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

Narrow Lake
Subpopulation

Upper Fraser
Local Population Unit

BRITISH COLUMBIA

Recommended Citation:

Photo credit: Doug Heard

EXECUTIVE SUMMARY

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1 BACKGROUND

1.1 INTRODUCTION TO THE PROGRAM

The Narrow Lake woodland caribou subpopulation was designated as Southern Mountain Caribou (Designatable Unit (DU) 9 – Southern Group) by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC; Environment Canada 2012b, 2014). As a group, the Southern Mountain group of woodland caribou is recommended as Endangered by Canada (Environment Canada 2014) and is Red-listed by the Province of British Columbia (British Columbia Conservation Data Centre 2017).

Woodland Caribou are further divided into Local Population Units by Environment Canada. Within the Southern Mountain Caribou group there are eleven Local Populations. The Narrow Lake subpopulation is in the Upper Fraser Local Population together with the North Cariboo and recently extirpated George Mountain subpopulations (Environment Canada 2014).

Range plans are required for all woodland caribou populations that are designated as threatened or endangered in Canada (Environment and Climate Change Canada and British Columbia Ministry of Environment 2017). The current designation for the North Cariboo subpopulation is “Endangered” and current monitoring indicates that while the numbers have declined 40-50% over the last decade, the Narrow Lake subpopulation appears stable since 2012 (Klaczek and Heard 2016).

This document spans the divide between these disparate designations in British Columbia and Canada, compiling past research, knowledge and management actions into guidance for the management and recovery of the Narrow Lake Southern Mountain caribou subpopulation within in the Upper Fraser Local Population Unit.

2 POPULATION DESCRIPTION

Southern Mountain Caribou (formerly known as mountain caribou) live in the Interior Wet Belt that stretches from northern Idaho and Washington States to central British Columbia. In contrast to Central and Northern Mountain Caribou, they remain in mature subalpine forest habitat year-round. In winter, Southern Mountain Caribou live in a deep snowpack and feed on lichens that grow on trees (Government of British Columbia 2017).

2.1 DISTRIBUTION

The Narrow Lake subpopulation occurs on the west side of the Rocky Mountains, in the highlands between the Willow and Bowron Rivers, southeast of Prince George, BC. Their range extends from Narrow Lake in the south to Tsus Lakes in the north.

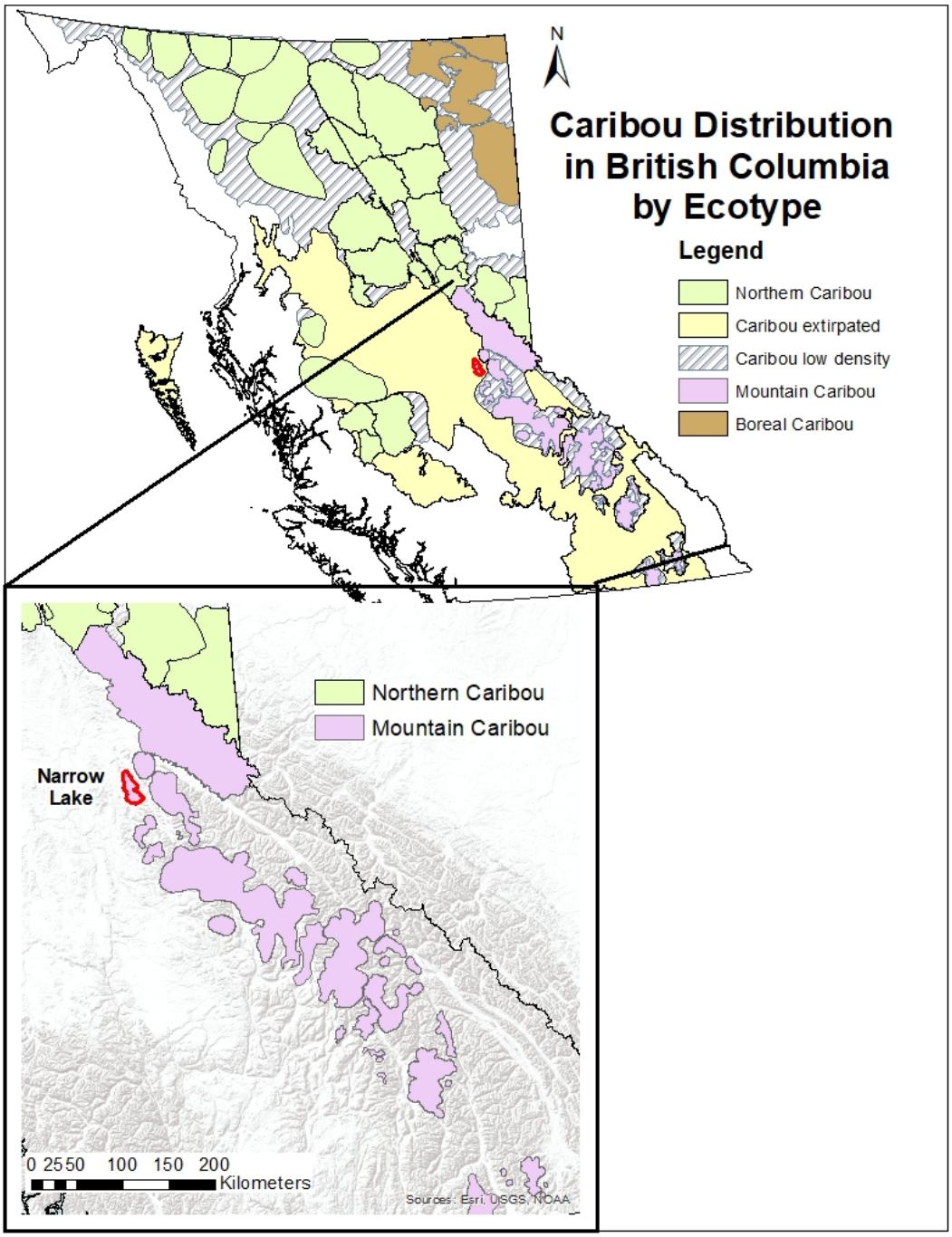

Figure 1: The geographical location of the Narrow Lake subpopulation of woodland caribou. The 424 km^2 range (inset: red outline) is situated within the Upper Fraser Region.

2.2 HABITAT AND BEHAVIOUR

A habitat survey in the range of the Narrow Lake caribou subpopulation found that 87% of the area is covered in spruce / balsam forest, with the rest evenly divided into alpine forest, alpine, immature forest and unrecovered forest (Stevenson and Hatler 1985). Woodland caribou in this region select mid-elevation

forests in early winter and higher elevation (subalpine) forests in late winter (Terry et al. 2000). Throughout the winter, Woodland Caribou in this region select strongly for higher elevation forests where arboreal lichens are relatively abundant (Johnson et al. 2004b). Spring calving, summer and fall rut habitat-use for Woodland Caribou in the Quesnel Highlands are well known. In the spring, caribou migrate to low elevations to forage on emergent growth, although females who are calving tend to stay in forests (Seip 1992b). Throughout the summer, caribou return to alpine habitats and subalpine forests (Seip 1992b). Although there is annual variation in where animals aggregate for the rut (Young and Freeman 2001), it usually occurs in open, alpine habitats.

2.3 Population Size and Trend

The Narrow Lake caribou subpopulation has declined from the first systematic counts taken in the 1990's (Figure 2). Seip et al. (2011) reported a decline from 81 to 41 estimated caribou at Narrow Lake from 1999 to 2011. Since 2011, the population has recovered somewhat to between 36 and 47 animals (Figure 2; Courtier and Heard 2014, Klaczek and Heard 2016). This subpopulation remains at a very low number.

