2010). Estimates of the percentage of calves in the population have somewhat mirrored ratios of calves: 100 females, being at or above thresholds associated with population stability (e.g. 15%; Bergerud 1996). The 2010 estimate of 14%, however, suggested a slightly declining or stable population while the calves: 100 female ratio potentially suggested a faster rate of decline. Determining whether juvenile recruitment is sufficient for population stability requires concurrent estimates of adult female survival. From 1991 – 1993, Wood (1996) estimated average annual female survival to be 73%, which is relatively low and juvenile recruitment during this same time period (17% calves) would have been insufficient to replace lost females. McNay and Giguere (2004) compiled radio-collar data (n = 63 individuals) from 1990 – 2004 and estimated the average annual survival of adults to be 91% in the Chase range. Note that this survival rate is not gender-specific and the actual survival rate for females may differ due to differences in survival probabilities between males and females (Bergerud and Elliott 1998).

Determining the current population trend for the Chase subpopulation is difficult given that it was last surveyed in 2010. In the 2014 federal *Recovery Strategy* for SM caribou, the trend for the Chase subpopulation was listed as unknown (Environment Canada 2014). Repeated estimates of population size from 1993 -2010, however, suggest a gradually declining population during this time period. This inference is further supported by the fact that the 1993 survey, which had the highest size estimate (690), had a smaller extent than the most recent survey (2010), which had the lowest estimate (347).

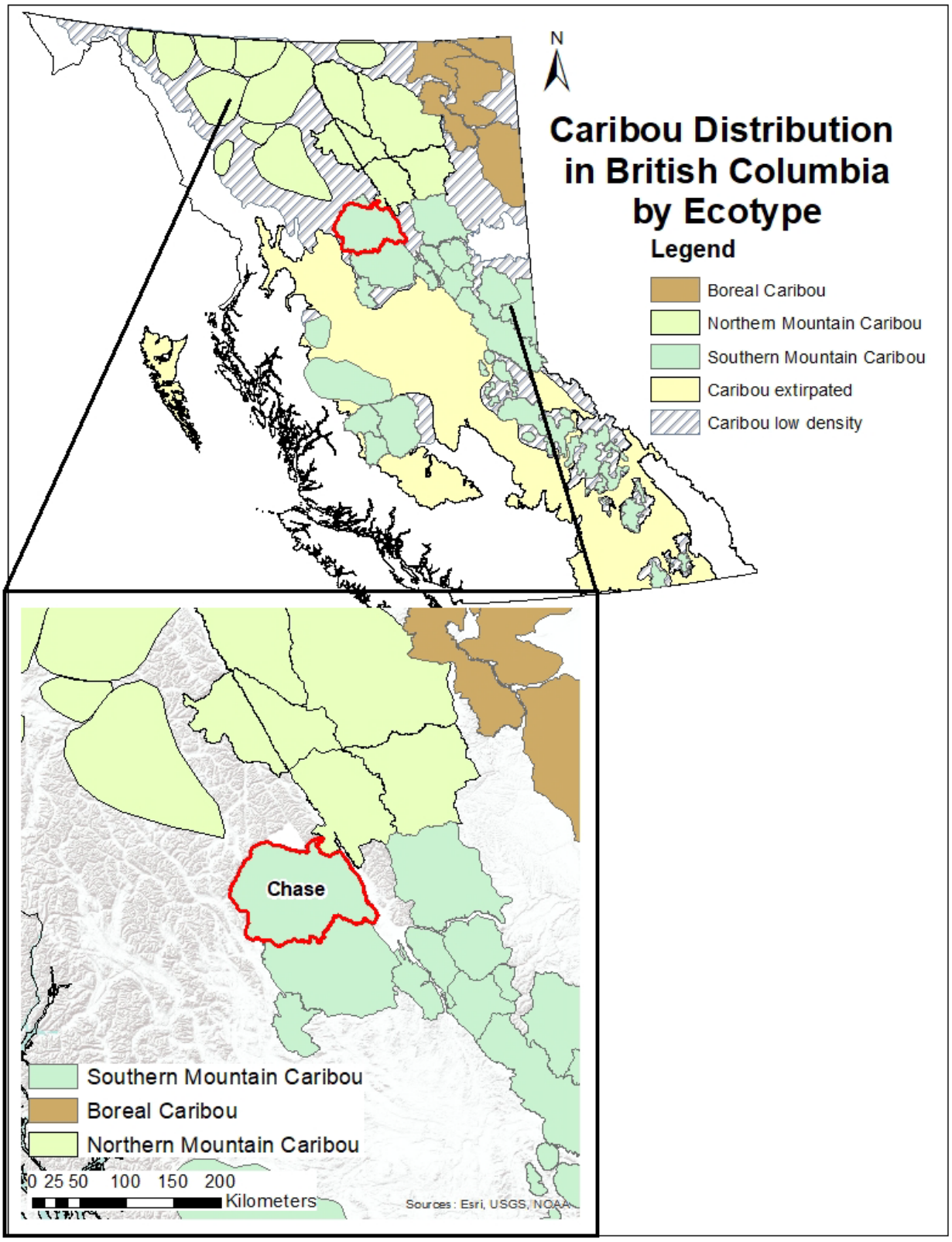

Figure 1: The geographical location of the Chase subpopulation of southern mountain caribou. The 11,747 km^2 range (inset: red outline) is situated in the Omineca Mountains in north-central British Columbia.

Table 1: Estimates of population size by year for the Chase subpopulation of southern mountain caribou in north-central British Columbia.

