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Status of northern mountain caribou (*Rangifer tarandus caribou)* in Yukon, Canada

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Abstract: Caribou (*Rangifer tarandus)* are an important ecological, cultural and economic resource in Yukon, Canada. Three caribou ecotypes occur within Yukon: Grant's *(R. t. granti)*, northern mountain *(R. t. caribou)*, and boreal *(R. t. caribou).* Northern mountain caribou are classified as a species of special concern under Canada's *Species at Risk Act,* and a national management plan for northern mountain caribou was recently completed. Twenty-six northern mountain caribou herds occur at least partially within Yukon, representing approximately 30,000 – 35,000 animals. Active monitoring of Yukon's northern mountain caribou began in earnest in the early 1980s. To date, over 200 fall composition surveys have been carried out, over 1000 animals have been fitted with radio-collars, and nearly 40 formal population estimates have been completed. Disease and contaminant monitoring of these caribou has indicated relatively low disease prevalence and contaminant loading. Northern mountain caribou are harvested in Yukon, with an average of 230 caribou harvested per year by licensed hunters (1995 – 2012) and an unknown number by First Nation hunters. Future challenges related to caribou management and conservation in Yukon include increasing levels of industrial development primarily through mineral exploration and development, ensuring harvest of these herds is conducted sustainably given the absence of total harvest information, inter-jurisdictional management of shared herds, existing uncertainty surrounding herd distribution and delineation, and dealing with vehicle-related mortality of caribou for certain herds. Overall, the population status (*i.e.*, trend) of eight herds is known, with two increasing, two decreasing, and four stable.

Key words: management; monitoring; northern mountain caribou; *Rangifer tarandus caribou;* status; Yukon.

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Background

Caribou (*Rangifer tarandus)* are an iconic species across Canada (Hummel & Ray, 2008). They are an important cultural, ecological, and economic resource in Yukon, Canada, and have been used by First Nations for thousands of years (Hare *et al.,* 2004). Two caribou subspecies occur in Yukon: Grant's *(R. t. granti)* and woodland *(R. t. caribou).* Within the woodland subspecies, two ecotypes are present: northern mountain and boreal. Twenty-six northern mountain caribou herds occur at least partially in Yukon in the southern 2/3 of the territory, roughly south of 66°N. (Fig. 1). Boreal caribou occur in a small, remote area of northeast Yukon (Fig. 1; Environment Canada, 2008; Nagy, 2011); while the large migratory Grant's caribou herds (Porcupine and Fortymile) occur in the northern and west-central portions of the territory.

Northern mountain caribou differ from both the more sedentary boreal ecotype and

the large migratory barren-ground (*i.e.*, Grant's caribou) herds. Northern mountain caribou generally migrate elevationally between winter and summer ranges, but may also migrate longer distances between these ranges (*e.g.*, Weaver, 2006). Herds may winter on windswept alpine slopes or in lower elevation forested areas (Kuzyk *et al.,* 1999; Florkiewicz *et al.,* 2007) where they forage on terrestrial lichens. At calving, the peak of which occurs roughly around 20 May (*e.g.*, Chisana Caribou Recovery Team, 2010), parturient females disperse to higher elevations (Barten *et al.,* 2001) away from conspecifics and other prey species such as moose *(Alces alces;* Bergerud *et al.,* 1984). This is in sharp contrast to the more well-defined calving grounds associated with barren-ground herds. Following calving, animals aggregate into small groups in alpine areas, often occurring on snow patches for thermoregulation and insect avoidance (Ion & Kershaw, 1989). The summer, or post-calving, season lasts until roughly late-September at which time males and females begin to aggregate on alpine plateaus during breeding (*i.e.*, the rut) which lasts until approximately the middle of October at which time breeding groups break up and animals prepare to move to their winter ranges.

