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

Thutade
Subpopulation

Northern Mountain Population

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

Thutade caribou are a newly delineated subpopulation of northern mountain (NM) caribou (Sittler et al. 2015), an ecotype of woodland caribou that is listed as *Special Concern* by the *Committee on the Status of Endangered Wildlife in Canada* (COSEWIC 2014). NM caribou currently occur in 45 subpopulations that are distributed across the northwestern section of British Columbia, the southwestern part of the Northwest Territories and the southern two-thirds of the Yukon Territory with one Yukon subpopulation being trans-boundary with Alaska (COSEWIC 2014). Within COSEWIC's (2011) Designatable Units classification system, which reflects evolutionary and ecological distinctions among caribou groups, NM caribou are considered part of Designatable Unit 7. In British Columbia, mountain-living caribou are classified into "northern" and "southern mountain" ecotypes, which reflect differences in feeding ecology during winter (Stevenson and Hatler 1985). The northern ecotype, which includes all NM caribou subpopulations, occurs in mountainous areas receiving relatively low annual snowfall and primarily forages on terrestrial lichens within mature conifer forests or wind-swept alpine slopes (Seip and McLellan 2008). The southern mountain ecotype, in contrast, inhabits the interior, deep-snow mountains and forages on arboreal lichens during winter as terrestrial foods are generally unavailable. Within British Columbia, NM caribou are currently *Blue-listed* with a conservation status of S2/S3 due to sustained declines in some subpopulations, uncertainty in the population trend of others, and high threats from predation and anthropogenic disturbance (BC Conservation Data Centre 2017).

2.1 DISTRIBUTION

The Thutade subpopulation has only recently been recognized and its current range is situated in an area previously designated as a zone of "trace occurrence" for caribou (McNay 2012, Sittler et al. 2015). This new range is located within the Omineca Mountains in the north-central portion of the province and the majority of its area falls within the Northern Boreal Mountains ecoprovince (Fig. 1). The 7837 km^2 range is typified by rugged alpine areas (Boreal Altai Fescue Alpine biogeoclimatic zone) and forested valleys (Spruce-Willow-Birch, Boreal White and Black Spruce, and Engelmann Spruce – Subalpine Fir zones; McNay 2011, 2012). The range is bounded to the east by the Finlay River and the Northern Rocky Mountain Trench, which separates the range from the adjacent Finlay caribou range. To the north, the range is bordered by the Frog and Spatsizi ranges, and to the south, the range abuts the Chase range. The delineation of the Thutade range resulted in changes to the boundaries of the Finlay and Chase ranges as the Thutade incorporated a small portion (122 km^2) of the Finlay range and a portion (714 km^2) of the Chase range. The north central portion of the Thutade range lies within the Muskwa-Kechika Management Area and the range also encompasses the southern portion of Finlay-Russel Provincial Park.

2.2 HABITAT AND BEHAVIOUR

NM 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 adjacent Frog subpopulation, a radio-collaring study (n = 55 females) conducted between 2000 and 2003 found that caribou generally selected higher elevation habitats (alpine and subalpine tundra) in late spring, summer and fall then move into lower elevation conifer forests during the winter and early spring (Elliot 2004). Thutade caribou appear to have similar behaviour as GPS radio-collared females (n = 15) monitored between 2012 – 2015 were generally at their highest elevations during summer and lowest during calving (Sittler et al. 2015). Considerable variation, however, may exist among individuals and among seasons. For example, in late winter, many caribou use wind-swept alpine ridges to access exposed terrestrial lichens, particularly during high snowfall years, whereas other individuals remain below treeline (Wood 1996, MacDonald et al. 2009). This variation in seasonal behaviour is evident in Thutade caribou as GPS locations from radio-collared animals occurred within polygons predicting both high- and low-elevation winter range (Sittler et al. 2015).

Differing spatial strategies are also found during calving with many females using high elevation sites above treeline while others calve in subalpine conifer forests prior to moving to higher elevation summer ranges (Wood 1996, Elliot 2004). Calving generally occurs from mid-May to mid-June (Radcliffe 2000). Similar to the grouping behaviour of other woodland caribou, the average group size of NM caribou is highest during the rut (late September to early October) and smallest during calving (Bergerud et al. 1984, Bergerud and Page 1987).

2.3 Population Size and Trend

Because the Thutade subpopulation has only been recently recognized, data estimating caribou demographics are limited. Prior to its official designation, the area comprising the Thutade range had been designated as a zone of trace occurrence. Dating back to early 1990s, this zone received periodic reconnaissance-level surveys where caribou observations were recorded. McNay (2012) reviewed these historic surveys and estimated a minimum of 301 caribou over the period in which the surveys were conducted (1990, 1991, 2003, 2007, and 2009; Table 1). In 2010, McNay (2012) recorded 216 caribou within the trace occurrence zone during an aerial survey conducted in October. This number equated to a density of 4.2 caribou / 100km^2. Using the current range boundaries, Sittler et al. (2015) estimated a minimum population of 102 caribou for the Thutade subpopulation using data from the 2010 survey. A subsequent survey in 2012 recorded 95 caribou within the Thutade range (Sittler et al. 2015).

