

WOODLAND CARIBOU PLAN

Narraway Subpopulation

Narraway
Local Population Unit

Disclaimer: This is a draft, phase one herd plan. Work was completed by a contractor to identify 1) current state of herd at time of writing 2) threats 3) previous management actions 4) Literature for the herd. Information contained is for reference only, and not specifically linked to the direction, management actions that the government of British Columbia intends to implement.



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EXECUTIVE SUMMARY

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1 BACKGROUND

1.1 INTRODUCTION TO THE PROGRAM

The Narraway woodland caribou subpopulation is grouped under Southern Mountain Caribou (Designatable Unit (DU) 8 – Central Group) population by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC; Environment Canada 2014). The Southern Mountain population of woodland caribou is listed as Endangered.

Woodland Caribou are further divided into Local Population Units by Environment Canada. Within the Central group there are three Local Populations. The Narraway subpopulation is in the Narraway Local Population Unit. (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 2016). The Narraway subpopulation is red-listed in BC, and current monitoring indicates that they are in decline and in need of comprehensive recovery planning.

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 Narraway Central Mountain caribou subpopulation.

2 POPULATION DESCRIPTION

Central mountain caribou occurs on the east side of the Rocky Mountains, north of Kakwa Provincial Park in the south, to the southern shore of the east arm of Williston Lake in the north.

The caribou use windswept alpine slopes and adjacent subalpine forests on the eastern edge of the Rockies for winter habitat. In summer, the caribou continue to occupy alpine and subalpine habitats (Saher and Schmiegelow 2005, British Columbia Ministry of Environment 2014, p. 12).