Caribou management is becoming increasingly challenging (Festa-Bianchet *et al.,* 2011) due to, among other factors, increasing land-use pressures, an increasing human population in Yukon (primarily in Whitehorse), and the uncertainty of the effects of climatic change (*e.g.*, changing forest fire regime, effects on predator and alternative prey species, and changes in parasite prevalence). In Canada, northern mountain caribou are federally designated as a species of special concern (COSEWIC, 2002) under the federal *Species at Risk Act.* A status reassessment of this ecotype is planned to begin in 2012 (J.C. Ray, COSEWIC, pers. comm.). As mandated following their listing as a species of special concern, a national management plan for northern mountain caribou was recently completed (Environment Canada, 2012).

The purpose of this report is to update the status of northern mountain caribou in Yukon including the best available information on herd sizes and trends, levels of monitoring, and conservation and management issues related to these herds. The last status assessment of Yukon mountain caribou is over 10 years old (Farnell *et al.,* 1998) and an update is warranted.

Population monitoring

A number of tools are used to monitor Yukon's northern mountain caribou herds, with monitoring efforts beginning in earnest in the early 1980s (Farnell *et al.,* 1998). The herd (*i.e.*, population) is the basic management unit for northern mountain caribou and radio-collar programs have been used extensively to track the distribution of individuals and subsequently map herd range boundaries (Fig. 1). Typically adult females have been collared and to date over 1000 animals have been fitted with radio-collars (Table 1). There were two peaks in collaring activity (Fig. 2); one in the mid-1990s associated with the Aishihik caribou recovery program (Hayes *et al.,* 2003) and the second in the mid-2000s associated with the Chisana caribou captive-rearing program (Chisana Caribou Recovery Team, 2010). Most of these collars were very high frequency (VHF) collars, but more recently both global positioning system (GPS; Klaza, Carcross, and Laberge herds) and satellite (Argos) collars (South Nahanni, Coal River, and La Biche herds) have been deployed. These collaring efforts have resulted in over 16,000 VHF relocations, and thousands more GPS and Argos relocations.

While many animals have been fitted with radio-collars and tracked, there remains uncertainty regarding herd "definition" in some areas. For example, data from four GPS-collared caribou in the Laberge herd in 2011, and the existing GPS radiocollar dataset for the Car-