Inferences on caribou population dynamics can be gained from estimates of adult female survival and juvenile recruitment (calves surviving to beyond nine months of age; Hatter and Bergerud 1991, DeCesare et al. 2012). For the Thutade range, estimates of juvenile recruitment are confined to fall (October – November) surveys conducted within and adjacent to the trace occurrence zone between 2010 and 2013 (Table 2). In 2010, calves comprised 13% of the caribou observed (n = 470) though 267 of these animals were recorded within either the Chase or Spatsizi ranges (McNay 2012, Sittler et al. 2015). Surveys conducted in the same area in 2012 and 2013 recorded similar values (13% and 14% respectively; Sittler et al. 2015). These values are near those associated with stable populations (~15%; Bergerud 1996), although the reported values are from fall surveys and therefore do not represent recruitment in the usual sense (e.g. 9-month old calves). For adult female survival, Sittler et al. (2015)

deployed radio-collars on 30 females within the trace occurrence zone and these animals were monitored for various periods from 2012 – 2015. While five mortalities were recorded, no estimates of annual survival were reported. These data, however, could be used to retrospectively estimate an annual survival rate for this time period. In the adjacent Finlay and Chase ranges, average annual survival of adult females was estimated to be 77% and 91%, respectively, for animals (Finlay = 35, Chase = 62) monitored for various periods between 1990 and 2004, though survival rates varied considerably from year to year (range: 60-100%; McNay and Giguere 2004).

Determining population trend for the Thutade range is difficult due to the range only recently being recognized, the limited number of aerial surveys to estimate population size, and the limited data on juvenile recruitment and adult female survival. Harvest data, however, are available for Wildlife Management Units (WMUs) overlapping the ranges and indices calculated from such data – such as catch-per-unit-effort (CPUE) and hunter success rate – can give an indication of population trend. The Thutade range is overlapped by Wildlife Management Units (WMUs) 6-18, 7-39, and 7-40. Note that WMUs 6-18 and 7-39 also overlap parts of the Chase and Spatsize caribou ranges and 7-40 extends into the Frog range. CPUE and success rates have been highly variable within WMU 7-40 while these indices show a declining trend in WMU 7-39 (Fig. 2). Compulsory inspection data show that 16 bulls have been harvested within the Thutade range since 2005 (M. Klaczek, BC Ministry of Forests, Lands, Natural Resource Operations Rural Development, *unpublished data*).

