

# WOODLAND CA PLAN Wells Gray

## Subpopulation

Wells Gray - Thompson Local Population Unit



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**EXECUTIVE SUMMARY**

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# 1 BACKGROUND

## 1.1 INTRODUCTION TO THE PROGRAM

All caribou within British Columbia are Woodland Caribou (*Rangifer tarandus caribou*). The Wells Gray South caribou are a subpopulation of the Mountain caribou ecotype within the Southern Mountain National Ecological Area (SMNEA), are listed as Threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and appear on Schedule 1 of the Federal Species at Risk Act (SARA) (EC, 2014; MCTAC, 2002). These caribou herds are red listed in British Columbia and are included in the Provincial Identified Wildlife Management Strategy (IWMS) under the provincial Forest and Range Practices Act (FRPA).

In 2011, COSEWIC defined 12 designatable units (DUs) for caribou in Canada, which represent discrete and evolutionarily-significant units of caribou. The Mountain Caribou ecotype in BC was reorganized into the Southern Mountain Caribou DU (DU9) (COSEWIC, 2014). They were assessed as Endangered in May 2014 (COSEWIC, 2014). This recommended listing of DU9 was submitted to the Federal Minister of the Environment for consideration under SARA in fall 2014.

Environment Canada is proposing a different categorization system, one where the SMNEA is divided into three groups, the Northern, Central, and Southern Groups. The Southern Group from the EC system would be DU9, identical to the Southern Mountain caribou under the COSEWIC system (EC, 2014; COSEWIC, 2014). No decision has been made and the Wells Gray South caribou subpopulation remains listed in the only category of SMNEA caribou and Threatened under SARA.

Woodland Caribou are further divided into Local Population Units (LPU's) by Environment Canada. Within the proposed DU9 there are eleven LPU's. The Wells Gray South subpopulation shares the Wells Gray – Thompson LPU with the Groundhog subpopulation (EC, 2014).

Recovery plans are required for all woodland caribou populations that will be designated as threatened or endangered in Canada (ECCC, 2016). This document spans the divide between these disparate designations provincially and federally, compiling past research, knowledge and management actions into guidance for the management and recovery of the Wells Gray South caribou subpopulation.

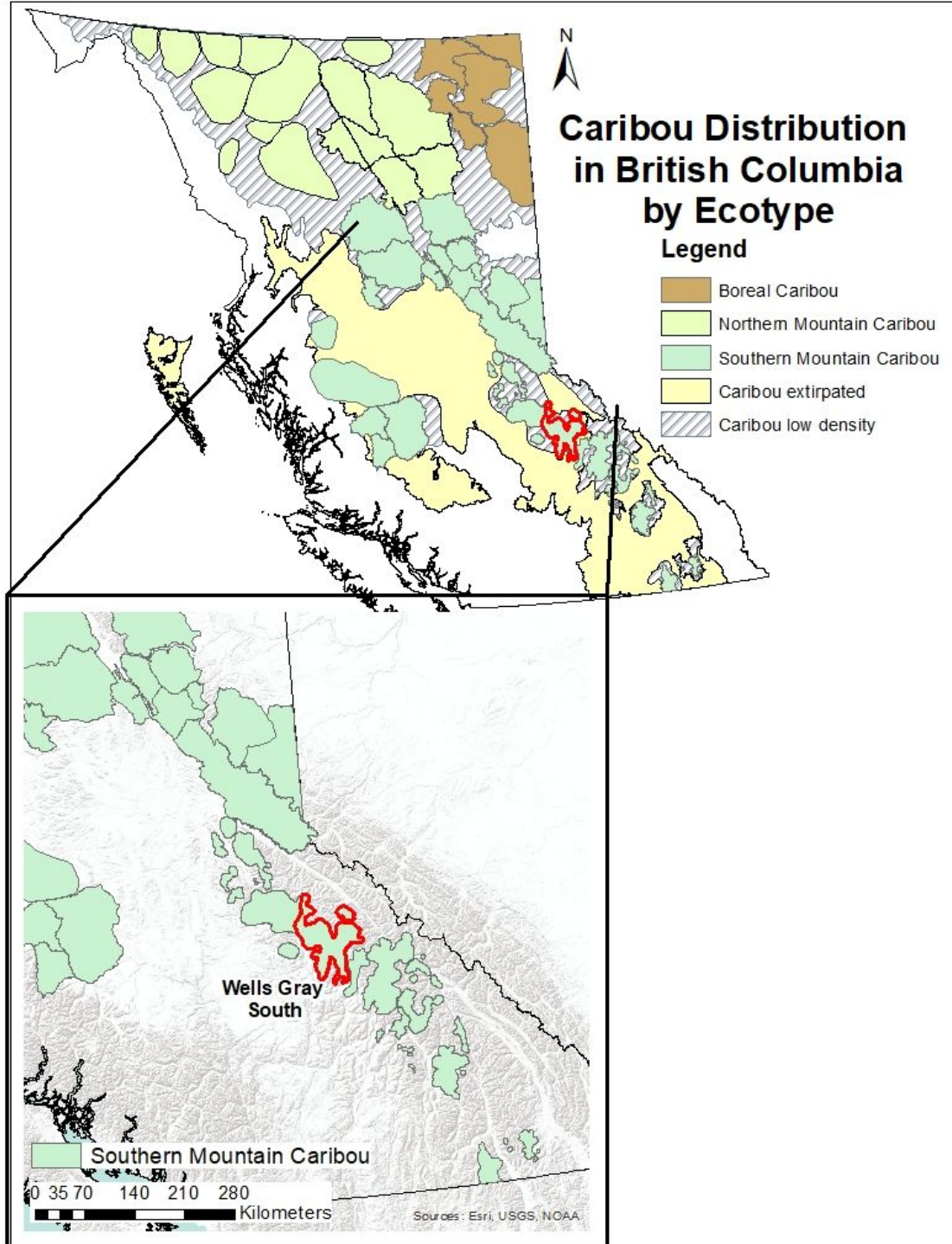
## 2 POPULATION DESCRIPTION

### 2.1 DISTRIBUTION

The Wells Gray South caribou sub population range includes approximately 12000 km<sup>2</sup> within the interior mountain ranges in south central British Columbia. From the community of Clearwater the subpopulation's boundary extends in a northwesterly direction to the east end of Camin Lake then northeast to the south end of Clearwater Lake. It then extends north along Clearwater and Hobson Lakes to the headwaters of the Clearwater River. From there the boundary turns in an easterly direction taking in the headwaters of the Raush and Canoe drainages to the community of Valemount. Leaving Valemount the boundary travels south along the western shore of the Canoe Reach of Kinbasket Lake to Foster Arm before heading east to Hellroar Creek and the North Thompson River. It then follows Highway 5 south and then west back to the community of Clearwater (HCRIG, 2005; EC, 2014; Furk, 2008) (Figure 1).

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Elevations within the subpopulation range from 500 meters to 3500 meters above sea level (Google Earth, 2018). In a southwest to northeast direction there is a transition to an increasingly rugged landscape with a wetter climate (BC Government, 1986). The Wells Gray South caribou subpopulation borders on the Wells Gray North subpopulation to the northwest and the Groundhog subpopulation to the east and south. These two subpopulations are also part of DU 9.



**Figure 1.** Caribou distribution in BC by ecotype. The Wells Gray South subpopulation is outlined in red.

## 2.2 HABITAT AND BEHAVIOUR

Mountain caribou live in the Interior Wet Belt that stretches from northern Idaho and Washington States to central British Columbia. In winter, mountain caribou live in the deep snowpack zone near treeline and feed almost exclusively on arboreal lichens (Young & Freeman, 2002; HCRIG, 2005). This preferred habitat type lies at approximately 1750 meters elevation in this LPU (HCRIG, 2005).

In April these caribou tend to move to lower elevations to feed on new plant growth, some to valley bottom but most descend only slightly returning to near treeline or above in late May to calve. They generally remain at these high elevations all summer feeding on various types of new growth in addition to lichens. Often these summer habitats are in the same locations as their winter habitats, although at times they may exhibit horizontal migration of up to 60 km (Seip, 1990; HCRIG, 2005; Young & Freeman, 2002).

When the initial snows return to the high elevations in the fall the Wells Gray South caribou descend, most to slightly lower elevations but some, more commonly at the south end of their range, to the cedar / hemlock forests at the valley bottoms (HCRIG, 2005). As the snowpack settles, commonly in January, they tend to move upslope to treeline again (MCTAC, 2002).

## 2.3 POPULATION SIZE AND TREND

Early survey boundaries were based on limited knowledge of caribou distribution so this data may not be suitable for trend determination. Deployment of radio collars beginning in the mid 1980's allowed refinement of survey boundaries based on the collar data. The Wells Gray South caribou are one of the larger subpopulations of the mountain caribou ecotype (proposed Southern Group or DU 9), however as with most mountain caribou they have experienced significant declines since systematic monitoring began 23 years ago, declining from approximately 340 to 140 caribou, a 59% decline.