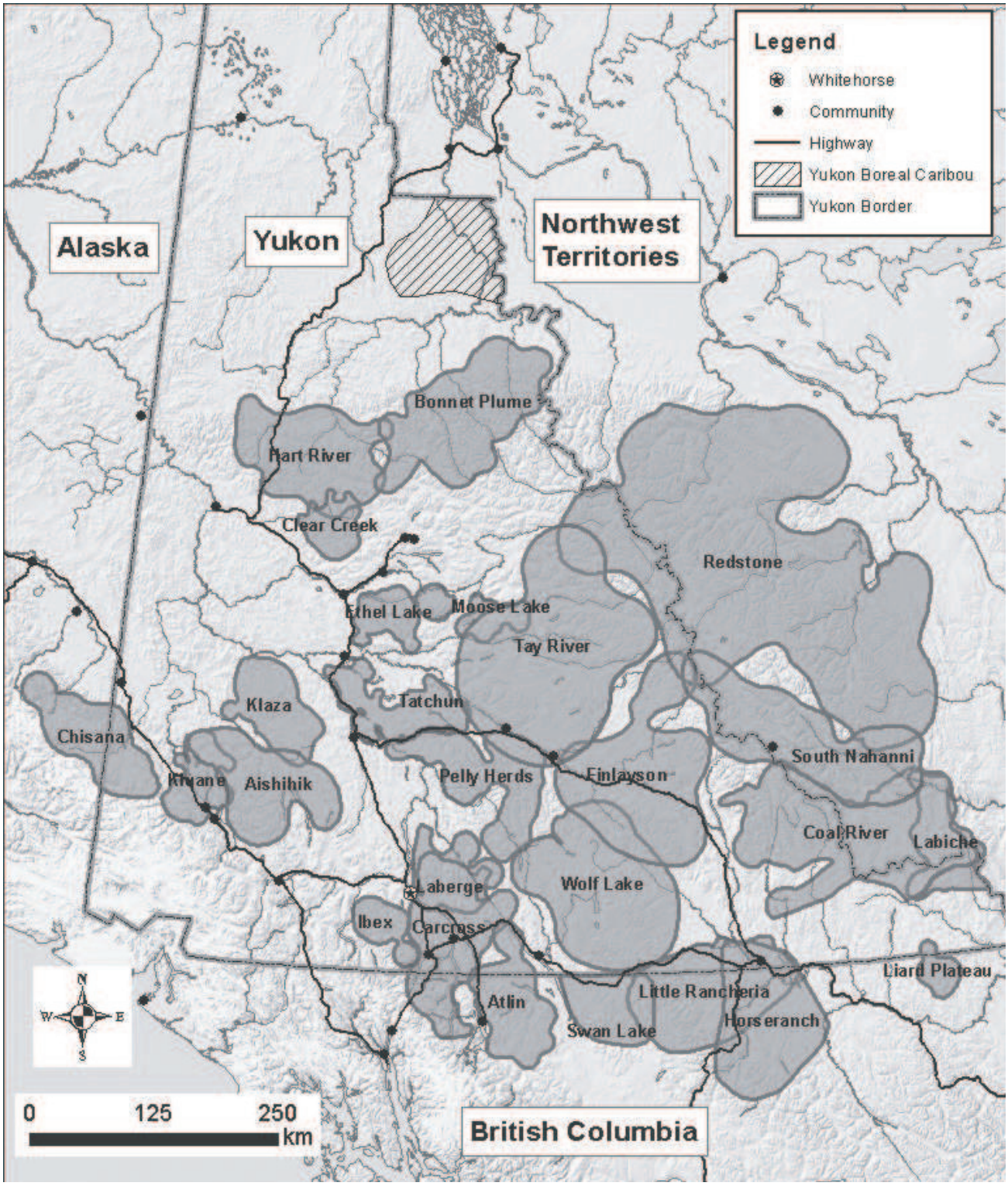

Fig. 1. Distribution of woodland caribou in Yukon, Canada. Northern mountain herds are individually labelled. The hatched area in the northeast Yukon represents the general range of boreal caribou in Yukon.

cross herd, will be used to assess whether these two herds are distinct. Distinguishing the Klaza and Aishihik herds is one objective of a recently initiated inventory study. GPS radio-collar relocations from animals collared in the Swan Lake area indicate their occurrence in Yukon just north of the Yukon-BC border (M. Williams, BC Ministry of Forests, Lands and

Table 1. Monitoring summary of northern mountain caribou herds occurring in the Yukon, Canada.

Herd	Size (Assessment Year)	Survey Method[b]	Current Known Trend	Number of Formal Population Estimates	Number of Collared Animals[c]	Number of Fall Composition Surveys[c]
Aishihik	2050 (2009)	MR	Increasing	2	91	21
Atlin[a]	800 (2007)	SPQ	Stable	2	11	1
Bonnet Plume	5000 (1982)	EO	Unknown	0	25	0
Carcross	800 (2008)	SRQ	Stable	3	72	18
Chisana	680 (2010)	MR	Stable	4	332	23
Clear Creek	900 (2001)	SRQ	Unknown	1	22	7
Coal River	450 (1997)	EO	Unknown	0	17	24
Ethel Lake	300 (1993)	SRQ	Unknown	1	12	17
Finlayson	3100 (2007)	SRQ	Decreasing	5	55	29
Hart River	2200 (2006)	MR	Unknown	1	79	2
Horseranch[a]	600 (1999)	SRQ	Unknown	1	-	-
Ibex	850 (2008)	SRQ	Increasing	3	23	25
Klaza	1180 (2012)	MR	Unknown	2	75	12
Kluane	180 (2009)	MR	Descreasing	2	36	21
La Biche	450 (1997)	EO	Unknown	0	4	1
Laberge	200 (2003)	SRQ	Unknown	0	29	4
Liard Plateau[a]	150 (2011)	MC	Unknown	0	3	1
Little Rancheria	1000 (1999)	EO	Unknown	2	11	6
Moose Lake	300 (1991)	SRQ	Unknown	1	4	1
Pelly Herds	1000 (2002)	EO	Unknown	0	29	4
Redstone[a]	10000 (2012)	EO	Unknown	0	-	-
South Nahanni	2100 (2009)	MR	Stable	2	86	8
Swan Lake[a]	400 (2005)	MC	Unknown	0	1	-
Tatchun	500 (2000)	MC	Unknown	0	24	17
Tay River	3750 (1996)	SRQ	Unknown	1	26	1
Wolf Lake	1400 (1998)	SRQ	Unknown	3	73	9

