SCIENCE-BASED GUIDELINES FOR MANAGEMENT OF NORTHERN MOUNTAIN CARIBOU IN YUKON

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SCIENCE-BASED GUIDELINES FOR MANAGEMENT OF NORTHERN MOUNTAIN CARIBOU IN YUKON

Yukon Department of Environment
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Summary

The following guidelines provide an overview of the scientific information used by Environment Yukon and other parties, as appropriate, to make monitoring and harvest management decisions specific to Northern Mountain caribou (*Rangifer tarandus caribou*) populations in Yukon. They are not meant to replace management planning but are a resource that will help promote consistent science-based input and responses to management plans, programs, and regulation proposals. They are a working document that will be reviewed periodically and updated based on new information. Future iterations of the guidelines are intended to include a section on mitigating impacts of land use on Northern Mountain caribou.

For clarity, the information in these guidelines is only part of what is needed to make wildlife management decisions. It complements other sources of information used to manage wildlife in Yukon, including traditional and local knowledge, as well as wildlife management processes undertaken by the Yukon Fish and Wildlife Management Board (YFWMB) renewable resources councils (RRCs), and others.

Decisions based on these guidelines will help ensure the long term sustainability of Yukon's Northern Mountain caribou populations, resulting in long term benefits for Yukoners.

Overview of caribou management guidelines

Two of the primary tools used to manage Northern Mountain caribou populations in Yukon are population monitoring (Section 3.1) and harvest management (Section 3.3).

Population monitoring (Section 3.1)

1. *Herds are the basic unit for caribou management. (Section 2.1)*
    - There are 26 herds of Northern Mountain caribou in Yukon and they occupy nearly all of south and central Yukon. Each herd typically has discrete range-use pattern and population characteristics. Population monitoring and harvest management are specific to individual herds.
    - Caribou herds that range across jurisdictional boundaries are managed in coordination with the appropriate jurisdictions.
2. *Aerial surveys are used to assess the status of caribou populations (Section 3.1).*
    - During surveys, animals are counted and classified into adult cows, adult bulls, and calves.
    - The criteria used to select which herds to monitor include:
        - If the herd is part of an existing long term monitoring program. Long-term data sets allow tracking and understanding of patterns related to annual environmental variability (e.g., climate) and other factors over time.

    - Existing or previous management concerns (e.g., the herd is small, accessible, subject to high harvest rates, and/or part of a previous recovery program).
    - Current and anticipated land use activities.
    - Social, financial, and political considerations.
  - At least 5 (and preferably 10) years of regular monitoring is needed to establish a herd's population trend.
    - Information from Yukon caribou herds indicate that after 10 years, the full variability in observed annual recruitment rates has typically occurred.
    - Individual estimates of fall recruitment are "snapshots" in time and will vary from year to year. It takes more than 5 years of recruitment ratio data to determine if a population is stable, increasing, or decreasing. A single "good" or "bad" year of recruitment is not sufficient to make management recommendations.
3. *A stable population growth rate generally requires an average fall recruitment ratio of 20 to 25 calves per 100 adult cows. (Section 2.6.3)*
  - Caribou calf survival in Yukon is generally low but can vary highly from one year to the next. In Yukon, recruitment ratios (the number of calves per 100 cows) have ranged from less than 10 to more than 50 calves per 100 cows. Most mortality occurs within the first months of life so fall ratios are typically a good indicator of the number of calves entering the herd as adults.
4. *A sex ratio of 30 bulls per 100 cows should ensure all females have the opportunity to reproduce. (Section 2.6.5).*
  - The natural survival rate of males is typically lower than females in ungulate populations. An equal number of bulls and cows would not be expected even if a population is not hunted. While in theory, a population may be able to sustain a sex ratio (the number of bulls per 100 cows) as low as 10 bulls per 100 cows before a decline in calf recruitment is observed, other effects such as the loss of genetic diversity may occur. Using a sex ratio of 30 bulls per 100 cows as a guideline for herd health takes a precautionary approach to management decisions.

Harvest management (Section 3.3)

Harvest rate recommendations are guidelines and may be adjusted based on specific and objective knowledge of a population, including its status, trend, accessibility, disturbance within the range, harvest pressure on adjacent herds, and other sources of mortality. Guidelines must also be considered in light of meeting obligations under the *Umbrella Final Agreement* (1993) specific to conservation and long term optimum productivity.

The following guidelines should be used to evaluate harvest rate recommendations for specific caribou populations:

5. *Small herds or herds in serious decline should be protected from all harvest.*
6. *Cow harvest should be avoided.*
    - Cow harvest—even if small—is associated with a higher risk of population decline.
        - Cow harvest has a bigger impact on populations than bull harvest. The loss of a cow means a loss of all the calves she could have produced during the rest of her lifetime.
    - The harvest of one cow is equal to the harvest of 3 bulls.
    - Pregnancy rate is typically high for sexually mature females and averages 93.5% so it is expected that most sexually mature cows will produce a calf.
7. *If a herd is in decline, a bull only harvest of up to 1% of total population size may be considered.*
    - Given fluctuations in annual calf recruitment, a declining herd *may* be able sustain a bull harvest of up to 1% of total population size. However, management decisions regarding harvest of declining herds should be made carefully using all relevant and available herd-specific information.
    - A bull only harvest of equal or close to 0% of the total population size should be considered for herds in serious decline.
    - All adult cow mortality (including harvest mortality) should be minimized in a declining herd.
8. *If a herd is stable, a bull-only harvest rate of up to 2% of total population size is likely sustainable.*
9. *If a herd is increasing, a bull-only harvest rate of up to 3 to 4% of total population size is likely sustainable.*
    - A maximum harvest rate of 3 to 4% of total population size is recommended to minimize the risk of harvest leading to a decline and to ensure a healthy bull:cow ratio.
10. *If information on a herd is limited or outdated, a bull-only harvest of up to 1% of the estimated total population size minimizes the risk of harvest causing a herd to decline significantly.*
    - Outside of recommending a harvest closure due to incomplete information, a harvest rate of up to 1% should mitigate the potential for an unsustainable harvest.
    - Actual harvest numbers should be based on the expertise of Yukon Fish and Wildlife staff and other knowledgeable individuals (e.g., First Nation partners, RRCs, etc.).
11. *Bull only harvest rates should be adjusted based on the number of cows removed from the population, in which the removal of 1 cow is equal to the removal of 3 bulls.*

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1 Introduction

1.1 Purpose

The following guidelines provide an overview of the scientific and technical information used by Environment Yukon and other parties, as appropriate, to make monitoring and harvest management decisions specific to Northern Mountain caribou (*Rangifer tarandus caribou*) populations in Yukon. The intent of the guidelines is to help users provide consistent science-based input and responses to management plans, programs, and regulation proposals based on the most up to date scientific information.