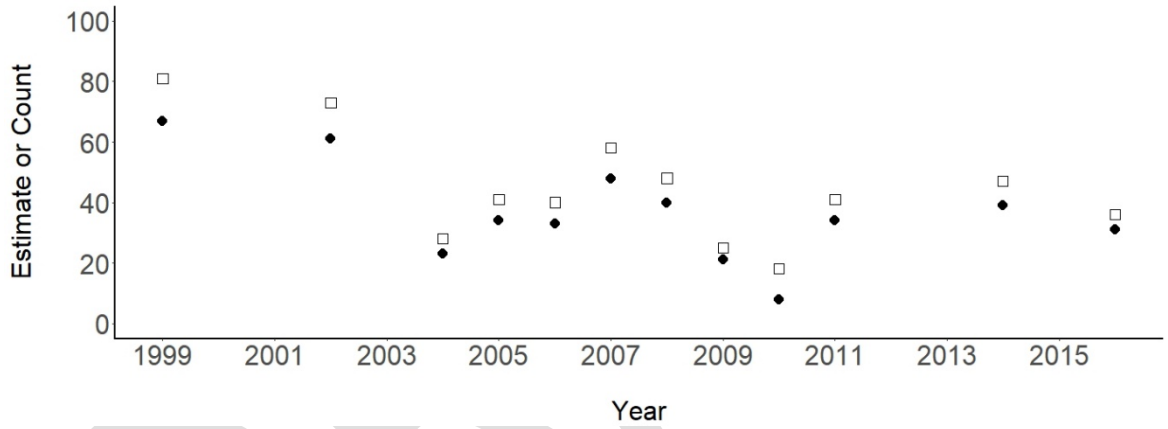

Figure 2: Caribou counts (filled dots) and estimates (hollow squares) for the Narrow Lake sub-population. Data from a variety of sources (Seip et al. 2005, Seip and Jones 2011, Courtier and Heard 2014, Klaczek and Heard 2016).

Caribou recruitment is measured as percent of calves in the population observed during a spring census (Bergerud and Elliot 1986). Recruitment in the Narrow Lake caribou subpopulation has been at or above threshold values only three years since 1999 (Figure 3).

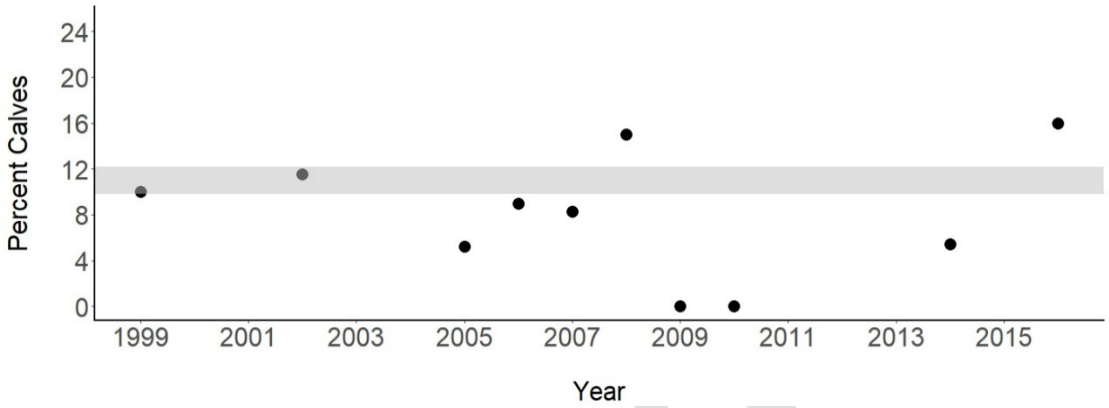

Figure 3: Caribou population recruitment measured in the Narrow Lake caribou subpopulation range. Recruitment is defined here as the percent of the estimated population that is in the calf cohort. Recruitment lower than approximately 10 to 12% is considered below a threshold that will balance natural mortality (grey band; Bergerud and Elliot 1986).

3 THREATS AND LIMITING FACTORS

Primary threats to caribou and their habitat have been noted by McNay et al. (2008), COSEWIC (2014) and a variety of independent studies (e.g., James et al. 2004, Wittmer et al. 2005b, Courtois et al. 2007, Seip et al. 2007, Wittmer et al. 2007). Here, threats are treated in isolation, but this does not discount the likelihood that they interact. Cumulate effects assessment (Sorensen et al. 2008, Johnson et al. 2015) is beyond the scope of this plan, but elements such as predation, human activities, and climate change are known to relate to one another. Work on boreal caribou has demonstrated the value in developing comprehensive range planning for woodland caribou that considers interacting threats (Angelstam et al. 2004, Environment Canada 2012b).

Here, the following threats are considered:

1. Predation
2. Food limitation
3. Human activities
    a. Industrial
    b. Recreational
    c. Other
4. Natural disturbance
5. Parasites and diseases
6. Climate change
7. Hunting and poaching

    Small population size effects

3.1 PREDATION

GPS collar and radio telemetry studies have indicated that the dominant, proximal cause of woodland caribou mortality is predation (Wittmer et al. 2013). Woodland caribou have evolved with their predators and have persisted despite millennia of predation (Bergerud 1988). While the predator species killing caribou vary

regionally (wolf, black bear, grizzly bear, cougar), their impact on woodland caribou populations has increased as the result of three dominant processes: apparent competition mediated by alternative prey hyperabundance (Hebblewhite et al. 2007), apparent competition mediated by expanding alternative prey distribution (Wittmer et al. 2007, DeCesare et al. 2010b, Latham et al. 2011a, Latham et al. 2011c), and enhanced predator access to woodland caribou habitat (Hayhurst 1983, Latham et al. 2011b). More generally, Bergerud (2007) has calculated that wolf densities greater than 6.5 wolves/1000 km^2 will result in woodland caribou declines. More recently, the federal recovery strategy identifies 3 wolves/1000 km^2 as a target (Environment Canada 2014).

There has been no direct study of mortality sources for Narrow Lake caribou, but wolves are assumed to be a primary caribou predator (Seip et al. 2008).

3.2 Food Limitation

Woodland caribou are herbivores and rare among animals as lichen eaters (Johnson et al. 2004a). While lichen makes up the bulk of their winter diet (Johnson et al. 2000, Parker et al. 2005), it is a smaller proportion of their summer diet (Denryter et al. 2017). And although habitat selection is predominantly thought to be influenced by predator avoidance, selected habitats must also be able to satisfy the animals' nutritional needs (Newsome et al. 2000, Brown et al. 2007). Trade-offs between these two fundamental demands (avoiding predators, finding food) raises the potential for woodland caribou to be food or energy limited as they seek predator refugia (Poole et al. 2000, Gustine et al. 2006). When it has been considered, estimates of caribou food abundance typically far exceeds population needs (Courtois et al. 2007).

There have been no studies of food availability and use by caribou in the Narrow Lake area. However, given the abundance and protected status of the high elevation habitat in this region as well as the few number of caribou, it would seem unlikely that they are food limited.

3.3 Human Activities

Human activities have consequences for woodland caribou conservation throughout British Columbia. This section focusses on the consequences of human industrial, recreational and other (agriculture, highway, linear feature clearing) activities (Wolfe et al. 2000).