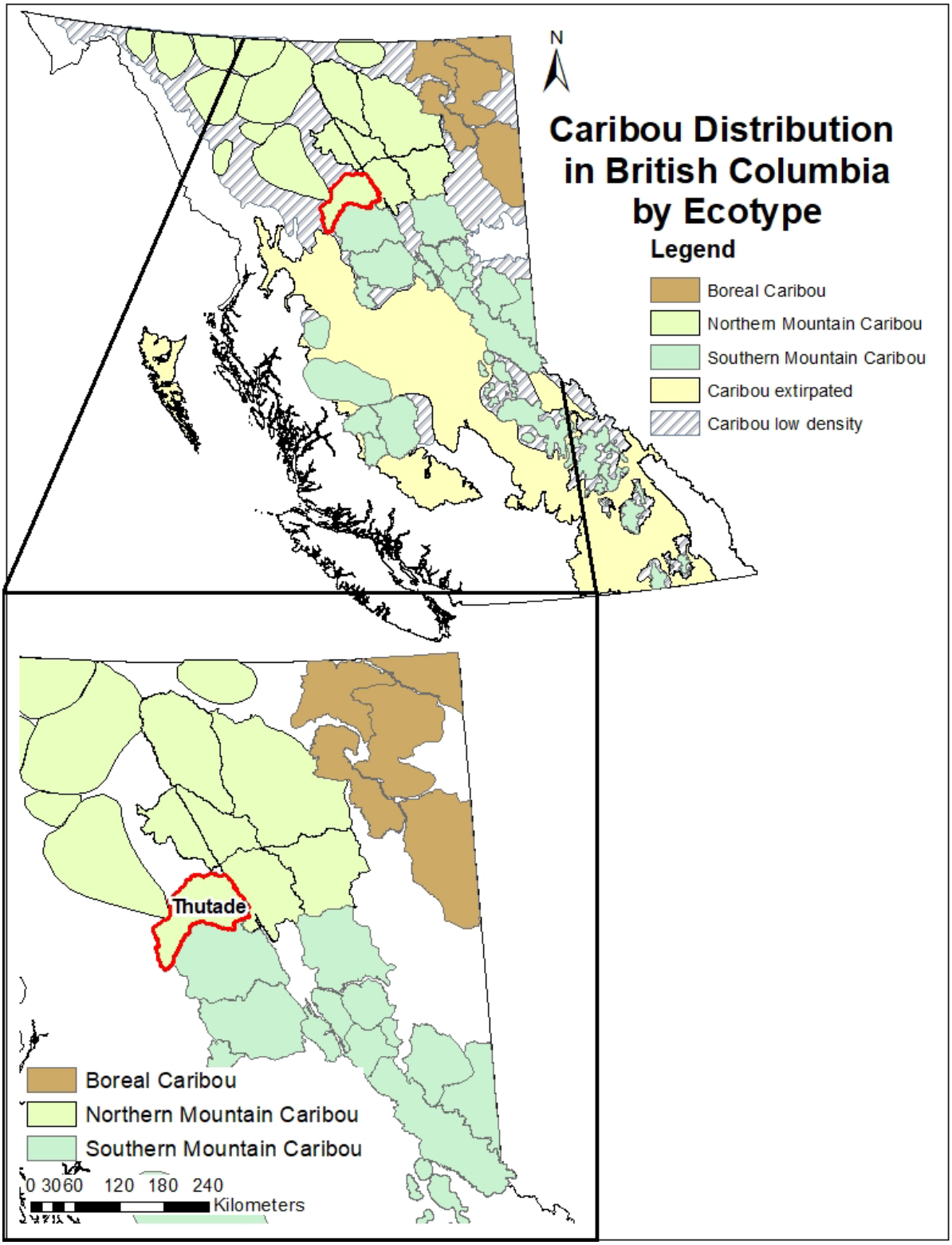

Figure 1: The geographical location of the Thutade subpopulation of northern mountain caribou.

Table 1: Minimum counts of caribou by year for the Thutade subpopulation of northern mountain caribou in north-central British Columbia.

Year	Estimate	Method	Survey Timing	Reference
1990-2009*	301	reconnaissance-level aerial survey	NA	McNay 2012
2010	102	minimum count	April	Sittler et al. 2015
2012	95	minimum count	October	Sittler et al. 2015

* Aerial surveys conducted in 1990, 1991, 2003, 2007, and 2009 in the southern zone of trace occurrence, portions of which later became the Thutade range.

Table 2: Estimates of the percentage of calves in the Thutade subpopulation of northern mountain caribou in north-central British Columbia. Percentages were estimated from aerial surveys conducted in the fall over areas along and adjacent to the range's boundary.

Year	% Calves	Survey Timing	Reference
2010	12	October	Sittler et al. 2015
2012	13	October	Sittler et al. 2015
2013	15	November	Sittler et al. 2015