Guidelines are not the same as a management plan but they will be used to provide science-based direction for managing wildlife populations and assessing population status and trend. Monitoring and management recommendations depend in part on this assessment; for example, survey work may be prioritized for a population deemed to be at increased risk of decline because of high harvest pressure. Environment Yukon uses as many lines of evidence as possible to make inferences about a population to ensure management actions are sound.

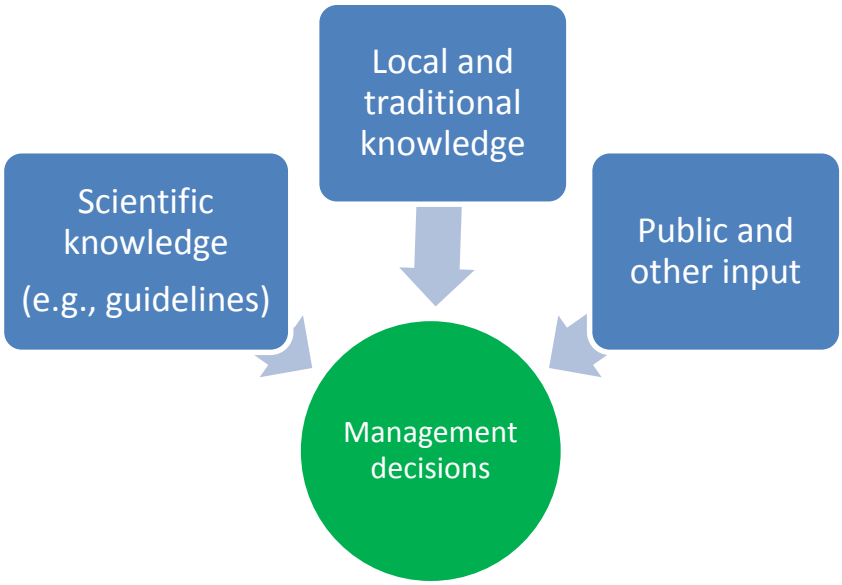

Figure 1. Role of guidelines in wildlife management in Yukon.

These guidelines are a starting point for discussion and may be adjusted pending more specific, objective knowledge of a population. They are one part of what is needed to make wildlife management decisions (Figure 1). Processes exist in Yukon to integrate scientific, local, and traditional knowledge and ensure that this knowledge is used to inform wildlife management. Public participation in wildlife management processes is facilitated by public bodies such as the Yukon Fish and Wildlife Management Board (YFWMB), Renewable

Resources Councils (RRCs), and others. For more information on the role of the YFWMB and RRCs in wildlife management, please see Chapter 16 of the *Umbrella Final Agreement* (1993).

1.2 Management and regulatory context

Stewardship of natural resources in Yukon is mandated through the Wildlife Act, Environment Act and constitutionally entrenched land claim agreements. Within Yukon land claim agreements, the principles of conservation[1], long term optimum productivity, and sustainability guide management programs while actions are guided through related legislation, policy, guidelines, or formal agreements.

1.3 Management principles for Yukon's wildlife

Management of Yukon's wildlife is guided by the following principles. These principles are derived from fundamental practices within the fields of wildlife management and conservation biology.

1. Naturally self-sustaining wildlife populations are the principal management objective.
2. Wildlife populations will be, to the best extent possible, managed within their natural range of variation.
3. Management of human activity, including harvest, disturbance, and land use are the primary tools available for recovering or maintaining wildlife and wildlife habitat.
4. Management will be adaptive.
5. The interests of all consumptive and non-consumptive users will be recognized and considered in the management of wildlife populations.
6. Management will be guided by the precautionary principle.
7. Management will, to the best extent possible, be ecosystem based.

1.4 Review process and future iterations of the guidelines

These guidelines are part of a living document which may be revised as new information becomes available. For example, future iterations of this document are intended to include a section on mitigating impacts of land use, as our knowledge of the specific responses of Yukon's Northern Mountain Caribou to human activity increases. Currently, Environment Yukon reviews and provides advice on a variety of land use and development applications, most commonly under the Yukon Environmental and Socio-Economic Assessment Act (YESAA). Other legislation, in addition to the Wildlife Act, Environment Act, and land claim agreements, is in place to ensure responsible resource development in

[1] Conservation as defined in the *Umbrella Final Agreement* (UFA; 1993): the management of Fish and Wildlife populations and habitats and the regulation of users to ensure the quality, diversity and Long Term Optimum Productivity of Fish and Wildlife populations, with the primary goal of ensuring a sustainable harvest and its proper utilization. In the UFA, Long Term Optimum Productivity is defined as productivity required to ensure the long term continuation of a species or population while providing for the needs of Yukon Indian People and other harvesters and non-consumptive users of Fish and Wildlife in the short term.

caribou range. These include the Forest Resources Act, Quartz Mining Act, and Placer Mining Act.

In addition to the as-needed revisions, these guidelines will be reviewed and updated, in full, every 10 years. This periodic review process will ensure the document remains current with scientific understanding, and relevant to Yukon.

2 Species background

2.1 Distribution and status

Caribou *(Rangifer tarandus)* are distributed globally across the northern boreal forest and tundra/taiga ecosystems (see Figure 2; Appendix 1). Forty-five herds of Northern Mountain caribou have been identified across their entire range in Yukon, Alaska, British Columbia, and the Northwest Territories (COSEWIC 2014). Of these, 26 herds are in Yukon and they occupy nearly all of south and central Yukon (Figure 3; Table 1).

Yukon's herds typically occupy a traditionally-used winter range. This pattern has allowed delineation of distinct herds. However, herd delineation is a dynamic process and in some areas, there is uncertainty regarding herd delineation and distribution. For example, caribou in the Greater Nahanni ecosystem and east (Figure 3; Finlayson, South Nahanni, Coal River, and the La Biche herds) exhibit weaker winter-range fidelity and the level of confidence in accurately identifying unique "herds" is consequently lower. In addition, some distinct herds exhibit range overlap at different times of the year. For example, the Clear Creek and Hart River herds have some overlap during the summer months, but are separate during the winter months. Ranges may be revised as new information becomes available (e.g., radio-collar data).