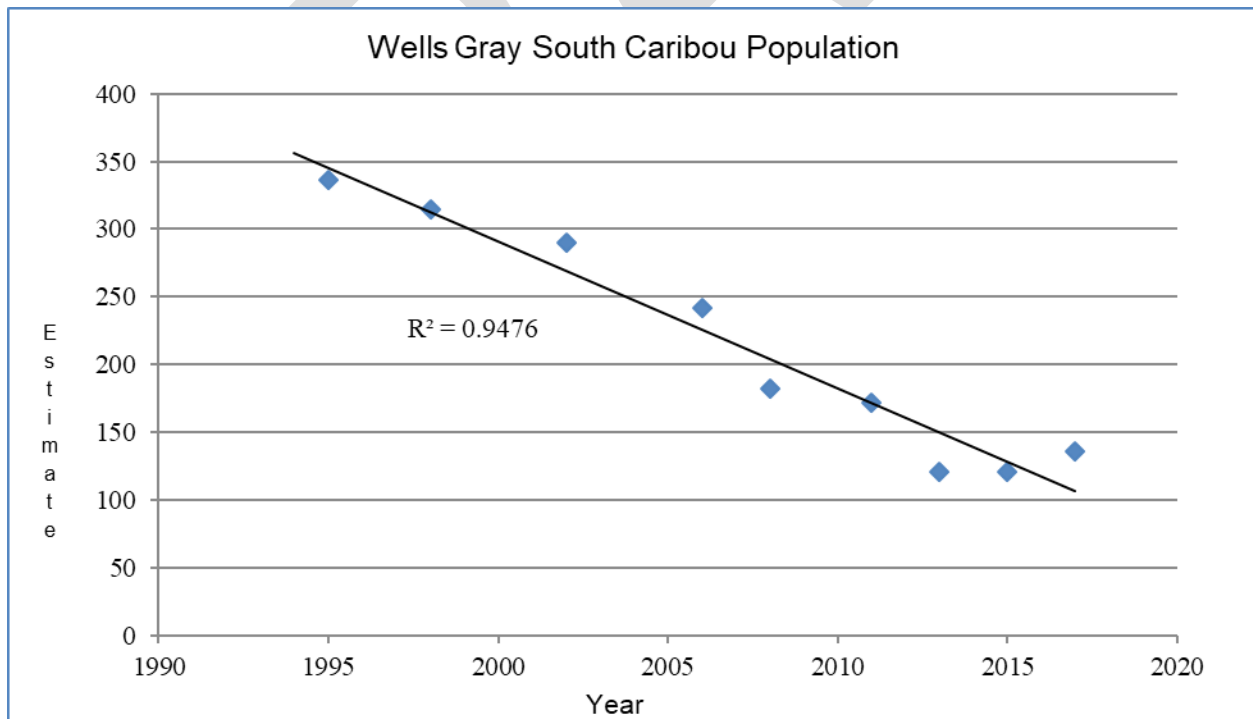


Figure 2: Wells Gray South caribou population trend based on population estimates (J Surgenor, pers. comm.)

### 3 THREATS AND LIMITING FACTORS

Current declines in woodland caribou populations have been ultimately attributed to direct and indirect effects of human activities and climate change (Vors & Boyce, 2009; Festa-Bianchet, et al., 2011; Environment Canada, 2014). For most populations, these effects have led to unsustainable rates of predation (McLoughlin, et al., 2003; Wittmer, et al., 2005b; Apps, et al., 2013) resulting in lowered rates of adult female survival and/or juvenile recruitment, two demographic rates that have high influence on caribou population dynamics (DeCesare, et al., 2012). Compared to other ungulates, caribou are particularly vulnerable to increasing predation because they have low reproductive rates (Bergerud, 2000). To reduce predation risk, caribou generally occur at low densities and have evolved to live in low productivity habitats that spatially separate them from other ungulates and their generalist predators (Bergerud, 1992). Effects from human activities and climate change likely compromise this spacing strategy by changing the abundance and spatial distribution of these other ungulates and predators, increasing the likelihood of caribou-predator encounters and consequently increasing predation rates (Festa-Bianchet, et al., 2011).

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

#### 3.1 PREDATION

Multiple GPS and radio telemetry studies throughout BC 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. Their impact on woodland caribou populations has increased due to the result of three dominant processes: apparent competition mediated by increased alternative prey abundance (Hebblewhite, et al., 2007), apparent competition mediated by expanding alternative prey distribution (Wittmer, et al., 2007; DeCesare, et al., 2009; Latham, et al., 2011b), and enhanced predator access to woodland caribou habitat mediated by roads and other industrial developments (James & Stuart-Smith, 2000; Latham, et al., 2011a; Wilson, 2009).

More generally, Bergerud (2007) has calculated that wolf densities greater than 6.5 wolves/1000 km<sup>2</sup> will result in woodland caribou declines. Out of thirteen known causes of caribou mortality between 1996 and 2004 in the Wells Gray South area twelve were attributed to predation, of which four were confirmed as wolf predation (Furk, 2003b; Furk, 2004).

While not specific to the Wells Gray South caribou subpopulation, studies have demonstrated that bears negatively impact calf recruitment and may impact adult survival (Adams, et al., 1995; Wittmer, et al., 2005a).

#### 3.2 FOOD LIMITATION

Lichens form the main part of caribou's winter diet, while in the summer a variety of vegetation is consumed. A comprehensive study of mountain caribou using bone marrow fat of deceased collared caribou suggests that population declines are linked to excessive predation, not body condition (McLellan, et al., 2012). Other studies also suggest that absolute quantity and quality of food does not limit growth of Woodland Caribou

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populations as long as adequate range is available to deal with severe snow conditions or loss of lichen producing habitat (Schaefer & Pruitt, 1991; Bergerud, 1996). However the result of supplemental feeding on the Kennedy Siding subpopulation suggests that caribou movements to reduce predation risk may reduce food intake and therefore lower nutritional condition (Heard & Zimmerman, 2017).

### 3.3 HUMAN ACTIVITIES

#### 3.3.1 INDUSTRIAL

##### 3.3.1.1 FORESTRY

Woodland caribou are an old-growth forest dependent species (Bergerud, 2000; Theberge & Oosenbrug, 1977) hence forest management affects their distribution and populations. Although some populations live seasonally in treeless, alpine ecosystems, all spend some of the year in forests. For this reason, forestry will affect woodland caribou populations. Forestry effects include “habitat loss” that reduces the amount of old-growth forest thus reducing forest-based food resources (Simpson, et al., 1994) and creating more, early seral forest habitat for apparent competitors such as deer and moose (Simpson & Woods, 1987; Cichowski, 1989; Seip, 1990; Stevenson, 1991). Factors such as the type of forest (Cichowski, 1989) and the size of cutblocks (Edmonds & Bloomfield, 1984) play a role in the effect of forestry practices on woodland caribou populations.

The western half of the Wells Gray South caribou subpopulation area is within Wells Gray Provincial Park and has been protected from forest harvesting since the Park’s creation in 1939. Forest harvesting began at lower elevations outside of the Park around the same time however it was not until the 1970’s that the rate of harvest increased dramatically. Most of the harvesting has been clearcutting (MWLAP, 2003). Currently regenerating cutblocks of age classes less than 50 years are abundant at all elevations in core and matrix habitat, in almost every valley within the LPU (BC Government, 2018). Clearcut forest harvesting continues at this time within the matrix habitat (Google Earth, 2018).

##### 3.3.1.2 MINING

Mineral exploration and 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 zone of influence (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). This physical footprint usually includes linear features such as roads and possibly powerlines, which increase predator travel efficiency, thus increasing the predation risk to the caribou (Latham, et al., 2011a; DeMars & Boutin, 2017).

Mineral tenures are abundant outside of Wells Gray Provincial Park in the eastern half of the LPU with 523 tenures totally over 100,000 ha, approximately half in core caribou habitat and half in matrix habitat (BC Government, 2018).

##### 3.3.1.3 OIL AND GAS

The potential impacts on caribou of oil and gas development would likely be similar but possibly more extensive than mining. However currently oil and gas extraction related activities are non-existent in this area.

##### 3.3.1.4 CLEAN ENERGY

Clean energy projects could include large hydroelectric dams and reservoirs, smaller run of the river hydroelectric projects, wind farms, and solar power generating projects. Research in southern British Columbia correlated hydroelectric development with declines in caribou populations (Simpson, 1987b). There are no large scale hydroelectric generating facilities or reservoirs within the Wells Gray – Thompson LPU. However there are 131



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water power tenures for smaller projects involving a total of 5600 ha along with another 97 applications (BC Government, 2018). There are no solar or wind power generating installations or proposals in the LPU.

### 3.3.1.5 OTHER

No other forms of industrial development are currently planned or underway within the Wells Gray South subpopulation area.

### 3.3.2 RECREATION

Recreational activities, both motorized and non-motorized, can impact caribou populations by displacing individuals into sub-optimal habitats (Seip, et al., 2007; Lesmerises, et al., 2018; Simpson & Terry, 2000), increasing stress levels (Freeman, 2008) and / or facilitating predator movement into caribou habitat (Whittington, et al., 2011). Unnecessary movements can deplete critical fat reserves, potentially decreasing the likelihood of successful parturition and calf rearing the following summer and potentially decreasing the ability to avoid predators (Seip, et al., 2007). Additional winter movements may also increase the amount of exposure to steep terrain, increasing the risk of mortality due to avalanches (Simpson, 1987a; Seip, et al., 2007; Kinley, 2003).

