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March 2022 Late-winter Composition Surveys of Bluenose-East and Beverly Barren-ground Caribou Herds

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ABSTRACT

This report describes the results of late-winter composition surveys of the Bluenose-East and Beverly barren-ground caribou herds conducted in March 2022. The main purpose of these surveys was to estimate the proportion of females in each herd that were still accompanied by a calf, which is an index of calf survival through the first nine to ten months of life. A survey of the Bathurst barren-ground caribou herd was not possible due to extensive mixing of Bathurst and Beverly collared caribou and the much greater size of the Beverly herd compared to the Bathurst herd.

Survey flying was carried out on March 8, 10, 12, 13, 14 and 15, 2022 with a total of 35.3 hours flown (33.0 hours on survey and 2.3 hours ferry flying). Wekweètì was the main base of operations, with one night at the Hoarfrost River site on the East Arm of Great Slave Lake to access an eastern portion of the Beverly herd. Poor weather prevented flying on March 9 and 11 with low cloud/mist and snowfall. Temperatures varied between about -20˚ and -32˚C with variable winds. The survey was focused on flying to locations of female and male collared Bluenose-East and Beverly barren-ground caribou, and classifying caribou (cows, calves, young bulls and prime bulls) nearby. Caribou were classified using motion-stabilized binoculars from the helicopter.

Most of the Bluenose-East barren-ground caribou herd was separate from the Bathurst and Beverly herds in areas east and southeast of Great Bear Lake and northwest of Wekweètì, based on collared caribou locations. The areas flown represented 45 of 51 female collars (88.2%), ten of 14 male collars (71.4%) and 55 of 65 total collars (84.6%) in the Bluenose-East herd at the time. In these areas 2,844 caribou were classified and a calf:cow ratio of 46.9 calves:100 cows (lower and upper 95% CI 44.1 and 49.6) resulted. This ratio was slightly lower than the 49.6 calves:100 cows (95% CI 45.6-53.0) estimated in the Bluenose-East herd in October 2021 and suggests very good recruitment in the herd for the calf cohort born in June 2021. Recent late-winter calf:cow ratios in the herd have shown good recruitment 2019-2022.

The Beverly collared caribou were distributed over a large landscape and some were beyond our flying range (too far east or north). Some Bathurst collared caribou were in the areas surveyed but we estimated that 95-96% of the caribou classified were Beverly, based on collar numbers and relative herd sizes. A total of 3,953 caribou were classified and a ratio of 51.1 calves:100 cows (95% CI 48.7-53.6) was estimated for the Beverly herd. This represented ten of 27 female collars (37.0 %), ten of 17 male collars (58.8%) and 20 of 44 total collars (45.4%) in the Beverly herd at the time. Some caution should be used with these results, given that only about half the herd was sampled. This calf:cow ratio suggested very good calf recruitment in the Beverly herd from the calves born in June 2021 and continued a series of strong calf recruitment years in this herd 2017-2022.

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INTRODUCTION

The Bathurst and Bluenose-East barren-ground caribou herds have calving grounds west of Bathurst Inlet (Bathurst) and west of Kugluktuk (Bluenose-East) in Nunavut (NU), with portions of the summer range in NU and the remainder of the ranges in the Northwest Territories (NWT) (Figure 1). The Beverly[1] herd has a calving ground in the Queen Maud Gulf lowlands and has much of its range in NU and the NWT. Historically the Bathurst and Beverly barren-ground caribou herds have ranged as far south as northern Saskatchewan.