There are an estimated 30,000 to 35,000 Northern Mountain caribou in Yukon; they are listed as "big game" under Yukon's *Wildlife Act*. Herds vary in size from about 200 to more than 5,000 (Table 1). Population trends for individual herds vary. Trends identified in Table 1 are based on a variety of information sources including the comparison of two population estimates, estimated human-caused mortality rates (harvest and others such as road-kill), and assessments of fall recruitment ratios (see Section 2.2.3).

Broad conclusions regarding overall trends in population size of Northern Mountain caribou are difficult to make due to this. For example, the Chisana herd has been relatively stable since 2003 whereas the Finlayson herd decreased from 1999 to 2007 and the Aishihik herd increased between 2001 and 2009 and is now stable. For more information on recent caribou surveys, see Environment Yukon's website.

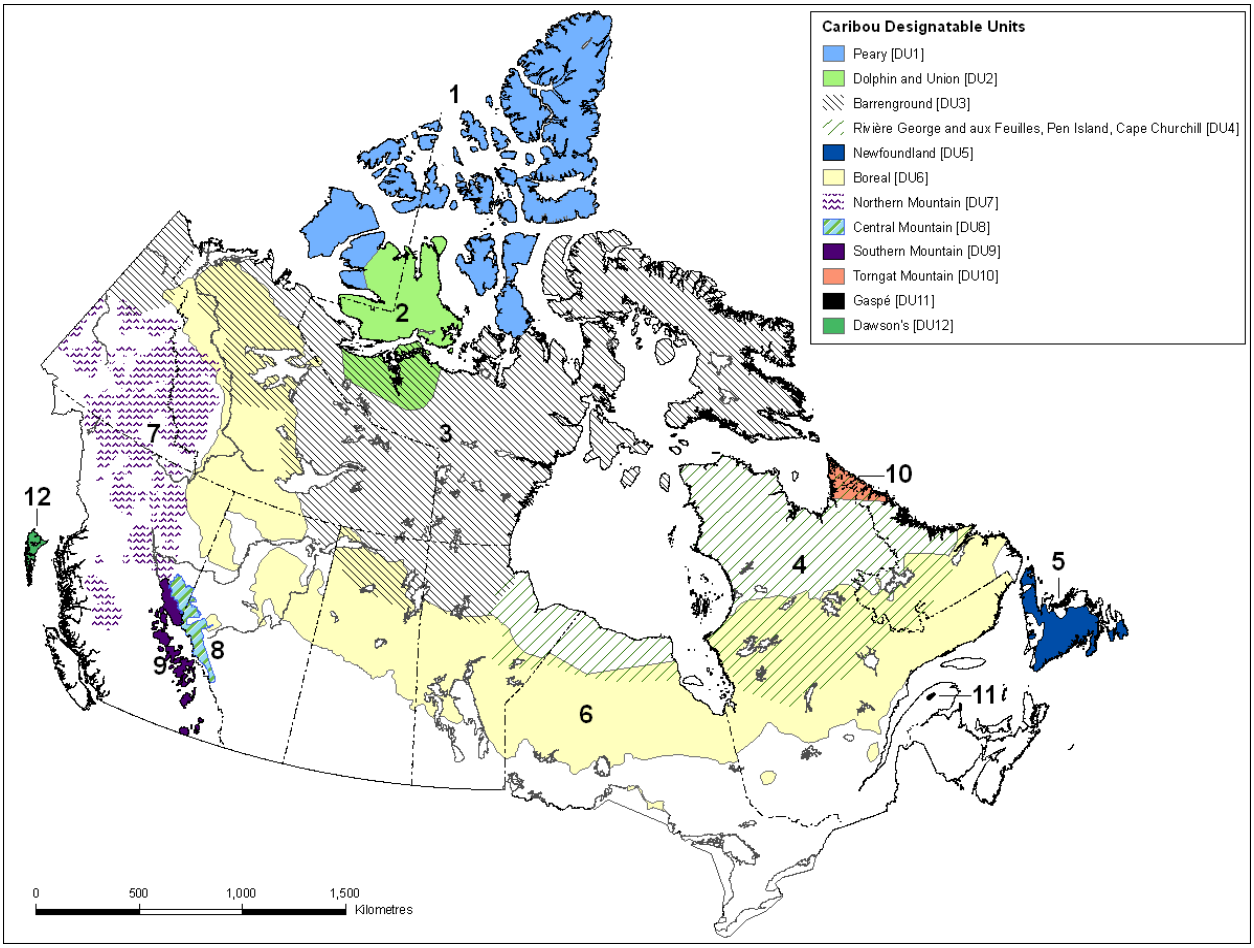

Figure 2. Designatable units for COSEWIC status assessments of caribou across Canada (from COSEWIC 2011).

Northern Mountain caribou were federally listed as a species of Special Concern under Canada's Species at Risk Act (SARA) in 2005 and again reassessed as Special Concern in 2014 (COSEWIC 2014). Environment Canada (2012) recently completed a *Management Plan for the Northern Mountain Population of Woodland Caribou in Canada*. The guidelines in this document will help Yukon meet many of the objectives laid out in the national management plan.

2.2 Habitat requirements

Northern Mountain caribou use a range of habitats across forest, subalpine, and alpine areas, with a tendency towards use of open habitats (e.g., Gustine and Parker 2008). Caribou require extensive space and a variety of habitats to persist. They also undertake traditional movements, presumably as a strategy to minimize predation, exploit forage resources on seasonal ranges, and avoid deep snow.