#### 3.3.2.1 SNOWMOBILE

Parts of the Wells Gray South area offer good snowmobiling opportunities and are easily accessible to significant human populations in the Kamloops area as well as foreigners from Alberta. Most of the premium snowmobiling areas are in the no harvest UWR; however the adjacent lower elevations in the valleys are not protected and forest harvesting is widespread. Forestry roads constructed to access these forests also provide the access required by the snowmobilers (Seip, et al., 2007; Lewis, 2005).

#### 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 (Wilson & Nyberg, 2009).

There are several helicopter and catski operations working in the area of the Wells Gray caribou subpopulation. Canadian Mountain Holidays (Cariboos and Valemount) and Mike Wiegele heliski have ski tenures in this area. From 2013 to 2017, 287 caribou were encountered by these operations, largely in the eastern part of the tenures with a range of animal responses from none to being very alarmed (Wilson, 2010; Pasztor, 2013; Heard, 2016; Wilmshurst & Gordon, 2016).

#### 3.3.2.3 OTHER

Backcountry skiing, snowshoeing, ATV use, hiking, mountain biking, and other similar activities could also stress or displace caribou from preferred habitat (MFLNRO Skeena, 2017). Access for these activities is facilitated by Highway 5 between Kamloops and Valemount, the numerous forestry roads branching off of it, and the road into Clearwater Lake.

### 3.3.3 OTHER

#### 3.3.3.1 AGRICULTURE

Agricultural development can impact caribou populations in several ways. These include the direct losses of habitat as forests are converted to fields and the supplementation of natural food sources for alternate prey such as

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elk and deer potentially increasing their populations, which in turn may support increased numbers of predators, increasing the predation risk to the caribou. In addition, domestic livestock could harbour diseases and parasites. Transmission to caribou has not been established within British Columbia (Martin, et al., 2011; Vors & Boyce, 2009).

There is agricultural development along the southern edge of the Wells Gray South caribou range near the community of Clearwater and a smaller amount at the northeast corner near the community of Valemount, elsewhere within or adjacent to the caribou range agriculture is virtually non-existent (Google Earth, 2018).

### 3.3.3.2 ROAD CORRIDORS

Direct mortality from collisions with vehicles is the most obvious threat when highways pass through caribou habitat. Less obvious threats applicable to all roads include direct loss of habitat along road right of ways; fragmentation of habitat, especially if traffic volumes form a crossing barrier (Apps & McLellan, 2006); the maintenance of permanent early seral along road edges supporting alternate prey and therefore predators; improved travel efficiencies for predators increasing predation risk; and improving human access for recreational use.

Highway 5 skirts the southern and eastern edges of the Wells Gray South caribou range for 200 kilometers between the communities of Valemount and Clearwater. Gravel surfaced forestry roads are abundant, located in almost every major valley outside of Wells Gray Provincial Park. A 60 km long road accesses Clearwater Lake in the western part of the caribou range within the Park (Google Earth, 2018).

### 3.3.3.3 LINEAR FEATURES

Linear features could include roads as mentioned above but could also include powerlines, pipelines, railways, and seismic lines. These features often result in direct loss of habitat, create permanent early seral conditions that benefit alternate prey and their predators, and improve travel and therefore hunting efficiency for predators (DeMars & Boutin, 2017). Avoidance by caribou may extend the area of impact well beyond the physical footprint (Vistnes & Nellemann, 2008).

Along with Highway 5 as mentioned above, the 200 kilometers along the North Thompson River corridor is shared with a transcontinental railway, a major powerline, and a major oil pipeline (Google Earth, 2018). There are plans to twin the oil pipeline in the very near future (Kinder Morgan, 2018).

### 3.3.3.4 HUNTING

Excessive hunting of caribou is likely responsible for the initial declines in and range contraction of sub populations throughout the southern two thirds of the province (Spalding, 2000; Freddy, 1974; Herbison, 1996), including the Wells Gray South caribou area.

Moose and deer hunting is common within the Wells Gray South caribou sub-population range however it is prohibited in Management Unit 3-45, which is the approximately half of Wells Gray Provincial Park (BC Government, 2016a; BC Government, 2016c). While reduction in alternative prey can be beneficial to woodland caribou, active hunting on caribou winter range may also contribute to accidental death by hunters who misidentify their prey. The specific impact to the Wells Gray South caribou sub-population is unknown.

## 3.4 NATURAL DISTURBANCE

Caribou populations are subject to impacts from a number of natural disturbances. Being dependent on old-growth forests, caribou are impacted by forest fires. In mountain caribou habitats, it takes a minimum of 150 years for a forest to recover from a fire to become caribou habitat again. In addition the early seral habitat created

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post-fire may facilitate population increases in alternate prey and their predators. Although caribou are likely adapted to the natural forest fire regime within and adjacent to their ranges, effects of forest fire may act cumulatively with human-mediated disturbances to negatively impact caribou demography (Sorensen, et al., 2008). Caribou may also be affected by insect or disease outbreaks that affect forest stand condition. For mountain-dwelling caribou, avalanches constitute another type of natural disturbance that can potentially impact demography, though under normal conditions their importance as a mortality should be small unless population sizes are small (Hebblewhite, et al., 2007; Seip & Cichowski, 1996).

### 3.5 PARASITES AND DISEASES

Caribou can be impacted by a range of native and introduced diseases and parasites (Bergerud, et al., 2008; Schwantje, et al., 2014). Disease and parasite outbreaks can limit caribou populations by affecting survival and reproductive rates (Albon, et al., 2002; Klein, 1991) and effects of disease and parasites may interact with other limiting factors such as predation and nutrition. Threats from disease and parasites are predicted to increase with climate change (see *Section 3.6* below), particularly if spatial overlap between caribou and other ungulate species increases (Bradley, et al., 2005; Dobson, 2009; Kutz, et al., 2005). For example, increasing expansion of white-tailed deer into caribou range may increase the prevalence of meningeal worm in caribou, a parasite that is highly pathogenic to caribou and whose usual host is white-tailed deer (Anderson, 1972).

Impacts from parasites and disease on the population dynamics of the Wells Gray South caribou subpopulation are not well studied however the province has recently increased its sampling program (MacBeth & Schwantje, 2018). Evidence to date from an extensive study suggests that mortality from natural causes (i.e. diseases and nutrition) is low (McLellan, et al., 2012; Apps, et al., 2013) and diseases and parasites are not thought to be a major driver of current declines in populations of southern mountain caribou (EC, 2014).

### 3.6 CLIMATE CHANGE

Climate change can potentially exert numerous effects on caribou population dynamics. Warmer winters may impact forage availability by increasing icing events and / or causing poor snow conditions that limit the ability of caribou to access lichens (Hansen, et al., 2011). A warming climate may also change the abundances and distribution of alternate prey and their generalist predators, potentially increasing rates of caribou predation (Latham, et al., 2011b; Dawe & Boutin, 2016). Climate change may alter the spatial and temporal distribution of insects, diseases and parasites, potentially affecting individual fitness and population dynamics (Bradley, et al., 2005). Changes to the natural disturbance regime (e.g. fire interval, fire intensity, avalanche frequency) may further impact caribou through mechanisms outlined in *Section 3.4*.

There is no specific information on how climate change may be affecting the Wells Gray South subpopulation of caribou, although the recent mountain pine beetle infestation has likely been exuberated by warmer winters (COSEWIC, 2014).

### 3.7 SMALL POPULATION SIZE EFFECTS

Caribou subpopulations that are small and isolated may be subject to negative demographic effects that can occur as a result of their small size (Caughley, 1994). However with an estimated current population estimate of 136 caribou the Wells Gray South caribou may not currently fit into this category.



## 4 MANAGEMENT HISTORY

### 4.1 HABITAT

#### 4.1.1 PROTECTION

Within the Wells Gray Thompson LPU 44% of the core caribou habitat and 20% of the matrix habitat is within Wells Gray Provincial Park and has been off limits to forest harvesting since the park was formed in 1939 (BC Government, 1986; Mahood, 2018).

In 2007 58 % of core habitat outside of the provincial park was designated as no harvest Ungulate Winter Range (UWR) under Government Action Regulation (GAR) orders (Mahood, 2018; BC Government, 2018). Combined with the provincial parks a total of 76 % of core habitat has been protected from further forest harvesting (Mahood, 2018). Protected matrix habitat remains at 20% as there is currently no protection of matrix habitat outside of provincial parks.

There are also coal land reserves, mineral no registration reserves, and old growth management areas (OGMA's) however these may overlap considerably with the UWR and therefore may not be cumulative (Mahood, 2018).

#### 4.1.2 ENHANCEMENT AND RESTORATION

Caribou habitat enhancement and restoration relates both to recreating or improving habitats for caribou seasonal range (termed ecological restoration) as well as managing linear disturbances (roads, seismic lines, pipelines, transmission rights of way) to prevent facilitated predator access (termed functional restoration) (Alberta Woodland Caribou Recovery Team, 2005; Dickie, et al., 2017; Dickie, et al., 2016). As well, habitat enhancement and restoration must be accompanied by protection to be effective (Schneider, et al., 2010). Restoration of caribou habitat takes place naturally through succession from early seral stages to mature and old forest. Standard silviculture practices could aid this process. Further habitat enhancement and / or restoration has not taken place within the Wells Gray South caribou subpopulation area.