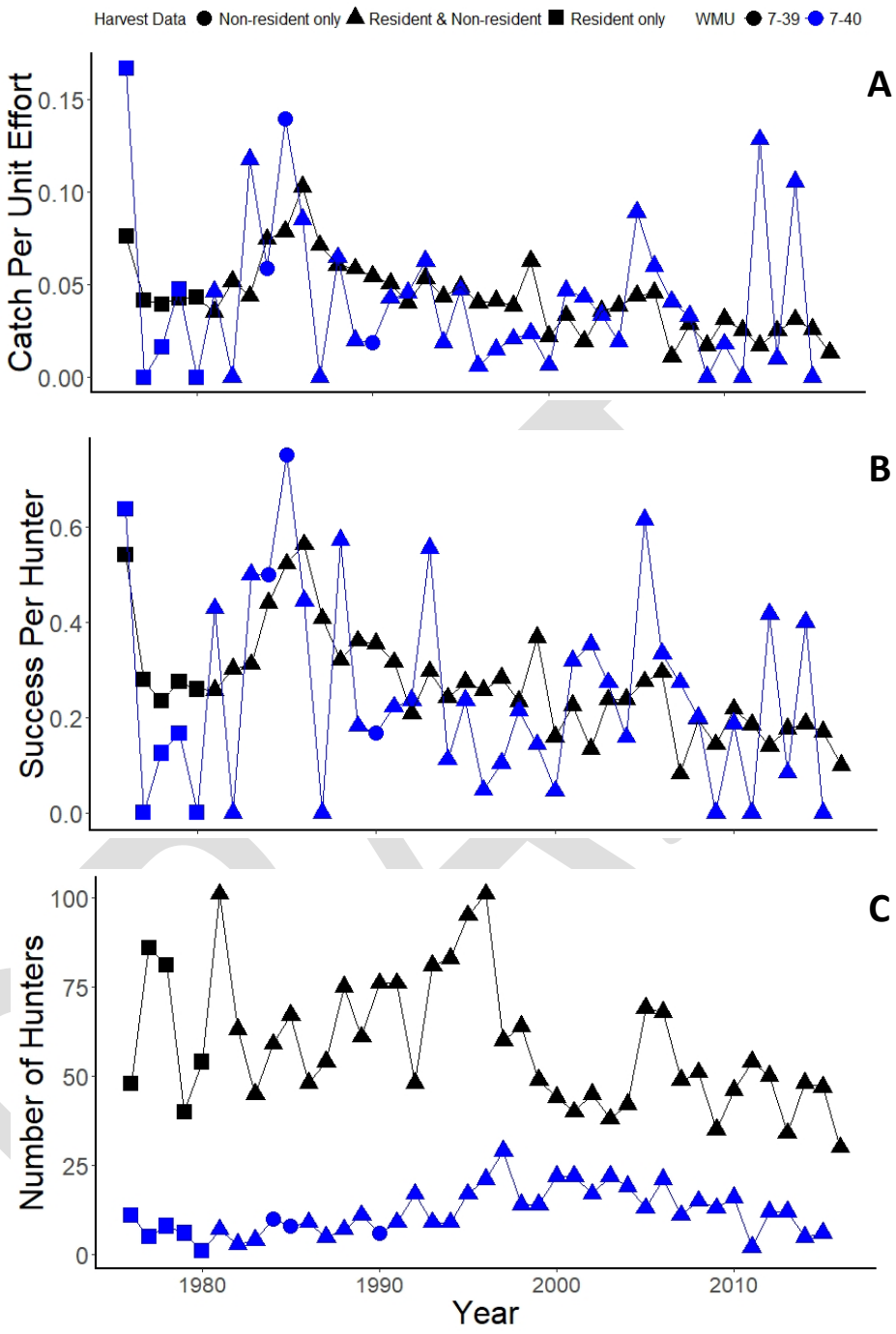

Figure 2: Harvest indices from 1976 to 2016 for Wildlife Management Units (WMUs) 7-39 and 7-40, which overlap the range of the Thutade subpopulation of northern mountain caribou in north-central British Columbia. Catch per unit effort (A) is the total kills divided by the total number of hunter-days. Success per hunter (B) is the total kills divided the total number of hunters. The total number of hunters (C) represents both resident and non-resident hunters. Note that WMU 7-39 also overlaps small portions of the Chase and Spatsizi caribou ranges and WMU 7-40 includes a portion of the Frog caribou range. Since 2005, these WMUs have had a 10-week general hunting season for bulls with 5 points or larger.

3 THREATS AND LIMITING FACTORS

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

The federal *Management Plan* for NM caribou (Environment Canada 2012*a*) and the recent status report by COSEWIC (2014) identified a number of threats potentially affecting NM caribou subpopulations and their habitat. These threats 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 discusses these threats – and others – and the order of discussion does not reflect their relative importance to a specific subpopulation. 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). Overall, the NM caribou population was recently assigned a threat impact rating of High by COSWEIC (2014).

3.1 PREDATION

Woodland caribou populations are naturally limited by predation, which results in caribou occurring at relatively low but stable densities within their range (Fuller and Keith 1981, Bergerud 1996, Bergerud and Elliott 1998). Because caribou have low rates of reproduction, their populations are sensitive to changes in predation rates. Indeed, increasing predation is 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 in these populations has been ultimately linked to human-mediated landscape disturbance and climate change, both of which alter the abundances and distributions of predators and alternate prey (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*.

Within the Thutade range, predation was the primary cause of adult female mortality among radio-collared individuals (*n* = 18) that were monitored for various periods between 2012 and 2015 (Sittler et al. 2015). Of the four mortality sites investigated, three were confirmed to be predation-caused (two by wolves, one by lynx). Findings from other studies conducted in other nearby NM caribou ranges such as the Spatsizi and Chase ranges also suggest that predation is a major limiting factor influencing caribou population dynamics in the region (Bergerud and Elliot 1986, Wood and Terry 1999, McNay et al. 2010). In the Spatsizi range, predation was found to be the primary cause of calf mortality and low rates of calf recruitment contributed to declining caribou numbers during the late 1970s (Bergerud and Elliot 1986). In the Chase range, predation was the sole cause of mortality among radio-collared females (*n* = 9 mortalities) monitored from June 2009 – March 2010 (McNay et al. 2010).

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 mountain-dwelling caribou in British Columbia, evidence to date suggests that food limitation is not a primary factor in recent populations declines (Wittmer et al. 2005*b*, McLellan et al. 2012). Such evidence, however, does not preclude any food limitation effect. For example, risk-sensitive foraging in highly altered landscapes may increase predation risk for caribou if such behaviour causes them to become more predictable in time and space or more clumped in their distribution (Fortin et al. 2013, DeMars et al. 2016). Food limitations may also result in smaller calves, which could have increased predation risk (Adams et al. 1995). Determining the magnitude of such food limitation effects, however, is difficult in a high predation environment because predation may occur before effects on body condition become evident (Cook and Cook 2015, Boutin and Merrill 2016).