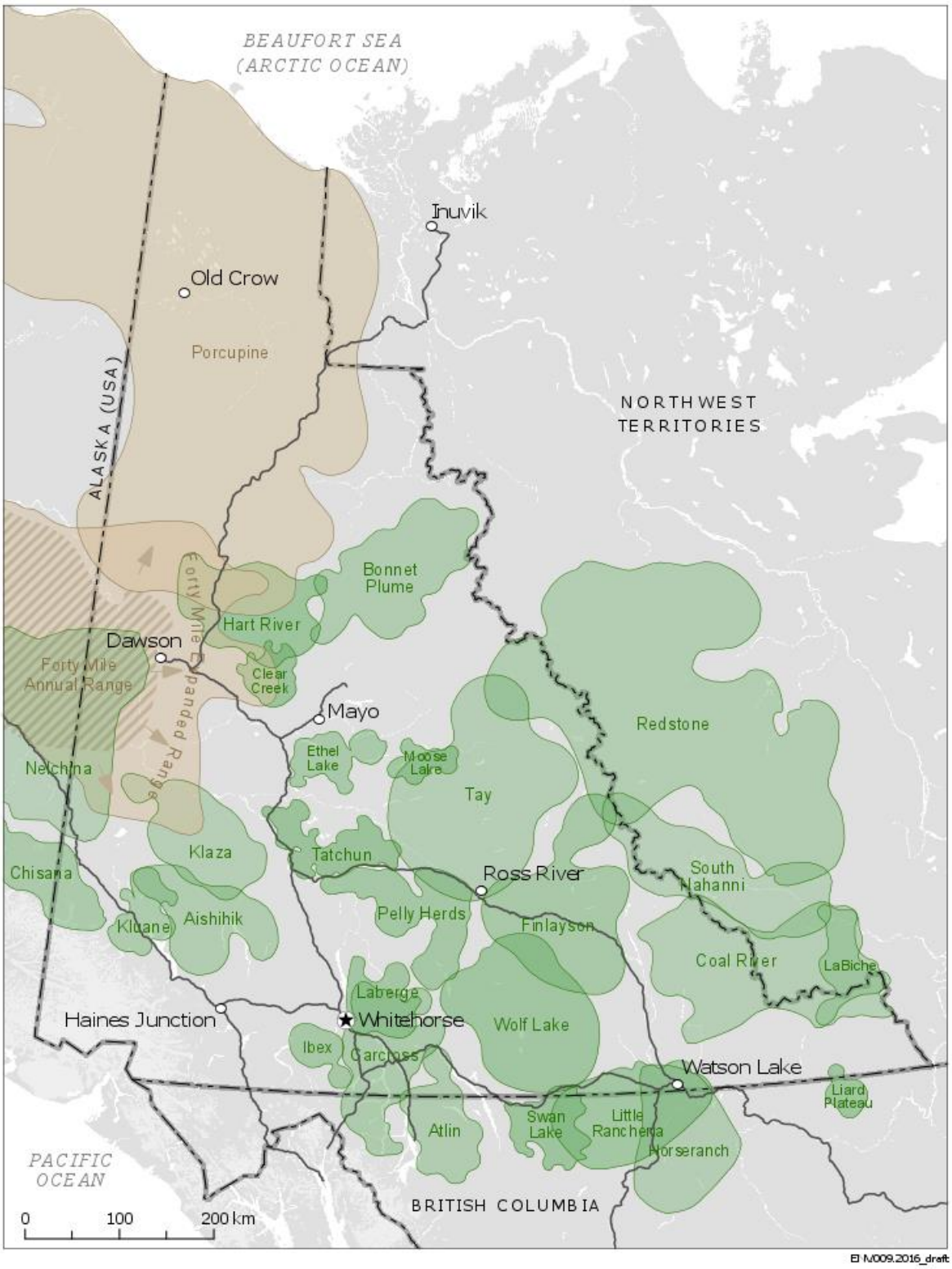

Figure 3. Distribution and herd status of *Rangifer tarandus* in Yukon. The Forty Mile, Nelchina, and Porcupine herds are Grant's caribou. All other herds are Northern Mountain caribou.

Table 1. Status of caribou herd populations in Yukon (as of 2015).

Herd	Population Estimate	Survey Technique*	Last Surveyed	Trend
Aishihik	2,050	Mark-Resight	2009	Stable
Atlin	800	Stratified Random Quadrat	2007	Stable
Bonnet Plume	5,000	Expert Opinion	1982	Unknown
Carcross	800	Stratified Random Quadrat	2008	Stable
Chisana	700	Mark-Resight	2013	Stable
Clear Creek	900	Stratified Random Quadrat	2001	Unknown
Coal River	450 – 700	Total Minimum Count	2008	Stable
Ethel Lake	300	Stratified Random Quadrat	1993	Stable
Finlayson	3,100	Stratified Random Quadrat	2007	Declining
Hart River	2,660	Mark-Resight	2015	Stable
Horseranch and Little Rancheria (currently considered two herds)	1750	Stratified Random Quadrat	1999	Declining
Ibex	850	Stratified Random Quadrat	2008	Increasing
Klaza	1180	Mark-Resight	2012	Stable
Kluane	180	Mark-Resight	2009	Stable
Laberge	100 – 300	Stratified Random Quadrat	2003	Unknown
Labiche	450 – 700	Total Minimum Count	1993	Unknown
Liard Plateau	150	Total Minimum Count	2011	Stable
Moose Lake	300	Stratified Random Quadrat	1991	Unknown
Pelly Herds	1000	Extrapolation	2002	Unknown
Redstone	10,000	Total Minimum Count	2012	Stable
South Nahanni	2,100	Mark-Resight	2009	Stable
Swan Lake	600 – 800	Stratified Random Quadrat	2007	Unknown
Tatchun	500	Total Minimum Count	2000	Stable
Tay River	3,750	Stratified Random Quadrat	1991	Unknown
Wolf Lake	1,500	Stratified Random Quadrat	1998	Unknown

In winter, caribou tend to be associated with climax forests that support a relatively high biomass of lichens. Winter habitat can be impacted by a wide range of disturbances, in part because lichens are slow growing, are relatively fragile to physical disturbances, and readily absorb airborne pollutants. In some parts of the Yukon, caribou winter habitat may be limiting; for example, Florkiewicz *et al.* (2007) reported that the Carcross herd is likely limited by the lack of effective winter habitat containing abundant lichen. In other seasons, caribou diet is more varied and also includes willow leaves, sedges, grasses, forbs, and fungi (e.g., Boertje 1984, Klein 1990).

2.3 Mineral licks

All Yukon ungulates use mineral licks, which are areas where dissolved elements or clays have been naturally deposited. Mineral licks, which are scattered throughout Yukon, provide animals with essential minerals such as sodium, magnesium and trace elements necessary for dietary and health reasons (Jones and Hanson 1985; Ayotte *et al.* 2006). Caribou generally prefer wet muck licks and mineral springs as opposed to dry earth licks favoured by some other species. Barren-ground caribou also use frozen lakes during late-winter to obtain minerals by licking the ice (Heard and Williams 1990) it is not known if Northern Mountain caribou exhibit the same behavior.

2.4 Habitat use and selection

Caribou often migrate to different seasonal ranges. Yukon Northern Mountain caribou winter in both lower elevation forested habitats and windswept alpine habitats (Kuzyk *et al.* 1999). Much of the remainder of the year is spent in higher elevation alpine and subalpine habitats.