Year	Estimate	Method	Survey Timing	Reference
1978	100+[1]	minimum count	March	Bergerud 1978
1993	690[2] (396-1085)	mark-resight estimate (95% CI)	March	Wood 1996, Wood and Terry 1999
1998	500-900	expert opinion	NA	Heard and Vagt 1998
2000[3]	126	minimum count	late winter	Zimmerman et al. 2002
2001	174	minimum count	late winter	Zimmerman et al. 2002
2002[4]	550	extrapolated estimate from mark-resight	March	Zimmerman et al. 2002
2007	561	minimum count with sightability correction factor extrapolated to entire range	February – March	Giguere and McNay 2007
2009	475	minimum count with sightability correction factor extrapolated to entire range	February – March	McNay et al. 2009
2010	347	minimum count with sightability correction factor extrapolated to entire range	March	McNay et al. 2010

[1] Aerial survey of the "Lay Range Herd", which occurred in an area encompassed by the current Chase range. The actual extent of the survey was not reported.
[2] Survey extent was focused on the Chase herd's primary winter range (Chase Mountain and Butler Ridge).
[3] Transect-based aerial surveys were conducted in 2000 and 2001 over high elevation winter range.
[4] From 2002 forward, surveys were conducted over the entire range using a stratified sampling design.

Table 2: Estimates of juvenile recruitment in the Chase subpopulation of southern mountain caribou in north-central British Columbia. Juvenile recruitment can be expressed as the number of calves per 100 females or as the percentage of calves in the population, both estimated when calves are ~ 9 months old. Ratios exceeding 28.9 calves:100 females or calf percentages exceeding 15% are generally associated with stable or increasing populations (Bergerud 1996, Environment Canada 2008).

Year	Calves: 100 Females	% Calves	Survey Timing	Reference
1993	-	17	March	Wood 1996
2002	38	-	March	Zimmerman et al. 2002
2007	31	14	March	Giguere and McNay 2007
2009	29	15	March	McNay et al. 2009
2010	21	14	March	McNay et al. 2010

3 THREATS AND LIMITING FACTORS

Current declines in many 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 with high influence on caribou population dynamics (DeCesare et al. 2012). For most populations, effects of human activities and climate change have led to unsustainable rates of predation (McLoughlin et al. 2003, Wittmer et al. 2005*b*, Apps et al. 2013). Compared to other ungulates, caribou are particularly vulnerable to increasing predation because they have low reproductive rates (Bergerud 2000). To reduce predation risk, caribou generally occur at low densities and have evolved to live in low productivity habitats that spatially separates them from other ungulates and their generalist predators (Bergerud 1992). Effects from human activities and climate change likely compromise this spacing strategy by changing the abundance and distribution of these other ungulates and predators, increasing the likelihood of caribou-predator encounters and consequently increasing predation rates (Festa-Bianchet et al. 2011).

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

3.1 PREDATION

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

For Chase caribou, predation is the dominant cause of adult mortality. Among 231 radio-collared caribou monitored in the Chase and adjacent Wolverine ranges for various periods between 1991 – 2006, the cause of death was confirmed for 81 individuals and of these, 70 were attributed to predation (McNay 2009). Wolves were the dominant predator (n = 43), followed by wolverine (n =5) and grizzly bears (n = 5), then black bears (n = 2). For the 15 other predation-related deaths, the predator species could not be identified. It is unclear as to whether the predation rate of adult caribou increased during the monitoring period.

Predation is also likely the main cause of calf mortality. Of the 43 caribou mortalities attributed to wolves between 1991 – 2006, ten were caribou calves (McNay 2009). Studies conducted in other caribou populations have also reported predation to be the main cause of calf mortality, with wolves, bears, and wolverine being the dominant predators (Adams et al. 1995, Gustine et al. 2006*a*, Pinard et al. 2012)

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*b*). Such avoidance behaviours may also result in caribou restricting their annual movements, leading to over-grazing of seasonal areas (Heard and Zimmerman 2017). Climate change may further affect food availability and quality; for example, an increase in rain-on-snow events may limit forage availability by increasing the probability of icing (Hansen et al. 2011).

For SM caribou, including the Chase subpopulation, evidence to date suggests that food limitation is not a primary factor in recent populations declines (Wittmer et al. 2005*b*, McLellan et al. 2012). Such evidence, however, does not preclude any food limitation effect. In 2014 and 2015, measures of body fat were estimated for 22 females captured within the nearby Graham range (Cook and Cook 2015). These measurements were, on average, lower than measurements recorded within nearby boreal caribou ranges, suggesting that caribou residing in montane environments may be food limited, particularly on summer / late fall ranges. Heard and Zimmerman (2017) reported similar findings of potential food limitation in the nearby Kennedy Siding subpopulation. In their study evaluating the population-level effects of supplemental feeding, they found that 37% of females appeared to be undernourished when first arriving at feeding stations in early winter. Heard and Zimmerman (2017) suggested that this effect could result if increased predation risk limits food intake and/or restricts traditional migratory movements causing caribou to overgraze seasonal ranges.

Cook and Cook (2015) suggested that lower body fat levels from food limitation could affect caribou populations by lowering pregnancy rates. Food limitations may also result in smaller calves, which could have increased predation risk (Adams et al. 1995). Determining the magnitude of food limitation effects, however, is difficult in high predation environments because predation may occur before effects on body condition become evident (Boutin and Merrill 2016).

