2021 POPULATION CENSUS OF THE COLUMBIA NORTH MOUNTAIN CARIBOU SUBPOPULATION

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Summary

Southern mountain woodland caribou (*Rangifer tarandus caribou)*, commonly referred to as “mountain caribou,” inhabit the North Columbia Mountains near Revelstoke, British Columbia. They were studied using radio-telemetry from 1992 to 2009 and populations remained relatively stable until the mid to late 1990s with between 290 and 375 caribou distributed amongst 4 subpopulations (Columbia North, Columbia South, Frisby-Queest, and Kinbasket South). Population censuses for the Columbia North (CN) subpopulation have consistently taken place since the 1980s. This report summarizes the March- April 2021 census.

The 2021 CN population census indicated that the subpopulation has approximately 184 individuals (90%CI 165-235), excluding a translocated female, and has increased overall since 2004, when the estimate was 136 (90%CI 129-143) animals. Sightability was high in 2021 (12 of 14 radio collars detected; 86%), consistent with previous years when the snowpack was similarly deep. Adult female survival was 0.92 for the year preceding the 2021 census. In 2021 calf recruitment was 13.8% across the CN and 16.4% within “The Hub” portion of CN, an area of densely populated high-value habitat. The average projected population growth (λ) in the CN was 1.03 and 1.06 within “The Hub”. Potential emigration based on marked individuals to the neighboring Groundhog subpopulation in recent years may indicate some meta-population function in the region. Amalgamating the observed caribou counts from the Groundhog and Columbia North subpopulations indicates a combined growth rate λ = 1.03 from 2013-2021 and λ = 1.05 between 2017 and 2021. Continued intensive management including habitat protection is required to maintain population growth and recover the caribou subpopulations in the Revelstoke area.

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Introduction

Mountain caribou are woodland caribou (*Rangifer tarandus caribou*) that are behaviorally adapted to the deep snowpack of southeastern British Columbia. During late winter they access arboreal lichens in the canopy of subalpine forests by walking on top of the deep snow. The Southern Group of Southern Mountain Caribou in British Columbia range from north of Prince George south along the interior mountain ranges ending in few small remnant island populations in the southern Columbia Mountains. Due to their low numbers, decreasing population trend, and shrinking and fragmented distribution, these caribou are listed as *Threatened* under Schedule 1 of the Federal *Species at Risk Act*, and were recommended for endangered listing in 2014 by COSEWIC (Committee on the Status of Endangered Wildlife in Canada, 2014). In 2002 they were added to the "Red List" (Extirpated, Endangered or Threatened) by the British Columbia Conservation Data Centre.

Mountain caribou populations are monitored in the Revelstoke area by annual aerial surveys. These censuses occurred initially from 1981-1985 by Simpson and Woods (1987), and at regular intervals until present. When snow depths, measured at Mt Fidelity, BC, exceed 300 cm in late March most caribou are at treeline where they are relatively easy to count from the air (Wittmer et al. 2005a, Serrouya et al. 2017b) and a near-complete census can be conducted.

In years where snow does not reach 300 cm mean caribou sightability falls below 90% (Serrouya et al. 2017b) reducing the efficacy of a full census, however, a recruitment survey can still be conducted. Recruitment surveys, coupled with adult survival rates of collared females, can be used to estimate the finite population growth rate (λ; Caughley 1977) using the Recruitment-Mortality equation of Hatter and Bergerud (1991), and DeCesare et al. (2012).

The last complete census occurred in 2017 and the estimate for the Columbia North (CN) subpopulation was 147, similar to what was found in 2014 (152). Due to low snowpack in 2018-2019, and COVID-19 related constraints in 2020, recruitment surveys were limited to a portion of the CN subpopulation known as "The Hub" which has the highest concentration of animals from this herd. Estimated annual population growth based on recruitment surveys increased from λ=1.04 in 2018 to λ=1.13 in 2020, however, estimates of population growth from this area are likely biased high compared to the entire subpopulation because they exclude more fragmented areas like Bigmouth Creek and Wood River which likely have a lower growth rate (van Oort et al. 2011). Nevertheless, these estimates provide continuity in population monitoring in years when a full population census is not possible.