Winter – As winter progresses, Northern Mountain caribou become particularly vulnerable to increasingly unfavourable snow conditions. While cold temperatures are not a problem for caribou, deep or hard-packed snow interferes with feeding (Johnson *et al.* 2001). Snow accumulation will trigger movement along traditional routes or migration corridors (Pullinger and Johnson 2010) to reach wintering habitats. During moderate winters, caribou may move to make use of subalpine shrub areas where snow conditions are less severe and where lichens, their primary food, are more readily available (Johnson *et al.* 2001).

Calving – For some cows in some herds, the location of calving sites appear to be traditional areas that are used repeatedly (Brown and Theberge 1985). Repeated use may be a strategy to avoid predators (Bergerud *et al.* 1984, Bergerud and Page 1987, Gustine *et al.* 2006). However, in many instances, specific calving sites are difficult to delineate because calving cows are solitary and widely dispersed.

Post-calving – There is increasing evidence that summer post-calving range may be key for at least some Northern Mountain caribou herds, as cows and their calves appear to congregate in areas of high quality forage necessary for the growth and development of newborn calves before winter (Pettorelli *et al.* 2005).

Cows and calves forced to use unfamiliar habitats may experience increased predation, insect harassment, or other factors that reduce calf survival (Klein 1980, Barten *et al.* 2001, Gustine *et al.* 2006). Avoiding predators through selection of calving habitat is important for calves in the first few months after birth as this is when they are most vulnerable to predation (Bergerud 1974, 1983; Adams *et al.* 1995).

Breeding – Males and females aggregate during the breeding season (rut) at high elevation sub-alpine habitats (Gustine and Parker 2008). These breeding areas are often used year after year (Environment Yukon, *unpublished data*) and disturbance to these habitats, or to caribou during this time, may disrupt breeding and thus negatively affect reproduction.

2.5 Climate change

Scientists predict increased average global temperatures and changes in precipitation regimes as a result of anthropogenic contributions of greenhouse gases to the atmosphere (Post *et al.* 2009). The most rapid and severe changes associated with this trend are expected for northern regions like Yukon and Alaska (ACIA 2005). Because of associated shifts in climate envelopes, scientists predict distributional shifts for many species and changes in habitat composition (Walther *et al.* 2002).

Such ecological changes have already been observed in the north, including the upward migration of the treeline observed in southwestern Yukon (Danby and Hik 2007) and the increase in shrub density in Alaska (Sturm *et al.* 2001, Tape *et al.* 2006). Changing climatic regimes may also lead to increased winter precipitation (i.e., snow; Environment Yukon 2009), more icing events, changes in the timing of spring green-up, the emergence of new diseases and parasites (Altizer *et al.* 2013) and increased forest fire frequency due to increasing temperatures (Gustine *et al.* 2014). These changes may alter behaviour, migration/movement patterns, and seasonal distribution across the landscape as caribou attempt to cope with changing forage distribution and availability.

Predicting the magnitude and direction of climate change impacts on caribou distribution and abundance in Yukon is difficult, but is still an important consideration when developing long term management and monitoring actions for caribou.

2.6 Population biology

2.6.1 Density

Northern Mountain caribou generally exist at low densities in Yukon, averaging 12 animals per 1,000 km^2 (Thomas and Gray 2002). While the role of density has not been formally assessed in Yukon's herds, it is assumed to be a weak factor affecting population dynamics. This is typical of most ungulates occurring in intact predator-prey systems (Wang *et al.* 2009).

2.6.2 Reproduction

The percentage of female Northern Mountain caribou three years or older that become pregnant in a given year (pregnancy rate) is typically high (93.5%, as determined from serum progesterone; Environment Yukon, *unpublished data*). This is also typical of Northern Mountain caribou in British Columbia (Seip and Cichowski 1996, Wittmer *et al.* 2005).

Information on age at first reproduction has not been assessed in Yukon Northern Mountain caribou; however, for mountain-dwelling caribou in Denali (Alaska), reproduction first began at 2 years of age for some females, with average birth rates of 27% (Adams and Dale 1998). The probability of reproduction by 2-year-olds was highly dependent on their body mass at 10 months of age (i.e., at the end of their first winter). Birth rates increased for 3 to 6 year olds and approached 100% for 7 to 13 year olds. Loss of reproductive capacity (senescence) appeared to begin once females reached 14 years of age (Adams and Dale 1998).

2.6.3 Calf survival and recruitment

On average, calf survival is generally low in mountain-dwelling caribou (Adams *et al.* 1995, Gustine *et al.* 2006), but typical of ungulates, it is one of the most variable demographic rates in a population (Gaillard *et al.* 2000). Most mortality occurs within the first month of life (the neonatal period; Adams *et al.* 1995). Predation is believed to account for much of this mortality. It is likely that climatic factors also influence predation rates on calves (Hegel *et al.* 2010b). For example, years with deep snow may limit the ability of cows to move up in elevation away from wolves.

In Yukon, fall recruitment ratios (the number of calves per 100 cows) have ranged from less than 10 to more than 50 calves per 100 cows. As most calf mortality occurs before winter (Adams *et al.* 1995), these ratios likely provide a reasonable indication of the number of calves entering ("recruited") into the herd as adults. However, they are an overestimate of "true" recruitment as yearling overwinter mortality will occur at higher rates than adult caribou, particularly during harsh winters.

Successful reproduction (and subsequent calf survival) in a given year can have important consequences for the dynamics of caribou populations. To ensure at least a stable population growth rate, a minimum fall recruitment ratio of 20 to 25 calves per 100 cows is necessary based on Yukon data:

- From 1997 to 2009 the Aishihik herd increased from approximately 1,150 animals to 2,044. During that time, 12 composition surveys were conducted, yielding an average recruitment ratio of 28 (SE = 2.4) calves per 100 cows.
- From 1999 to 2007, the Finlayson herd decreased from 4,130 to 3,077 animals. During that time, 8 composition surveys were completed, yielding an average recruitment ratio of 18 (SE = 2.1) calves per 100 cows.
- From 2003 to 2010, the Chisana herd was relatively stable, with herd size ranging from a low of 682 to a high of 766. During that time, the

average recruitment ratio was 21 (SE = 1.2) calves per 100 cows. Using 10 years of demographic data from this herd, Hegel (2015) modelled parameters for an average Yukon caribou herd. In the absence of hunting, recruitment ratios of 18 calves per 100 cows were sufficient for the herd to maintain a stable trend over a 10-year period.