To date, there have been no studies explicitly evaluating the nutritional condition of Thutade caribou. Studies, however, have been undertaken in the nearby Pink Mountain and Graham ranges. In the winters of 2001-2002 and 2002-2003, Parker and Gustine (2007) assessed nutritional status of Pink Mountain caribou by estimating rump fat on captured animals (*n* = 38; see also Gustine et al. 2007), quantifying pregnancy rates and evaluating body mass of newborn calves. Their findings suggested that, at the time, these caribou were not nutritionally limited as all indices had values similar to other caribou populations considered to be robust. More recently, rump fat assessments were made on adult females captured during the winter of 2014-2015 in other NM caribou ranges (e.g. Graham; Cook and Cook 2015). Results of this study suggested that the nutritional condition of mountain-dwelling caribou was

lower than caribou found further east on the boreal plains. The degree to which these lower nutritional scores affect caribou population dynamics, however, is not yet fully understood.

3.3 Human Activities

Human activities within and adjacent to caribou range are believed to be a primary driver of current declines in many populations of woodland caribou (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).

Forestry impacts within the Thutade range are relatively minimal due to its remoteness with few roads (Sittler et al. 2015). An analysis using cutblock GIS data up to 2015 suggests that cutblocks comprise < 1% of the Thutade range with the majority of cutblocks occurring along the range's periphery, particularly along the Northern Rocky Mountain Trench and in the range's southwest corner.

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 Kemess Underground mine is located within the Thutade range northeast of Thutade Lake. This open-pit copper and gold mine was operational from 1998 to 2011, though applications have been submitted for the mine to re-open in ~ 2018 (http://www.mining.com/web/bc-copper-gold-mine-to-reopen-after-six-years/). Sittler et al. (2015) also reported that other portions of the Thutade range were

being considered for hard rock mining and provided photographs of caribou near a mining exploration site situated in alpine habitat. Current GIS analyses show an extensive line of mining tenures running through the range's central third.

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).

Using GIS data available from the BC Oil and Gas Commission up to 2016, there are currently no impacts from oil and gas development within the Thutade range.

3.3.1.4 Clean Energy

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

There are no wind power or other clean energy developments within the Thutade range.

3.3.1.5 Other

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

The north-central portion of the Thutade range is situated within the Muskwa-Kechika Management Area, which highly manages snowmobiling and other forms of motorized. Snowmobiling within this area is restricted to specific designated routes and none of these occur within the Thutade range (http://www.muskwa-kechika.com/management-area/access-management). Because of its remoteness, snowmobile use within other areas of the Thutade range is likely minimal and most activity is concentrated around the First Nations communities of Tsay Ken Dene and Fort Ware.

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 or cat-skiing companies operating within the Thutade 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).

The overall impact of summer recreational activities on the Thutade subpopulation of NM caribou is likely minimal. Off-road vehicle use, hiking and horseback riding all occur within the Thutade range though their intensity is likely low due to the remoteness of this range and the small number of developed trails.

3.3.2.4 OTHER

In many ranges of mountain-dwelling caribou, backcountry skiing (i.e. ski touring) has become an increasingly popular activity. Simpson and Terry (2000) rated this activity's threat to caribou as low

because of its non-motorized nature. Because of the range's remoteness, ski touring impacts within the Thutade range are likely minimal.

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 impacts from agriculture within the Thutade caribou range.

3.3.3.2 Major Highway Corridors

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

There are no major highways within or adjacent to the Thutade range. There is an all-weather gravel road in the Northern Rocky Mountain Trench on the range's eastern boundary. This road connects the communities of Fort Ware and Tsay Keh Dene.

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). With natural resource exploration increasing in NM caribou ranges, the creation of new linear features is becoming an increasingly important management concern as such features may result in increased harvest by allowing easier human access to caribou habitat (Seip and McLellan 2008, Hegel and Russell 2013).

Compared to other caribou ranges in British Columbia, the Thutade range has been minimally impacted by linear features. The majority of linear features are forestry roads located within and adjacent to the Northern Rocky Mountain trench on the range's eastern boundary.

3.3.3.4 HUNTING

Historical records indicate that NM caribou have long been hunted by First Nations in BC (Spalding 2000). Guided hunting has occurred within the Northern Rocky Mountains at least since the 1940s (Spalding 2000). Currently, licensed hunting for caribou is still allowed within WMUs 7-39and 7-40, which overlap the Thutade range. Harvest is restricted to 5-point bulls with a bag limit of one. Within British Columbia, all licensed harvest of caribou has been tracked since 1976 by compulsory inspection or hunter surveys. For a review of harvest statistics within the Thutade range, see *Section 2.3 Population Size and Trend* and Figure 2 above.

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 ~3% of the Thutade range with the majority of these fires situated along the periphery of the range. Within the last 50 years, the largest fire occurred in 1971 (9,008 ha burned) and was situated in the south-central portion of the range.