### 4.2 RECREATION AND ACCESS MANAGEMENT

From a management perspective recreational activities can be grouped into various categories including commercial / non-commercial, summer / winter, motorized / non-motorized, by specific activity such as snowmobiling / heli skiing, or a combination of these.

In 2007 a five year moratorium on new commercial recreation tenures was enacted. This moratorium was renewed in 2013 and expired on March 31, 2018 (BC FLNRO, 2013). The boundaries mirror the caribou no harvest UWR and as such would cover 58 % of core caribou habitat outside of Wells Gray Provincial Park but within the Wells Gray Thompson LPU (Mahood, 2018).

#### 4.2.1 SNOWMOBILE

Public snowmobiling is not allowed within Wells Gray Provincial Park (BC Government, 1986). Sixty four percent of core caribou habitat within the LPU but outside of provincial parks is closed to snowmobile use under the BC Wildlife Act (Mahood, 2018; BC Government, 2018) Snowmobiling in the remaining 36 % of core habitat is managed through agreements with the local snowmobile clubs. The Conservation Officer Service provides education and conducts regular compliance and enforcement patrols. **Enforcement resulted in:**

#### 4.2.2 HELI SKI / CAT SKI

The helicopter and cat skiing industry, through membership with Helicat Canada, Has been guided by best management practices since 2011 (under a Memorandum of Understanding (MOU)) that stipulate minimum

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distances that the helicopters and skiers should avoid caribou by (BC Government, 2014). Area closures in some locations were recommended in the 2005 Recovery Implementation Plan (HCRIG, 2005) but were not implemented (BC Government, 2018).

### 4.2.3 SUMMER RECREATION

Recreation within the provincial parks in the Wells Gray South LPU is focussed on non-motorized backcountry recreation (BC Government, 1986). Outside of provincial parks there are no limitations on non-commercial, non-winter recreational activities.

## 4.3 PREDATORS

### 4.3.1 WOLF MANAGEMENT

Wolf hunting is managed as general open seasons through the provincial hunting regulations. There are no restrictions on the number of wolves harvested per person annually (no annual bag limit) for the Wells Gray South caribou subpopulation area outside of Wells Gray Provincial Park (Management Units (MUs) 3-39, 3-40, 3-43, 3-44) Within the Park (MU's 3-45 and 3-46) hunting of wolves is prohibited (BC Government, 2016a). Wolves are also trapped by registered trappers for their fur. There is no requirement for compulsory inspection or compulsory reporting of wolves harvested in Region 3 (BC Government, 2016a).

Hunting and trapping does not usually result in the removal of complete packs, remaining pack members can reproduce and recover within one year providing food resources are available. Partial pack removal can also splinter packs, resulting in more wolves as their territorial system is compromised (B. McLellan, pers. comm. 2017). Complete pack removal targeting the Wells Gray South wolves, carried out from a helicopter, would likely be more effective.

Efforts to determine wolf presence / absence, population size, territories size, etc., was undertaken by the way of transects, howling surveys, and collaring in the 2003 – 2005 period (Jones, 2004; Lewis & Eustache, 2006). Track surveys were again undertaken beginning in 2015 (B. Ernst, pers. comm., 2018).

### 4.3.2 COUGAR MANAGEMENT

The annual bag limit for cougar is two outside of Wells Gray Provincial Park (Management Units (MUs) 3-39, 3-40, 3-43, 3-44) Within the Park (MU's 3-45 and 3-46) hunting of cougars is prohibited. There is a province wide requirement for compulsory inspection of cougars (BC Government, 2016a).

### 4.3.3 OTHER

Bear and wolverine predation on neonates and caribou in the spring can also have a significant impact on caribou populations (Wittmer, et al., 2005a; MFLNRO Skeena, 2017). However bears and wolverine populations are likely not greater than historic levels, instead grizzly bears and wolverines themselves may be at risk in some areas (BC Conservation Data Centre, 2017). In addition, as bears are more abundant than caribou and only a small portion of the diet of any one bear would be caribou, a very large number of bears would have to be culled to have an effect (MFLNRO LNG, 2015).

## 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

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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 (CCRIG, 2005).

### 4.4.1 MOOSE MANAGEMENT

Throughout British Columbia, moose are a common and sustaining prey of wolves (Messier, 1994). But their expanding range (Bergerud & Elliot, 1986), a wolf numerical response to moose densities (Messier & 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 & 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.

Hunting moose in the Wells Gray South caribou range is managed through a combination of general open seasons and limited entry hunts. There is no hunting of moose in MU 4-45, which is within Wells Gray Provincial Park (BC Government, 2016a; BC Government, 2016c). Setting and achieving targeted moose populations estimated to natural forest seral conditions (CCRIG, 2005) has not been attempted.

### 4.4.2 DEER MANAGEMENT

Managing deer populations in support of caribou conservation is a challenge. Both white tail and mule deer can support predator populations that have negative effects on caribou (Latham, et al., 2011b). Both species 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 (BC Government, 2016a). 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 & 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.

Both mule deer and white tail deer are present within the Wells Gray South caribou subpopulation area. There is a general open season for both white tail (both sexes) and mule deer bucks and limited entry hunts in some parts of the caribou range for antlerless mule deer only (BC Government, 2016a; BC Government, 2016c). Setting and achieving targeted deer populations estimated to natural forest seral conditions (CCRIG, 2005) has not been attempted.

### 4.4.3 OTHER

Elk may be present within the Wells Gray South area however in low enough numbers that there is no harvest (BC Government, 2016a; BC Government, 2016c).

## 4.5 POPULATION REINFORCEMENT

### 4.5.1 MATERNITY PENNING

Maternal penning to increase calf recruitment is a tool that has not been used with the Wells Gray South caribou subpopulation. It is not a viable tool for caribou populations over 100 animals (MFLNRO LNG, 2015). Penning requires a minimum of 60% of the female population penned and an annual female survival rate greater than 85% to be effective (DeMars, 2017). The number of females that would have to be penned to produce a significant increase to recruitment rates would be cost prohibitive.

### 4.5.2 CAPTIVE BREEDING

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

### 4.5.3 TRANSLOCATION

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

There have been no translocations of caribou into the Wells Gray South caribou subpopulation; however it has been used a source for transplants to the South Selkirk caribou population in the late 1990's (Almack, 1998).

### 4.5.4 OTHER

Predator exclusion fencing or other forms of population reinforcement have not been implemented for the Wells Gray South caribou subpopulation.

## 4.6 STEWARDSHIP/OUTREACH

Stewardship Management Agreements (SMA's) are in place for many caribou subpopulation areas that also experience high recreational snowmobile use. The general concept is that while key areas of caribou are closed to snowmobile use, the snowmobiling community will act as stewards in implementing best management practices in other areas of caribou habitat that remain open to snowmobile use. Considerable outreach efforts at industry trade shows, snowmobile retailers, etc. may also be undertaken (CO Service, 2013; CO Service, 2014).

## 4.7 RESEARCH AND MONITORING

There have been decades of research into caribou biology and conservation including research specific to the Wells Gray – Thompson LPU (Furk, 2003a; Furk, 2003b; Furk, 2004; Kellner, et al., 2010; Lewis, et al., 2005; McLellan, et al., n.d.; Mowat & Stanley, 1999; Mowat & Poole, 1999). 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 these factors are well understood in a broad sense, ongoing research is necessary to fine tune caribou responses to ecological stimuli and human disturbance.

## 5 IMPLICATIONS TO OTHER WILDLIFE

Management actions focused on conserving caribou will necessarily have impacts on other wildlife species. Caribou require landscapes where densities of other ungulates and predators are low; thus, management actions undertaken for caribou may result in population sizes of moose, deer, and wolf that are much lower than those currently experienced (Serrouya, et al., 2015; Serrouya, et al., 2017). Reducing the populations of these species may occur from either direct management actions (e.g. lethal control) or through environmental changes (e.g. habitat restoration for caribou) that lowers the extent of their suitable habitat.

Conserving caribou will likely benefit a myriad of other species co-occurring within old-growth forests. In this context, caribou may be considered an “umbrella” species (Bichet, et al., 2016). Such species generally have large spatial requirements and are sensitive to environmental changes, both attributes associated with caribou. Meeting the habitat requirements of caribou will therefore result in the habitat needs of many other species also being met.

## 6 IMPLICATIONS TO OTHER VALUES

Enacting measures to conserve caribou will likely have impacts on social, political and economic values. Most woodland caribou populations occur in working landscapes managed for natural resource extraction. Conserving caribou in these landscapes will likely require limits on these activities, which will likely invoke socioeconomic costs (Schneider, et al., 2011). To effectively mitigate these impacts while conserving caribou in multi-use landscapes, conservation planning will need to incorporate both economic costs and the biological needs of caribou in a spatially-explicit modelling framework (Schneider, et al., 2011; Schneider, et al., 2012).