3.3 HUMAN ACTIVITIES

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

3.3.1 INDUSTRIAL

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

3.3.1.1 FORESTRY

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

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

The Chase range is overlapped by the Mackenzie Timber Supply Area (TSA) and the region's economy is highly dependent on the forest sector (BC Land Use Coordination Office 2000). Over the last four decades, the Chase range has been impacted by forestry activities. In the early 1990s, Wood (1996) noted that clearcut forest harvesting was extensive within the Boreal White Spruce – Black Spruce zone, though the extent of harvest was limited to the range's three major river valleys. The current allowable annual cut within the Mackenzie TSA is 4.5 million m^3, with the majority (> 70%) focused on pine-leading and deciduous stands (Nicholls 2014). Using cutblock GIS data spanning 1988 - 2015, cutblocks comprise ~1% of the Chase range's area. The majority of cutblocks are situated in low-elevation valleys in the southeast portion of the range.

3.3.1.2 Mining

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

The Chase range overlaps the planning area of the Mackenzie Land and Resource Plan (BC Land Use Coordination Office 2000). This area is known to have significant mineral values compared to other regions in the province. As such, the Chase range has a number of mine tenures situated within its borders and McNay et al. (2008) noted that disturbances from mining represent a significant short-term (< 10 years) threat to Chase caribou. Using GIS data of mine tenures from the BC Data Catalogue (accessed May 2017), mine tenures comprise ~ 12.5% of the range's area. Most of these tenures occur within the Omineca Mountains running in a north-south direction through the central portion of the range.

3.3.1.3 Oil and Gas

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

There are currently no impacts from oil and gas development within the Chase range. The Omineca Mountains region, however, does contain oil and gas resources, which could be considered for development in the future (BC Land Use Coordination Office 2000).

3.3.1.4 Clean Energy

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

al. 2013). Such avoidance can alter seasonal migration patterns (Mahoney and Schaefer 2002), which can result in negative demographic impacts (Bolger et al. 2008). Power lines associated with energy development can also increase predation risk for caribou because these features create relatively permanent early seral habitat that is favorable to other ungulates (e.g. moose, white-tailed deer) and provide movement corridors for predators (Latham et al. 2011*a*, Dickie et al. 2017).

Wind power tenures are present within the Chase range (McNay et al. 2008); however, to date there are no wind power developments.

3.3.1.5 Other

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

3.3.2 Recreation

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

3.3.2.1 Snowmobile

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

To date, impacts from snowmobiling have not been noted during aerial surveys of the Chase range, perhaps suggesting that impacts from this activity are relatively low overall. The community of Mackenzie does have an active snowmobile club with groomed trail networks nearby, but the remoteness of the Chase range from Mackenzie may preclude high use in this area. Nevertheless, the potential impacts of motorized recreation on mountain caribou winter habitat in the Omineca region have been recognized and management recommendations have suggested restricting snowmobile use with high quality winter range (Brade 2003). McNay et al. (2008) also suggested that snowmobiling could pose a longer-term threat (> 10 years) within the Johansen Lake area, which is used by Chase caribou during the calving season and summer.

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 no heli-skiing companies currently operating within the Chase range.

3.3.2.3 Summer Recreation

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

All of these activities occur within the Chase range though the extent of these trails and their intensity of use has not been explicitly quantified (BC Land Use Coordination Office 2000). The remoteness of the Change range and its limited road access suggests that impacts from summer recreation are relatively low.

3.3.2.4 Other

Chase 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. For the Chase range, impacts from backcountry skiing are likely minimal due to its remoteness and limited access by roads.

3.3.3 Other

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

3.3.3.1 Agriculture

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

There are no agricultural impacts within the Chase range.

3.3.3.2 Major Highway Corridors

Major highways can constitute a direct source of mortality (i.e. road kill) for caribou and may further alter or impede caribou movements (Leblond et al. 2013). Although road kill of caribou is generally rare, it can become an increasingly important mortality source for small populations (Kinley and Apps 2001). With respect to movement impacts, the relative permeability of highways to caribou movement is inversely related to traffic volumes (Leblond et al. 2013) and, as such, major highways with high traffic may lead to population fragmentation (Apps and McLellan 2006).

There are no major highways within the Chase range.

3.3.3.3 Linear Features

Industrial activities within forested systems are often accompanied by the creation of linear features such as roads, railways, power lines, pipe lines and seismic lines. Such features are thought to increase predation of caribou by

increasing predator hunting efficiency (McKenzie et al. 2012, Dickie et al. 2017) and facilitating predator movement into caribou range (Whittington et al. 2011, DeMars and Boutin 2018). Linear features may further contribute to caribou-predator spatial overlap if such features facilitate the movement of alternate prey into caribou range (Dawe and Boutin 2016, Fisher et al. 2017).

Within the Chase range, the most prevalent forms of linear features are secondary roads associated with forestry (estimated length = 1941 km; density = 0.16 km/km^2; data source: https://catalogue.data.gov.bc.ca/dataset/forest-tenure-road-segment-lines). Compared to other caribou ranges, the density of linear features is relatively low in the Chase range, though caribou may still be impacted by such features if their location facilitates predator movement into caribou habitats (DeMars and Boutin 2018).

3.3.3.4 HUNTING

Historical records indicate that SM caribou have long been hunted by First Nations (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 province-wide population declines of caribou during the early 20th century (Bergerud 1978, Spalding 2000). Since the 1940s, guided hunting has also occurred within the Omineca Mountains and guiding tenures cover most of the Mackenzie Timber Supply Area (BC Land Use Coordination Office 2000, Spalding 2000).