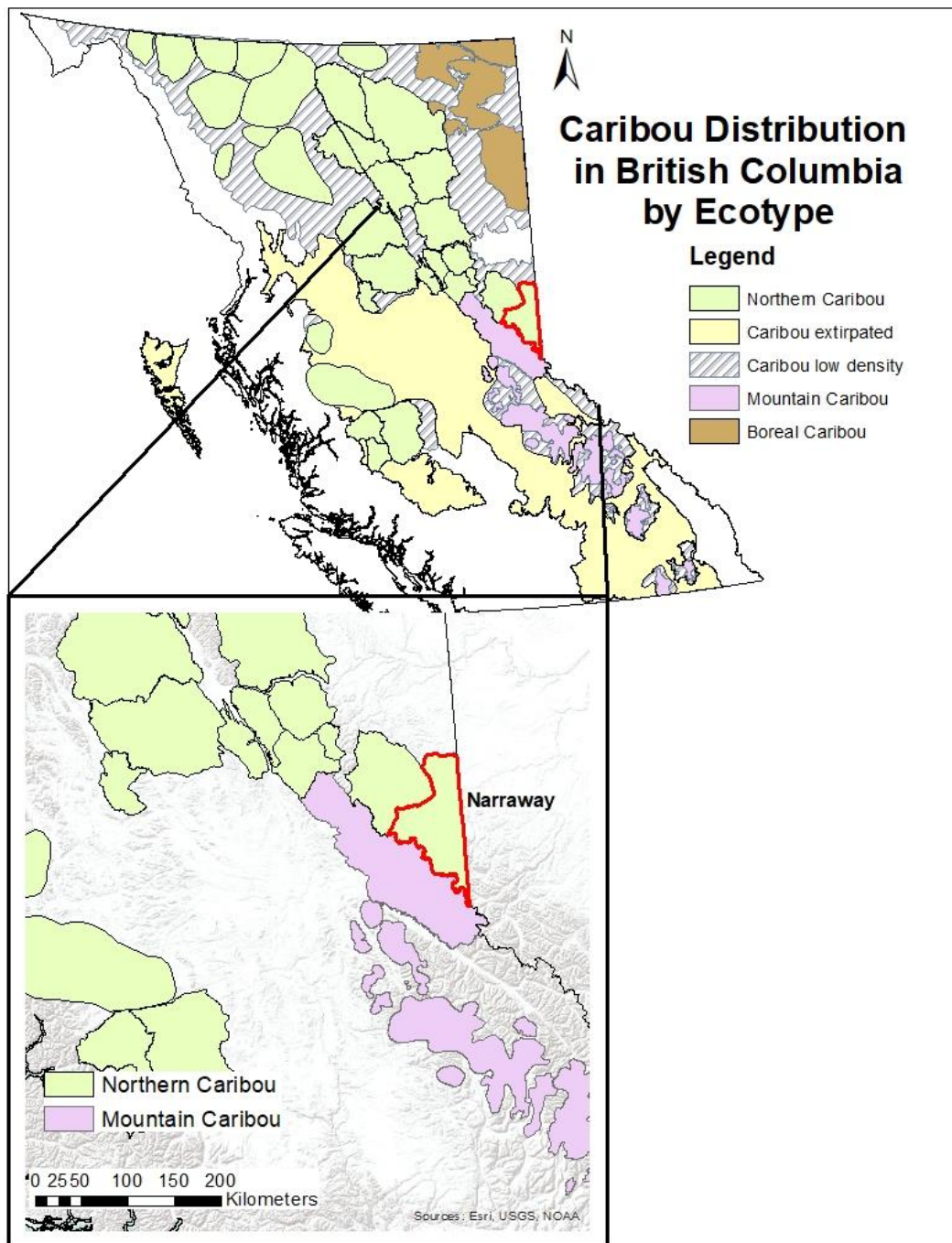


Figure 1: The geographical location of the Bearhole-Redwillow portion of the Narraway subpopulation of woodland caribou. The 6372 km² range (inset: red outline) is situated within the Peace Region.

2.1 HABITAT AND BEHAVIOUR

The Narraway caribou subpopulation is a British Columbia-Alberta transboundary herd, with the majority of its range within BC (British Columbia Ministry of Environment 2014). It is composed of two groups, the South

Woodland Caribou Plan for the Narraway Subpopulation

Narraway subgroup and the Bearhole-Redwillow subgroup, based on three core areas of use (South Narraway, Bearhole Lake, Redwillow River; British Columbia Ministry of Forests, Lands and Natural Resource Operations and British Columbia Ministry of Environment 2015).

The Narraway caribou subpopulation uses low-elevation boreal forest habitat east of the Rocky Mountains.

While the two groups are generally separate on the winter range, they have similar seasonal movement patterns and some overlap and exchange based on the collar data. In fall, most caribou migrate to the east side of the Rocky Mountains where they winter in low-elevation forest that extends into Alberta. Here the caribou range widely over an extensive area and use pine–lichen forests, tamarack bogs, and mature spruce forests. The caribou feed on terrestrial and arboreal lichens in the pine–lichen forests, and arboreal lichens in the tamarack bogs and mature spruce forests. Some of the caribou in the southern Narraway group use high-elevation alpine habitat during the winter. In late spring, the herd migrates to high elevation calving and summer range deep into the Rocky Mountains, as far west as Herrick Creek in the Fraser River drainage (British Columbia Ministry of Forests, Lands and Natural Resource Operations and British Columbia Ministry of Environment 2015).

In summer, most of the caribou migrate up to 100 km to summer ranges in the Rocky Mountains, with most using areas on the west side of the Rocky Mountains. The caribou primarily use subalpine forest habitat during the summer. However, the Bearhole-Redwillow group remains in the low-elevation boreal forest throughout the summer. These individuals are likely the remnants of a Boreal Caribou population that historically would have been much more numerous and extended farther east throughout boreal forest habitat (British Columbia Ministry of Environment 2014).

Within the range of the Narraway subpopulation, a total of 35,961 hectares of high-elevation winter habitat and 111,798 hectares of low-elevation winter habitat have been identified (Seip and Jones 2013b, a)

2.2 POPULATION SIZE AND TREND

The Narraway caribou subpopulation is composed of three distinct groups; the Bearhole, Redwillow and South Narraway herds (British Columbia Ministry of Forests, Lands and Natural Resource Operations and British Columbia Ministry of Environment 2015) all separated by topography, or in the case of the South Narraway, a provincial boundary. The South Narraway herd is in Alberta. During a short interval 2011 and 2012, the Bearhole-Redwillow herd showed high adult survival and high calf recruitment (Figure 3) but based on very little data. This Narraway caribou subpopulation is outside the Peace region wolf control area but adjacent wolf control may have affected caribou in the Narraway range (Seip and Jones 2017). The South Narraway herd in Alberta seems to in an ongoing decline in the absence of any population management actions (Seip and Jones 2017).