[a] Herds not typically monitored by Environment Yukon.
[b] MR – mark-resight, SRQ – stratified random quadrat, MC – minimum count, EO – expert opinion.
[c] Collaring/surveys by, or in collaboration with, Environment Yukon.

Natural Resources Operations, unpubl. data), and ambiguity exists around the discreteness of three herds in this border region: Little Rancheria, Horseranch, and Swan Lake. Whether or not there are two or three distinct herds in the Pelly "herds" remains a question for managers. Finally, spatial data from radio-collared caribou and genetic information (Zittlau, 2004) in the southeast portion of Yukon and into the Northwest Territories (NWT; Finlayson, South Nahanni, Coal River, La Biche, and Redstone) has led to questions surrounding herd designations there. Future analysis of these data will be conducted to address this question (*e.g.*, Roffler *et al.,* 2012).

A second tool used to monitor these herds has

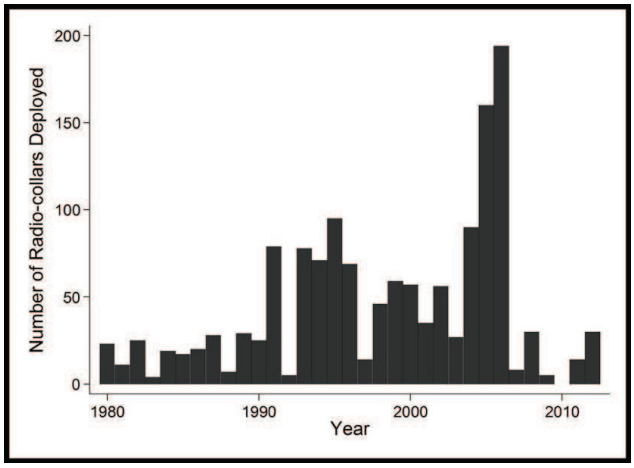

Fig. 2. Number of radio-collars deployed on Yukon northern mountain caribou from 1980 – 2012.

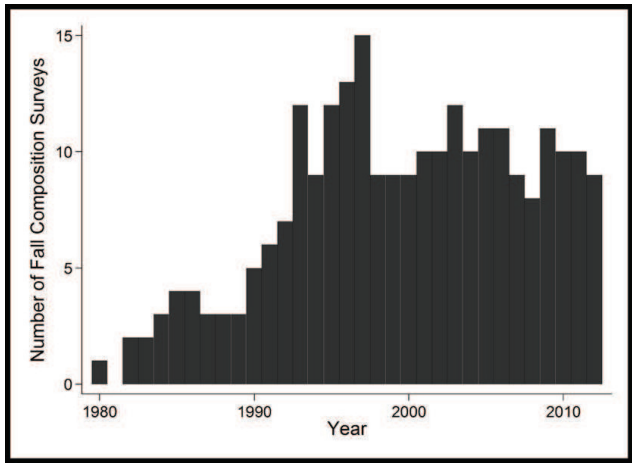

Fig. 3. Number of fall composition surveys conducted on Yukon northern mountain caribou from 1980 – 2012.