Licensed hunting for caribou still occurs within the Chase range. Five Wildlife Management Units (WMUs) overlap the range: 6-18, 7-27, 7-38, 7-39, and 7-40. Among these, WMU 7-27 has not had a general season for caribou since at least 2005. Within the remaining four WMUs, each has a general 8-week hunting season for 5-point or larger bulls and these regulations have been in place since 2005. WMUs 7-38 and 7-39 have the largest spatial extent (~70% coverage) within the Chase range and since 2000, the number of bulls harvested annually within these two WMUs has averaged 2.1 and 8.9, respectively (M. Klaczek, BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development, *unpublished data*). Note that only ~40% of the area of WMU 7-39 overlaps the Chase range.

3.3.3.5 POACHING

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

3.4 NATURAL DISTURBANCE

Caribou populations are subject to impacts from a number of natural disturbances. Being dependent on old-growth forests, caribou are impacted by forest fires. Areas burned by fire may be avoided for up to 50 years (Dalerum et al. 2007) and the early seral habitat created post-fire may facilitate population increases in predators and alternate prey. Although caribou are likely adapted to the natural forest fire regime within and adjacent to their ranges, effects of forest fire may act cumulatively with human-mediated disturbances to negatively impact caribou demography (Sorensen et al. 2008). Caribou may also be affected by insect or disease outbreaks that affect forest stand condition. For example, mountain pine beetle outbreaks can highly impact old-growth pine stands, affecting lichen availability (Cichowski and Haeussler 2015, Apps and Dodd 2017) – a primary forage resource for caribou – and increasing the likelihood of fire (Lynch et al. 2006). For mountain-dwelling caribou, avalanches constitute another type of natural disturbance that can potentially impact demography, though under normal conditions their importance as a mortality should be small unless population sizes are small (Seip and Cichowski 1996, Hebblewhite et al. 2010).

Within the boreal forests of north-central British Columbia, the median return interval for forest fires is ~ 100 years (Johnstone et al. 2010). Using forest fire data available to 2015, the extent of areas burned < 50 years ago constitutes < 4% of the Chase range with the majority of these fires situated along the periphery of the range. Within the last 50 years, the largest fire occurred in 1970 (23,578 ha burned) and was situated on the range's northeastern corner.

The Chase range has been affected by mountain pine beetle. By 2014, the Mackenzie Timber Supply Area, which overlaps the Chase range, has had ~75% of its mature lodgepole pine stands killed by beetle infestation (Nicholls 2014). Most infestations are confined to lower elevations forests (https://www.for.gov.bc.ca/hre/bcmpb/year13.htm). Projections into the year 2024 do not suggest an expansion in the current spatial extent of infestations.

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).

Evidence to date suggests that mortality from natural causes (i.e. diseases and nutrition) is low (McLellan et al. 2012, Apps et al. 2013) and diseases and parasites are not thought to be a major driver of current declines in populations of SM caribou (Environment Canada 2014). For the Chase subpopulation, most reports from radio-collaring studies in the early 1990s and mid- to late-2000s do not mention parasites, disease, or poor body condition being prevalent among captured caribou (Wood 1996, Wood and Terry 1999, MacDonald 2009), although mortality site investigations of two calves in the early 2000s did suggest that death was caused by *Pasturella mutocida* infection (Zimmerman et al. 2001).

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*.

Impacts of climate change on the Chase range have not been well studied. The negative impacts of the northward expansion white-tailed deer have been documented in ranges of boreal caribou (Latham et al. 2011*b*, Dawe and Boutin 2016) but whether white-tailed deer have impacted caribou ranges in British Columbia's northern mountains remains unclear.

Recent analyses using demographic data from boreal caribou subpopulations in northeast British Columbia have suggested that woodland caribou may be impacted from effects of climate change other than those related to alterations in predator-prey communities. Specifically, juvenile recruitment was negatively affected by increasing mean winter temperatures while adult female survival was positively associated with the timing of spring (i.e., later onset of spring growing conditions equated to increased survival; DeMars et al. 2017). Collectively, these relationships suggest that warmer winter temperatures and lowered snowfall may have a negative effect on caribou population dynamics. It is unknown whether the Chase subpopulation has been specifically impacted by these predicted effects of climate change.

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.

Currently, potential effects from small population size are likely to be minimal in the Chase subpopulation as recent demographic data suggests a population size of > 300 animals (see *Section 2.3*).

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. For the most part, many of these recommendations were focused on mountain caribou residing in the deep snow mountains, which British Columbia recognized as “mountain caribou”, and were not developed specifically for more northern subpopulations such as the Chase, which are considered the “northern” ecotype provincially. Nevertheless, these recommendations – and others - are reviewed here because they are broadly applicable and have been incorporated into more recent management strategies.

In 2002, the Mountain Caribou Technical Advisory Committee outlined a strategy that emphasized identifying and protecting critical habitat, monitoring the size and movement of caribou populations, managing predators and managing the populations of other ungulate species (Mountain Caribou Technical Advisory Committee 2002). In 2004, an independent panel reviewing recovery of mountain caribou in the South Columbia Mountains suggested an adaptive management approach emphasizing protection of old-growth forests, population monitoring of caribou, reducing populations of predators and other ungulates, and limiting recreational activities in caribou range (Messier et al. 2004). The Mountain Caribou Science Team issued similar recommendations in 2006 and further suggested potentially augmenting small subpopulations and that habitat protection should promote connectivity among subpopulations (Mountain Caribou Science Team 2006). In 2008, McNay et al. (2008) issued recommendations specific to caribou herds in the province’s north-central mountains. These recommendations included protecting large patches of old-growth forest, managing human-mediated disturbance so that total disturbance (human-mediated + natural) is within the range of natural variability, managing

recreation access, and managing alternate prey and predators. One year later, Wilson (2009) outlined actions for managing predators and other ungulates within and adjacent to caribou range, including species-specific density targets. In 2013, the *Implementation Plan for the Ongoing Management of South Peace Northern Caribou* was developed, which had four main implementation objectives: *i)* protect 90% of high-elevation winter range; *ii*) conduct predator and prey population management; *iii*) manage and reduce the industrial footprint; and *iv*) monitor management actions and modify accordingly (BC Ministry of Environment 2013).