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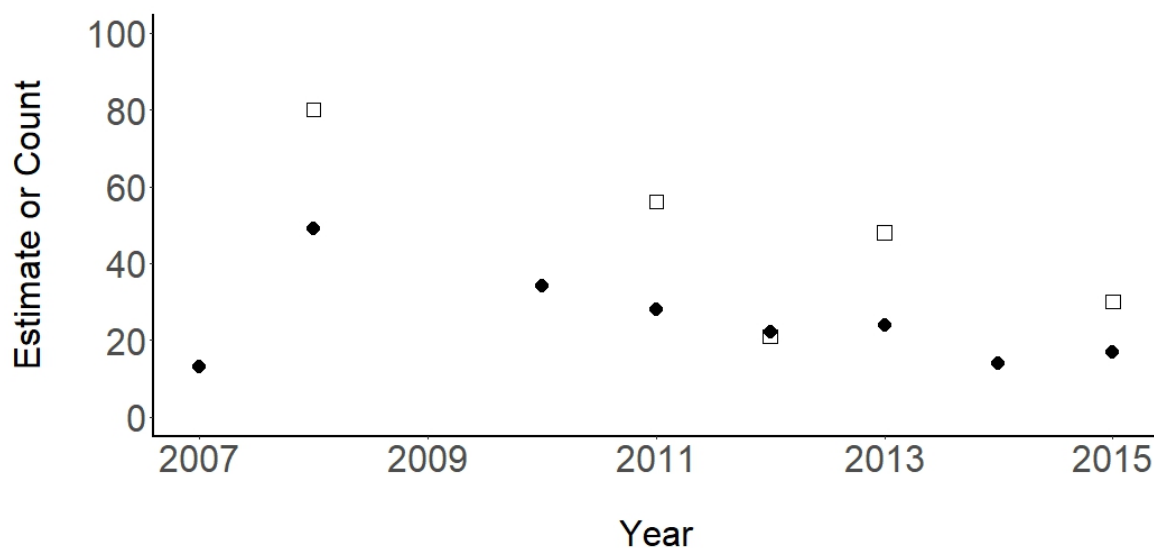


Figure 2: Caribou counts (filled dots) and estimates (hollow squares) for the Narraway sub-population. Data from Seip and Jones (2013b, 2016a).