3.3.1 Industrial

Industrial activities include forestry, mining, oil, gas and clean energy development. Caribou are affected by industrial activities both due to the associated infrastructure as well as the resulting impacts on their habitat. A additional factor to measure and understand industrial effects on caribou is the Zone of Influence (ZOI; Polfus et al. 2011). This is the area beyond the actual footprint of an industrial development or activity that affects caribou (Dyer et al. 2001). Industrial impacts, where they occur in the habitat of Woodland Caribou, have been shown to have strong direct, and indirect affects (Rippin et al. 1996, Brown 1998, Culling et al. 2004, Environment Canada 2008, Semeniuk et al. 2012, Hervieux et al. 2013, Environment Canada 2014, DeMars and Benesh 2016, Hebblewhite 2017).

3.3.1.1 Forestry

Woodland caribou are an old-growth forest dependent species (Bergerud 2000). Hence, forest management affects their distribution and population dynamics. Although Mountain Caribou populations live seasonally in treeless, alpine ecosystems, all spend some of the year in forests. For this reason, forestry and natural disturbances will affect woodland caribou populations through habitat destruction and fragmentation

(Smith et al. 2000). Forestry effects include very general "habitat loss" that reduces the amount of old-growth forest, to reduction in forest-based food resources to creating more, early seral forest habitat for apparent competitors (see below) such as deer and moose (Simpson and Woods 1987, Cichowski 1989, Seip 1990, Stevenson 1991, Cumming 1992). Factors, such as the type of forest (Cichowski 1989) and the size of cutblocks (Edmonds and Bloomfield 1984), play a role in the effect of forestry practices on woodland caribou populations. The ZOI of clearcuts for woodland caribou in Newfoundland was found to be 15 km beyond the actual cut block (Chubbs et al. 1993). Hence, even an array of small forestry clearings can have a significant influence on caribou habitat availability.

The Narrow Lake caribou subpopulation range is almost entirely surrounded cutblocks of varying age, and 126 km^2 of its area (~30%) has either been logged or borders on large cutblocks. Much of this is concentrated in the southern half of the range. The extent of logging surrounding and within its range likely has had a large effect on this population's access to habitat and interactions with other ungulate species and their shared predators (Terry et al. 2000, Lewis et al. 2005, Cumming 2011, Ehlers et al. 2014, 2016).

The Narrow Lake range falls within the Prince George Timber Supply Area (TSA). But a 2009 Ungulate Winter Range designation (U-7-003) and a wildlife habitat area 7-003 prevent harvesting in about 90% of this subpopulation's current range (Nicholls 2017) focussed on high-elevation winter habitat.

3.3.1.2 Mining

Mine sites deter caribou both for the activities that occur there when they are active as well a for the habitat they destroy. Mines have a 2 km ZOI when they are active, but this shrinks to the physical footprint of the mine site when mines are dormant, inactive or abandoned (Polfus et al. 2011).

There are no mines in the subpopulation range of the Narrow Lake caribou, although there are large gold claims in the areas adjacent to their southern and western boundary.

3.3.1.3 Oil and Gas

Oil and gas development threaten caribou populations through habitat destruction, human activity, access, habitat fragmentation and elevated predation (Dyer et al. 2001, Boutin et al. 2012, Hervieux et al. 2013). Given the spatial scope of developments and the range of activities that take place in caribou habitat to develop oil and gas resources (well sites, access roads, pipelines, seismic lines) cumulative effects of this combined with other activities (e.g. forestry, hydroelectric) also play a large role in threatening resident caribou herds (Nitschke 2008). A study of the energy consequences to caribou of being disturbed by oil and gas exploration found that individuals in active plays can lose more than 15% of body mass over winter attributed to noise displacement (Bradshaw et al. 1998).

The Narrow Lake caribou subpopulation is not in an area with oil and gas fields.

3.3.1.4 Clean Energy

Clean energy refers to hydroelectric dams and wind farms. Hydroelectric reservoirs in caribou range can destroy or fragment habitat and cut off movement corridors. Research in southern British Columbia correlated hydroelectric development with declines in caribou populations (Simpson 1987b). Hydroelectric dams, during their construction and operation have a ZOI that exceeds their footprint (Nellemann et al. 2003). Wind farm development can destroy caribou habitat, reduce forage availability, displace caribou and increase early-seral habitat that promotes growth of alternative prey populations (British Columbia Ministry of Environment 2014).

There are no clean energy developments in the range of the Narrow Lake caribou subpopulation, although the Mount George Wind Park proposal is about 25 kilometers to the west of its current home range.

3.3.1.5 OTHER

There are no other major developments planned for the Narrow Lake caribou subpopulation range.

3.3.2 RECREATION

Recreational use of caribou habitat refers largely to fall and winter activities, including snowmobiling, commercial heli-skiing, commercial cat-skiing and hunting. In some jurisdictions, winter tour skiing and mountaineering are also relevant recreational activities as is summer use with off highway vehicles (OHVs). Numerous studies have shown that woodland caribou to varying degrees avoid mechanized winter activities (Simpson 1987a, Simpson and Terry 2000, Mahoney et al. 2001, Kinley 2003, Wilson and Hamilton 2003, Seip et al. 2007). Despite numerous records of displacement, no study has been able to draw a direct link between winter recreational use and woodland caribou population decline.

3.3.2.1 SNOWMOBILE

Snowmobile use in caribou habitat can result in their displacement (Simpson 1987a, Apps et al. 2001, Kinley 2003). Studies in British Columbia and elsewhere have shown that caribou are far less likely to occupy winter habitats that are being used for recreational snowmobiling than equivalent habitats without snowmobile use (Mahoney et al. 2001, Seip et al. 2007). The mechanisms of displacement include caribou avoiding or fleeing snowmobiles while they are in use, ease of access to caribou habitat by hunters and the facilitation of predator movement into caribou winter habitat from packed trails created by snowmobiles (Bergerud 1988, Polfus 2010).

UWR protections that cover high elevation habitat for the Narrow Lake caribou subpopulation excludes snowmobiling from approximately 90% of their area. The exception is the Wolverine Access Trail that allows transit along a designated trail across the Narrow Lake caribou UWR. The lack of road access to this area suggests that this caribou subpopulation has very little risk of disturbance by snowmobile recreation (Simpson and Terry 2000).

3.3.2.2 HELI-SKI / CAT-SKI

Helicopter and cat-skiing are backcountry recreational activities that enable off-piste skiers to access high mountain terrain using either a helicopter or a tracked snow-cat that shuttles them to the top of ski runs. This is a commercial activity with numerous operators in British Columbia represented under one umbrella organization, HeliCat Canada (HCC). In southern British Columbia, HCC partners with the British Columbia government and non-government organizations to monitor caribou and helicat ski operations and minimize operational impacts.

There are no cat-ski operations in the area of the Narrow Lake caribou subpopulation and it is considered to be of low risk of being included in tenures for helicopter or cat-skiing, largely due to unsuitable terrain (Simpson and Terry 2000).

3.3.2.3 OTHER

Backcountry tour skiing and mountaineering are recreational activities that occur in caribou habitat and can have an impact on woodland caribou conservation. Backcountry skiing (a term embracing of backcountry ski touring, unsupported, off-piste skiing and snowmobile assisted off-piste skiing) and mountaineering bring their participants into alpine areas that overlap with mountain caribou populations at sensitive times of the year (rut,

winter). Unexpected encounters between individuals and people who are not in a vehicle can be very stressful for caribou and they can show a very strong flight response (McKay 2007).

Due to unsuitable terrain, there is very low use of the Narrow Lake caribou subpopulation range for backcountry skiing (Simpson and Terry 2000) or mountaineering. There are no ski resorts in this area.

3.3.3 OTHER

Other human activities occur in caribou habitat and have the potential to harm caribou and / or affect caribou populations. Agriculture, transportation corridors, electrical transmission rights-of-way, oil and gas exploration and pipelines and hunting all have known effects on caribou populations (James and Stuart-Smith 2000, Wolfe et al. 2000).