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 Chase subpopulation under these four broad categories: habitat management, predator management, alternate prey management, and population reinforcement.

4.1 HABITAT

Protecting and restoring sufficient habitat for caribou to carry out essential life processes and reduce predation risk is fundamental to achieving self-sustaining populations (Environment Canada 2014, Ray et al. 2015). SM caribou require large tracts of undisturbed habitat and have evolved to inhabit old-growth forests, which separates them – both in terms of elevation and horizontal space – from other ungulates and their generalist predators(Seip 1992, Rettie and Messier 2000, Apps et al. 2001). 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). Such quantitative assessments have yet to be conducted for most ranges of SM caribou – including the Chase subpopulation.

4.1.1 PROTECTION

In the *Recovery Action Plan for Northern Caribou Herds in North-central British Columbia*, the recommended recovery actions included protecting caribou habitat to ensure at least 40-60% of a subpopulation's range is old-growth (70-140 years old) forest and to ensure that the total disturbance footprint (natural + human-mediated) fell

within the natural range of variability (McNay et al. 2008). Within the Chase range, these actions informed the development of zones designated as Ungulate Winter Range (UWRs) where logging is prohibited or severely restricted. UWRs specific to caribou cover ~ 40% of the range's area. When considering UWRs designated for all ungulate species, UWRs comprise 76% of the range's area. The Chase range also contains provincial parks and protected areas, which encompass ~ 7% of the range's area and provide even stronger protections as no industrial development is permitted.

4.1.2 Enhancement and Restoration

To date, there have been no management actions to enhance or restore caribou habitat within the Chase range.

4.2 Recreation and Access Management

The range of the Chase subpopulation is generally remote and thus conflicts between recreational activities and caribou management have been less pronounced compared to SM caribou ranges further south. Nevertheless, the need to management recreation and access within caribou ranges of the Omineca region has been recognized, prompting the development of recommended management actions (Brade 2003).

4.2.1 Snowmobile

To reduce potential snowmobile-caribou conflicts, Brade (2003) suggested that government work with local snowmobile clubs and the BC Snowmobile Federation to identify caribou management zones (e.g. areas with limited or no snowmobile access) and zones appropriate for snowmobile use. McNay et al. (2008) noted that snowmobiling represented a potential long-term threat to Chase caribou and consequently suggested that no snowmobiling be allowed within high-elevation winter range.

Because of the negative impacts that snowmobiling can have on SM caribou, the provincial government closed many areas to snowmobiling within SM caribou ranges beginning in 2009. To date, these closures have not extended into the Chase range (http://www.env.gov.bc.ca/fw/wildlife/snowmobile-closures/).

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).

Currently, there are no heli- or cat-ski companies operating within the Chase range and thus it is not subjected to impacts from these activities.

4.2.3 Summer Recreation

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

4.2.4 Other

There are no other restrictions on recreational activities within the Chase caribou range.

4.3 Predators

Actions aimed at managing predators may include liberalizing hunting and trapping quotas (Cluff and Murray 1995), diversionary feeding (Lewis et al. 2017), managing alternate prey (Serrouya et al. 2017*c*), 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

Within British Columbia, active management of wolves began in the early 1900s with the introduction of a bounty program, which lasted until 1955 (BC Ministry of Forests, Lands and Natural Resource Operations 2014). Predator control programs were also initiated during the 1940s and the combined effect of these initiatives resulted in wolf populations declining to their lowest estimated numbers provincially in the late 1950s. The suppression of wolf numbers resulted in population peaks of caribou in northeastern British Columbia during the 1960s (Bergerud 1978, Spalding 2000) though the specific effects of wolf control on the Chase subpopulation is unknown.

Since the cessation of province-wide wolf control, northeastern British Columbia has had a few periods of wolf removals. From 1978 – 1980, 71 wolves were removed from the Horseranch Mountains and an unknown number of wolves were removed from the Muskwa range by local guide outfitters (Bergerud and Elliott 1998). In the 1980s, wolf removal experiments were conducted in northeastern British Columbia to test the effects of wolf predation on recruitment rates – and consequently population growth rates – of four ungulate species (Bergerud and Elliott 1998). Within the Muskwa study area, wolves were removed in 1984 (60% reduction over a 6775 km^2 area), 1985 (77% reduction over 13,570 km^2) and in 1987 (62% reduction over 10,000 km^2). Within the Kechika study area, which included the Horseranch Mountains, wolves were removed in 1982 (85% reduction over 3833 km^2), 1983 (83% reduction over 7123 km^2), 1984 (76% reduction over 9961 km^2) and 1985 (65% reduction over 18,400 km^2). These removals resulted in high recruitment rates and probable population growth in caribou populations in the two study. Effects of the wolf removal program, however, were short-term as recruitment rates in the Muskwa study area had lowered from 30.4 calves per 100 females in the last year of wolf removal to 17.5 calves per 100 females three years later.