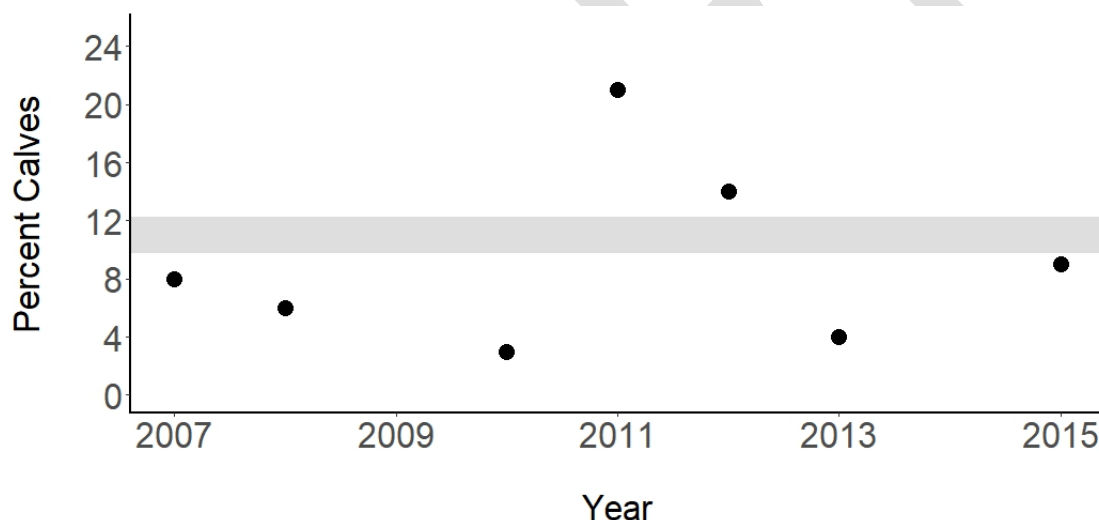


Figure 3: Caribou population recruitment measured in the Narraway caribou subpopulation range. Recruitment is defined here as the percent of the estimated population that is in the calf cohort. Recruitment lower than approximately 10 to 12% is considered below a threshold that will balance natural mortality (grey band; Bergerud and Elliot 1986). Data from Seip and Jones (2013b, 2016a).

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 km² will result in woodland caribou declines. More recently, the federal recovery strategy identifies 3 wolves/1000 km² as a target (Environment Canada 2014).

By following radio collared females, government biologists were able to attribute mortality to their source. From 2002-2015, 9 collared female Narraway caribou died. Six were killed by wolves and 3 by unknown means (Seip and Jones 2016b). Wolf predation is clearly an important mortality source for this subpopulation.

3.2 FOOD LIMITATION

Woodland caribou are herbivores and rare among animals as lichen eaters (Johnson et al. 2004). 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).

Narraway caribou eat predominantly terrestrial lichen but will also eat arboreal lichen in some low elevation habitats. Lichen abundance is not likely limiting in this region, but access to lichen under deep snow may be. Pine-lichen stands between 80 and 100 years have the highest terrestrial lichen biomass (Coxson and Marsh 2001, Sulyma and Coxson 2001). While specific management of pine forests that produce lichen for food in the

Narraway caribou subpopulation winter range is recommended, there is little indication that food is currently limiting for this small group (Seip and Jones 2017).

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 infrastructure that is associated with it as well as the resulting impacts on their habitat. A key concept 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). Zones of influence vary by activity and by the presence and absence of people.

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 Narraway caribou subpopulation is almost entirely within the Dawson Creek Timber Supply Area (TSA). This is a 23,000 km² area with an allowable annual cut of 1,860,000 m³. There are about 465 cutblocks in the Narraway caribou subpopulation range for a total area of 164 km² or 2.6% of their range area. Forest fragmentation and habitat loss from forestry is only a local issue.

3.3.1.2 MINING

Mine sites deter caribou both for the activities that occur there when they are active as well as 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 significant coal deposits immediately to the west of the Narraway caribou subpopulation range, but none within their range. There are however 36 mineral claims (held by one company; Fertoz International Inc.) that cover an area of 119 km².

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).

There are extensive gas fields in the northeastern half of the Narraway caribou subpopulation range. The area covers approximately 3000 km², or approximately 47% of the subpopulation range. This includes the Noel, Cutbank, Kelly, Hiding Creek, Quay and Red Deer plays. Within this area there are approximately 900 surveyed gas well pads in this area with accompanying pipelines and access roads. There are some surveyed gas wells within caribou high elevation winter range.

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).

The Red Willow Wind Project is a major undertaking on Tumbler Ridge is in the pre-application phase of development. This will be a 200 – 350 Megawatt facility with approximately 80 wind turbines (Boralex 2017). Turbines, if built, will be outside of caribou high elevation winter range.

3.3.1.5 OTHER

There are no other, major industrial or urban developments planned for the Narraway 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 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).

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The mountains in the range of the Narraway caribou subpopulation are popular for recreational snowmobile use. Snowmobiling is not permitted in Bearhole Lake Provincial Park, but it is popular in the area of Bearhole Lake, west of the park and the Narraway caribou subpopulation range. Wapiti River, near Wapiti Lake Provincial Park is also popular for snowmobiling. Snowmobiling is also very popular in Kakwa Provincial Park at the southern extent of the range. Snowmobiling is zoned in the park with areas under 2000m elevation differentiated from areas over 2000m to protect ungulate winter range. There is a 50-km long snowmobile trail that leads from the park border to Kakwa Lake within the Provincial Park and snowmobile access to the Narraway caribou subpopulation range from neighbouring Alberta.