In many caribou ranges, reducing the current densities of other ungulate species will be fundamental to conserving caribou (Serrouya, et al., 2015). Lowered populations of big-game species such as moose will initially result in greater hunting opportunity however will result in reduced hunting opportunities in the long term. While incorporating hunters in the initial lowering of these populations can be advantageous and seen as a “win-win” (Serrouya, et al., 2015), the long-term suppression of these populations will likely require support from the regional hunting community.

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

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

## 7 PARTNERS / NEIGHBOURS

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

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

## 8 RECOMMENDED ACTIONS

### 8.1 SHORT TERM (WITHIN 6-12 MONTHS)

#### 8.1.1 HABITAT PROTECTION

- Begin discussions on methods to increase no harvest protection of core habitat as mapped by Environment and Climate Change Canada (ECCC) to 100%.
- Begin discussions on converting the target of a wolf density of 3 per 1000 km<sup>2</sup> in matrix habitat to a system tangible to the forest industry, potentially a cap on the amount of early seral forest age classes.
- Initiate Land Act Reserves over remaining untenured areas of core habitat for major industrial uses including metal mining, placer mining, and natural gas.

#### 8.1.2 ALTERNATE PREY MANAGEMENT

- Move towards management of moose populations to densities of  $< 0.3 / \text{km}^2$  in all core and matrix caribou habitat.
- Review if changes are required to white tail deer hunting management to facilitate lower predator populations.

#### 8.1.3 PREDATOR MANAGEMENT

- Collar 1 – 2 wolves per pack to improve current knowledge of wolf densities, movements and populations.
- Review compulsory inspection data and anecdotal reports for cougar to determine prevalence.

#### 8.1.4 RESTORATION

- Initiate discussions with the forestry sector on decommissioning and rehabilitating roads to reduce predator travel efficiency and to limit recreational access.
- Initiate discussions with the forestry sector to begin exploring silviculture and forestry management options and prescriptions which will increase the speed at which early seral forests mature. This will include legislative options under FRPA which could support this work.

#### 8.1.5 RECREATION

- Assess if current snowmobile restrictions are adequate to prevent the displacement of caribou from preferred habitat.
- In conjunction with the Conservation Officer Service, continue compliance monitoring and enforcement of current snowmobile restrictions.
- Update heliski industry best management practices. Experience in other mountain caribou areas suggest that the 500 meter flight and skier avoidance guideline is inadequate; suggest updating to 3 km skier and flight avoidance and / or ensure area closures are in key locations.

### 8.2 MEDIUM TERM (WITHIN 12-24 MONTHS)

#### 8.2.1 HABITAT PROTECTION

- Increase no harvest protection of core habitat as mapped by Environment and Climate Change Canada (ECCC) to 100%.
- Convert the target of a wolf density of 3 per 1000 km<sup>2</sup> in matrix habitat to a system tangible to the forest industry, potentially a cap on the amount of early seral forest stages.



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### 8.2.2 ALTERNATE PREY MANAGEMENT

- Continue management of moose populations to densities of  $< 0.3 / \text{km}^2$  in all core and matrix caribou habitat.
- Manage white tail deer populations to lower predator populations if necessary.

### 8.2.3 PREDATOR MANAGEMENT

- Introduce a wolf cull if densities are greater than 3 wolves /  $1000 \text{ km}^2$

### 8.2.4 RESTORATION

- Rehabilitate forestry road segments to inhibit predator movement and prevent mechanized access.
- Initiate silviculture and forestry management options and prescriptions which will increase the speed at which early seral forests mature.

### 8.2.5 RECREATION

- Improve on current snowmobile restrictions to prevent the displacement of caribou from preferred habitat if necessary.
- In conjunction with the Conservation Officer Service, continue compliance monitoring and enforcement of current snowmobile restrictions.

### 8.2.6 POPULATION MONITORING

- Continue caribou population monitoring through annual or bi-annual aerial censuses.

## 8.3 LONG TERM (WITHIN 24-48 MONTHS)

### 8.3.1 HABITAT PROTECTION

- Monitor whether the introduction of a cap on the amount of early seral forest is producing the desired result.

### 8.3.2 ALTERNATE PREY MANAGEMENT

- Continue management of moose populations to densities of  $< 0.3 / \text{km}^2$  in all core and matrix caribou habitat.
- Continue management of white tail deer populations if necessary.

### 8.3.3 PREDATOR MANAGEMENT

- Continue the wolf cull if densities are greater than 3 wolves /  $1000 \text{ km}^2$

### 8.3.4 RESTORATION

- Continue to rehabilitate forestry road segments to inhibit predator movement and prevent mechanized access.
- Continue with silviculture and forestry management options and prescriptions which will increase the speed at which early seral forests mature.

### 8.3.5 RECREATION

- In conjunction with the Conservation Officer Service, continue compliance monitoring and enforcement of current snowmobile restrictions

### 8.3.6 POPULATION MONITORING

- Continue caribou population monitoring through annual or bi-annual aerial censuses.

### 8.3.7 OUTREACH

- Continue with a regional outreach program to foster support for management that will promote growth of the Wells Gray South caribou program.

## 9 LITERATURE CITED

- Adams, L., Singer, F. & Dale, B., 1995. Caribou calf mortality in Denali national park, Alaska. *Journal of Wildlife Management*, Volume 59, pp. 584-594.
- Alberta Woodland Caribou Recovery Team, 2005. *Alberta woodland caribou recovery plan 2004/05 - 2013/14*, Edmonton, Alberta: Alberta Sustainable Resource Development, Fish and Wildlife Division.
- Albon, S. et al., 2002. The role of parasites in the dynamics of a reindeer population. *Proceedings of the Royal Society of London: Biological Sciences*, Volume 269, p. 1625–1632.
- Almack, J., 1998. *Mountain caribou recovery in the Southern Selkirk Mountains of Washington, Idaho, and British Columbia*, Olympia, WA: Washington Department of Fish and Wildlife.
- Anderson, R., 1972. The ecological relationships of meningeal worm and native cervids in North America. *Journal of Wildlife Diseases*, Volume 8, pp. 304-310.
- Apps, C. & McLellan, B., 2006. Factors influencing the dispersion and fragmentation of endangered mountain caribou populations. *Biological Conservation*, Volume 130, pp. 84-97.
- Apps, C. et al., 2013. Spatial factors related to mortality and population decline of endangered mountain caribou. *The Journal of Wildlife Management*, Volume 77, p. 1409–1419.
- Balmford, A. et al., 2002. Economic reasons for conserving wild nature. *Science*, Volume 297, p. 950–953.
- BC Conservation Data Centre, 2017. *BC Conservation Data Centre*. [Online] Available at: <http://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/conservation-data-centre> [Accessed 4 October 2017].
- BC FLNRO, 2013. *Notice of continuation and amendment of a Section 16 map reserve*. Victoria, BC: s.n.
- BC Government, 1986. *Wells Gray Park Master Plan*, Victoria, BC: Ministry of Lands, Parks, and Housing, Parks and Outdoor Recreation Division.
- BC Government, 2014. *Memorandum of understanding regarding management of helicopter and snow cat skiing in mountain caribou habitats*. Victoria, BC: s.n.
- BC Government, 2016a. *2016-2018 Hunting and trapping regulations synopsis*. Victoria, BC: s.n.
- BC Government, 2016c. *British Columbia limited entry hunting regulations synopsis 2016-2017*, Victoria, BC: BC Ministry of Forests, Lands, and Natural resource Operations.
- BC Government, 2018. *Provincial Data Warehouse*, Victoria, BC: s.n.
- BC Ministry of Water, L. a. A. P., 2003. *Summary of timber harvesting on caribou winter range in the North Thompson*, Kamloops, BC: BC Ministry of Water, Land, and Air Protection.
- Bergerud, A. & Elliot, J., 1986. Dynamics of caribou and wolves in northern British Columbia. *Canadian Journal of Zoology*, Volume 64, pp. 1515-1529.