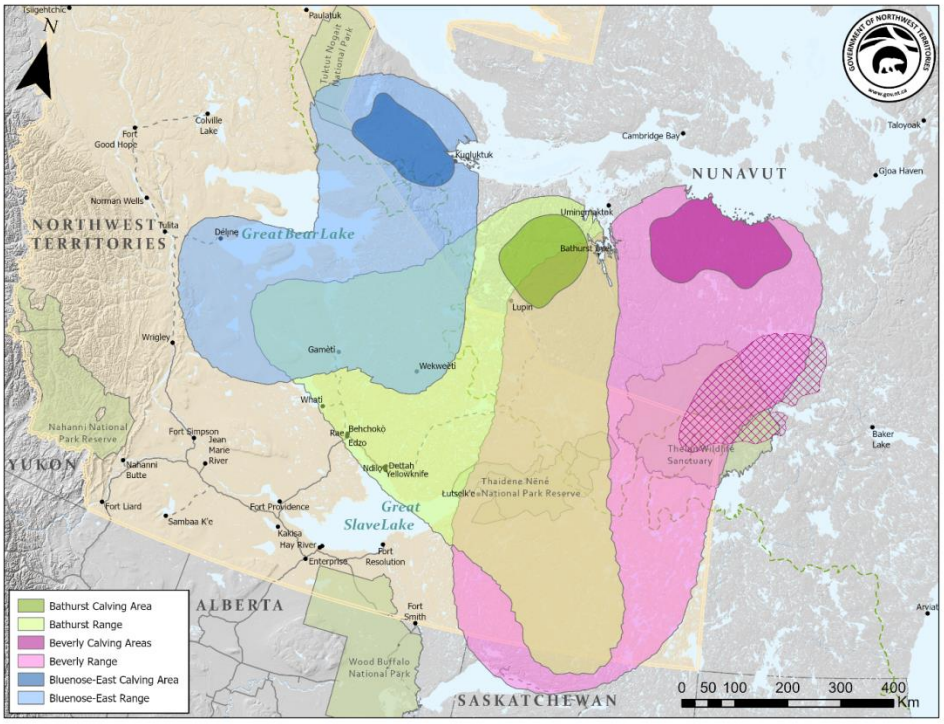

Figure 1. Annual ranges and calving grounds of the Bluenose-East, Bathurst, and Beverly herds, based on accumulated radio collar locations of cows (adapted from Nagy et al. 2011). The calving ground used up to about 2009 by the inland-calving Beverly herd is shown as a cross-hatched area.

In 2021, the Bathurst caribou herd was estimated at approximately 6,200 caribou after a decline of about 99% from its peak numbers estimated at 470,000 in 1986 (Adamczewski et al. 2022a). Its rate of decline slowed between 2018 and 2021 to about 8% per year and the herd showed some improvement in demographic indicators. The Bluenose-East herd stabilized between 2018 and 2021 after a steep decline 2010-2018 and was estimated at about 23,200 caribou in 2021, with improved demographic indicators 2018-2021 (Boulanger et al. 2022). The Beverly herd was

[1] The Beverly herd described in this report is the herd defined by the Government of NU as calving in the central and western Queen Maud Gulf. This herd may not correspond exactly to the Beverly herd defined prior to 2009 with an inland calving ground south of Garry Lakes (Adamczewski et al. 2015).

estimated at approximately 103,000 in 2018 (Campbell et al. 2019) with a slow declining trend of about 5%/year. March calf:cow ratios for this herd in recent years have been very good (Adamczewski et al. 2022c).

March estimates of calf:cow ratios have been monitored as an index of calf survival through the first nine to ten months of life in all three herds, although these ratios are also influenced by pregnancy rate or initial productivity of young in June. Calves of the year generally survive at much lower rates than caribou at least one year old; after the first year their survival rates are usually higher and similar to those of older caribou (Bergerud 2000; Bergerud et al. 2008). At a year of age, surviving calves are considered to be "recruited" into the adult segment of the population; hence these surveys are sometimes called recruitment surveys.

In recent winters, these three caribou herds have wintered primarily in the North Slave region of the NWT. Monitoring of the Bathurst and Bluenose-East herds has been more intensive in recent years because of the extensive declines in both herds (see WRRB 2019a and b) and the need for collaborative management actions; this has included annual late-winter composition surveys to estimate the calf:cow ratio at about nine months of age. Monitoring of the Beverly herd has been somewhat less intensive due to its much larger size and lower rate of decline; however late-winter composition surveys have been flown at regular intervals for this herd to monitor calf recruitment.

Mixing of these three caribou herds on the winter range has created challenges for composition surveys as it can be difficult to ascribe calf:cow ratios to an individual herd in mixed areas. Estimating Bathurst calf:cow ratios in late winter has been particularly challenging in recent winters due to extensive overlap with the much larger Beverly herd. The main objective of the surveys in March 2022 was to estimate the late-winter calf:cow ratios in the Bluenose-East, Beverly and Bathurst herds (if possible) as on-going monitoring of demographic health in these populations.

METHODS

The survey began in Yellowknife on March 8, 2022 with a Great Slave Helicopters A-Star AS-350 B2, call sign C-GDCV, piloted by J. Krieger and with ENR staff J. Williams and J. Adamczewski on board (Figure 2). Wekweètì was the main base of operations. The survey crew spent one night (March 12/13) at the Hoarfrost River Huskies base north of the East Arm of Great Slave Lake, to be able to fly to some of the more easterly Beverly collars east of Great Slave Lake. Survey flying continued on March 10, 12, 13, 14 and 15, and the crew returned to Yellowknife on March 15. Z. Simpson from Wekweètì assisted as an observer on a portion of the survey. Fuel was used mainly at Wekweètì, but was also used from caches at Lockhart Lake, Little Crapeau Lake, Port Radium (eastern shore of Great Bear Lake), Lac de Gras and the Hoarfrost River base. The helicopter flew to last locations of Bluenose-East, Bathurst and Beverly collared caribou; caribou groups near collared caribou were classified along with other groups found nearby or between collared caribou.