3.3.2.2 *HELI-SKI / CAT-SKI*

Helicopter skiing 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 Helicopter or Cat skiing operations or tenures in the range of the Narraway caribou subpopulation, although Bearpaw HeliSkiing operates adjacent to the Kakwa Provincial Park.

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, Lesmerises et al. 2018).

Dezaiko Lodge, that caters to backcountry skiers, is located south of Monkman Provincial Park and just west of the Narraway caribou subpopulation range. There are multiple backcountry ski and snowmobile trails in Kakwa Provincial Park and parts of Bearhole Lake Provincial Park within the caribou range.

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 are Agricultural Land Reserve lands in the northeast of the Narraway caribou subpopulation range, but in general, agriculture is not a prominent activity in this area.

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).

Highways 52 (the Heritage Highway) traverses the northern extent of the Narraway caribou subpopulation range for approximately 62 km.

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 (Newton et al. 2017, DeMars and Boutin 2018).

The gas-field development in the northern half of the Narraway caribou subpopulation range is accompanied with hundreds of kilometers of seismic lines, pipeline rights-of-way and well site access roads. These features can be seen on satellite images of the region but have not been quantified. There are no major electricity transmission corridors in this area.

3.3.3.4 HUNTING

The Narraway caribou subpopulation is within the Peace Wildlife Management District and overlaps with wildlife management units 7-19 and 7-20. Caribou hunting ended in 1986 in unit 7-20 (north) and in 2001 in 7-19 (south). There is no season for caribou now. Between 1976 and the end of caribou hunting in both management units, there were 45 caribou killed by resident hunters. Guided caribou hunting occurred between 1982 and the general cessation of hunting in each unit, during which time 5 caribou were killed.

There are general open seasons for deer (mule and white-tailed), moose, elk, bighorn sheep (7-19 only), black bear, wolf, cougar, wolverine, lynx and hare. Hunting is permitted in Kakwa, Bearhole, Monkman and Wapiti Lake Provincial Parks within this caribou subpopulation range, although special restrictions apply on seasons and open areas (Government of British Columbia 2017a).

3.3.3.5 POACHING

Caribou poaching is an unregulated, indiscriminate and largely unknown 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 (Stevenson 1990).

There are no records of caribou poaching of Narraway caribou from the South Peace region from Conservation Officer Service records (Government of British Columbia 2017b).

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).

Fire areas in the Narraway caribou subpopulation range have been recorded since 1925 with only 625 km² burned (1%). The largest fire years have been 2014, when more than half of the total area burned (335 km²) and 2006 when 100 km² burned. These recent, large burns will be decades recovering as caribou habitat.

Mountain Pine Beetle have been recorded in the Narraway caribou subpopulation range since 1984 and continue to be present in its pine forests. Only 62 km² were recorded as having a severe infestation (0.1%) although approximately 4600 km² had at least a light infestation at some point over that period (72%).

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 tenuis*) 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 Narraway 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 areas in the Rocky Mountains will experience differing patterns of winter snow that could affect food access and mobility for animals (Fyfe and Flato 1999). 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, MacNearney et al. 2016a) 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).

Genetic research on caribou populations in west-central Alberta, including the Narraway subpopulation found differentiation among herds linked to migration patterns (McDevitt et al. 2009). Because migration patterns are sensitive to climate and climate change (Austin and Rehfish 2005), it may be important for understanding and protecting the Narraway caribou migration range.

3.7 SMALL POPULATION SIZE EFFECTS

Small population effects include several threats to caribou populations that are unique to small (approximately less than 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 Narraway caribou subpopulation is very small and declining (Figure 2). With a highway traversing its range, its habitat fragmented by gas development and forestry, multi-species hunting in its range and abundant avalanche terrain the potential for accidental deaths that could kill a large proportion of the population is high. However, Seip and Jones (2016b) reported sources of mortality for Narraway (Bearhole-Redwillow) caribou from 2002–2015 and there were no accidental deaths (although one third of all deaths were of unknown causes). Overall, in the Peace region, accidents account for 5% of caribou deaths.