been fall composition surveys (*i.e.*, rut counts). These surveys are intended to sample a portion of the herd during breeding when males and females are aggregated on high alpine plateaus. They are not intended to estimate herd abundance. During these surveys, habitats deemed to have a high probability of breeding caribou are flown via helicopter. Once observed, animal groups are counted and subsequently classified into five categories: calves, adult females (*i.e.*, non-calf), immature bulls, mature bulls, and unclassified. The ratio of calves to cows is used as an index of recruitment into the herd, and the ratio of total bulls to cows used as an estimate of its adult sex ratio. From 1980 – 2012, 252 separate fall composition surveys have been conducted on Yukon's northern mountain caribou herds (Table 1; Fig. 3). Adult sex ratios of Yukon herds roughly average 45 bulls per 100 cows (Environment Yukon, unpubl. data) and generally there is little concern that there are too few bulls to limit breeding potential of oestrous cows.

Recruitment rates are much more variable (Hegel *et al.,* 2010) and have ranged from < 10 to > 50 calves per 100 cows. This is typical of the high variability observed in juvenile survival of most ungulates (Gaillard *et al.,* 2000). Due to this variability, generating inferences regarding a herd's dynamics from only one recruitment rate is problematic and multiple years of data should be considered. While some overwinter mortality of caribou calves inevitably occurs, research from mountain caribou in other areas with similar systems has documented that the majority of mortality occurs within the first few weeks of life (Adams *et al.,* 1995; Gustine *et al.,* 2006). Fall and subsequent late-winter (*i.e.*, March/April) recruitment rates are available for the Aishihik herd from five years. Four of these years indicated a decrease in recruitment from fall to late-winter. One year indicated a slight increase which is likely an artefact of sampling error and thus we assumed no decrease in recruitment in that year. The average absolute decrease in recruitment for these five pairs of fall and subsequent late-winter surveys was 4.3 calves per 100 cows (range: 0 – 8.7; Environment Yukon, unpubl. data).

A third key monitoring tool is the estimation of herd abundance. Due to the increased cost associated with estimating abundance compared to composition, abundance estimates have been carried out much less frequently.

Table 2. Disease prevlence (1988-1997) in Yukon northern mountain caribou (from Farnell et al., 1999).

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

Abundance of herds that were the focus of specific management actions have been estimated as well as those herds with specific conservation concerns (*e.g.*, small size, increasing industrial development). The first abundance estimates in Yukon were minimum counts, but given the issues with this approach (*e.g.*, Caughley & Goddard, 1972) and their lack of sightability estimates, a stratified random quadrat approach (Farnell & Gauthier, 1988) was used during most of the 1980s and 1990s. More recently, mark-resight approaches, using either temporary dyes or radio-collars as marks, have been used to estimate herd abundance (Hegel *et al.,* 2012). In cases where only limited information is available, minimum counts from a composition survey, for example, or expert opinion have been cautiously used to provide a crude indication of the herd's size (Table 1), while acknowledging the limitations of these approaches. However, in determining the trend for a given herd (Table 1), only formal population estimates are used (*i.e.*, those accounting for sightability and having an associated measure of precision). We also avoid making assessments of current trends for herds with abundance estimates that are deemed too old (*i.e.*, > 10 years). Thirty-seven formal population estimates have been conducted on 18 separate herds (Table 1).

Animal health

From the 1980s to the present, diseases, parasites, and contaminants have been assessed in Yukon's northern mountain caribou herds. Animal health issues are important both for the potential impact on population dynamics (*e.g.*, Albon *et al.,* 2002) and because caribou are an important food resource for Yukoners. Serological surveys of 11 herds conducted from 1988 to 1997 indicated a low prevalence of infectious diseases (Farnell *et al.,* 1999; Table 2). Kutz (2002) reported relatively low parasitic prevalence and intensity in a preliminary survey of three herds (Finlayson, Little Rancheria, and South Nahanni). Hoar et al. (2009) reported near 100% prevalence of Trichostrongylidae species in the Chisana herd, but with low levels of intensity.