3.3.3.1 AGRICULTURE

The effects of agriculture on caribou conservation are largely the result of conversion of low-elevation habitat to crops and pasture (habitat destruction) and the food subsidy they provide for alternative prey (deer, elk, moose). Habitat conversion is functionally similar to clearcut logging in that it removes overstory vegetation and can alter landscape properties like vegetation composition and local snow depth. Growing hay and grain crops within or adjacent to caribou range has the potential to increase the regional population size of deer, elk and moose that eat crops (Bowden 1985, Côté et al. 2004, Butler et al. 2008, Hatter et al. 2017). Access to crops improves population growth of these species and their predators like bears and wolves. These, in turn, predate caribou, putting downward pressure on caribou populations.

Spread of disease and parasites from and to cattle is also a threat to woodland caribou from agricultural operations (Neiland et al. 1968, Trainer 1973, Wobeser 1976, Sifton 2001), and is discussed in section 3.5 (Parasites and Disease).

There is no agricultural activity in the range of the Narrow Lake caribou subpopulation.

3.3.3.2 MAJOR HIGHWAY CORRIDORS

Where they occur in caribou habitat, highways have strong, negative effects on caribou populations (Curatolo and Murphy 1986, Apps and McLellan 2006, McFarlane et al. 2009). Vehicle activity on highways poses a movement barrier for caribou as they are either reluctant to approach a roadway or get killed trying to cross it (Dyer et al. 2002, Rytwinski and Fahrig 2012). Habitat and population fragmentation results as populations are unable to move between ranges and populations decline. Highways and roadways can also provide access to people to caribou range that increases the potential for disturbance. Linear disturbances, such as roadways have a large ZOI (Wolfe et al. 2000, Oberg 2001, Polfus et al. 2011, Whittington et al. 2011).

There are no major highways that cross the range of the Narrow Lake caribou subpopulation. Highway 16 (the Yellowhead Highway) passes about 18 kilometers north of their range, and Highway 97 (the Cariboo Highway) is about 45 kilometers to the west. These highways would certainly affect caribou attempting to disperse west or north out of their current range.

3.3.3.3 LINEAR FEATURES

Linear features are narrow land disturbances that tend to traverse entire ranges. They include seismic cut lines, pipelines, forestry roads and overhead power transmission rights-of-way. Linear features are not necessarily cleared to a roadway standard, but enable both four-wheel-drive access and ease travel for predators and

alternative prey (Hebblewhite et al. 2010a). One hypothesized effect is that linear features facilitate predator movement into and within prey habitat thereby increasing predator-prey overlap (DeMars and Boutin 2018).

Although there are logging roads still in the range of the Narrow Lake caribou subpopulation, there are no linear corridors such as transmission rights of way or pipelines in the area.

3.3.3.4 HUNTING

The range of the Narrow Lake caribou subpopulation straddles two wildlife management units (WMU) within the Omineca Region; 7-6 and 7-7. There are active hunting seasons in this region for mule deer, white-tailed deer, moose, elk, black bear, wolf, cougar and other smaller game. Moose is the most commonly hunted species and there is no caribou season (last legal hunt was in 1985 and no caribou have been killed during a hunt since 1976).

The number of animals harvested by hunters of all species is relatively low, likely due to the limited access to the area (e.g. from 1976 to 2013, 381 mule deer, 105 white-tailed deer and 9295 moose).

3.3.3.5 POACHING

Caribou poaching is an unregulated, indiscriminate and largely unreported source of mortality across their range. Animals are taken in any season, of any age or sex and in any number. This kind of additive mortality can have a profound impact on caribou populations in British Columbia (Johnson 1985) and interacts with habitat management and human access (Edmonds 1986, Stevenson 1990).

There have been no formal charges for poaching caribou in the Narrow Lake caribou range from available records (beginning in 2006). In general, poaching has not been found to be a key factor limiting caribou in this region largely due to the poor road access (Seip and Cichowski 1996). In general, however, information on poaching is poor (Bradshaw and Hebert 1996).

3.4 NATURAL DISTURBANCE

Fire as a natural disturbance can have large-scale and long-lasting impacts on woodland caribou (Environment Canada 2014). Fire kills individuals, destroys habitat and changes predator-prey dynamics by improving habitat for alternative prey and increasing wolf-caribou spatial overlap (Robinson et al. 2012). Fire suppression, on the other hand, has increased the possibility of very large and intense fires that could alter entire range areas (Environment Canada 2012a). Mountain pine beetle infestations are also natural disturbances with large-scale and long-term effects (Cichowski and Williston 2005).

While there have been large wildfires in the region, and some have crossed into the range of the Narrow Lake caribou subpopulation, the area burned within the range is relatively small. Only 34.2 km^2 has burned within its boundary representing 8% of the total area. The most recent fire occurred in 2013 and the oldest recorded fire burned in 1961, with 9 starts occurring in 1981.

Approximately 328 km^2 of pine forest in the range of the Narrow Lake caribou subpopulation range (77%) has been infested with mountain pine beetle (MPB) between 1999 and 2014. Most of this area has been lightly affected (237 km^2) in the northern half of the range, with only 16 km^2 considered having a severe MPB infestation (Figure 4).

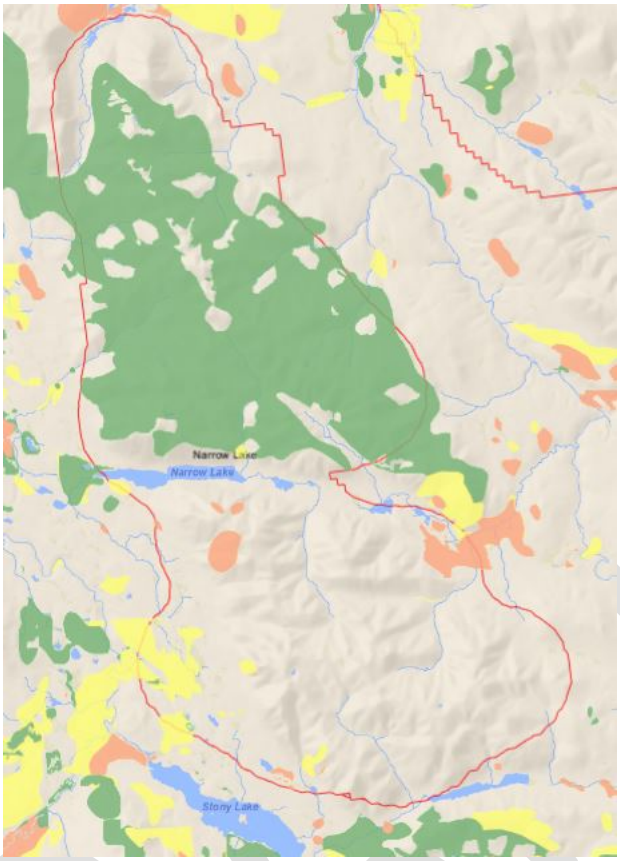

Figure 4: Mountain Pine Beetle mapping of the Narrow Lake caribou subpopulation range (red outline). Green represents light infestation, yellow is moderate infestation and red is severe infestation. Infestation severity areas can overlap as forests change from light to moderate and severe infestation.