In the winter of 2015, wolf reductions were also initiated in caribou ranges in north-central BC, specifically the Klinse-za, Kennedy Siding and Quintette ranges (Seip and Jones 2015). Across these ranges, 57 wolves were removed in 2015, 201 in 2016 and 93 in 2017. Since the reductions began, all three subpopulations have had increases in adult survival, calf recruitment and population size while the Graham subpopulation, which served as a control, continued to decline (Seip and Jones 2017). Effects of this recent wolf control on the Chase subpopulation, which range lies further northwest of the wolf control areas, are unknown.

Currently, there is an eleven month general hunting season for wolves with no bag limit in WMUs 7-27, 7-38, 7-39, and 7-40, which all overlap the Chase range. WMU 6-18, which overlaps the northwest corner of the range, has a 10.5 month season with a bag limit of three wolves.

4.3.2 Cougar Management

Being situated at the northern edge of cougar distribution within western North America, the Chase range likely has a low density of cougars (McNay 2009), though their population has not been explicitly enumerated. McNay (2009) reported that no predation of Chase caribou by cougars had not been documented up to 2006. Because of their likely low impact on the population dynamics of Chase caribou, cougars have not been subject to management actions in the context of caribou conservation. There are no general hunting seasons for cougar within WMUs overlapping the Chase range.

4.3.3 Other

Within the context of caribou conservation, there have been no other management actions directed at other predators (e.g. bears or wolverine) within the Chase range.

4.4 Alternate Prey

Declines in many populations of woodland caribou have been attributed to apparent competition, an indirect interaction between two or more prey species and a shared predator (Holt 1977, DeCesare et al. 2010, Hebblewhite 2017). In this process, increased abundances of other ungulate species – stemming from an increase in favourable habitat following landscape alteration – has led to higher populations of predators, resulting in unsustainable predation of caribou. Because of these linkages, recommended strategies for recovering caribou populations includes reducing the abundances of primary prey (McNay et al. 2008, Wittmer et al. 2013, Serrouya et al. 2015, Boutin and Merrill 2016).

4.4.1 Moose Management

The Chase range has received periodic surveys to estimate moose abundance and/or density, though these surveys were not specifically focused on the Chase range *per se* and the areas surveyed generally exceeded the current boundaries of the Chase range. In 1998, a reconnaissance-level aerial survey focusing on high-quality moose habitat within the Chase range recorded 269 moose (Pacific Slope Consulting 1999). Two years later, Demarchi (2000) recorded in 313 moose in a larger study area. In 2002, an aerial survey using a stratified random block design (n = 12 sample units surveyed) recorded 178 moose in the Chase range (no population estimate given; Zimmerman et al. 2002). In 2007, Walker et al. (2007) estimated a moose density of 0.59 moose / km^2 in the Northern Williston Watershed, which included portions of the Chase range. This density is higher than proposed thresholds conducive to caribou persistence (e.g. < 0.2 – 0.3 moose / km^2; Bergerud 1996); however, this survey was focused on moose habitat and did not include the entirety of caribou range.

To date, there has been no active management of moose in the context of caribou conservation within the Chase range. Currently, there is a general hunting season for bull moose of any size within WMU 6-18 while the general hunting season is restricted to spike-fork bulls within WMUs 7-27, 7-38, 7-39, and 7-40. The bag limit is one in all five WMUs. The impact of First Nations hunting on moose populations is unknown.

4.4.2 Deer Management

White-tailed deer and mule deer are present within the Chase caribou range. Mule deer are more abundant (http://www.env.gov.bc.ca/fw/wildlife/management-issues/docs/2017_Provincial_Ungulate_Numbers_Sept_18_Final.pdf), although the northern distribution and abundance of white-tailed are likely increasing (Latham et al. 2011*b*, Dawe and Boutin 2016). There are general hunting seasons for both mule deer and white-tailed deer within WMUs overlapping the Chase range. Within WMUs 7-27, 7-38, 7-39 and 7-40, there is a 3-week season for mule deer bucks 4-points or larger followed by a 4.5-week season for bucks of any size. Within these same WMUs, there are 12-week seasons for white-tailed deer bucks. The bag limit for each species is one. Hunting for either species is closed within WMU 6-18, which overlaps the northwest corner of the Chase range.

To date, there have been no management actions targeted toward deer in the context of caribou conservation in the Chase range.

4.4.3 OTHER

Elk (*Cervus elaphus*), mountain goat (*Oreamnos americanus*) and Stone's sheep (*Ovis dalli stonei*) are also present within the Chase caribou range. For elk, there is a 4-week general hunting season for bulls with six points or larger in WMUs 7-27, 7-38, 7-39 and 7-40 while WMU 6-18 is closed to elk hunting. For Stone's sheep, there is a general hunting season for full curl rams in WMUs 6-18, 7-39, and 7-40. There are also general hunting seasons for mountain goat in all five WMUs overlapping the Chase range. The bag limit for each species is one. None of these species have been subject to management actions in the context of caribou conservation.

4.5 POPULATION REINFORCEMENT

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

4.5.1 MATERNAL PENNING

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

Maternal penning has not t been used within the Chase caribou range.