If adult cow survival is reduced, the recruitment ratio needed for a stable population will need to increase (Section 3.3).

2.6.4 Adult mortality

Adult cow survival plays a key role in driving herd dynamics as fewer cows means fewer calves (Gaillard *et al.* 2000; DeCesare *et al.* 2012). Sources of mortality for adult caribou include harvest and natural sources of mortality including predation. In their assessment of the effects of wolf control, Hayes *et al.* (2003) detected no difference between adult female survival in their "treatment" and three neighbouring "control' herds, suggesting wolf predation did not have a significant effect on this vital rate in an area where wolves had alternate prey (Dall's sheep and moose). However, Hayes *et al.* (2003) did report an increase in recruitment for the Aishihik herd following wolf removal.

While adult female survival rates for Northern Mountain caribou are only available for a limited number of herds, Hayes *et al.* (2003) reported rates of 0.89 for both the Aishihik and Wolf Lake herds and 0.77 to 0.83 in the Chisana herd (during a period of possible decline). Measuring annual variability in adult female survival is challenging due to small sample sizes. Unless specific survival data are available for a herd, a conservative adult female annual survival rate of 0.85 to 0.90 is reasonable to assume for Yukon's Northern Mountain caribou herds (i.e., 10% to 15% die each year).

2.6.5 Adult sex ratio

Mysterud *et al.* (2002) reviewed the role of males in ungulate population dynamics and found that sex ratios need to be highly biased in favour of females to observe a decline in productivity (e.g., less than 10 bulls per 100 cows). Holand *et al.* (2003) experimentally adjusted both sex ratios and male age structures in captive reindeer and found that productivity was not affected even if males only made up 10% of the herd. White *et al.* (2001) reported a similar finding for mule deer and elk. However, other effects may occur, including loss of genetic diversity in the herd.

Based on research on other ungulates (reindeer, caribou, moose, elk, etc.; Holand *et al.* 2003, Mysterud *et al.* 2002), a sex ratio of 30 bulls per 100 cows should ensure reproduction is maximized and herd size sustained. The natural survival rate of males is typically lower than females in ungulates (Toïgo and Gaillard 2003), so even in unhunted populations, an equal number of bulls and cows is not be expected. In the unhunted Carcross and Ibex herds, adult sex ratios of roughly 50 bulls per 100 cows have been observed. In general, sex ratios in Yukon herds range from 25 to 50 bulls per 100 cows (Yukon Government, *unpublished data*).

2.6.6 Male age structure

Male age structure (the ratio of immature to mature males) may affect population growth by influencing calving dates (Holand *et al.* 2003), and subsequently calf survival (Adams *et al.* 1995). Holand *et al.* (2003) found that calving dates were later when there were more young males in the population. Later calving dates may leave less time during the summer for calves to gain mass necessary to survive the winter. Thus, male age structure, which can be estimated during monitoring surveys, may be a valuable indicator of population status.

2.6.7 Disease and parasites

Work to date suggests disease and parasites are not significant factors limiting caribou population growth rates: serological surveys indicate low levels of exposure to specific pathogens (Farnell *et al.* 1999; also see Appendix 2) and Kutz (2001) reported a low prevalence of gastrointestinal parasites in Yukon herds (Appendix 2).

There is concern about the potential transfer of diseases from deer to caribou, particularly as deer expand their range across Yukon. These diseases include Chronic Wasting Disease (CWD) and meningeal brainworm, which is shed by white-tailed deer and is fatal to caribou (Trainer 1973). Recent experimental work determined that CWD was fatal for experimentally infected reindeer (Mitchell *et al.* 2012). CWD is known to occur in Alberta and Saskatchewan but is not currently present in wildlife in Yukon. Surveillance for CWD is carried out by the Yukon government's Animal Health Unit and focuses on Yukon's cervids, including elk, deer, moose, bison, and caribou.

Transmission of diseases from domestic animals (e.g., livestock) is also a concern and efforts must continue to reduce or eliminate interaction and the potential for interaction between domestic animals and wild caribou.

3 Management guidelines

3.1 Population monitoring

Herd size is a population parameter used by managers to decide on appropriate management actions. However, population surveys are costly and there are not enough resources to regularly estimate the size of all Yukon's Northern Mountain caribou herds. Select herds are monitored annually during the fall rut when males and females are grouped on high elevation plateaus and can be counted and classified as cows, bulls, calves, and yearlings. Herd composition is based on these surveys, and produces estimates of the sex ratio (number of bulls per 100 cows) and recruitment ratio (number of calves per 100 cows). These surveys are not intended to provide an estimate of the herd's size. Recruitment ratios provide an estimate of the number of calves entering the herd as adults. As licenced harvest of Northern Mountain caribou is sex-biased (i.e., bulls only), tracking the number of bulls in a herd is one measure that is used to assess the effect(s) of harvest on the herd.

Roughly speaking, herds selected for annual monitoring are evenly distributed across Yukon and have been regularly assessed for many years. Long-term data sets allow biologists to track and understand patterns related to annual environmental variability (e.g., climate) over time. Herds having unique management concerns (e.g., that were the focus of past recovery efforts: Kluane, Carcross, Chisana, and Ibex) and/or smaller herds (e.g., Kluane and Ethel Lake) are also monitored regularly. Small caribou herds are generally at greater risk of decline or local extirpation—i.e., when they no longer exist in the wild (Wittmer *et al.* 2010). Additional herds may be monitored during larger-scale inventory projects or to address specific management concerns.

Recruitment is annually variable, so characterizing herd trend based on a single recruitment estimate is not a sound management practice. Herd trend is normally based on at least 5 and preferably 10 years of regular calf recruitment monitoring as it takes several years of information to establish if a herd is increasing, decreasing or stable. Information from Yukon caribou herds indicate that after 10 years, the full variability in observed annual recruitment rates has typically occurred (*unpublished data*).

3.2 Population management

Management of human activities are the most practical, cost-effective and socially acceptable tools for Northern Mountain caribou management. For example, hunting regulations are intended to allow for sustainable harvesting opportunities while ensuring the long-term welfare of caribou populations.

As described in the *Yukon Wolf Conservation and Management Plan* (Government of Yukon 2012) wolf harvest may be used as a community-based management tool to reduce local predation on caribou, but it is subject to a number of criteria, including verifiable harvest reporting for caribou and wolves, a harvest management plan for all users, and an agreed upon, collaborative approach to program design, implementation and evaluation.