3.5 PARASITES AND DISEASES

Caribou are generally susceptible to a range of native and introduced diseases and parasites found in other ungulate species. Brucellosis is a contagious disease of ruminants which can cause spontaneous abortions particularly among first time breeding females (Neiland et al. 1968). The bacteria causing brucellosis in caribou is primarily *Brucella suis* that also affects swine (Jones 2014). Caribou are highly susceptible to the meningeal worm (*Parelaphostrongylus tenius*) that is fatal in some, but not all, deer species (Anderson 1972, Trainer 1973). Early reports of woodland caribou declines in eastern Canada attributed it to their overlap with white-tailed deer who are meant to be the primary host of *P. tenuis* (Cringan 1956). Besnoitiosis is a disease caused by infection with the protozoan parasite *Besnoitia besnoiti* and is known in wildlife and livestock around the world (Walden et al. 2014). It can cause spontaneous abortions in pregnant females and infertility in males, but it is primarily expressed as facial hair loss in infected animals. It has been found in free-ranging woodland caribou in northern Saskatchewan in 1976 (Wobeser 1976), captive caribou (Glover et al. 1990).

Caribou are also susceptible to tape worms (*Echinococcus granulosus, E. multilocularis, Taenia ovis krabbei*), bot flies (Oestrinae), warble flies (Hypodermatinae), liver flukes (*Fascioloides magna*), lumpy jaw (*Actinomyces bovis*), muscle worms (*Parelaphostrongylus andersoni, P. odocoilei*), and winter tick (*Dermacentor albipictus*) (Miller et al. 2014b).

There is no reported occurrence of brucellosis or tuberculosis in British Columbia in any species, severe symptoms of Besnoitiosis have not been found in caribou in British Columbia (Miller et al. 2014a). However, many of the other parasites can be found in woodland caribou in British Columbia with affects on individuals, but no reported population-effects on the Narrow Lake caribou subpopulation. Chronic wasting disease, which has the potential for strong negative effects on this subpopulation has not been detected in British Columbia in any species (Schwantje 2015).

3.6 Climate Change

For species such as woodland caribou that undergo seasonal migrations, have predators with seasonal cycles, respond to plant and insect phenology and are sensitive to snow depth and season length, climate change will have direct effects (Vors and Boyce 2009). With alpine tundra habitats predicted to shrink in a warming climate, the effects of climate change on caribou may be profound (Harding and McCullum 1997, Swift and Ran 2012). Natural resource industries, such as forestry and oil and gas are both vulnerable and have a role to play in climate change mitigation (Houghton et al. 2001). How they adapt may also have consequences for caribou (Racey 2005). Climate change adds much complexity to managing caribou for long-term recovery, including how it affects the distribution of alternative prey (Seip 2008, Dawe and Boutin 2016) and available food (Parker et al. 2009).

Climate change models for British Columbia suggest that mountains in the Cariboo region will experience increased winter snow loads (Dawson et al. 2008, Griesbauer and Green 2010) that could affect food access and mobility for animals. Such a change could be positive for snow adapted, arboreal lichen eating caribou. This benefit could be negated by more frequent freeze-thaw cycles (Plummer et al. 2006) that will improve the ability to predators to move across frozen crusts as well as access to food for caribou (Gillett et al. 2004, Dawson et al. 2008). Predictions of forest type shifts due to climate change mediated by fires suggest that black spruce may be replaced by white spruce and lodgepole pine, affecting caribou habitat (Hebda 1997).

Information cited in planning timber harvest in the Prince George Timber Supply Area (of which Narrow Lake is part), suggest that mean annual precipitation has increased by 11.6% and mean annual temperature has increase by 1.6°C (twice the global average) since 1895 (Nicholls 2017). Extreme maximum temperatures are increasing and projected to continue to increase while instances of late fall and early spring cold snaps are decreasing. Snowpack is predicted to decline, growing degree days projected to increase and growing-season droughts are predicted to become more common (Foord and Hopkins 2016, Nicholls 2017). These changes and predictions will have profound implications for caribou habitat, food, predator-prey interactions and movements.

3.7 Small Population Size Effects

Small population effects include several threats to caribou populations that are unique to small (approximately less that 50 animals) and isolated subpopulations. These include reproductive and genetic isolation (McDevitt et al. 2009), predation (Sinclair et al. 1998, Abrams 2002), Allee effects where small groups are more vulnerable to predators (McLellan et al. 2010), risk of demographic bottlenecks where single-sex or male-dominated cohorts lead to population decline and increased chance that localized natural events such as avalanches (McClung 2001), fires or floods that kill a disproportionate number or key members of a small herd (Hebblewhite et al. 2010b). Movement barriers that prevent inter-population dispersal exacerbate small population effects by preventing small or extirpated populations of rescue (Gilpin 1990). Small population effects can be a particular hazard for species with slow growth rates (Laikre et al. 1997).

The Narrow Lake caribou subpopulation is well within the density where small population effects may have an effect. While there is no direct evidence of small population effects at Narrow Lake, events such as wildfires and phenomena such as sex-ratio anomalies have a real potential to slow recovery and / or extirpate this population.

The genetic viability of caribou subpopulations is dependant upon their size and dispersal (inter-population migration) ability (Weckworth et al. 2012). Small populations are subject to genetic drift that is a simple function of their small and unique gene pool as well as reduced gene flow (Boulet et al. 2007). Populations that are small and declining are particularly susceptible to genetic isolation (Laikre et al. 1997, Weckworth et al. 2012).

van Oort et al. (2010) suggested that the potential for genetic isolation of the Narrow Lake caribou subpopulation is among the highest in British Columbia. They are over 20 km distant from the nearest neighbouring herds with few adults capable of movements that would enable interaction. They recommended population reinforcement to alleviate small population effects (van Oort et al. 2010). Based on a number of criteria, Hatter et al. (2004) suggested that the Narrow Lake population is unlikely to persist under current conditions beyond 2024.

4 MANAGEMENT HISTORY

4.1 HABITAT

Habitat management in this area is overseen by the provincial government and implemented by the forestry industry through application of their AAC (see above). Active restoration takes place in the form of cutblock replanting that accelerates seedling establishment (Cichowski 1989, 1996). For their part, forestry regulations prescribe practices to manage resource use and protect forests that are caribou habitat (Seip 1998). However, given the almost complete absence of forestry within the Narrow Lake caribou subpopulation range, this scale of habitat management is not being undertaken.

4.1.1 PROTECTION

Provincial park legislation does not automatically protect caribou habitat from forestry, mining and petroleum resource activities. When land is acquired for a provincial park, with it comes the mineral and coal leases as well as timber and related licences (with compensation) (Government of British Columbia 1996a). Hunting is also prohibited (Government of British Columbia 1996b). Petroleum and natural gas tenures are permitted by the British Columbia Park Act (Section 33 Government of British Columbia 1996a) but are not relevant in this subpopulation range.

There are no national or provincial parks in the Narrow Lake caribou subpopulation range. However, almost its entire area (largely its higher elevation winter range) is protected by an ungulate winter range (U-7-003) and a smaller wildlife management area (7-003).

4.1.2 ENHANCEMENT AND RESTORATION

Large-scale habitat restoration and enhancement for caribou protection and recovery generally refers to oil and gas activities (well sites, seismic lines) rather than forestry. Habitat restoration is very expensive and rarely undertaken at a scale that is beneficial to caribou (Schneider et al. 2010, Dickie et al. 2017). Small-scale habitat restoration actions, like decommissioning roads, replanting seismic lines or installing movement and visual barriers along pipelines can be effective (MacNearney et al. 2016, Pigeon et al. 2016, DeMars and Boutin

2018). Nevertheless, it is considered an essential step for caribou recovery in the absence of protection required for natural habitat regrowth that can take tens of decades.