This report updates the Revelstoke area Columbia North (CN) subpopulation inventory to include the March-April 2021 census. Using the mark-resight proportions of 14 collared caribou we estimated population size and 90% confidence intervals using the joint hypergeometric maximum likelihood estimator (White, 1996) following the techniques described by Wittmer et. al (2005a). This is the first population estimate with associated parameter variance since 2006. The most recent censuses for other Revelstoke-area caribou subpopulations were Columbia South (2020; 4 adults, 0 calves), Monashee South (2016; 1 adult, 0 calves), Frisby-Queest (2020; 6 adults, 0 calves), and Kinbasket (2008; 2 adults, 1 calf).

Study Area

The 2021 census covered the CN subpopulation (4526 km^2) as described by Wittmer et al. (2005a). This area includes all known late-winter caribou habitat in the Monashee Mountains from Bourne Creek and Anstey River north to Howard Creek, along with the Selkirk Mountains north from Downie Creek (excluding the Esplanade Range and other areas south of Windy Creek) to the Cummins and Wood Rivers in the Rocky Mountains (including Pacific, Jeffry, Molson and Harvey Creeks; **Figure 1**). Census values were summarized for this entire area but also subdivided into "The Hub", a 693 km^2 area of high-value habitat (**Figure 1**) that is densely populated in late winter, relative to the rest of the CN subpopulation range.