Large-scale predator control is one other management tool that has been used in the past in Yukon. As per the *Yukon Wolf Conservation and Management Plan* (Government of Yukon 2012), there is strong public opposition from Yukoners to using this approach as an ungulate management tool; moreover, this type of program is costly, has only short term impacts unless it is intensive and maintained indefinitely, and lacks community involvement. Any predator control program specific to wolves must respect the *Yukon Wolf Conservation & Management Plan* (and any periodic revisions to that plan) (Government of Yukon 2012).

3.3 Harvest

3.3.1 Harvest allocation

Opportunities for caribou harvest are shared by all users. More intensive management actions are considered for herds where necessary (e.g., where the total harvest by all users exceeds sustainable levels, where the management goal is to recover a herd that has declined, etc.). In Yukon, the principle of

sharing the allowable caribou harvest among all Yukoners is recognized in government policy and the *Umbrella Final Agreement* (1993). Specific sharing or allocation formulas, if they exist, are identified in individual Yukon First Nation final land claim agreements. The licenced harvest allocation is shared between residents and non-residents.

3.3.2 Harvest monitoring and reporting

Reliable information on the annual caribou harvest by all hunters is a cornerstone of effective population management. Environment Yukon has kept records of the annual caribou harvest reported by licenced hunters in each Game Management Subzone since 1979. Harvest is assigned to specific caribou herds based on the location of the kill. This information is essential and helps ensure the annual caribou harvest does not exceed sustainable limits. All successful licenced caribou hunters must report their harvest to an Environment Yukon office no later than 15 days after the end of the month in which the caribou was killed. Some First Nation governments collect voluntary information or field observations and share the harvest information with Environment Yukon. Where First Nation harvest is not available, it is typically estimated. Yukon First Nation final agreements assume all users will report their harvest; this information is needed to manage wildlife effectively.

3.3.3 Harvest management considerations

Harvest is often a significant source of adult mortality in hunted ungulate populations. A key consideration in managing the harvest of Northern Mountain caribou is to ensure it is sustainable and does not lead to population declines. Other risk factors must also be considered when assessing harvest sustainability. These include additional mortality sources (e.g., vehicle collisions); current herd status and trend; herd accessibility (e.g., proximity to access); harvest restrictions on adjacent herds; and levels of human disturbance in a herd's range, including habitat fragmentation and alteration that may affect survival and reproductive performance (and hence growth potential). For example, it may be necessary to temporarily suspend or limit harvest for vulnerable herds whose range is accessible or where key habitat is significantly impacted. Small herds or herds in serious decline should be protected from all harvest. Limitations on harvest may also need to be considered if there is a consistent (i.e., 5 to 10 year) decline in bull to cow ratios where monitored.

3.3.4 Harvest rate recommendations

Knowledge of what constitutes a sustainable harvest rate is critical. Computer simulation models can be used to evaluate different harvest management strategies and help guide harvest rate recommendations. For caribou, harvest models were used to *estimate* future herd abundance, assuming conditions similar to the recent past, and to *predict* herd abundance after altering harvest rates, sex of the harvest, initial herd status, etc.

To assess the effect of harvest on population trend, data from one Northern Mountain caribou population were used to create a "generalized" caribou population that was initially stable (Hegel 2015). The effect of different harvest scenarios on this general population were assessed as the percent change in the population over a 10-year period. Ten years was considered appropriate as it encompasses a full cycle of the Pacific Decadal Oscillation, which is known to influence ecological dynamics in Yukon (Hegel *et al.* 2010a; Loehr *et al.* 2010), it is slightly longer than the generation time for caribou (~9 years), and is an appropriate length of time from a management decision-making perspective. Recommendations are consistent across the range of sex ratios typically observed in Yukon (25 to 50 bulls per 100 cows). Any harvest that resulted in a 10% or less decline in population size over a 10 year period was considered sustainable (i.e., an acceptable level of risk).

The harvest rate recommendations outlined here are generally applicable to all of Yukon's Northern Mountain caribou herds; however, population-specific harvest rate recommendations should be developed where detailed population-specific information is available and where a specific management need exists.

Effects of a bull vs cow harvest on a stable herd

Modelled cow harvest resulted in a 10-year population decline three times greater than bull harvest of an equivalent rate. For example, a cow harvest of 2% resulted in an approximately 30% decline over 10 years whereas a bull harvest of 2% over the same time period resulted in only a 10% decline. In other words, the population impact of harvesting 1 cow is equivalent to the population impact of harvesting 3 bulls. Even a minimal cow harvest of 0.5% resulted in roughly a 3% herd decline over 10 years. This means that even if the herd is increasing, there is a high risk of decline if cows are harvested.

Understanding the impacts of a bull vs cow harvest on population trends is useful for adjusting overall harvestable numbers when losses of cows are considered. While recruitment of calves is certainly important in influencing herd growth rate and size, adult cow survival plays a key role in driving herd dynamics as fewer cows means fewer calves (Gaillard *et al.* 2000). As adult survival decreases, higher rates of recruitment are needed to achieve population stability (DeCesare *et al.* 2012; Figure 4).

Sustainable harvest of a stable herd

Based on model results and given variability in calf recruitment, a bull only harvest rate of up to 2% of the total population size is likely sustainable for stable herds. Herd size, which is necessary to estimate a harvest rate, is based upon the best available information which may include empirical population estimates, minimum counts (i.e., from fall composition surveys), or local knowledge (Section 2.1).