The disturbances in the range of the Narrow Lake caribou subpopulation that are in need of restoration include forestry cutblocks and haul roads. A large part of the northern half of their range has been affected by light MPB infestation, and there are smaller areas in the south with severe infestation. These could be candidate sites for restoration. The UWR report for this area commits to reclaiming and restoring all resource roads in this area (Stevenson et al. 2003) although there are no reports of restoration occurring.

4.2 Recreation and Access Management

Road access to woodland caribou habitat elevates conservation threats including conflicts with snowmobiles, hunting pressure, habitat fragmentation and in some cases predation (James et al. 2004, Apps and McLellan 2006, Seip et al. 2007, Apps and Dodd 2017). A key element of caribou life history is how they seek separation from competitors (moose, deer, elk) and their predators (Bergerud and Elliot 1986, Wittmer et al. 2007). Constructed access roads into woodland caribou habitat connects them to their threats and contributes to population declines (Dussault et al. 2012).

There are 603 kilometers of active, pending and retired forestry roads in the Narrow Lake caribou subpopulation (1.42 km/km^2). This is relatively high compared to other jurisdictions (Nellemann and Cameron 1998, Beauchesne et al. 2013) but not all (Schneider et al. 2003). Despite there being poor highway access to this area, access by resource roads is potentially great. However, UWR protections in this area restrict human access by limiting new roads, encouraging reclamation of old roads and creating a 2 km access buffer around all caribou winter range (Stevenson et al. 2003).

4.2.1 Snowmobile

The conditions of UWR U-7-003 prohibits snowmobile use in most of the Narrow Lake caribou subpopulation range. A maintained snowmobile trail that traverses the UWR allows recreational snowmobile users and trappers to cross the UWR east to west at Narrow Lake. Occasional surveillance of snowmobile use in this range has been conducted, although reports have not been found (Seip et al. 2011).

4.2.2 Heli-ski / Cat-ski

UWR provisions prohibit heli- and cat-ski tenures in the range of the Narrow Lake caribou subpopulation.

See section 3.3.2.2 for general threat information.

4.2.3 Other

Due to the unsuitability of terrain, there appears to be little interest in other winter recreation (backcountry ski-touring, x-country skiing) in this area. In summer, access to Narrow Lake via the Willow Forest Road permits fishing and boating, and surrounding area off-highway vehicle use.

4.3 Predators

Unsustainable predation is acknowledged as a key, proximal mechanism of woodland caribou decline across Canada (Bergerud and Elliot 1986, Bergerud 1988). Woodland caribou metapopulations have persisted

despite ongoing predation from wolves, bears (black and grizzly) and cougars for millennia, but the existential impact of predators on caribou is a recent phenomenon. Human changes to habitats, fragmentation, movement barriers, dynamics of alternative prey and predator access to caribou habitat have led to conditions where caribou subpopulations are permanently extirpated.

Shrinking old-growth forest caribou habitat has forced caribou into increasingly smaller ranges, making their home range potentially more predictable to predators. Seasonal migratory routes track through predator rich areas and bringing them into closer proximity to alternative prey species that can sustain higher predator populations (Seip 1992a, Apps et al. 2013). Road and seismic line clearing and winter trail packing makes travel for predators into caribou critical habitats more efficient, elevating, in particular, wolf predation (Dickie et al. 2016). And, finally, a shift in forest structure towards younger age classes has favoured moose, deer and elk at densities that can support greater predator densities. Not only does this shift bring woodland caribou into closer proximity to predators, but it also promotes greater predator abundance (Hebblewhite et al. 2007).

Although habitat changes facilitate unsustainable predation, habitat regrowth and restoration occurs too slowly to recover woodland caribou in the short-term. As a result, direct predator management is a caribou recovery tool to ensure that populations persist long enough to benefit from habitat restoration efforts (Wilson 2009, Brook et al. 2014, Hervieux et al. 2014).

4.3.1 Wolf Management

Wolves are an important, year-round caribou predator. Caribou populations in northern British Columbia were shown to decline when wolf densities were 9–10/1000km^2 but increased at wolf densities from 1–4/1000km^2 (Bergerud and Elliot 1986). For this reason, target wolf densities that would enable caribou recovery are set to 6.5/1000km^2. In the absence of effective habitat or alternative prey management to achieve these densities, direct wolf management must be undertaken to achieve caribou conservation goals.

Because of the low population size of the Narrow Lake caribou subpopulation, its measured, rapid decline, and the attribution of this decline to unsustainable predation, a wolf reduction program was initiated in 2008 (Seip et al. 2008). But this effort consisted of liberalized trapping limits for wolves and only yielded a removal of 2 wolves in one year and was discontinued (Seip et al. 2008, D.R. Seip, pers. comm.).

4.3.2 Cougar Management

Cougars are found in the range of the Narrow Lake caribou subpopulation, but not at high densities. A cougar hunt in the two wildlife management units that overlap with their range has only yielded four resident and non-resident kills between 2009 and 2013. There are no cougar trapping data for this area, nor is there a systematic management program. Given that caribou mortalities due to cougar predation are likely very low, no cougar management through hunt or cull is being planned.

4.3.3 Other

Grizzly bears, black bears and wolverines are also woodland caribou predators (Seip 1992a, Wittmer et al. 2005a). However, their protection status, seasonality and / or low predation rate and dependence on caribou as food does not warrant management to benefit caribou populations. In rare cases associated with intensive caribou management programs (captive breeding, maternity penning) bear or wolverine removal may be conducted.

Grizzly bears and black bears are relatively abundant in the range in and around the Narrow Lake caribou subpopulation (Proulx 2006). Since 1976, 1158 grizzly and black bears have been hunted in the wildlife management units that overlap with their range indicating robust populations. The grizzly bear hunt has been suspended as of 2017 (McLellan et al. 2017) but black bear hunting continues. No management to benefit caribou recovery, outside of the use of hunting regulations, is in place. It is not known what the impact of bear predation on caribou is in the Narrow Lake area.

4.4 Primary Prey

Moose, elk, white-tailed deer and mule deer (including black-tailed deer) share large, mammalian predators such as wolves, bears and cougars. In what is known as apparent competition (Holt 1977), an increase in one prey population will lead to a decrease in a second prey population. It appears as if these two, prey species are competing with each other. But the decline of the second prey species is due to the boost that their shared predator population experiences because of the high density of the first prey species. Woodland caribou have avoided apparent competition by occupying habitats distant from other deer species. However, changes to their habitats, movement barriers and facilitated predator access have limited their ability to continued isolation. Across their range, woodland caribou populations have been subject to apparent competition (DeCesare et al. 2010b, Wittmer et al. 2013). For this reason, managing primary prey, either directly through hunting quotas, or indirectly through habitat management has become a needed management action.

4.4.1 Moose Management

Throughout British Columbia, moose are a common and sustaining prey of wolves (Messier 1994). But their expanding range (Bergerud and Elliot 1986), a wolf numerical response to moose densities (Messier and Joly 2000) and apparent competition with woodland caribou mean that even moderate moose densities in or adjacent to caribou range poses a threat to caribou persistence (Seip and Cichowski 1996, Lessard et al. 2005, Serrouya et al. 2017). Moose densities respond positively to early seral forest habitat and negatively to human hunting, and moose numbers have been falling around the province in response to harvest pressure (Moose Management Technical Team 2015). Lessard et al. (2005) found that a 10% increase in the moose harvest could stabilize caribou populations.

Moose densities in the entire Omineca region (7a) have been declining after a peak that occurred between 2000 and 2011 (Kuzyk 2016). Moose management occurs by issuing hunting licences in wildlife management units. Currently there is a fall bow and rifle season for spike-fork (young) bulls only in units 7-06 and 7-07 that overlap with the Narrow Lake caribou subpopulation range. Between 1976 and 2013, 10,411 moose were killed by resident and non-resident hunters (mean = 137 moose hunted per year). Beyond issuing hunting permits, no specific moose management to benefit caribou recovery is in place.