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, like the Narraway caribou, are particularly susceptible to genetic isolation (Laikre et al. 1997, Weckworth et al. 2012).

4 MANAGEMENT HISTORY

4.1 HABITAT

The Narraway caribou subpopulation is divided into two groups; the Bearhole-Redwillow group in the north and the Narraway group in the north (Stevenson and Hatler 1985) divided by the Red Deer Valley (Seip and Jones 2013a). The key difference between them is that part of the Narraway group winters at high elevations while the Bearhole-Redwillow group and most of the Narraway group winter at low elevations (Austin 2012, Seip and Jones 2013a). The Narraway group live in the alpine and subalpine during the summer, migrating from the west side of the Rocky Mountains to the east side (Alberta) in autumn (Seip and Jones 2013a). In this area, low-elevation habitat is composed largely of mature lodgepole pine and spruce/aspen types whereas high elevation range is alpine and mature spruce-balsam poplar (Stevenson and Hatler 1985).

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).

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 four provincial parks in the range of the Narraway caribou subpopulation; Kakwa, Wapiti Lake, Monkman and Bearhole Lake. Hunting is permitted in all of these parks with some season and area restrictions. Overall there is 1291 km² of the Narraway range protected by provincial parks (20%). Large parcels of Ungulate Winter Range (UWR) cover much of this caribou subpopulation range. There are 25 separate units; 22 of which are no tree harvest zones, 3 are conditional harvest and 5 are established for specifically caribou (the rest are for bighorn sheep, mountain goat or elk) but caribou are considered in all for protection. In total, UWR cover 2314 km² (36%) of the land area of the Narraway caribou subpopulation, 1990 km² (31%) committed to caribou protection.

There are also 10 established or proposed Wildlife Habitat Areas to protect calving and rutting habitat in the south Narraway group range. These overlap with UWR area and protect 677 km² of caribou habitat.

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. 2016b, 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 (Bentham and Coupal 2015, van Rensen et al. 2015).

Seismic restoration research is being conducted in northeastern British Columbia to explore methods to reduce seismic line effects and effective seismic line restoration (Bohm et al. 2015, DeMars and Benesh 2016, Tigner and Bentham 2016). Large-scale restoration in the Narraway caribou subpopulation range has not been done.

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 728 km of forestry roads and 106 km of petroleum access roads. This is 0.13 km road / km² range area which is very low (Dyer et al. 2002, Smith 2004, Apps and McLellan 2006, Beauchesne et al. 2014, COSEWIC 2014, Bennett 2017). Managing user access road networks will be a part of caribou persistence and recovery.

4.2.1 SNOWMOBILE

Snowmobile access is managed in WHAs (see above) inasmuch as new access roads are not permitted and human disturbance is limited (with closure dates). Although there are no trail or area closures in the Narraway caribou subpopulation range, there is a cluster of trail and area closures to snowmobiles directly on its southwestern boundary. Snowmobiling is prohibited in the provincial parks. These protections effectively restrict snowmobile access to caribou winter habitat from the British Columbia side.

4.2.2 HELI-SKI / CAT-SKI

There is no helicopter or cat ski activity directly in the range of the Narraway caribou subpopulation. See section 3.3.2.2 for general threat information.

4.2.3 OTHER

There are no specific management actions to regulate or limit other recreational activities such as backcountry skiing or summer (non-hunting) 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 1992, 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 occur 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).

Predation was found to be the dominant source of mortality for Narraway caribou, accounting for 6 of 9 (66%) deaths among collared females in the Bearhole-Redwillow herd from 2002–2015 (Seip and Jones 2016b)

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 9–10/1000 km² but increased at wolf densities from 1–4/1000 km² (Bergerud and Elliot 1986). For this reason, target wolf densities that would enable caribou recovery are set to 6.5/1000 km². 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.

The Bearhole-Redwillow range is outside of the wolf control area but the wolf removal in the adjacent area may have drawn some wolves out of the Bearhole-Redwillow range leading to higher adult survival and high calf recruitment. The sample sizes, however, are too small to draw any firm conclusions (Seip and Jones 2017).