## Woodland Caribou Plan for the Wells Gray South Subpopulation

- Bergerud, A. & Mercer, W., 1989. Caribou introductions in eastern North America. *Wildlife Society Bulletin*, Volume 17, pp. 111-120.
- Bergerud, A. T., 1992. Rareness as an antipredator strategy to reduce predation risk for moose and caribou. In: *Wildlife 2001: Populations*. Edited by DR. McCullough & R.B. Barrett. Elsevier, London, pp. 1008-1021.
- Bergerud, A. T., 1996. Evolving perspectives on caribou population dynamics, have we got it right yet?. *Rangifer Spec. Issue*, 9, pp. 95-116.
- Bergerud, A. T., 2000. Caribou. Pp658-693 in S. Demarais and P.R.Karusmann, editors. *Ecology and Management of large Mammals in North America*. New Jersey: Prentice Hall.
- Bergerud, A. T., Luttich, S. N. & Camps, L., 2008. The return of caribou to Ungava.. *McGill-Queen's University Press*.
- Bergman, E. J., Doherty, P. F., White, G. C. & Holland, A. A., 2015. Density dependence in mule deer: a review of evidence. *Wildlife Biology*, Volume 21, p. 18–29.
- Bichet, O. et al., 2016. Maintaining animal assemblages through single-species management: the case of threatened caribou in boreal forest. *Ecological Applications*, Volume 26, pp. 612-623.
- Boertje, R., Keech, M. & Paragi, T., 2010. Science and values influencing predator control for Alaska moose management. *The Journal of Wildlife Management*, Volume 74, p. 917–928.
- Bradley, M., Kutz, S., Jenkins, E. & O'Hara, T., 2005. The potential impact of climate change on infectious diseases of Arctic fauna. *International Journal of Circumpolar Health*, Volume 64, pp. 468-477.
- Brown, T. L. et al., 2000. The future of hunting as a mechanism to control white-tailed deer populations. *Wildlife Society Bulletin*, Volume 28, p. 797–807.
- Caughley, G., 1994. Directions in conservation biology. *The Journal of Animal Ecology*, Volume 63, pp. 215-244.
- CCRIG, 2005. *Recovery implementation plan for threatened woodland caribou in the Hart and Cariboo mountains recovery area*, British Columbia, s.l.: BC Ministry of Environment.
- Cichowski, D. B., 1989. *Seasonal movements, habitat use, and winter feeding ecology of woodland caribou in west-central British Columbia*, Vancouver, BC.: University of British Columbia.
- CO Service, 2013. *Operation Out of Bounds*, Prince George, BC: Conservation Officer Service.
- CO Service, 2014. *Operation Out of Bounds*, Prince George, BC: Conservation Officer Service - Omineca Zone.
- COSEWIC, 2014. COSEWIC assessment and status report on the Caribou Rangifer tarandus, Northern Mountain population, Central Mountain population and Southern Mountain population in Canada. *Committee on the Status of Endangered Wildlife in Canada*, p. xxii + 113.
- Dawe, K. & Boutin, S., 2016. Climate change is the primary driver of white-tailed deer (*Odocoileus virginianus*) range expansion at the northern extent of its range; land use is secondary. *Ecology and Evolution*, Volume 6, p. 6435–6451.

## Woodland Caribou Plan for the Wells Gray South Subpopulation

- DeCesare, N. et al., 2012. Estimating ungulate recruitment and growth rates using age ratios. *The Journal of Wildlife Management*, Volume 76, pp. 144-153.
- DeCesare, N., Hebblewhite, M., Robinson, H. & Musiani, M., 2010b. Endangered, apparently: the role of apparent competition in endangered species conservation. *Animal Conservation*, Volume 13, pp. 353-362.
- DeCesare, N. J., Hebblewhite, M., Robinson, H. S. & Musiani, M., 2009. Endangered, apparently: the role of apparent competition in endangered species conservation. *Animal Conservation*, Volume 13, pp. 353-362.
- DeMars, C., 2017. *Recovery action plan for Southern Mountain caribou within the Kootenay Region.*, s.l.: s.n.
- DeMars, C. A. & Boutin, S., 2017. Nowhere to hide: effects of linear features on predator-prey dynamics in a large mammal system. *Journal of Animal Ecology*.
- Dickie, M. et al., 2017. Evaluating functional recovery of habitat for threatened woodland caribou. *Ecosphere*.
- Dickie, M., Serrouya, R., McNay, R. & Boutin, S., 2016. Faster and farther: wolf movement on linear features and implications for hunting behaviour. *Journal of Applied Ecology*, Volume 54, pp. 253-263.
- Dobson, D., 2009. Climate variability, global change, immunity, and the dynamics of infectious diseases. *Ecology*, Volume 90, pp. 920-927.
- Dumont, A. et al., 2000. Population dynamics of northern white-tailed deer during mild winters: evidence of regulation by food competition. *Canadian Journal of Zoology*, Volume 78, p. 764-776.
- EC, 2014. Environment Canada. Recovery Strategy for the Woodland Caribou, Southern Mountain population (*Rangifer tarandus caribou*) in Canada. *Species at Risk Act Recovery Strategy Series*, p. vii + 103.
- ECCC, 2016. *Environment and Climate Change Canada. Range Plan Guidance for Woodland Caribou, Boreal Population*, Ottawa: Environment and Climate Change Canada.
- Edmonds, E. J. & Bloomfield, M., 1984. *A study of woodland caribou (Rangifer tarandus caribou) in west-central Alberta, 1979 to 1983. Unpublished report AFW-84-045*, s.l.: Alberta Energy and Natural Resources Fish and Wildlife Division.
- Environment Canada, 2014. Environment Canada. Recovery Strategy for the Woodland Caribou, Southern Mountain population (*Rangifer tarandus caribou*) in Canada. *Species at Risk Act Recovery Strategy Series*, p. vii + 103.
- Environment Canada, 2014. *Recovery Strategy for the Woodland Caribou, Southern Mountain Population (Rangifer tarandus caribou) in Canada*, s.l.: Species at Risk Act Recovery Strategy Series.
- Festa-Bianchet, M. et al., 2011. Conservation of caribou (*Rangifer tarandus*) in Canada: an uncertain future. *Canadian Journal of Zoology*, Volume 89, pp. 419-434.
- Forrester, T. D. & Wittmer, H. U., 2013. A review of the population dynamics of mule deer and black-tailed deer *Odocoileus hemionus* in North America. *Mammal Review*, Volume 43, p. 292-308.
- Freddy, D., 1974. *Status and management of the Selkirk caribou herd 1973, Masters Thesis*, Moscow, Idaho: University of Idaho Graduate School.

## Woodland Caribou Plan for the Wells Gray South Subpopulation

- Freeman, N., 2008. *Motorized backcountry recreation and stress response in mountain caribou (Rangifer tarandus caribou)*. M.Sc. thesis, Vancouver, BC: University of British Columbia.
- Fryxell, J. M., Jussell, D. J. T., Lambert, A. B. & Smith, P. C., 1991. Time lags and population fluctuations in white-tailed deer. *Journal of Wildlife Management*, Volume 55, p. 377–385.
- Furk, K., 2003a. *Forest attributes Associated with mountain caribou early winter feeding sites in the North Thompson watershed of BC*, Kamloops, BC: BC Ministry of Water, Land, and Air Protection.
- Furk, K., 2003b. *Survival rates and Sources of Mortality for Mountain Caribou in the Clearwater Forest District: preliminary report from telemetry data*, Kamloops, BC: Ministry of Water, Land, and Air Protection.
- Furk, K., 2004. *North Thompson caribou project interim progress report: April 2013 to March 2004*, Kamloops, BC: BC Ministry of Water, Land, and Air Protection.
- Furk, K., 2008. *2008 Population Census of Mountain Caribou in Wells Gray Park, the North Thompson Watershed and a portion of the Adams River Watershed of the Ministry of Environment Thompson Region*, Kamloops, BC: BC Ministry of Environment.
- Google Earth, 2018. Mountain View, California: Google Incorporated.
- Hansen, B. et al., 2011. Climate, icing, and wild arctic reindeer: past relationships and future prospects. *Ecology*, Volume 92, pp. 1917-1923.
- Hayek, T. et al., 2016. An exploration of conservation breeding and translocation tools to improve the conservation status of boreal caribou populations in western Canada. *Centre for Conservation Research, Calgary Zoological Society, Calgary, AB.*
- HCRIG, 2005. *Recovery implementation plan for threatened woodland caribou in the Hart and Cariboo mountains recovery area, British Columbia*, s.l.: BC Ministry of Environment.
- Heard, D., 2016. *Helicopter and snowcat skiing operations in relation to mountain caribou, 2014-2015. Final Report*, Victoria, BC: Ministry of Forests, Lands and Natural Resource Operations.
- Heard, D. & Zimmerman, K., 2017. *Supplemental feeding of Kennedy Siding caribou, September 2016 to January 2017*, Vancouver, BC.: Peace Northern Caribou Program.
- Hebblewhite, M. J. et al., 2007. Conditions for caribou persistence in the wolf-elk-caribou systems of the Canadian Rockies. *Rangifer*, Volume Special Issue 17, pp. 79-90.
- Herbison, B., 1996. *Central Selkirks caribou, historic to present times: apparent trends and emerging priorities*, Argenta, BC: s.n.
- Hervieux, D. et al., 2014. Managing wolves (*Canis lupus*) to recover threatened woodland caribou (*Rangifer tarandus caribou*) in Alberta. *Canadian Journal of Zoology*, Volume 92, p. 1029–1037.
- Holt, R. D., 1977. Predation, apparent competition, and the structure of prey communities. *Theoretical Population Biology*, Volume 12, p. 197–229.