4.5.2 CAPTIVE BREEDING

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

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

4.5.3 TRANSLOCATION

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

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

4.5.4 OTHER

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

4.6 STEWARDSHIP/OUTREACH

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

4.7 RESEARCH

Most subpopulations of mountain-dwelling caribou in the northern part of British Columbia are relatively little studied, perhaps because they are a lower management priority due to being less threatened than subpopulations found further south (Environment Canada 2012). Within British Columbia, one of the first research efforts aimed at evaluating caribou ecology and behaviour in the province's northern region began in the late 1970s with Bergerud's (1978) surveys of various subpopulations to estimate size, juvenile recruitment and population trend. Since then, numerous studies have been conducted within the region's caribou ranges, with research focusing on predator-prey dynamics (Bergerud and Elliot 1986, Bergerud and Elliott 1998, Gustine et al. 2006*b*), estimating vital rates (Parker and Gustine 2007, McNay et al. 2014), spatial behaviours (Bergerud et al. 1984, Bergerud and Page 1987), habitat selection (Wood 1996, Gustine and Parker 2008, Polfus et al. 2014), responses to disturbance impacts (Polfus et al. 2011), pregnancy rates (McNay et al. 2014), diet (Denryter et al. 2017) and nutritional condition (Parker and Gustine 2007). These studies have collectively informed broad strategies aimed at managing and recovering caribou populations (e.g. (McNay et al. 2008, Environment Canada 2012, 2014), though further herd-specific research will likely be necessary to develop effective strategies for individual subpopulations (Environment Canada 2012, 2014).

For the Chase subpopulation, the first investigations into herd structure, composition and habitat use occurred during the early 1990s (Wood 1996, Wood and Terry 1999). From 1991 – 1994, 30 individuals were radio-collared within the Chase and adjacent Wolverine ranges. Data from these animals showed that Chase caribou undergo bi-annual movements between their winter ranges located in the east to calving and summer areas located in the more western Osilinka and Wrede Ranges. These data also demonstrated that winter strategies within Chase caribou can vary by individual and by year depending on the amount of snowfall (see *Section 2.2 Habitat and Behaviour*). This study also provided the first estimate of caribou population size within the Chase range (Wood 1996).

The next period of research focusing on the Chase subpopulation occurred from the late 1990s to the late-2000s. The first of these studies evaluated ecological factors affecting caribou in the Omineca region (Zimmerman et al. 2001). This study deployed radio-collars on caribou, wolves and moose in three study areas, one of which was the Chase range. A primary objective of the study was to assess the hypothesis that logging alters predator-prey dynamics resulting in negative impacts on caribou populations. The initial data collected seemed to support this hypothesis. Data from this study and additional radio-collar data collected during the mid- to late-2000s (n = 49 females captured between 2006 and 2009; MacDonald 2009) allowed for further modelling of seasonal ranges (McNay et al. 2006), an assessment of landscape-mediated predation risk (McNay 2009), estimates of calf survival (McNay et al. 2009), and estimates of seasonal mortality rates and causes (Zimmerman et al. 2001, McNay et al. 2010). The concomitant radio-collaring of wolves further assisted in understanding mortality causes (McNay et al. 2010).

In 2017, a new study was initiated within the Chase range to assess caribou response to wide-spread habitat alteration resulting from wildfires, pine beetle infestations, and salvage logging (http://fwcp.ca/project/exploring-habitat-changes-chase-caribou-herd/). The study involves monitoring radio-collared female caribou to assess habitat use, adult mortality and calf survival in altered habitat conditions and to further compare these metrics to those recorded in pre-disturbance conditions.

4.8 MONITORING

In the last 40 years, the most intensive monitoring of the Chase subpopulation occurred during the 1990s and from 2000 – 2010. From 1991 - 1994, a radio-collaring study within the Chase range yielded the first estimates of caribou population size and demographic parameters such as adult survival and juvenile recruitment (Wood 1996, Wood and Terry 1999). Monitoring of the Chase subpopulation resumed in 1998 when a second radio-collaring study was initiated (Zimmerman et al. 2002). During this study, the Chase range was surveyed in three consecutive years (2000-2002) to estimate population size, though differences in survey extent and effort prevented inferences on population trend. The most recent bout of intensive monitoring occurred from 2006 – 2010. During this time, aerial surveys were conducted in three years – 2007, 2009, and 2010 – to estimate population size and juvenile recruitment (Giguere and McNay 2007, McNay et al. 2009, 2010).

Since 2010, the Chase subpopulation has primarily been monitored by harvest statistics, although a recent survey was attempted in 2017 but relatively few caribou were recorded (http://fwcp.ca/project/studying-habitat-alterations-chase-caribou-herd/). This recent survey was part of a new research project initiated in 2017 to assess caribou response to wildfires, pine beetle infestations and salvage logging occurring with the Chase range.

5 IMPLICATIONS TO OTHER WILDLIFE

Management actions focused on conserving caribou will necessarily have impacts on other wildlife species. Caribou require landscapes where densities of other ungulates and predators are low; thus, management actions undertaken for caribou may result in population sizes of moose, deer, and wolf that are much lower than those currently experienced (Serrouya et al. 2015, 2017*c*). 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). Lowered populations of big-game species such as moose and white-tailed deer will result in reduced hunting opportunities. While incorporating hunters in the initial lowering of

these populations can be advantageous and seen as a "win-win" (Serrouya et al. 2015), the long-term suppression of these populations will likely require support from the regional hunting community.