Wolf hunting is permitted in the Peace region, with a 11 month hunting season and a 7 month trapping season (Westereng 2015). Hunting and trapping are aimed to protect livestock primarily, but also impact wolf densities in areas where caribou are present. The number of wolves killed each year has increased since 1976 with from 45 to 360 wolves hunted and trapped each year in the entire Peace region (Westereng 2015).

4.3.2 COUGAR MANAGEMENT

Cougars are uncommon in the Narraway caribou subpopulation range (Spalding 1994) but their population is likely increasing. A 1979 survey in the Omineca-Peace area of the province estimated that there were between 50 and 300 cougars in the area and at that time, cougars were considered “not present” throughout much of the Narraway caribou subpopulation range (Goodchild et al. 1980). Cougar hunting in the Peace region is gaining popularity but the number of successful hunts is increasing. From 1977 through 2013, 77 cougars were killed by hunters, almost half of which (47%) taken since 2012. In British Columbia, particularly in the south (Wittmer et al. 2005a), cougars are a significant caribou predator. Cougar densities respond positively to deer

density, and as deer densities climb, so will cougar densities. Nevertheless, in northern British Columbia, there are no verified reports of cougar predation on caribou.

4.3.3 OTHER

Grizzly bears, black bears and wolverines are also woodland caribou predators (Seip 1992, 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.

Although grizzly bears and black bears are common in the Narraway caribou subpopulation range, records of them preying upon caribou are rare. From 2002 to 2015, bears were responsible for just 2 of 61 (3%) adult caribou mortalities. No information on bear predation of caribou calves is available, but typically this is greater than in adults. Although no concerted bear management for caribou recovery is occurring, bear hunting is popular and ongoing, offering a management tool, if needed, to reduce caribou mortality by bears. On average 28 black bears and 5 grizzly bears are killed by hunters in the wildlife management units overlapping the Narraway caribou subpopulation range.

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, Seip 2008). 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 populations in the Peace (7b) region are stable (1987 – 2014, Figure 3; Kuzyk 2016). There are no programs to manage moose populations to lower densities to promote caribou recovery in the Narraway caribou subpopulation range.

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.

Deer populations in the Peace region and, specifically, management units 7-19 and 20 are steadily increasing. Harvest statistics from 1987 through 2013 show an average increase of about 6 animals per year ($P < 0.05$, $r^2 = 0.36$) with a recent acceleration in offtake. This is indicative of a population increase, particularly given the concurrent increase in hunters. Beyond adjusting harvest regulations to increase offtake, no direct deer management is being conducted.

4.4.3 OTHER

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

The elk population in the range of the Narraway caribou subpopulation appears to be rapidly increasing. Elk killed per hunter has increased from 4% to 27% since 1976. An elk monitoring project for a proposed wind energy project just north of the Narraway caribou range found 231 elk in a 145 km² area (1.6 elk / km²) which is a moderate density for British Columbia (Government of British Columbia 2014, Robitaille and Privé 2016). Elk population management via either a liberalized hunt or government sponsored cull may be necessary in the future (Hebblewhite et al. 2007).

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. 2016b). 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 Narraway caribou subpopulation range, but maternity penning near Chetwynd, just north of the Narraway range, to reinforce the Moberly herd has been operating since 2015 (Seip and Jones 2016a).

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 an *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. 2016b).

Captive breeding to reinforce the Narraway caribou subpopulation is not being planned. High primary prey densities, declining population and lack of predator control do not make this a strong candidate herd for such a reinforcement approach (Hayek et al. 2016b).

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. 2016b). 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. 2016b).

Because of its already small size the Narraway caribou subpopulation is not a candidate as a source population for translocation. As well, because the population is declining and factors such as primary prey and predators are not being managed, they are not a strong target candidate population for translocation (Hayek et al. 2016a).