## Woodland Caribou Plan for the Wells Gray South Subpopulation

- Imperial Metals, 2017. *Imperial Metals - Ruddock Creek Project*. [Online]  
Available at: <https://www.imperialmetals.com/projects/ruddock-creek/maps-and-diagrams>  
[Accessed 22 06 2018].
- James, A. & Stuart-Smith, A., 2000. Distribution of caribou and wolves in relation to linear corridors. *Journal of Wildlife Management*, Volume 64, pp. 154-159.
- Johnson, C., Ehlers, L. & Seip, D., 2015. Witnessing extinction – Cumulative impacts across landscapes and the future loss of an evolutionarily significant unit of woodland caribou in Canada. *Biological Conservation*, Volume 186, pp. 176-186.
- Jones, J., 2004. *Region 3 Wolf research progress report 2003 / 2004*, Kamloops, BC: Wildlife Branch Ministry of Water, Land, and Air Protection.
- Kellner, M. et al., 2010. *Forest harvesting and lichen availability for mountain caribou in the Interior Cedar Hemlock zone of the North Thompson*, Kamloops, BC: Simpcw Development Corporation.
- Kinder Morgan, 2018. *Trans Mountain Pipeline, Planning the Route*. [Online]  
Available at: <https://www.transmountain.com/planning-the-route>  
[Accessed 02 05 2018].
- Kinley, T., 2003. *Snowmobile–mountain caribou interactions: a summary of perceptions and an analysis of trends in caribou distribution*, Victoria, BC: British Columbia Ministry of Water, Land and Air Protection.
- Klein, D., 1991. Limiting factors in caribou population ecology. *Rangifer*, Volume 11, pp. 30-35.
- Kutz, S., Hoberg, E., Polley, L. & Jenkins, E., 2005. Global warming is changing the dynamics of Arctic host-parasite systems. *Proceedings of the Royal Society of Biological Sciences*, Volume 272, p. 2571–2576.
- Latham, A., Latham, M., Boyce, M. & Boutin, S., 2011a. Movement responses by wolves to industrial linear features and their effect on woodland caribou in northeastern Alberta. *Ecological Applications*, Volume 21, p. 2854–2865.
- Latham, A., Latham, M., McCutchen, N. & Boutin, S., 2011b. Invading white-tailed deer change wolf-caribou dynamics in northeastern Alberta. *Journal of Wildlife Management*, Volume 75, pp. 204-212.
- Lesmerises, F., Dery, F., Johnson, C. & St Laurent, M., 2018. Spatiotemporal response of mountain caribou to the intensity of backcountry skiing. *Biological Conservation*, Volume 217, pp. 149-156.
- Lessard, R. et al., 2005. Should ecosystem management involve active control of species abundances?. *Ecology and Society*, Volume 10, p. 1:online.
- Lewis, D., 2005. *A review of mountain caribou - snowmobile interactions in the North Thompson and Columbia watersheds*, Kamloops, BC: Forest Insight Consulting.
- Lewis, D. & Eustache, C., 2006. *Wolf inventory in the North Thompson Valley, British Columbia*, Kamloops BC: Simpcw Development Corporation.
- Lewis, D., Serrouya, R. & McLellan, B., 2005. *Mountain caribou use of partial cut forests in the North Thompson Valley, British Columbia*, s.l.: s.n.

## Woodland Caribou Plan for the Wells Gray South Subpopulation

- Mahood, C., 2018. *Protections in Critical Habitat by LPU 20180210*. Williams Lake, BC: BC Ministry of Forests, Lands, and Natural Resource Operations.
- Martin, C. et al., 2011. A survey of the transmission of infectious diseases/infections between wild and domestic ungulates in Europe. *Veterinary research*, Volume 42, p. 70.
- McKay, T., 2007. *Woodland caribou response to encounters with people in Jasper National Park*, Victoria, BC: Royal Roads University.
- McLellan, B. et al., n.d. *Quantifying forest stand and landscape attributes that influence mountain caribou habitat fragmentation and predation rates*, Revelstoke, BC: BC Ministry of Forests Research Branch.
- McLellan, B., Serrouya, R., Wittmer, H. & Boutin, S., 2010. Predator-mediated Allee effects in multi-prey systems. *Ecology*, Volume 91, pp. 286-292.
- McLellan, M. et al., 2012. Implications of body condition on the unsustainable predation rates of endangered mountain caribou. *Oecologia*, Volume 169, pp. 853-860.
- McLoughlin, P., Dzus, E., Wynes, B. & Boutin, S., 2003. Declines in populations of woodland caribou. *The Journal of Wildlife Management*, Volume 67, pp. 755-761.
- MCST, 2006. *Management options and related actions for mountain caribou in British Columbia*, Victoria, BC: Mountain Caribou Science Team.
- MCTAC, 2002. *A strategy for the recovery of mountain caribou in British Columbia*, Victoria, BC: Mountain Caribou Technical Advisory Committee, Ministry of Water, Land and Air Protection.
- Messier, F., 1991. The significance of limiting and regulating factors on the demography of moose and white-tailed deer. *Journal of Animal Ecology*, Volume 60, p. 377–393.
- Messier, F., 1994. Ungulate population models with predation: a case study with the North American moose. *Ecology*, Volume 75, p. 478–488.
- Messier, F. & Joly, D. O., 2000. Comment: Regulation of moose populations by wolf predation. *Canadian Journal of Zoology*, Volume 78, p. 506–510.
- MFLNRO LNG, 2015. *LNG Caribou Program: A plan to support the conservation and management of Northern and Mountain Caribou populations and habitat potentially affected by LNG pipeline projects*, North Area: MFLNRO.
- MFLNRO Skeena, 2017. *South Skeena caribou strategy - a plan to support the conservation and management of the Telkwa, Tweedsmuir-Entiako and Takla caribou herds*, Smithers, BC: s.n.
- Mowat, G. & Poole, K., 1999. *Caribou site seasonal home ranges in the North Thompson watershed of British Columbia*, Kamloops, BC: BC Ministry of Environment, Lands, and Parks.
- Mowat, G. & Stanley, D., 1999. *Caribou site level habitat selection in the North Thompson watershed of British Columbia*, Kamloops, BC: BC Ministry of Environment, Land, and Parks.
- Oberg, P. R., 2001. *Responses of mountain caribou to linear features in a west-central Alberta landscape*, s.l.: s.n.

## Woodland Caribou Plan for the Wells Gray South Subpopulation

- O'Brien, D., Manseau, M., Fall, A. & Fortin, M., 2006. Testing the importance of spatial configuration of winter habitat for woodland caribou: An application of graph theory. *Biological Conservation*, Volume 130, pp. 70-83.
- Parker, K., Barboza, P. & Stephenson, T., 2005. Protein conservation in female caribou (*Rangifer tarandus*): Effects of decreasing diet quality during winter. *Journal of Mammalogy*, Volume 86, pp. 610-622.
- Parker, K. L., Barboza, P. S. & Gillingham, M. P., 2009. Nutrition integrates environmental responses of ungulates. *Functional Ecology*, Volume 23, p. 57–69.
- Pasztor, C., 2013. *Pasztor, C. 2013. Mountain caribou compliance monitoring: interactions between mountain caribou and helicopter and snowcat skiing operations*, Victoria, BC: BC Ministry of Environment.
- Pierce, B. M., Bleich, V. C., Monteith, K. L. & Bowyer, R. T., 2012. Top-down versus bottom-up forcing: evidence from mountain lions and mule deer. *Journal of Mammalogy*, Volume 93, p. 977–988.
- Pigeon, K. E. et al., 2016. Toward the restoration of caribou habitat: Understanding factors associated with human motorized use of legacy seismic lines. *Environmental Management*, Volume 58, p. 821–832.
- Plummer, D. A. et al., 2006. Climate and climate change over north america as simulated by the Canadian RCM. *Journal of Climate*, Volume 19, p. 3112–3132.
- Polfus, J., 2010. *Assessing cumulative human impacts on northern woodland caribou with traditional ecological knowledge and resource selection functions. Dissertation*, Missoula, MT: The University of Montana.
- Polfus, J., Hebblewhite, M. & Heinemeyer, K., 2011. Identifying indirect habitat loss and avoidance of human infrastructure by northern mountain woodland caribou. *Biological Conservation* 144:2637–2646.. *Biological Conservation*, Volume 144, pp. 2637-2646.
- Proulx, G. & Brook, R., 2017. Fencing large predator-free and competitor-free landscapes for the recovery of woodland caribou in western Alberta: An ineffective conservation option. *Animals*, Volume 7, p. 2.
- Ray, J. C. et al., 2015. Conservation status of caribou in the western mountains of Canada: Protections under the Species At Risk Act, 2002-2014. *Rangifer*, Volume 35, p. 49–80.
- Robinson, H. S. et al., 2012. The effect of fire on spatial separation between wolves and caribou. *Rangifer*, Volume 32, p. 277–294.
- Robinson, H. S., Wielgus, R. B. & Gwilliam, J. C., 2002. Cougar predation and population growth of sympatric mule deer and white-tailed deer. *Canadian Journal of Zoology*, Volume 80, p. 556–568.
- Rytwinski, T. & Fahrig, L., 2012. Do species life history traits explain population responses to roads? A meta-analysis. *Biological Conservation*, Volume 147, p. 87–98.
- Schaefer, J. & Pruitt, W., 1991. Fire and woodland caribou in southeastern Manitoba. *Wildlife Monographs, A Publication of the Wildlife Society*, Volume 116.
- Schneider, R., Hauer, G., Adamowicz, W. & Boutin, S., 2010. Triage for conserving populations of threatened species: The case of woodland caribou in Alberta. *Biological Conservation*, Volume 143, pp. 1603-1611.
- Schneider, R. et al., 2012. Selection of reserves for woodland caribou using an optimization approach. *PLoS ONE* 7:e31672.