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

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

7 PARTNERS / NEIGHBOURS

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

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

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

8 RECOMMENDED ACTIONS

In 2014, the federal *Recovery Strategy* for SM caribou was released to outline objectives and strategies for recovering and managing subpopulations of SM caribou (Environment Canada 2014). The primary goal of the *Recovery Strategy* is to "achieve self-sustaining populations in all LPUs within their current distribution". Achieving this goal requires meeting a number of objectives, which include:

i. Evaluating and monitoring population size and trend
ii. Protecting and restoring suitable caribou habitat. Such habitat includes high- and low-elevation seasonal ranges and matrix habitat, which collectively allow caribou sufficient space and resources to carry out life processes.
iii. Evaluating disturbance impacts in a cumulative affects framework
iv. Understanding and managing predator-prey dynamics
v. Assessing risks from climate change to caribou
vi. Assessing health risks (e.g. parasites and disease) to caribou
vii. Where appropriate, managing harvest for sustainable use with priority access given to First Nations
viii. Fostering multi-stakeholder stewardship and developing knowledge sharing programs

Below, recommended management actions are outlined for the Chase subpopulation. Following the framework of the federal *Recovery Strategy*, actions are grouped under six headings – Mortality and Population Management, Landscape Level Planning, Habitat Management, Managing Recreational Activities, Population Monitoring, and Communication and Involvement.

Recommended Actions for the Chase Subpopulation

1. *Mortality and Population Management*

    - *Manage harvest for sustainable use*

      Current hunting regulations allow for a general season on 5-point bulls within much of the Chase range with no quota on the number of animals harvested. Hayes et al. (2003) suggested that harvest rate should not exceed 2% of the population. The last estimates for the Chase range suggested a population size of 347 – 475 caribou, which equates to a maximum annual harvest of 7-9 bulls. Over the last decade, compulsory inspection data have suggested that ≤ 5 bulls per year have been harvested within the Chase range (M. Klaczek, BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development, *unpublished data*), which may be sustainable if the population has not declined further.

    - *Manage predators and alternate prey*

      Caribou population dynamics are sensitive to the abundance and distribution of predators and alternate prey. Within the Chase range, understanding the status of moose and wolf populations can provide inferences as to whether predator-prey conditions are conducive to caribou population persistence. For example, caribou populations are less likely to persist when moose densities exceed 0.3 / km^2 (Bergerud 1996, Wilson 2009) and when wolf densities exceed 6.5 / 1000 km^2 (Bergerud and Elliot 1986).

2. *Landscape Level Planning*

    - *Maintain a spatial inventory of natural and anthropogenic disturbances within caribou range*

      Substantial evidence demonstrates a negative relationship between caribou population growth rates and the amount of disturbance within caribou range (Environment Canada 2008, 2014). Analyses from these populations suggest that the spatial extent of buffered (500-m) disturbances should not exceed 35% of caribou range.

    - *Manage current and future anthropogenic disturbances in a cumulative effects framework*

      Because caribou ranges like the Chase reside in multi-use landscapes, coordination among governments, industry and First Nations will be required to ensure that the cumulative disturbance footprint does not exceed levels associated with caribou population declines. McNay et al. (2008) further suggested that anthropogenic disturbances such as logging be clustered rather than dispersed throughout the range.

    - *Maintain functional connectivity between important season ranges*

      Identify frequently used migration corridors and avoid disturbances within or adjacent to these routes (McNay et al. 2008).

3. *Habitat Management*

    - *Identify then ensure protection of core habitat areas*

      McNay et al. (2006) provided an initial assessment of seasonal ranges for Chase caribou, including an assessment of habitat quality. Although UWRs cover a large proportion of the Chase range, management protections should be re-visited to ensure protection of > 90% of high-quality winter and summer ranges and calving areas (see Seip and Jones 2014).

- *Evaluate the effects of mountain pine beetle infestations on caribou habitat availability and population dynamics*

  A large proportion of pine-leading stands within the Chase range have been impacted by mountain pine beetle infestations, which may affect forage availability for caribou. Such impacts could also alter the spatial distribution of caribou and adversely affect caribou population dynamics.

4. *Managing Recreational Activities*

   - Brade (2003) and McNay et al. (2008) have identified snowmobiling as a long-term threat to Chase caribou. Similar to access management actions employed for other SM caribou subpopulations, snowmobiling closures should be considered in important low- and high-elevation winter ranges.

5. *Population Monitoring*

   - *Develop a consistent monitoring program to track population size and trend*

     The last survey to derive a size estimate for the Chase subpopulation was completed in 2010, leading to uncertainty in its current size and trend. Going forward, population size should be estimated at regular intervals (e.g. every 3 years) using a consistent survey design (see Wittmer et al. 2005*a* and Serrouya et al. 2014, 2017*a* for examples and discussion). In the absence of consistent estimates of population size, trend can be monitored indirectly using Hatter and Bergerud's (1991) "R/M" equation, which estimates the population growth rate (λ) by relating annual adult female survival (S) to juvenile recruitment (R) ($\lambda = S / (1 - R)$; DeCesare et al. 2012*b*, Serrouya et al. 2017*a*). This indirect approach requires a sample of radio-collared females to estimate S and late-winter composition surveys to estimate R. An advantage to the indirect approach is that by maintaining a sample of radio-collared animals, information on mortality causes can also be collected, which can provide insights into mechanisms influencing population declines. If an indirect approach is used, periodic surveys should still be done to validate trend estimates (Serrouya et al. 2017*a*).

6. *Communication and Involvement*

   - *Facilitate shared stewardship with all relevant stakeholders, including guide outfitters and First Nations*

     The Chase range has a long history of use by First Nations and incorporating traditional knowledge and perspectives should be integral to any management plan. The Chase range is also an important area for guided hunting and local outfitters should be consulted and included in management planning.

8.1 Short Term (Within 6-12 Months)

[BLANK FOR NOW]

8.2 Medium Term (Within 12-24 Months)

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8.3 Long Term (Within 24-48 Months)

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