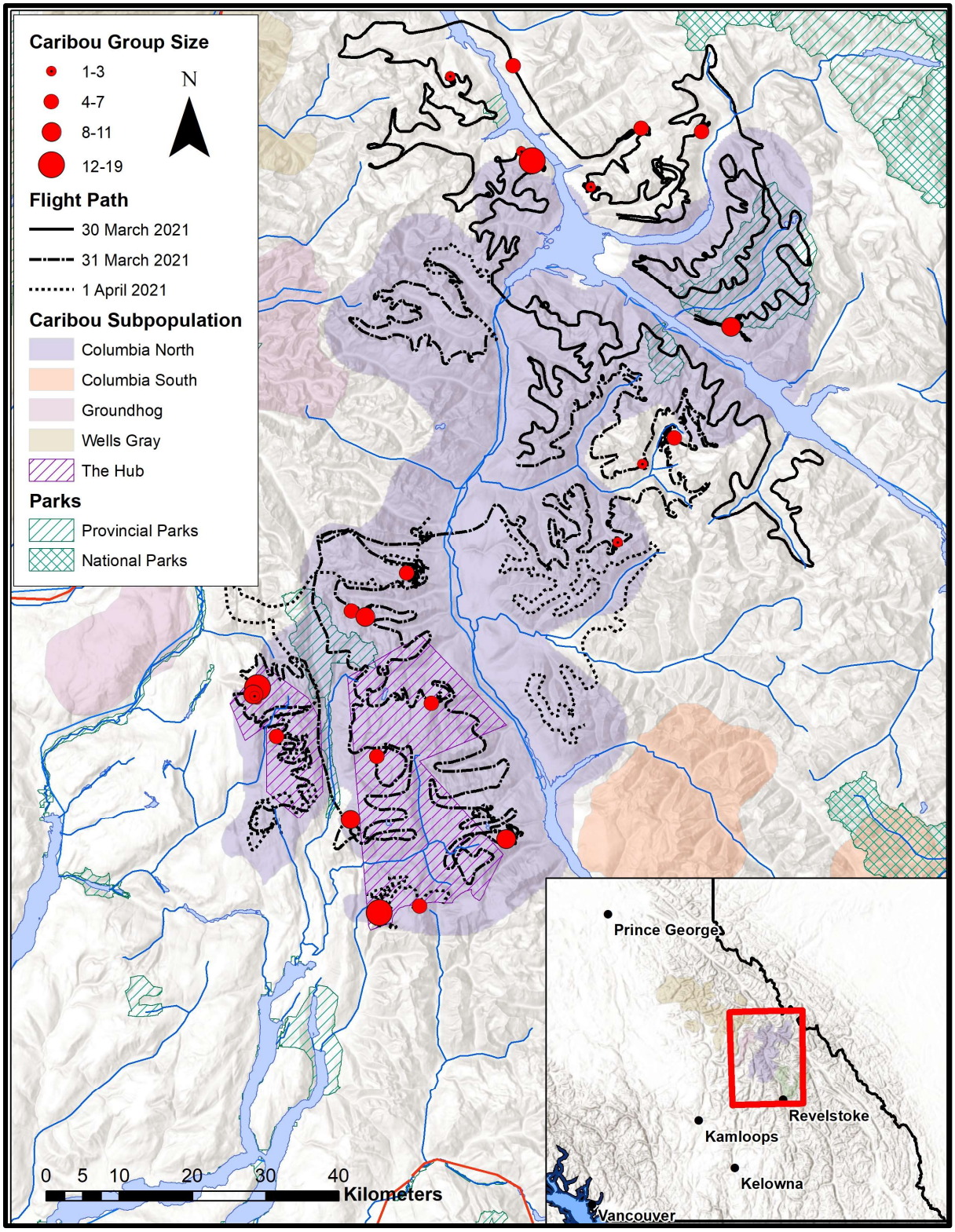

Figure 1: Flight paths and caribou groups – 2021 Columbia North caribou census. Subpopulation boundaries are 95% kernel home ranges (Wittmer et al. 2005a). "The Hub" portion of the CN is indicated by purple crosshatch.

Methods

Captured adult female caribou were fitted with Vectronic VHF-GPS radio collars with satellite location upload. Caribou were monitored until either their collar faded or stopped working or there was a mortality signal indicating that the animal had died or dropped its collar. All caribou mortality signals were investigated to determine the cause of death. Daily survival was calculated as the cumulative number of deaths per days monitored [1]

S = (no. deaths)/(days monitored) [1]

Annual survival is then the exponentiated daily survival rate for each day in the year.

Caribou were censused during late winter when they were in open subalpine parkland (Simpson and Woods 1987, McLellan et al. 1994, Seip 1992). Flaa and McLellan (2000) identified snowpacks >300 cm as an indicator of caribou presence in subalpine late-winter habitat in this area. Snowpack depth was determined using data provided by Parks Canada for Mt. Fidelity in Glacier National Park, British Columbia. All suitable late-winter habitat within the study area was surveyed from a Bell 206 helicopter with two experienced observers and a navigator. We flew a contour path near treeline (1800–2130 m; see Wittmer et al. 2005a for details) until tracks were observed then followed them until caribou were sighted. The total number of caribou, including the number of calves, were counted and subsequently confirmed amongst observers. High-resolution digital photographs using a 300-mm telephoto lens were taken of each group and their locations were recorded with a GPS.

All-male groups were easily identifiable; however, discriminating between young males and adult females in mixed groups was difficult and would have required additional harassment. Therefore, we limited our classification to calves and adults, as per most provincial mountain caribou censuses. Differentiation between calves and yearlings in the field can be challenging, as result, photographs were subsequently examined carefully to confirm calf numbers within the mixed groups. If the photo review was unclear the value observed from the helicopter was used as the estimate for the number of calves.

Population estimates and 90% confidence intervals were derived using the joint hypergeometric maximum likelihood estimator in program NOREMARK (White 1996). If the lower confidence limit was less than the total number of caribou observed, the census number was used. We used the same methods described by Wittmer et al. (2005a) and previous population censuses of the CN subpopulation from 1994-2008.

We estimated the finite population growth rate (λ) for the entire CN subpopulation and for only the “The Hub” portion using the recruitment-mortality equation [1]

$\lambda = S / (1 - R_{RM})$ [2] (Hatter and Bergerud 1991)

$R_{RM} = (CC / 2)/(1+ CC /2)$ (DeCesare et al. 2012)

$$CC = PC / PAF$$

$$PAF = (PAFOA * PA) / 100$$

$$PA = 100 - PC$$

$$PAFOA = (100 / (BC + 100)) * 100$$

where λ is the finite rate of change (Caughley 1977), *S* is adult female survival, *PC* is the percent calves from the total population, *CC* is the calf to cow ratio, *BC* is the bull to cow ratio, *PAF* is the percent adult females of the population, *PAFOA* is the percent adult females of the adults. Note that the *BC* is not known, but we assume that the BC varied between 50 and 70 per 100 cows based on Serrouya et al. (2017a) and provide estimates for both boundaries of probable sex ratios.

Results

Most of the suitable late-winter habitat was flown over three consecutive days (March 30th-April 1st, 2021) in the CN subpopulation (**Figure 1**). The census survey took 18.5 hours of flying time plus an additional 10.3 hours for ferrying and re-fueling. Four drainages on the west side of Lake Revelstoke that are usually surveyed were missed (Horne, Scrip, Twentyone, Pat; **Figure 1**) because of high winds and poor visibility that were deemed dangerous by the pilot.