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. 2016b). 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 Narraway 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. 2016b). 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 Narraway caribou subpopulation lives in habitats in both British Columbia and Alberta. Cross boundary herds have extra management challenges owing to provincial differences in management objectives and approaches. However, they also have stewardship advantages owing to the potential to capture the attention of separate jurisdictions, stewards and interested groups. For instance, the stewardship potential is great for maternity pen near Chetwynd, immediately north of the Narraway caribou subpopulation range as local groups can participate in its operation and outreach towards tangible conservation benefit (Hayek et al. 2016c). With the large number of caribou herds in this area, opportunities for stewardship and outreach with First Nations communities, hunting clubs, outdoor recreation groups and naturalist groups is high. Messages around this small and declining population in comparison to other populations that are stable or increasing under more direct management intervention (predator management, reinforcement) could focus attention on caribou recovery.

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.

Research has been conducted on the Narraway caribou subpopulation on both sides of the British Columbia / Alberta border. Together with other populations in the south Peace region of British Columbia (British Columbia Ministry of Environment 2014) and west central Alberta, university, industry and government based research has demonstrated habitat use (Goddard 2003, Seip and Jones 2013a, MacNearney et al. 2016a), population distribution and density (Saher and Schmiegelow 2005, Seip and Jones 2017), resource selection (DeCesare et al. 2012) protection (Goddard and Scheck 2005, Weckworth et al. 2013) and sources of mortality (DeCesare 2009, Seip and Jones 2016b). While there remain gaps in our understanding of the ecology and demographics of this herd, research has provided a thorough understanding of their status.

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.

The Narraway caribou subpopulation is small and declining. Systematic monitoring of this subpopulation has been undertaken since 2007 to measure its population size, composition and trajectory (Figure 2, 3). Ongoing monitoring of this subpopulation's size and distribution is needed to support efforts for its reinforcement (Hayek et al. 2016b).

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 Narraway caribou subpopulation and their habitat may benefit or inhibit the protection of other species and their habitats (British Columbia Ministry of Environment 2013). Predator management directly affect wolves, who's populations have been intentionally reduced, and other ungulate species like moose, who's densities may also have to be held low to facilitate caribou conservation (Serrouya et al. 2017).

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).

Recreational snowmobile use has been restricted adjacent to the Narraway caribou subpopulation range using legal area and trail closures. As well Wildlife Habitat Area and Provincial Park protections restricts or prevents forestry over much of the subpopulation range. The last caribou hunt was in 2001 and the last caribou killed by a resident hunter was in 2000 (non-resident, guided hunters killed the last hunted caribou in the region in 1996).

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 Narraway 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 (Indigenous):** Kelly Lake Cree Nation (As'in'i'wa'chi Ni'yaw Nation), Kwadacha First Nation, Kelly Lake Metis, Kelly Lake First Nation, Sauteau First Nation, West Moberly First Nation, Foothills First Nation, McLeod Lake Indian Band

Local: Chetwynd, Tumbler Ridge, McLeod Lake

Regional: Dawson Creek, Prince George, Grande Prairie, Grande Cache, McBride

Organizations: **Recreation:** British Columbia Snowmobile Federation (Prince George Snowmobile Club, Tumbler Ridge Ridge Riders Snowmobile Club, McBride Big Country Snowmobile Association), Alberta Snowmobile Association (Wembley Snowmobile Club, Swan City Snowmobile Club), Land Conservancy of British Columbia, Outdoor Recreation Council of British Columbia, Quad Riders Association of British Columbia, Alberta Off-Highway Vehicle Association, Prince George ATV Club, Grizzly Valley ATV Club, Prince George Horse Society, Prince George Off-Road Motorcycle Association, Prince George Snowmobile Club, Dawson Creek Ski Club, Dawson Creek Nordic Ski Club, Bearpaw HeliSkiing, Dezaiko Lodge

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 predator management program with a goal of maintaining wolf populations at a density of less than 6.5 wolves/1000 km² verified by periodic wolf population counts.

- Initiate a regional outreach program to foster support for management that will promote ongoing growth of the Narraway 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).
- Initiate access management on oil and gas developed areas as well as in the forested regions of the Narraway caribou subpopulation including service road rehabilitation.

8.3 LONG TERM (WITHIN 24–48 MONTHS)

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

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