The Thutade range has been impacted by the mountain pine beetle with affected areas primarily situated in lower-elevation forests. Projections into the year 2020 do not suggest that infestations will spread significantly beyond their current spatial extent (https://www.for.gov.bc.ca/hre/bcmpb/year13.htm).

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 Thutade caribou are not well studied. In nearby ranges of boreal caribou, a three-year study documented a number of potential disease and pathogenic threats to these subpopulations, including the pathogenic bacterium *Erysipelothrix rhusiopathiae*, the protozoan parasite *Neospora caninum*, and high winter tick (*Dermacentor albipictus*) loads (Schwantje et al. 2014). Winter tick in particular was identified as an emerging threat to caribou in the region as moderate to severe infestations were observed in all ranges, although its prevalence in NM caribou has not been explicitly assessed. In the federal *Management Plan* for NM caribou, determining the role of disease and parasites in limiting caribou populations was identified as a priority for future research (Environment Canada 2012*a*).

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 Thutade 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 NM caribou ranges is 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 Thutade 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 Thutade subpopulation as recent estimates suggest a population size of ~100 (see *Section 2.3*). It also unclear the extent to which Thutade caribou interact with neighboring ranges (e.g. Spatsizi, Frog, Chase). Movement among these ranges may reduce the likelihood of small population size effects.

4 Management History

Many subpopulations of NM caribou have a limited history of active management, which in part may be due to the remoteness of their ranges and a lack of baseline information. In its initial assessment of NM caribou, COSEWIC (2002) suggested that most subpopulations were stable because their habitat was remote and relatively intact. Only two subpopulations were thought to be at risk with the primary threats being altered predator-prey dynamics and increased human access. Twelve years later, a reassessment of NM caribou found two subpopulations to be increasing, seven were stable, nine were decreasing, and the statuses of the remaining 27 subpopulations were unknown due to data deficiencies (COSEWIC 2014). For subpopulations within British Columbia, one subpopulation was thought to be stable, seven were decreasing and the population trends for the remaining 15 were uncertain.

In 2012, the federal *Management Plan* for NM caribou was developed to prevent further population declines and avoid their potential listing as threatened or endangered. The *Plan* recommended a series of management actions to address the uncertainties surrounding the status of many subpopulations and to outline recovery measures for those in decline (Environment Canada 2012*a*). These actions were similar to those recommended for recovering Boreal and Southern Mountain caribou (Environment Canada 2012*b*, 2014), and broadly included the following key components:

i. Managing and protecting of 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 access management.

ii. Managing the populations of other ungulate species.

iii. Managing of predator populations.

As a fourth key component, the *Management Plan* also recommended that NM caribou be managed for a sustainable harvest, which is unique to this population as Boreal and Southern Mountain caribou are no longer hunted.

This section reviews management actions undertaken for the Thutade subpopulation under five broad categories: habitat management, recreation and access management, predator management, alternate prey management, and population reinforcement. For a review of this subpopulation's harvest history and management, see Sections *2.3 Population Size and Trend* and 3.3.3.4 *Hunting*.

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). NM caribou require large tracts of undisturbed habitat and have evolved to inhabit alpine areas and old-growth forests, which separates them – both in terms of elevation and horizontal space – from other ungulates and their generalist predators (Bergerud et al. 1984, Bergerud and Page 1987, Seip 1992). In winter, NM caribou use mature forests and wind-swept alpine areas to access lichen (Johnson et al. 2004). Summer ranges are typified by alpine birch-sedge meadows (Oosenbrug and Theberge 1980, Denryter et al. 2017). Spatial requirements for NM caribou also extend beyond seasonal areas of high use (i.e. habitat cores) and can include "matrix" habitat, areas of relatively low use that may be used during migration (Environment Canada 2012*a*).

The 2012 federal *Management Plan* for NM caribou suggests that effective habitat management for each subpopulation requires delineating and protecting habitats with high influence on population dynamics (e.g. calving areas, rutting ranges, winter ranges, movement corridors). Because natural and anthropogenic disturbances are known to negatively impact habitat quality (Wittmer et al. 2007, Sorensen et al. 2008), active restoration may be required for those subpopulations residing in highly disturbed landscapes.

4.1.1 PROTECTION

The north-central portion of the Thutade range (~ %) lies within the Muskwa-Kechika Management Area, which is managed to maintain wilderness values. Provincial Parks and Protected Areas within the Muskwa-Kechika Management Area, which encompass ~ 6% of the range's area, provide even stronger protections as no industrial development is permitted in these areas. Approximately 75% of the range's area is also designated as Ungulate Winter Range (UWR), primarily for mountain goat and Stone's sheep though areas specified as caribou UWR comprise 680 km^2 (~8.6% of the range's area).

4.1.2 Enhancement and Restoration

There has been no management actions to enhance or restore caribou habitat within the Thutade range.