Contaminants have been monitored by the Northern Contaminants Program (NCP; *e.g.*, Braune *et al.,* 1999). Generally, contaminant levels in Yukon northern mountain caribou are low and within safe levels for human consumption. Cadmium levels in the Tay River and Finlayson herds are elevated relative to other herds; however this is likely a result of greater background cadmium levels occurring naturally in the herd's range (Braune *et al.,* 1999; Gamberg *et al.,* 2005). Due to these low levels, the NCP has ceased their broad-scale survey of contaminants in northern mountain caribou in Yukon. The NCP will assess contaminant levels in northern mountain herds when specifically requested to do so by a community.

Overall, Yukon's northern mountain caribou are considered healthy; however, continued monitoring is warranted in light of potential changes in future environmental conditions. For example, with a warming temperature trend, host-parasite dynamics in northern latitudes may change, with warmer temperatures potentially resulting in increased prevalence and/or intensity of parasitic infections (Kutz *et al.,* 2005).

Harvest

In Yukon, licensed hunting of northern mountain caribou is limited to bulls, with the season occurring from 1 August to 31 October. All licensed hunters in Yukon are required to report their kill to an Environment Yukon office; a requirement which began in 1994. Licensed harvest of caribou is managed by the Yukon government under regulations outlined in the Yukon Wildlife Act and described in the Yukon hunting regulations summary (*e.g.*, Environment Yukon, 2012). For regulatory purposes hunters are classified into two categories: licensed and First Nation (*i.e.*, aboriginal). Licensed hunters may be either residents or non-residents of Yukon. All non-residents must be guided when hunting in Yukon. Non-Canadian non-residents (*i.e.*, alien) must be guided by a registered Yukon outfitter. Non-residents who are Canadian citizens must be guided by either a registered Yukon outfitter or by a Yukon resident under a special guiding license.

Subsistence harvest rights of members of individual First Nations are constitutionally entrenched and are not subject to Yukon hunting regulations when hunting within their individual traditional territory or in areas of overlap between the traditional territories of > 2 First Nations. First Nation members hunting within the traditional territory of another First Nation with a signed land claim agreement are subject to Yukon harvest regulations and are thus considered licensed hunters in this case. As First Nation harvest is not regulated by the Yukon government, formal statistics (*e.g.*, harvest rates, sex ratio of harvested animals) describing subsistence harvest of mountain caribou are not available for all herds.

Licensed harvest of most northern mountain caribou herds in Yukon is open in the sense that it is not under a limited-entry or lottery system; however, for a few herds harvest is either closed or managed under a permit hunt authorization (PHA). A PHA is a lottery-based system in which a pre-determined number of permits are awarded to drawn licensed hunters. PHAs are authorized under the *Wildlife Act* and are initiated where a conservation or management concern has been identified. PHAs require a regulation change under the *Wildlife Act* and thus go through a formal public review process with the Yukon Fish and Wildlife Management Board. Currently (*i.e.*, as of 2012) the Finlayson, Klaza, and Aishihik herds are harvested under a PHA. Due to its small size (Table 1), the Kluane herd is closed to all licensed hunting, and a voluntary harvest closure, for all hunters, is requested for the Ethel Lake herd by the Yukon government and the First Nations in this area. As part of their recovery program, the Southern Lakes herds (Atlin, Carcross, Laberge, and Ibex; Farnell *et al.,* 1998) are closed to all licensed harvest and the First Nations in these areas have also implemented a voluntary harvest closure. The Chisana herd will be harvested under a PHA beginning in 2013.