4.4.2 Deer Management

Managing deer populations in support of caribou conservation is a challenge. Both can support predator populations that have negative effects on caribou (Latham et al. 2011c). Both can transmit diseases that could be catastrophic were they to spread to caribou populations (see above; Habib et al. 2011). Where mule deer and white-tail deer ranges overlap, mule deer tend to decline, perhaps also due to apparent competition (Robinson et al. 2002). In British Columbia, there is active management to increase mule deer populations through habitat

protection (British Columbia Ministry of Environment 2017) and manage white-tailed deer populations through hunting regulations (British Columbia Ministry of Forests, Lands and Natural Resource Operations 2015). Neither are strictly regulated by either predators or food. White-tailed deer populations respond strongly to food availability as well as hunting or predation (Fryxell et al. 1991, Messier 1991, Dumont et al. 2000). Mule deer are similar, but tend to be more vulnerable to predation, food availability, severe weather and loss of native winter habitat (Pierce et al. 2012, Forrester and Wittmer 2013, Bergman et al. 2015). Indeed, regulating deer density using hunter tags must counter some difficult trends (declining number of hunters, increase prey refugia from hunters and increased use of residential areas by deer) to be successful (Brown et al. 2000). Managing deer populations to a lower density will require managing artificial food sources (hay, grain), and access to high quality habitats as well as increased hunting pressure.

Like moose, deer (white-tailed and mule) are managed in the range of the Narrow Lake caribou subpopulation through hunting tags. There is a fall, rifle season for bucks, a fall bow and youth season for bucks and doe (antlerless) mule deer and a fall rifle, bow and youth season for white-tailed deer in Omineca management units 7-06 and 7-06 that overlap with Narrow Lake caribou. Between 1987 and 2013, an average of only 5 deer were killed by resident and non-resident (the non-resident hunt began in 2008) hunters. Mule deer populations in the Omineca region are estimated to be between 3000 and 6000 animals and increasing while white-tailed deer are estimated to between 500 to 1000 individuals and also increasing (Appendix 1 in Brunt and Schmidt 2012). No deer management for the benefit of woodland caribou populations is occurring in this region.

4.4.3 Other

Elk, like moose and deer, are wolf prey and could potentially facilitate apparent competition with caribou (DeCesare et al. 2010b).

Elk are not common throughout the Omineca region with between 500 and 2000 individuals, but increasing (Brunt and Schmidt 2012). There is a fall rifle and bow hunt for elk in 7-06 and 7-07, but between 1985 and 2013, only 40 animals have been killed by hunters.

4.5 Population Reinforcement

The International Union of Conserving Nations (IUCN) has established guidelines for reintroductions and related conservation translocations (IUCN Species Survival Commission 2012), of which population reinforcement is one tool. In this document, reinforcement is defined as an intentional movement and release of an organism into an existing population of conspecifics within its indigenous range. It differs from reintroduction in that the species has not been extirpated from that range (DeCesare et al. 2010a), but existing populations are being added to. The management tools described in this section are based on the assumption that caribou populations are being reinforced and not reintroduced.

4.5.1 Maternity Penning

Maternity penning (sometimes called maternal penning) is a technique to increase calf recruitment by capturing and temporarily penning pregnant females to protect them from predators. These females are held through parturition and for up to six weeks after calves are born. By this time calves are large and strong enough to better avoid predators, improving their survival probability and population recruitment. Thus, if young-of-the-year predation is a contributing factor to unsustainable population decline, maternity penning can be an effective

mitigation (Hayek et al. 2016). Maternity penning is an *in situ* method where the pen is constructed within their home range and animals are never moved outside of their home range.

There is no maternity penning operating or planned for the Narrow Lake region. However, with the Narrow Lake population so small and declining, they would be a candidate for such reinforcement actions. What is required is an understanding of the mechanism of the decline and specific actions to manage the decline.

4.5.2 Captive Breeding

Captive breeding is a conservation method that captures both male and female animals and moves them permanently to a facility where they are bred under controlled conditions (IUCN Species Survival Commission 2012). The objective is to create a surplus of female calves in the breeding facility that can then be translocated to ranges to reinforce small populations. To be effective, recipient populations should have low adult female survival that this action can reverse. This is a *ex situ* approach that takes animals away from their home range and returns animals to ranges that may not be where they originate (Harding and McCullum 1997). A number of factors, such as source animals, animal husbandry, genetic bottlenecks, gene mixing with destination herds, status of destination herds, disease transmission, fate of male calves among others must be considered in such an effort (Dolman et al. 2015, Hayek et al. 2016).

Captive breeding to reinforce the Narrow Lake caribou subpopulation is occurring, although it could be justified given the small size of the population and its declining trend. This would be particularly effective with small predator populations to increase the number of breeding female caribou.

4.5.3 Translocation

Translocation is the reinforcement of small populations by moving animals directly from a sustainable population (Ray et al. 2015, Hayek et al. 2016). The goal is to rapidly increase the numbers of animals of all ages and sexes in the target population (Miller et al. 2007, DeCesare et al. 2010c). Animals are captured in their home range, transported to the target range and either soft released in a temporary pen that offers an opportunity for individuals to adjust to their new surroundings, or hard released directly into the destination habitat.

Compared with other reinforcement methods, translocation is a relatively cost-effective approach to add animals to small populations. It has been tried successfully and unsuccessfully with caribou populations in Canada and British Columbia (Compton et al. 1995, Stronen et al. 2007, Hayek et al. 2016).

There have been no translocations to the Narrow Lake caribou subpopulation, nor are there any being planned. However, this reinforcement approach may be useful for this small and declining herd.

4.5.4 Other

The proximate cause of caribou population declines is predation. While predator management is a direct way to manage this threat, an alternative solution is predator exclusion fencing (Hayek et al. 2016). In part, this approach is linked to direct predator management as any predators within an exclusion fence would be lethally removed, and it is linked to maternity penning as this is a form of small-scale, temporary predatory exclusion fencing. However, there are recent, and very large scale (thousands of hectares), proposals to erect predator exclusion fencing as a mitigation for caribou populations where habitat restoration is an unrealistic goal but the

caribou population is critically low (Boutin and Merrill 2016, Cornwall 2016, Hebblewhite 2017, Proulx and Brook 2017).

To date, this conservation method has not been attempted anywhere, including in the range of the Narrow Lake caribou subpopulation (Antoniuk et al. 2016).

4.6 STEWARDSHIP/OUTREACH

Local communities and stewards are an essential part of caribou recovery. Management actions to recover very small populations are at times expensive, controversial and require the imposition of new and restrictive regulations (Hayek et al. 2016). Gaining the social licence to conduct management actions like predator management, translocation, captive breeding and access restrictions requires outreach. Effective outreach programs to local communities and regional populations must accompany planning for management actions (Antoniuk et al. 2015). This includes information to municipal and regional administrations, business stakeholders, recreational groups, conservation organizations, farming organizations, hunting clubs among others (see below). Outreach must be timely, targeted and inclusive to be effective (Wilkinson 2010).

Stewardship is the active participation by citizens or citizen groups in conservation and recovery programs. For caribou this can take a number of forms ranging from ambassador programs where citizen volunteers promote caribou conservation at community events, habitat protection through conservation offsets (Robichaud and Knopff 2015) to fund-raising and operating reinforcement activities such as maternity pens.