4.2 Recreation and Access Management

The Thutade caribou range is generally remote and has much lower recreational activity than caribou ranges situated in mountainous areas of southern British Columbia. As a result, there are minimal management actions focused on recreation and access.

4.2.1 Snowmobile

Snowmobile use within the Thutade range is low compared to ranges of mountain-dwelling caribou located further south in the province (Simpson and Terry 2000, BC Ministry of Environment 2003). Within the Muskwa-Kechika Management Area, snowmobiling is restricted to designated routes and none of these occur within the Thutade range.

4.2.2 Heli-ski / Cat-ski

There are no heli- or cat-ski companies operating within the Thutade and thus it is not subjected to impacts from these activities.

4.2.3 Summer Recreation

Due to its remoteness and lack of road access, the Thutade range sees relatively light summer recreational use. Within the Muskwa-Kechika Management Area, motorized vehicles are restricted to a few specified access routes and none of these occur in the Thutade range. Other activities in the range include backpacking, horseback riding and guide outfitting, all of which occur at a low intensity and consequently there are no restrictions on these types of recreation.

4.2.4 Other

There are no other restrictions on recreational activities within the Thutade 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 (Bergerud and Elliott 1998, 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 Thutade subpopulation are 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 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 Thutade subpopulation, which range lies further north of the wolf control areas than Graham, are unknown.

Currently, there is an eleven month general hunting season for wolves with no bag limit in WMUs 7-39 and 7-40, which overlap the Thutade range. In WMU 6-18, which overlaps the range's southwestern corner, the general hunting season extends from 1 August to 15 June with a bag limit of three.

4.3.2 Cougar Management

Being situated at the northern edge of cougar distribution within western North America, the Thutade range likely has a low density of cougars, though their population has not been explicitly enumerated. To date, cougar predation of Thutade caribou has not been documented and consequently cougars have not been subject to management actions in the context of caribou conservation. Within WMU 7-52, there is a general hunting season for cougars with a bag limit of one. There is no general hunting season for cougars within WMUs 6-18, 7-39 and 7-40.

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 Thutade 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 (Wittmer et al. 2013, Serrouya et al. 2015, Boutin and Merrill 2016).

4.4.1 Moose Management

WMUs within the Thutade range have received few surveys to estimate moose densities and/or abundance. In 1998, a survey of what was known as the Chase study area, which encompassed at least a portion of the Thutade range (near Thutade Lake), recorded 269 moose (Pacific Slope Consulting 1999). In 2007, Walker et al. (2007) estimated a moose density of 0.59 moose / km^2 in the Northern Williston Watershed, which included WMUs 7-39 and 7-40 and the entire Finlay River watershed and thus overlapped portions of the Thutade 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 Thutade range. Licensed general hunting for moose within WMUs 7-39 and 7-40 is restricted to a 13-week season for spike-fork bulls with a bag limit of one. Within WMU 6-18, there is a 10-week general season for all bulls. 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 Thutade caribou range, though both likely occur at low densities. Mule deer may be more abundant (Kline 2013) although the northern distribution and abundance of white-tailed are likely increasing (Latham et al. 2011*b*, Dawe and Boutin 2016). Within WMUs 7-39 and 7-40, there are general hunting seasons for both mule deer and white-tailed deer bucks. The bag limit for each species is one. Hunting is closed for both species within WMU 6-18. To date, there have been no management actions targeted toward deer in the context of caribou conservation in the Thutade caribou range.

4.4.3 Other

Elk (*Cervus elaphus*), mountain goat (*Oreamnos americanus*) and Stone's sheep (*Ovis dalli stonei*) are also present within the Thutade caribou range. For elk, there is a 4-week general hunting season in WMUs 7-39 and 7-40 for six-point bulls and larger. WMU 6-18 is closed for elk hunting. For Stone's sheep, there are 10-week general hunting seasons for full curl rams in all three WMUs. For mountain goat, there are 8-week general hunting seasons in WMUs 7-39 and 7-40 and a 10-week season in WMU 6-18. 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 been used within the Thutade 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 Thutade 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 Thutade subpopulation.

4.5.4 Other

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

4.6 Stewardship/Outreach

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4.7 Research

Most subpopulations of NM caribou are relatively little studied, perhaps because they are a lower management priority due to being less threatened than populations of boreal and southern mountain

caribou (Environment Canada 2012*a*). Within British Columbia, the first research efforts aimed at evaluating NM caribou ecology and behaviour 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 NM caribou ranges, with research focusing on predator-prey dynamics (Bergerud and Elliot 1986, Bergerud and Elliott 1998, Gustine et al. 2006), estimating vital rates (Parker and Gustine 2007, McNay et al. 2014), spatial behaviours (Bergerud et al. 1984, Bergerud and Page 1987), habitat selection (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). While these studies have collectively informed the broad management strategies outlined in the federal *Management Plan* for NM caribou, further herd-specific research will likely be necessary to develop effective strategies for individual subpopulations (Environment Canada 2012*a*).