## Woodland Caribou Plan for the Wells Gray South Subpopulation

- Schneider, R. et al., 2011. Achieving conservation when opportunity costs are high: optimizing reserve design in Alberta's oil sands region. *PLoS ONE* 6:e23254.
- Schwantje, H., 2015. *Chronic Wasting Disease*. In: *Wildlife Diseases*. Government of British Columbia, Victoria, BC. [Online]  
Available at: <http://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/wildlife/wildlife-health/wildlife-diseases/chronic-wasting-disease>  
[Accessed 18 09 2017].
- Schwantje, H., Macbeth, B., Kutz, S. & Elkin, B., 2014. *British Columbia boreal caribou health program progress report: year 1 (November 1, 2013 - December 31, 2014)*, Victoria, BC: Science, Community and Environmental Knowledge fund .
- Seip, D., 1992. Factors limiting woodland caribou populations and their interrelationships with wolves and moose in southeastern British Columbia. *Canadian Journal of Zoology*, Volume 70, pp. 1494-1503.
- Seip, D. & Cichowski, D., 1996. Population ecology of caribou in British Columbia. *Rangifer* 16:73–80.. *Rangifer*, Volume 16, pp. 73-80.
- Seip, D. R., 1990. *Ecology of woodland caribou in Wells Gray Provincial Park*. No. B-68, Victoria, BC.: British Columbia Ministry of Environment and Parks.
- Seip, D. R., 1998. Ecosystem management and the conservation of caribou habitat in British Columbia. *Rangifer*, Volume 18, p. 203–211.
- Seip, D. R., 2008. Mountain caribou interactions with wolves and moose in central British Columbia. *Alces*, Volume 44, p. 1–5.
- Seip, D. R., Johnson, C. & Watts, G., 2007. Displacement of mountain varibou from winter habitat by snowmobiles. *Journal of Wildlife Management*, Volume 71, p. 1539–1544.
- Serrouya, R. et al., 2017. Experimental moose reduction lowers wolf density and stops decline of endangered caribou. *PeerJ* 5, Volume e3736.
- Serrouya, R. et al., 2015. Using predator-prey theory to predict outcomes of broadscale experiments to reduce apparent competition. *The American Naturalist*, Volume 185, pp. 665-679.
- Sielecki, L. E., 2010. *Wildlife accident monitoring and mitigation in British Columbia* , s.l.: s.n.
- Sifton, E., 2001. *Disease risk assessment for an experimental captive breeding program of Mountain Caribou in British Columbia*. final, Nelson, BC: Wildlife Branch BC Ministry of Environment, Lands and Parks.
- Simpson, K., 1987a. *The effects of snowmobiling on winter range use of mountain caribou*, Nelson, BC: Ministry of Environment and Parks, Wildlife Branch.
- Simpson, K., 1987b. *Impacts of hydro-electric reservoir on populations of caribou and grizzly bear in southern British Columbia*. BCEP--WR-24, Victoria, BC: British Columbia Ministry of Environment and Parks.
- Simpson, K., Kelsall, J. & Leung, M., 1994. *Integrated management of mountain caribou and forestry in southern British Columbia*, Victoria. BC: BC Ministry of Environment, Lands, and Parks.

## Woodland Caribou Plan for the Wells Gray South Subpopulation

- Simpson, K. & Terry, E., 2000. *Impacts of backcountry recreation activities on mountain caribou*. *Wildlife Working Report No. WR-99*, Victoria, BC: Ministry of Environment, Lands and Parks Wildlife Branch.
- Simpson, K. & Woods, G. P., 1987. *Ecology of woodland caribou in Wells Gray Provincial Park*. , Victoria, BC: British Columbia Ministry of Environment and Parks, No. B-67.
- Sinclair, A. R. E. et al., 1998. Predicting effects of predation on conservation of endangered prey. *Conservation Biology*, Volume 12, p. 564–575.
- Sorensen, T. et al., 2008. Determining sustainable levels of cumulative effects for boreal caribou. *Journal of Wildlife Management*, Volume 72, pp. 900-905.
- Spalding, D., 2000. The early history of woodland caribou (*Rangifer tarandus caribou*) in British Columbia. *BC Ministry of Environment, Lands, and Parks, Wildlife Branch Wildlife Bulletin No. 100*, p. 61.
- Steenweg, R., 2011. *Interactions of wolves, mountain caribou and an increased moose hunting quota - primary prey management as an approach to caribou recovery*, Prince George, BC: University of Northern British Columbia.
- Stevenson, S. K., 1990. Managing second-growth forests as caribou habitat. *Rangifer*, Volume Special Issue No. 3, p. 139–144.
- Stevenson, S. K., 1991. Forestry and caribou in British Columbia. *Rangifer* , Volume 11, pp. 124-129.
- Swift, K. & Ran, S., 2012. Successional responses to natural disturbance, forest management and climate change in British Columbia forests. *2012*, Volume 13.
- Theberge, J. & Oosenbrug, S., 1977. *Analysis for potential for an ecological reserve in the Telkwa Mountains, British Columbia, to protect mountain caribou*, Faculty of Environmental Studies, University of Waterloo, Ontario: BC Department of Environment and BC Department of Recreation and Travel Industry.
- Trainer, D., 1973. Caribou mortality due to the meningeal worm. *Journal of Wildlife Diseases*, Volume 9, pp. 376-378.
- van Oort, H., McLellan, B. N. & Serrouya, R., 2010. Fragmentation, dispersal and metapopulation function in remnant populations of endangered mountain caribou. *Animal Conservation*, Volume 14, pp. 215-224.
- Vistnes, I. & Nellemann, C., 2008. The matter of spatial and temporal scales: a review of reindeer and caribou response to human activity. *Polar Biology*, Volume 31, pp. 399-407.
- Vors, L. & Boyce, M., 2009. Global declines of caribou and reindeer.. *Global Change Biology*, Volume 15, p. 2626–2633.
- Walden, H. S. et al., 2014. Chapter 60 - Miscellaneous Parasitic Diseases. In: *Equine Infectious Diseases (Second Edition)*. St. Louis: W.B. Saunders, p. 505–514.
- Weckworth, B. V. et al., 2012. Reconstruction of caribou evolutionary history in western North America and its implications for conservation. *Molecular Ecology*, Volume 21, p. 3610–3624.
- White, G., 1996. Population estimation from mark-resighting surveys  
<http://www.cnr.colostate.edu/~gwhite/software.html>. *Wildlife Society Bulletin*, Volume 24, pp. 50-52.



## Woodland Caribou Plan for the Wells Gray South Subpopulation

- Whittington, J. et al., 2011. Caribou encounters with wolves increase near roads and trails: a time-to-event approach. *Journal of Applied Ecology*, Volume 48, p. 1535–1542.
- Wilmshurst, J. & Gordon, S., 2016. *Mountain Caribou Compliance Monitoring: Interactions between Mountain Caribou and Helicopter and Snowcat Skiing Operations during the 2015-16 Skiing Season. draft report*, Victoria, BC: BC MFLNRO.
- Wilson, S., 2010. *Analysis of mountain caribou sighting data collected by heli-ski and snow-cat skiing operators in 2009-10. final report*, Victoria, BC: BC Ministry of Environment.
- Wilson, S. F., 2009. *Recommendations for predator-prey management to benefit the recovery of mountain caribou in British Columbia*, s.l.: s.n.
- Wilson, S. & Nyberg, J., 2009. *A proposed monitoring and adaptive management strategy for mountain caribou recovery implementation*, Victoria, BC: Ecosystems Branch, BC Ministry of Environment.
- Wittmer, H., Sinclair, A. & McLellan, B., 2005b. The role of predation in the decline and extirpation of woodland caribou. *Oecologia*, Volume 144, pp. 257-267.
- Wittmer, H. U., Ahrens, R. N. M. & McLellan, B. N., 2010. Viability of mountain caribou in British Columbia, Canada: Effects of habitat change and population density. *Biological Conservation*, Volume 143, p. 86–93.
- Wittmer, H. U. et al., 2005a. Population dynamics of the endangered mountain ecotype of woodland caribou (*Rangifer tarandus caribou*) in British Columbia, Canada.. *Canadian Journal of Zoology*, Volume 83, pp. 407-418.
- Wittmer, H. U., McLellan, R., Serrouya, R. & Apps, C. D., 2007. Changes in landscape composition influence the decline of a threatened woodland caribou population. *Journal of Animal Ecology*, Volume 76, pp. 568-579.
- Wittmer, H. U., Serrouya, R., Elbroch, L. M. & Marshall, A. J., 2013. Conservation Strategies for Species Affected by Apparent Competition. *Conservation Biology*, Volume 27, pp. 254-260.
- Wobeser, G., 1976. Besnoitiosis in a woodland caribou. *Journal of Wildlife Diseases*, Volume 12, pp. 566-571.
- Wolfe, S., Griffith, B. & Wolfe, C., 2000. Response of reindeer and caribou to human activities. *Polar Research*, Volume 19, pp. 63-73.
- Yellowhead Mining, 2015. *Yellowhead Mining - Harper Creek Project*. [Online] Available at: <http://www.yellowheadmining.com/s/ProjectMaps.asp> [Accessed 22 06 2018].
- Young, J. & Freeman, N., 2002. *Towards integrated management solutions: The Quesnel Highland caribou project radio-telemetry final report 1993-2000*, Williams Lake, BC: BC Ministry of Water, Land, and Air Protection.