Figure 2. March 2022 North Slave barren-ground caribou composition survey crew of (left to right): pilot J. Krieger, J. Williams and J. Adamczewski. Observer Z. Simpson from Wekweètì assisted on two days and is not pictured. Photo GNWT/ENR.

Locations of collared Bathurst, Beverly and Bluenose-East females and males were monitored throughout March 2022 and used to plan survey flying. Additional collars were placed on caribou from these herds in March 2022 by a capture crew also operating from Wekweètì but were not used in planning the survey as their herd identity would not be known until June (cows) or July (bulls).

Caribou were classified from the front seat of the helicopter using motion-stabilized Canon 10x42 binoculars. Caribou were classified as calves (based on smaller size and short face), cows (based on presence of a vulva patch), young bulls (based on absence of a vulva patch and presence of hard antlers) and prime bulls (based on absence of a vulva patch and no antlers). Identification of prime bulls as lacking antlers assumes that mature males shed their antlers soon after the fall breeding season while younger bulls retain them longer into winter (Nagy et al. 2021). Yearling caribou (about 21 months old) were not distinguished and were included with cows and young bulls. In smaller groups (<20) it was usually possible to classify all or nearly all the caribou. In larger groups the focus was on recording an unbiased cross-section of the caribou.

Group sizes recorded were the numbers of caribou classified, thus for larger groups the groups under-represent actual groups of caribou seen, particularly in areas where hundreds or thousands of caribou were present.

Trimble Yuma 2 tablet computers were used to record observations with a GPS waypoint taken for each observation. Garmin GPS model 276Cx units were used to plan flights and record flight lines. The pilot also used a tablet with the ForeFlight™ program to plan flights. In addition to caribou, we also recorded observations of other large mammals, including moose, muskoxen and wolves. Although we included some bull collars in the survey flight planning, the main priority was to assess the calf:cow ratios in each herd. Proportions of bulls recorded are not representative of herd sex ratios because of the tendency of bulls to segregate from cows through much of the winter.

RESULTS

Survey Conditions and Daily Flying

In general, survey conditions were good through much of the survey (Figure 3), with the exception of March 9 and 11 when low cloud, ice fog and snowfall prevented survey flying. On March 10 weather north of Wekweètì was poor, which constrained flying to the Wekweètì area.

Figure 3. Field conditions during March 2022 composition surveys of Bluenose-East and Beverly caribou herds in the North Slave region. Top left near Lac de Gras with winter road, top right east of Artillery Lake, bottom left at Port Radium, Great Bear Lake, and bottom right near Wekweètì.

Temperatures during the survey were generally between -20˚ and -32˚C with variable winds. Western portions of the survey area, particularly where many of the Bluenose-East collars were found, were generally forested or taiga transition areas, while eastern and central portions were largely above treeline. It appeared from the air and from the ground that snow cover was exceptionally shallow and relatively soft. In many areas there was less than one foot of

accumulated snow. Dave Olesen's observations (the Hoarfrost base owner), for the area around the Hoarfrost River base also indicated that snow cover was exceptionally shallow in winter 2021-2022.

A summary of daily flying and areas surveyed is in Table 1. In total 35.3 hours were flown during the surveys, including ferry flying of 2.3 hours between Yellowknife and Wekweètì and survey flying of 33.0 hours.

Table 1. Flying hours and main tasks during March 2022 North Slave barren-ground caribou composition surveys.