Prior to its delineation, the area encompassed by the current Thutade range was known as a zone of trace occurrence for caribou. Until recently, little was known about caribou ecology in this region with inferences on caribou numbers and spatial distribution primarily derived from reconnaissance-level aerial surveys conducted periodically between 1990 and 2009 (reviewed in McNay 2012). Starting in 2010, more focused research was initiated in the region to better understand caribou ecology. This research included aerial surveys to estimate caribou numbers and spatial distribution (McNay 2012) and the deployment of radio-collars on a sample of females (n = 18; Sittler et al. 2015). Results from this research culminated in the delineation of the Thutade range and refinement of adjacent range boundaries. Since the finalization of these range boundaries, no subsequent research has been conducted within the Thutade range (K. Sittler, Wildlife Infometrics Inc., *personal communication*).

4.8 MONITORING

The Thutade caribou range has only recently been delineated and thus it has received only limited monitoring. Prior to its delineation, the area encompassed by the Thutade range was known as a zone of trace occurrence and monitoring of caribou within this region was limited to reconnaissance-level surveys (1990, 1991, 2003, 2007, and 2009) that were generally conducted to assess potential impacts of proposed mine developments or to enumerate other ungulate species (McNay 2012). In 2010, more focused monitoring was initiated in what is now the Thutade range, beginning with an aerial survey to assess caribou distribution and abundance. In the winters of 2012 and 2013, 18 radio-collars (15 GPS, 3 VHF) were deployed on females within the Thutade range to understand seasonal movements and further aerial surveys were conducted in October 2012 and November 2013 (Sittler et al. 2015). Since this latter time, no further surveys have been conducted within the Thutade range and no additional radio-collars have been deployed (K. Sittler, Wildlife Infometrics Inc., *personal communication*).

5 IMPLICATIONS TO OTHER WILDLIFE

Management actions focused on conserving caribou will necessarily have impacts on other wildlife species. Caribou generally 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

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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

In 2012, the federal *Management Plan* for NM caribou was released to outline objectives and strategies for recovering and managing subpopulations of NM caribou (Environment Canada 2012*a*). The primary goal of the *Management Plan* was to facilitate cooperative management of NM caribou to prevent the population from becoming threatened or endangered. Inherent to the latter part of this goal is that subpopulations are maintained within their natural range of variability. To achieve this goal, the *Management Plan* outlined a number of objectives, including:

i. Evaluating and monitoring population size and trend
ii. Managing harvest for sustainable use
iii. Identifying and protecting demographically important habitats
iv. Understanding and managing predator-prey dynamics
v. Assessing health risks (e.g. parasites and disease) to caribou
vi. Evaluating disturbance impacts in a cumulative affects framework
vii. Foster multi-stakeholder stewardship and develop knowledge sharing programs

The relative importance and order of implementation of the above objectives will vary by subpopulation and will depend on such factors as current population size, population trend (stable, increasing or decreasing) and known threats. To assess progress toward management objectives, the *Management Plan* recommended that population size and trend, habitat conservation and the reduction of threats be used as performance measures.

Below, recommended management actions are outlined for the Thutade subpopulation. Following the framework of the federal Management Plan, actions are grouped under three headings: Population Management, Habitat Management, and Communication and Involvement.

Recommended Actions for the Thutade Subpopulation

1. *Population Management*

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

      Population size should be estimated at regular intervals (e.g. every 3-5 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, period surveys should still be done, however, to validate trend estimates (Serrouya et al. 2017*a*).

- *Manage harvest for sustainable use*

  Current hunting regulations allow for a general season on 5-point bulls within the Thutade 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. Although precise estimates of population size for the Thutade range are lacking, observations of the minimum number alive have been ~ 100 animals. Over the last decade, an average of 1.1 bulls have been harvested per year within the Thutade range (M. Klaczek, unpublished data) has averaged 1.1 bulls within WMUS 7-39 and 7-40 combined.

2. *Habitat Management*

   - *Identify then ensure protection of core habitat areas*

     The Thutade range is situated in an area managed for multiple uses and consequently could undergo significant landscape change from industrial development (Sittler et al. 2015). To balance caribou conservation with responsible resource development, core habitat areas for caribou within the Thutade range should be identified to inform the development of effective, range-level management strategies.

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

     Substantial evidence from boreal and southern mountain caribou populations 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. Maintaining an inventory of disturbances within the Thutade range should be a priority, particularly given the area's potential for future industrial developments (Sittler et al. 2015).

3. *Communication and Involvement*

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

     The Thutade range has a long history of use by First Nations and incorporating traditional knowledge and perspectives should be integral to any management plan. The Thutade

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)

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8.2 Medium Term (Within 12-24 Months)

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8.3 Long Term (Within 24-48 Months)

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