Conditions for the census were variable. The snowpack depth in Glacier National Park on Mt. Fidelity exceeded 300 cm as of February 21st and was 393 cm on March 30th, 2021. This provided sufficient opportunity for animals to ascend into their late-winter range, thereby increasing census confidence. New snow (16 cm) was recorded at Mt. Fidelity on March 29th, 10 cm of new snow March 30th and 2 cm on March 31st. The overnight snowfalls reduced the extent of caribou tracks. Winds were considered light for the first two days of the census period and moderate for the third. Lighting varied from flat to sharp each day.

A total of 158 caribou in 26 groups were enumerated over the three-day census (**Figure 1**). Twelve of 14 collared caribou were sighted resulting in a mark-resight population estimate of 184 caribou (90% CI: 165-235). One additional translocated South Selkirk female was seen in "The Hub" with a group of 8 other caribou including two calves. This female was excluded from population size estimates so that absolute population size remains comparable with previous population estimates and inferences can be drawn without bias resulting from supplemented population increase [1]. This female was included to derive estimates of survival and recruitment

[1] The population estimate including a transplanted female from the South Selkirk population is $\hat{N}$=185 (90% CI: 166-236).

rates because of the potential lack of independence between group size and these parameters. Ten of 26 groups included calves and 13.8% of all observed caribou were calves (**Table 1**). Of these, 67 caribou in 9 groups were in "The Hub" (including the SS female) and 16.4% (11) of them were calves (**Table 2**).

The estimated finite rate of population increase in "The Hub" portion of the CN subpopulation ranged from λ=1.05 to λ=1.07 assuming the population's adult sex ratio was 5:10 or 7:10 males to females respectively (**Table 1**). The estimated rate of increase for the entire CN was λ=1.03 to λ=1.04 following the same adult sex ratio assumptions. Adult female survival was 0.917, based on 14 radio marked caribou monitored between 9 and 364 days (median = 364 days).

Discussion

The 2021 Columbia North subpopulation census shows that the population has increased to an estimated 184 individuals (90% CI: 165-235) by an average of 1.94 % annually since 2006 when the estimate was 138 (90% CI: 127-181)[2] caribou.

There is also evidence that some caribou emigrated to the neighbouring Groundhog subpopulation. In 2018 one of three caribou captured there had an ear tag from the maternity pen (in CN). In 2019, one caribou in the cow-calf verification photo-survey of the Groundhog subpopulation had a non-functioning collar from a different population; the caribou was assumed to be from the Columbia North population. The Groundhog population 2020 winter survey count found an increase to 31 individuals from 19 the previous year and only 4 of these were calves. Due to the thorough survey effort for the relatively small area, researchers were confident that these animals were not missed in previous years and that approximately 8 caribou immigrated from a different subpopulation. The geographic proximity, movement of 2 or 3 collared individuals from the CN in 2018–2019, previously documented movements between the CN and Groundhog subpopulations (van Oort et al. 2011), and spring/summer movement of collared Groundhog animals to the eastern herd boundary with CN (B. Ernst pers. Comm.) indicate that CN is the likely source of the immigrant caribou. Amalgamating the observed caribou counts from the Groundhog and Columbia North subpopulations indicates a combined growth rate λ = 1.03 from 2013–2021 and λ = 1.05 between 2017 and 2021 (**Table 3**).

This movement could explain the difference between the realized population growth rate and the 2-3% higher projected population growth rate based on survival and recruitment parameters for individuals in the Hub since 2018 (Table 1). Continuing to monitor the finite rate of increase from survival and recruitment rates (projected λ) for the entire subpopulation as

[2] The 2008 census population size estimate was 166 caribou (90% CI: 142-268) but this estimate was based on 6 collared caribou and as a result had relatively wide confidence limits.

well as “The Hub” will increase our understanding of how emigration events affect realized population growth.

Recruitment rates for the CN in 2021 were 13.8% and were consistent with estimates from previous years when the entire population was monitored (Table 1), though recruitment within “The Hub” was 16.4%; at the higher end of the range of estimates since the 1990s excluding calves from the maternity pen in 2019. Bergerud (1992) states that a calf recruitment rate of 15% is required for a stable population, but this rule of thumb will depend on the survival rate of adult females. It is hypothesized that alternate prey reduction through increased moose harvesting quotas has indirectly reduced wolf populations and possibly increased caribou survival within “The Hub” and other portions of the CN subpopulation range (Serrouya et al. 2017b). Further assistance such as increased calf recruitment through maternity penning, may have supported the increased recruitment within “The Hub.”