The Narrow Lake caribou subpopulation is a small and relatively inaccessible herd that, on its own, is not high profile in British Columbia. It is even considered by some to be extirpated. However, as Narrow Lake is in close proximity to other herds (North Cariboo, Barkerville), outreach and stewardship opportunities for these subpopulations should be combined.

Prince George is an important hub for caribou research and conservation in central British Columbia. There are a number of caribou populations in the region, government offices focussed on caribou monitoring, Indigenous communities with cultural links to caribou and a university campus (University of Northern British Columbia) that conducts important, fundamental research on caribou and their habitat.

There is already a Community Working Groups for species at risk in Prince George; specifically, for white sturgeon recovery. These are composed of First Nations, ENGO, Industry, Provincial and Federal Government representatives. A similar group could be established for caribou conservation. As well, the Spruce City Wildlife Association is a membership group of hunters, naturalists, anglers, trappers, guides and environmentalists conducting projects for wildland protection (SCWA 2017). Outreach to groups such as this to promote programs and education in caribou themes.

4.7 RESEARCH

Every caribou subpopulation in British Columbia requires some degree of management action; habitat protection or restoration, population reinforcement, alternative prey management or predator control. Yet few caribou subpopulations in British Columbia have sufficient, herd-specific information to enable confident

management decisions. To fill these gaps, scientific research and traditional ecological knowledge must be gathered to fill critical gaps.

There have been decades of research into caribou biology and conservation. This body of work has informed scientists and policy makers of the key factors that contribute to caribou population dynamics, important threats and potential solutions. Key findings have been the proximate role of predation and apparent competition in caribou population fluctuations and the ultimate role of habitat destruction in caribou population declines. While their interactions are broadly understood, ongoing research to fine tune caribou responses to ecological stimuli and human disturbance including habitat fragmentation and primary prey density can improve our management.

While we know generally what causes declines in caribou populations, specific management actions are enabled by having a richer understanding of key interactions. Research on mortality sources for the Narrow Lake herd is a key need for this herd. Given the establishment of harvest restrictions in the area through the ungulate winter range protections, it would be interesting to research cutblock recovery and experiment with methods to speed recovery to functional caribou habitat.

4.8 MONITORING

Ecological, population and industrial footprint monitoring is an essential activity towards the conservation and recovery of woodland caribou. This provides the information that enables the detection of conservation threats, the effectiveness of management activities and the status of target populations. Although it cannot replace conservation action, it is an essential piece of the caribou recovery program.

Together with the research need of understanding sources of mortality for the Narrow Lake caribou subpopulation and differential age and sex mortality rates, population and distribution monitoring of predator populations along with caribou and the other ungulates are essential information needs for this herd. In addition, monitoring information on recreational use of this area, both winter and summer, would assist in understanding caribou recovery in this area.

5 IMPLICATIONS TO OTHER WILDLIFE

Changing population trends of woodland caribou will require manipulating the environment in ways that favour caribou ecology and life history at the expense of other wildlife. More old growth forest will benefit caribou but not moose or deer. Reducing adult female and calf mortality may require lethal wolf control. Maternity penning makes calves, common spring prey for black and grizzly bears, less vulnerable to these predators. None of these management actions can or will imperil other wildlife species but will precipitate changes to their population density and/or distribution.

Actions taken to protect and manage the Narrow Lake caribou and their habitat may benefit or inhibit the protection of other species and their habitats (British Columbia Ministry of Environment 2013). The potential need for predator management will directly affect wolves, whose populations would be intentionally reduced, and other ungulate species like moose, whose densities may also have to be lowered to facilitate caribou conservation.

6 IMPLICATIONS TO OTHER VALUES

The recovery and protection of woodland caribou populations will affect a range of human values and activities across caribou range (Scarfe 2006). These include recreational / commercial activities such as camping, snowmobiling and backcountry skiing, commercial resource extraction activities such as forestry, mining and oil and gas development as well as non-commercial resource uses such as hunting. Research shows that none of these activities will have to be halted to protect woodland caribou (Kruse et al. 1998, Hebblewhite et al. 2006, Hebblewhite 2017). However, changes to operations, seasonal restrictions and area closures will be required, locally affecting some recreational and commercial activities (Government of Alberta 2016).

In the range of the Narrow Lake caribou subpopulation, there are limited commercial activities. Currently commercial logging operations in the area are compelled to avoid UWR that has been established over much of the high elevation terrain to protect caribou and prevents logging in this area.

Recreational snowmobiling is also prohibited in this area, affecting winter recreationalists (Grant 2017). Heli- and cat-ski tenures will not be granted here, although the terrain is not suitable for this activity.

7 PARTNERS / NEIGHBOURS

Partners are existing or potential groups that can contribute to woodland caribou management with expertise, funding, in-kind or moral support. Neighbours are groups within in the caribou subpopulation area that are currently not participating in caribou management but that could be affected by caribou management. Neighbours include local governments, industry tenure holders, and recreation groups. Neighbours could potentially become future partners.

Below is a list of communities in and adjacent to Narrow Lake subpopulation range, organizations that have a clear interest in how this area is managed and businesses that have a commercial interest in the area. This may not be a complete list, particularly of distant organization with an inherent interest.

Communities: **First Nations**: Lheidli-T'enneh First Nation, ?Esdilagh First Nation (Alexandria Indian Band), T’exelc First Nation (Williams Lake Indian Band), Carrier Chilcotin Tribal Council (Red Bluff Indian Band (Lhtako Dene), Lhoosk'uz Dene' Government Administration) , Cariboo Tribal Council

Local: Quesnel, Dunkley, Wells, Sugarcane

Regional: Prince George (and outlying communities), Williams Lake, McBride

Organizations: **Recreation**: British Columbia Snowmobile Federation (Wells Snowmobile Club, Prince George Snowmobile Club, Williams Lake Powder Kings Snowmobile Club, Quesnel Snowmobile Club), Land Conservancy of British Columbia, Outdoor Recreation Council of British Columbia, Quad Riders Association of British Columbia, Prince George ATV Club, Quesnel Cross Country Motorcycle Association, Caledonia Ramblers Hiking Club, Prince George Horse Society, Prince George Off-Road Motorcycle Association, Williams Lake Off Road Motorcycle Association,

Prince George Snowmobile Club, Northwest Brigade Canoe Club, Hickory Wing Ski Touring Club, Silvertip Heli-ski

Protection: Western Canada Wilderness Committee, BC Spaces for Nature, Yellowstone to Yukon Initiative

8 RECOMMENDED ACTIONS

8.1 SHORT TERM (WITHIN 6–12 MONTHS)

Initiate / resume predator management with a goal of maintaining wolf populations at a density of less than 6.5 wolves/1000km^2 verified by periodic wolf population counts.

Initiate a regional outreach program to foster support for management that will promote ongoing growth of the Narrow Lake (combined with North Cariboo and Barkerville) caribou program.

8.2 MEDIUM TERM (WITHIN 12–24 MONTHS)

Continue caribou population monitoring through annual or bi-annual aerial census or through non-invasive techniques such as scat mark-recapture (Ball et al. 2007).

Continue moose and deer population monitoring.

8.3 LONG TERM (WITHIN 24–48 MONTHS)

Maintain and enforce current population (no caribou hunt) and habitat (UWR, Wildlife Habitat Areas) protection.

Ensure a supply of habitat that supports a sustainable caribou population by allowing it to recover. This will be measured using remote sensing tools of aerial extent of undisturbed or recovering vegetation classes.

Rehabilitate forestry road segments in the Narrow Lake caribou subpopulation range to prevent mechanized access and inhibit predator and primary prey (moose and deer) movement.

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