From 1995 to 2012 (n = 18), annual licensed harvest (*i.e.*, non-First Nation) of northern mountain caribou in Yukon averaged 230.4 animals/year (SE = 7.6, range: 196 – 306). The average annual resident and non-resident harvest during this time was 108.2 (SE = 4.6, range: 83 – 151) and 122.3 animals/year (SE = 3.7, range: 100 – 155), respectively. There was a negative trend in the number of northern mountain caribou harvested by licensed hunters from 1995 – 2012 (Fig. 4), with the decline being greater in resident hunters over non-residents. This may be due to the increasing urban population of Yukon, but it also generally follows hunter participation trends in other jurisdictions (*e.g.*, Boxall *et al.,* 2001). One coarse metric of hunter participation rates is the number of caribou seals sold prior to the hunting season. All licensed hunters require a seal which must be immediately attached to a harvested animal. From 1995 – 2011, there was an increase in the number of seals sold to

non-residents (β = 7.7, SE = 2.0) and a decrease in the number of seals sold to licensed resident hunters (β = -15.9, SE = 5.1; Environment Yukon, unpubl. data). Caribou seals are not differentiated between northern mountain caribou and barren-ground caribou (*i.e.*, Porcupine herd) which makes drawing inferences from their sales, with respect to northern mountain caribou, challenging. Seal sales do not necessarily have a strong relationship with success rates or the number of animals harvested, but the decline in the number of seals sold to Yukon residents may be an indication of a decreasing level of interest in harvesting caribou.

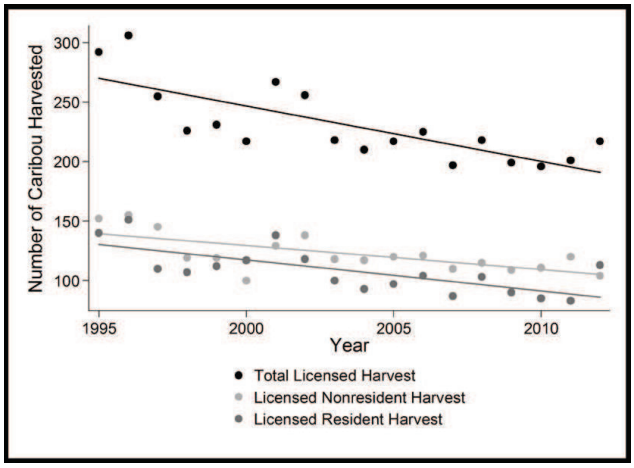

Fig. 4. Licensed harvest of northern mountain caribou (1995 – 2012) in Yukon, Canada. Trend lines indicate decreasing total licensed harvest (β = -4.65, SE = 0.96) for both non-resident (β = -2.02, SE = 0.53) and resident (β = -2.60, SE = 0.63) hunters.

Land-use

Human land-use within caribou ranges is a management concern for a number of herds in Yukon. For example, a large portion of the Carcross herd's winter range is occupied by the footprint of the City of Whitehorse and surrounding rural residential subdivisions which have reduced the effectiveness of this winter habitat (Florkiewicz *et al.,* 2007). Summer and winter habitat effectiveness has also been reduced for the Atlin herd from human activities on the landscape (Polfus *et al.,* 2011). While the direct habitat lost through human activities may be small in some cases, the indirect losses due to caribou avoidance may be greater (Weir *et al.,* 2007; Polfus *et al.,* 2011). Additionally, increased development and activities in caribou range often results in increased access which may result in caribou being more vulnerable to harvest pressure.

The recent rise in metals prices has preceded a substantial increase in mineral exploration activity in Yukon and a number of new operational mines are proposed over the next few years. This increase in mineral exploration and development will undoubtedly influence future research and monitoring. For instance, significant advanced exploration activity is occurring in the Klaza herd's range (Yukon Geological Survey, 2011) where a large inventory study was recently initiated, and a four-year inventory program of the South Nahanni herd, now finished, was initiated in part due to exploration activity and a potential mine and access road along the Yukon-NWT border. An intensive study of the Liard Plateau herd was initiated in 2010 due to proposed development within its range (S. McNay, Wildlife Infometrics, pers. comm.). A number of exploration activities are also occurring in the ranges of the Tay River, Finlayson, Clear Creek, and Hart River herds. The increase in mineral exploration and development brings a number of management issues including direct and indirect habitat loss, increased access potentially increasing harvest pressure, and the cumulative effects of natural (*e.g.*, fire) and anthropogenic effects in caribou ranges.