Most of the CN late-winter range is now closed to snowmobiling, however, use continues in late-winter habitat at Bourne/Pettipiece Pass, Mt. Grace, Mt. Celista and Bischoff Lakes, where only partial closures or permitted openings are in effect. In most years heli-skiing is active throughout the majority of the CN late-winter range. The COVID-19 pandemic resulted in a reduction in heli-skiing for the 2020-2021 winter, however, the degree of reduction has not been quantified. The slight increase of the CN subpopulation is an encouraging pattern and suggests that population management actions aimed at reducing predation rates are improving caribou abundance (Serrouya et al. 2017a). Continued monitoring and maintaining treatments aimed at improving caribou survival rates while maintaining and improving habitat integrity will be important to gauge the long-term effects of recovery efforts.

Despite recent population stability and a modest increase, the CN remains small and subject to multiple proximate threats that increase the chance of extinction from stochastic factors and Allee effects (e.g. Hebblewhite et al. 2010, McLellan et al. 2010), in addition to the effects of unsustainable predation rates (Wittmer et al. 2005b) and recent habitat loss (Nagy-Reis, 2021). However, habitat gain through natural succession has appeared to offset loss for the 2000 to 2012 time period, when “gain” data was available. We note, however, that habitat gain does not constitute caribou-old growth forage habitat, but rather a transition out of moose habitat that disrupts the predator-prey system.

Short-term but immediate conservation actions to maintain population stability and promote further growth include managing the predator-prey system to conditions that would have existed under a natural forest age class. Long-term habitat preservation, habitat restoration, and backcountry recreation management will help minimize the risk of future population decline (Seip et al. 2007, Lewis and McLellan 2007) and increase meta-population function in the region. Boutin and Merrill (2016) recommended that population management tools be applied simultaneously to recover herds.

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Table 1. Population censuses results and recruitment values (% calves) for the Columbia North caribou subpopulation. Adapted from (McLellan et al. 2006).

Columbia North	Observed (+ Tracks)	Calves (%) (+ Pen)	Hub λ [CN λ]	Number Collared	Collars Observed	Calculated Estimate	90% CL
1994	206 (209)	19.4		12	12	206	206-229
1996	167 (193)	19.2		11	11	167	167-188
1997	203 (204)	11.8		17	15	230	210-280
2002	145 (152)	11.7		7	7	145	145-175
2004	129 (136)	14.0		12	12	129	129-143
2006	125 (131)	14.3		10	9	138	127-181
2008	139 (142)	12.9		6	5	166	142-268
2010	NA[a]	10.4		0	NA	NA	NA
2011	101 (123)[b]	8.9		0	0	NA	NA
2012	NA[a]	12.9		0	NA	NA	NA
2013	148 (152)	14.2		0	0	NA	NA
2014	115[c] (123)	13.3		0	NA	NA	NA
2015	NA[a]	10.8(11.5)		NA[d]	NA	NA	NA
2016	NA[a]	11.8(14.8)		NA[e]	NA	NA	NA
2017	147	14.1(15.6)		NA[f] [KB2]	NA	NA	NA
2018	NA[a]	11.6(15.0)	1.04		NA	NA	NA
2019	NA[a]	16.7(21.3)	1.05	NA	NA	NA	NA
2020	NA[a]	14.5	1.13	NA	NA	NA	NA
2021	158[g]	13.8	1.06 [1.03]	14	12	184	165-235

[a] No population estimate was conducted these years, only a calf composition count was done for "The Hub".

[b] This number includes groups of 16 tracks seen at Pettepiece Pass, but these were likely from the same animals actually observed at Caribou Basin 7 days later (see Results). No double-counting occurred because the 16 were not included in the value 101 presented above.

[c] The 2014 estimate is considered to be unreliable due to a very low snowpack. This number (115 or 123) is considered to be very conservative.

[d] 10 adult females were collared, and 2 juveniles had ear tags. All 10 adults, 2 surviving calves, and one juvenile were located using a mix of standard census methods and telemetry.

[e] 13 adults were collared and on-air during the survey along with 8 collared calves and an additional calf with ear tags only.

[f] 10 adults were collared and on-air during the survey along with 2 collared calves and 2 calves with ear tags only.

[g] Excluding one female translocated from the South Selkirk population.

Table 2. Percent calves recorded in "The Hub" portion of the Columbia North subpopulation. Sample size (calves/total number seen) should not be used to infer population trend because some years the area surveyed varied considerably. This summary is presented as a sample to show how recruitment varied in the core caribou habitat ("The Hub") of the Columbia North subpopulation.