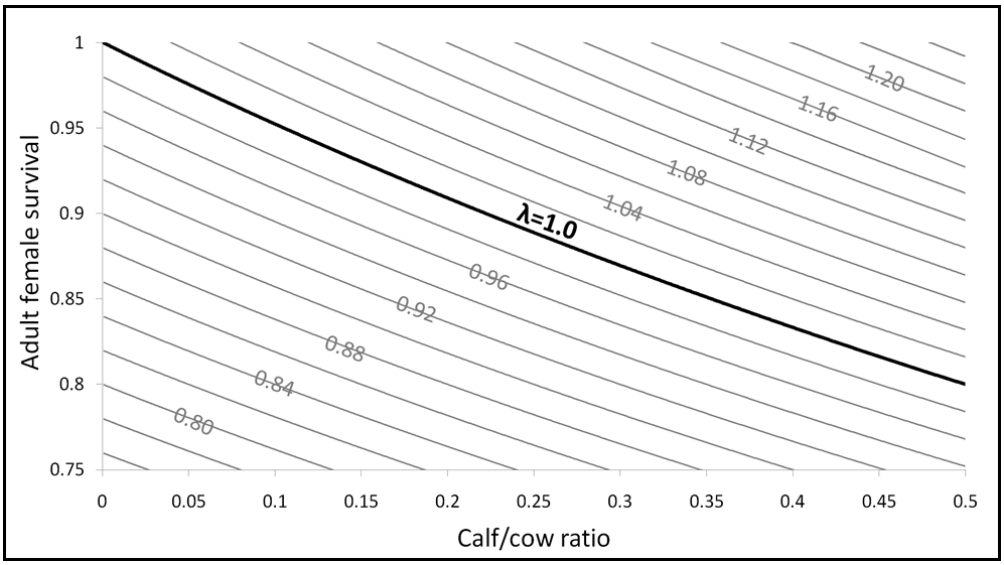

Figure 4. Contour plot depicting the range of possible population growth rates (λ) for a woodland caribou population according to the paired values of adult female survival and late winter calf/cow ratios (figure adapted from DeCesare et al. 2012 and provided by NJ DeCesare). λ = 1.0 indicates a stable population.

Sustainable harvest of an increasing herd

The influence of harvest on population trend may differ depending on if the harvested population is increasing and the rate at which the population is increasing. To ensure a population is not overharvested, a maximum bull-only harvest rate of 3 to 4% of the total population size is recommended for increasing herds as it is likely sustainable and minimizes the risk of harvest leading to a population decline if calf recruitment declines. A higher harvest rate may be sustainable if the population is rapidly increasing but this should be evaluated on a case by case basis.

Sustainable harvest of a declining herd

Identifying a sustainable harvest rate for a declining population is challenging. The rate of decline and an understanding of the factors that contributed to the decline will influence harvest rate recommendations. Certainly for a declining population, all adult cow mortality, including harvest based mortality, should be minimized. Because annual recruitment fluctuates from year to year, a declining population may be able to withstand a modest bull harvest of up to 1% of the total population size. However, management recommendations regarding harvest rate should be made carefully using all relevant and available population-specific information.

Sustainable harvest of a herd with unknown status

A bull-only harvest of up to 1% of the estimated total population size is recommended for those herds where information on sex ratio or population size is limited or outdated and herd status is unknown. This harvest rate should mitigate the potential for an unsustainable harvest and population declines. Actual harvest and annual recruitment should be monitored regularly to determine whether additional management actions are required.

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APPENDIX 1

Species description

Common Name: Northern Mountain caribou
Scientific Name: *Rangifer tarandus caribou* Gmelin
Local Names: Woodland caribou, Northern Mountain caribou
COSEWIC Designatable Unit: Number 7 (COSEWIC 2011)
SARA Listing: Schedule 1, Special Concern

Caribou (*Rangifer tarandus*) occur across the entire circumpolar region. Five subspecies exist in North America. These subspecies include Woodland caribou (*R. t. caribou*), two subspecies of Barren-ground caribou: Grant's caribou (*R. t. granti*) and Barren-ground caribou (*R. t. groenlandicus*), Peary caribou (*R. t. pearyi*), which inhabit the High Arctic, and reindeer (*R. t. tarandus*), which were introduced from Russia into North America (Bergerud *et al.* 2008).

Two of these subspecies are native to Yukon: Woodland caribou (*Rangifer tarandus caribou)* and Grant's caribou (*Ranger tarandus granti).* Biologists recognize a further division of Woodland caribou into five geographically distinct ecotypes (having different ecological relationships with the environments they occur in). Of these five, the Northern Mountain and Boreal ecotypes occur within Yukon. Two populations of Grant's caribou are also found in Yukon—the Porcupine and Fortymile herds. Woodland caribou are a more sedentary subspecies of caribou (relative to Barren-ground) that inhabit forest ecosystems across Canada.

These guidelines address only Northern Mountain caribou, due to the different ecology and management issues between Northern Mountain, Boreal, and Grant's caribou. However, information from other ecotypes was used to develop the guidelines as certain impacts are consistent across all subspecies.

APPENDIX 2

Disease, parasites, and viruses in Northern Mountain caribou

Table S1. Seroprevalence of antibodies to potential bacterial and viral pathogens in Yukon Northern Mountain caribou (1988 to 1997)

Disease	Prevalence (%)	Sample Size
Brucellosis	0	408
Infectious Bovine Rhinotracheitis	0.9	440
Bovine Viral Diarrhea	0	435
Parainfluenza 3	0	434
Respiratory Syncytial Virus	0	402
Bluetongue	0	272
Epizootic Hemorrhagic Disease	1.2	416
Leptospirosis	0.8	253

Table S2. Serological testing for Yukon mountain caribou herds (1998 to 2014)

Disease agent	Apparent prevalence % (no. pos/no. tested)	Herd(s) tested	Year(s) (note that not all herds are tested in all years listed)
Mycobacterium avium subsp. *paratuberculosis* (MAP)	3.7% (1/27)	Hart River, Klaza	2011, 2012
Bovine herpesvirus 1 (IBR)	29.4% (30/102)	Carcross, Chisana, Hart River, Klaza, Kluane, Laberge, Nahanni	1998, 2002, 2008, 2011-2014
Bovine parainfluenza virus 3 (PI3)	4.9 % (5/102)	Carcross, Chisana, Hart River, Klaza, Kluane, Laberge, Nahanni	1998, 2002, 2004, 2008, 2011-2014
Erysipelothrix rhusiopathiae	4.5% (3/66)	Carcross, Hart River, Klaza, Laberge, Nahanni	1998, 1999, 2002, 2004, 2008, 2013, 2014
Leptospira spp.	0% (0/8)	Klaza	2012
Bovine respiratory syncytial virus (BRSV)	0% (0/102)	Carcross, Chisana, Hart River, Klaza, Kluane, Laberge, Nahanni	1998, 2002, 2008, 2011-2014
Bovine viral diarrhea virus 1 (BVD-1)	0% (0/102)	Carcross, Chisana, Hart River, Klaza, Kluane, Laberge, Nahanni	1998, 2002, 2008, 2011-2014
Bovine coronavirus (BCV)	0% (0/66)	Carcross, Chisana, Hart River, Klaza, Kluane, Laberge, Nahanni	1998, 2002, 2008, 2011, 2013, 2014