Highway mortality

A number of herd ranges are bisected by major Yukon highways which pose a mortality risk for animals crossing roads, or aggregating on them to take advantage of road salts used during winter highway maintenance. Two herds in particular, Carcross and Little Rancheria (Fig. 1), experience the most vehicle related mortal-

ity. On average (2001 – 2010) 15.4 (SE = 2.2) northern mountain caribou are killed on Yukon highways each year. These data represent minimum numbers of mortalities as they only include carcasses documented by Environment Yukon and do not take into account those animals which may have been injured through a collision and which subsequently succumbed to their injuries away from the road.

While the number of animals killed on highways may appear small, this likely represents a source of additive mortality. In particular for the Little Rancheria herd which is harvested in both Yukon and British Columbia, the addition of road-kills could have the potential to impact herd growth. This may be especially influential if females are killed. Unfortunately, data regarding the sex ratio composition of road-killed animals are unavailable.

The use of caribou deterrents, such as lithium chloride (Brown *et al.,* 2000), and additional road signage is currently being explored. Given the increase in the number of operating mines and mineral exploration the volume of heavy truck traffic carrying ore and other equipment is expected to increase on Yukon highways which may further increase caribou-vehicle collisions. With this increase in traffic volumes, road mortalities could become an even greater conservation concern in the future.

Summary

Of the 26 herds occurring in Yukon, population trend is known for eight (~ 31%; Table 1). Of these eight herds, two are increasing, two are decreasing, and four are stable. This variability in trend somewhat contrasts the general pattern of decline in *Rangifer* populations described by Vors & Boyce (2009); however, recent estimates of large barren-ground herds (*e.g.*, Porcupine herd) also indicate some are recovering from low levels. Additionally, while trend is known for a number of herds, it is unknown for nearly 70% of Yukon's northern mountain herds.

Radio-collar studies of caribou are ongoing, albeit at reduced levels than observed historically (Fig. 2). Recent radio-collaring efforts have largely been in response to specific management concerns and information needs. Fall composition surveys are also ongoing. Eight herds (Aishihik, Carcross, Chisana, Ethel Lake, Finlayson, Ibex, Kluane, and Tatchun; Fig. 1) have been identified for annual monitoring, when feasible, with the aim that results, particularly with respect to recruitment, provide a general indication (*i.e.*, above or below average) of the condition across all herds. Maintaining long-term time series of these data also provides the basis for analyses into the drivers of these demographic patterns (*e.g.*, Hegel *et al.,* 2010). Lack of information on trend, herd size, total harvest levels, and other vital rates will increase the challenges associated with management of Yukon's northern mountain caribou herds, particularly with the increasing land-use pressures facing them and the uncertainty of future climatic conditions. A number of herds also cross jurisdictional boundaries. Coordinated management and monitoring of these herds will likely be required into the future. For example, a multi-jurisdictional management plan (Chisana Caribou Herd Working Group, 2012) for the Chisana herd was recently formally approved, the signature page of which includes six parties representing multiple countries, agencies, and First Nations. A tri-agency research program on the South Nahanni herd is now complete. Such multi-agency partnerships increase the ability to carry out expensive research and monitoring programs.

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Zittlau, K.A. 2004. *Population Genetic Analyses of North American Caribou (Rangifer tarandus).* Ph.D. dissertation. University of Alberta, Edmonton. 187pp.Table 1. Monitoring summary of northern mountain caribou herds occurring in the Yukon, Canada.