Year	Percent calves	Sample size
1989	14.3	(5/35)
1990	16.2	(6/37)
1991	18.2	(6/33)
1994	21.3	(19/89)
1996	15.2	(5/33)
1997	10.4	(5/48)
2002	10.4	(5/48)
2004	14.5	(10/69)
2006	13.2	(5/38)
2008	15.5	(9/58)
2010	11.1	(5/45)
2011	7.9	(6/76)
2012	13.3	(8/60)
2013	16.1	(15/93)
2014	14.9	(10/67)
2015		
2016	14.8[a]	(12/81)
2017	16.1[a]	(15/93)
2018	15.0[a]	(107/16)
2019	21.3[a]	(19/89)
2020	14.5	(8/55)
2021	16.7	(11/66)

[a] Inclusive of both "wild" recruitment and recruitment contributions from the maternity pen.

Table 3. Observed caribou counts (not estimated) in the Columbia North and Groundhog caribou subpopulations. These values exclude tracks.

Year	Groundhog	Columbia North	Sum
1999	24	na	
2006	23	na	
2008	23	na	
2010	9	na	
2011	6	na	
2013	11	148	159
2015	14		
2017	13	147	160
2018	19		
2019	18		
2020	31		
2021	34	159	193

Note that "na" is inserted here to avoid the temptation of adding these 2 herd values when there was less evidence of inter-subpopulation movement.

Appendix 1—Details of caribou group size and age structure

Details of individual caribou groups observed during the 2021 CN caribou census. * Including a translocated female from the South Selkirk population.

Date	Total Observed	Calves (photo confirmed)	Location	UTM Zone	UTM Easting	UTM Northing
2021-03-30	8	2	Cummins	11U	422946	5765289
2021-03-30	4	0	Wood	11U	418938	5792069
2021-03-30	2	1	Dainard	11U	403757	5784475
2021-03-30	4	0	Harvey	11U	410645	5792506
2021-03-30	4	0	Hugh Allen	11U	393138	5801049
2021-03-30	3	0	Buster	11U	384534	5799601
2021-03-30	2	0	Kelley	11U	394240	5789319
2021-03-30	14	3	Franchere	11U	395702	5788050
2021-03-31	2	0	Bigmouth	11U	410804	5746537
2021-03-31	5	0	Bigmouth	11U	415218	5750093
2021-03-31	1	0	Argonaut	11U	407444	5735830
2021-03-31	6	1	Fernie	11U	378569	5731508
2021-03-31	6	0	Hoskins	11U	370972	5726352
2021-03-31	8	1	Hoskins	11U	372825	5725541
2021-03-31	4	0	Kerbyville	11U	381964	5713718
2021-03-31	3	0	Seymour	11U	392238	5694638
2021-03-31	9	2	Seymour	11U	392133	5695035
2021-03-31	5	0	Blais	11U	374472	5706446
2021-03-31	11	1	Seymour	11U	370815	5697773
2021-03-31	19	3	Dudgeon	11U	358097	5715804
2021-03-31	2	0	Dudgeon	11U	358054	5714190
2021-03-31	9*	2	Dudgeon	11U	357522	5714906
2021-03-31	3	0	Dudgeon	11U	357716	5714689
2021-03-31	6	0	Cayanne	11U	360762	5709172
2021-04-01	4	0	Myoff	11U	380306	5685870
2021-04-01	15	6	Anstey	11U	374777	5684983
TOTAL	**159**	**22**	**CN**			

Appendix 2—Details of Survival

Details of individual adult female caribou survival in the year before the 2021 CN caribou census. * Including a translocated female from the South Selkirk population.

Date Start	Date End	Days at Risk	Fate
2020-04-01	2021-03-31	364	Active
2020-04-01	2021-03-31	364	Active
2020-04-01	2021-03-31	364	Active
2020-04-01	2021-03-31	364	Active
2020-04-01	2021-03-31	364	Active
2020-04-01	2021-03-31	364	Active
2020-04-01	2021-03-31	364	Active
2020-04-01	2021-03-31	364	Active
2020-04-01	2021-03-31	364	Active
2020-04-01	2021-03-31	364	Active
2020-04-01	2021-03-31	364	Active
2020-04-01	2020-12-16	259	Fade*
2020-04-01	2020-12-20	263	Fade
2020-04-01	2020-05-03	32	Dead
2020-04-01	2020-04-10	9	Dropped

Days at risk = 4203
Deaths = 1
Daily survival = 0.9997621
Annual survival rate = 0.916812