Date	Flying Hours	Tasks and Notes
March 8	5.3	Ferry Yellowknife to Wekweètì 1.3 hours; survey west and north of Wekweètì; Bluenose-East herd; survey 4.0 hours.
March 9	0	No flying; poor weather (low cloud/snowfall)
March 10	3.7	Partial day due to poor weather north of Wekweètì; survey areas near Wekweètì; Bluenose-East herd; survey 3.7 hours.
March 11	0	No flying; poor weather (low cloud/snowfall)
March 12	7.4	Survey from Wekweètì west to Lac de Gras, then to Hoarfrost River on East Arm of Great Slave Lake, then north of Hoarfrost River; mostly Beverly caribou; survey 7.4 hours.
March 13	6.8	Survey from Hoarfrost River east of Artillery Lake, then Hoarfrost River west to Lockhart Lake, then Lockhart River to Wekweètì; mostly Beverly caribou; survey 6.8 hours.
March 14	7.4	Survey northwest of Wekweètì, to Little Crapeau Lake, to Port Radium, to Wekweètì; Bluenose-East herd; survey 7.4 hours.
March 15	4.7	Survey northwest towards Great Bear Lake, back to Wekweètì, ferry to Yellowknife 1.0 hours; Bluenose-East herd; survey 3.7 hours.
Totals	35.3	Ferry hours 2.3 total; 33.0 hours survey time

Bluenose-East Survey Results

An overview of the Bluenose-East March 2022 survey area is in Figure 4. Most of the Bluenose-East collared caribou were east and southeast of Great Bear Lake, with lower numbers of collars northwest of Wekweètì and surrounding Wekweètì. The areas flown represented 45 of 51 female Bluenose-East collars (88.2%), ten of 14 male collars (71.4%) and 55 of 65 total collars (84.6%) in the Bluenose-East herd at the time (Table 2). There were two female Beverly collars near the north end of the Bluenose-East collar distribution east of Great Bear Lake and another Beverly cow collar further south and we did not survey caribou in their vicinity. An area northeast of Wekweètì was not flown as it had a mix of Bluenose-East, Bathurst and Beverly collared caribou, thus survey results from that area would have been difficult to interpret.

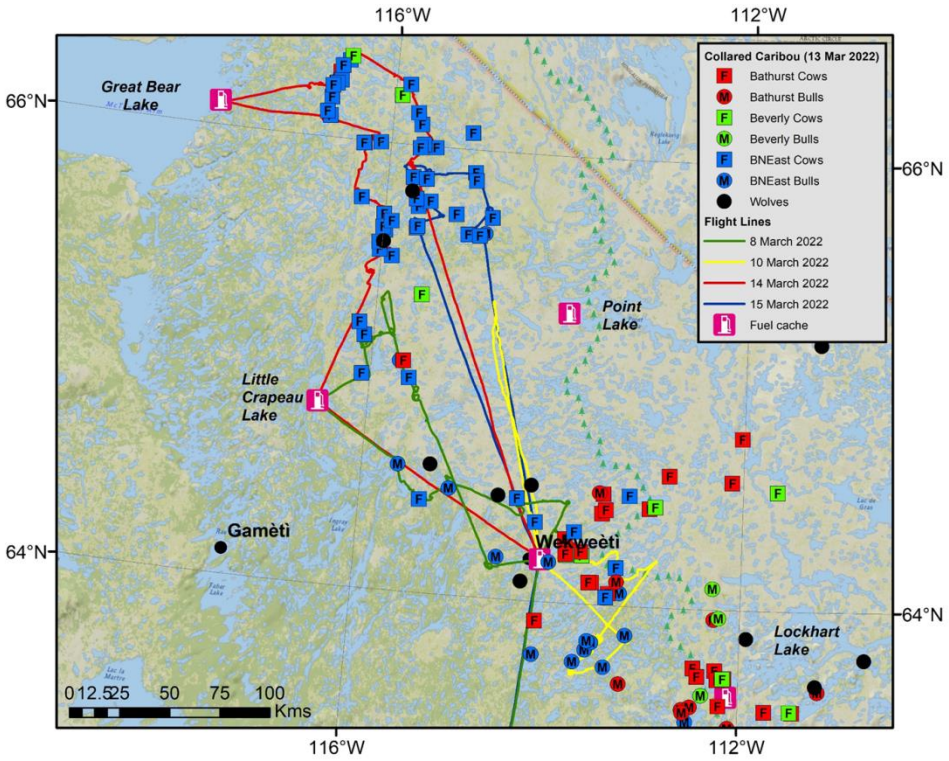

Figure 4. Collared caribou locations, fuel caches, wolf sightings and flight lines March 8, 10, 14 and 15 on Bluenose-East composition survey. Collar locations are from March 13 and include Bathurst, Bluenose-East and Beverly collared caribou.

Table 2. Numbers of collared caribou available on the Bluenose-East herd in March 2022 during composition survey, and numbers of collared caribou in surveyed areas.

Description	Female Collars	Male Collars	Total Collars
Collars in Survey Area	45	10	55
All Collars Available	51	14	65

To assess regional variation in Bluenose-East caribou composition, observations were grouped in three regional sectors (Figure 5).

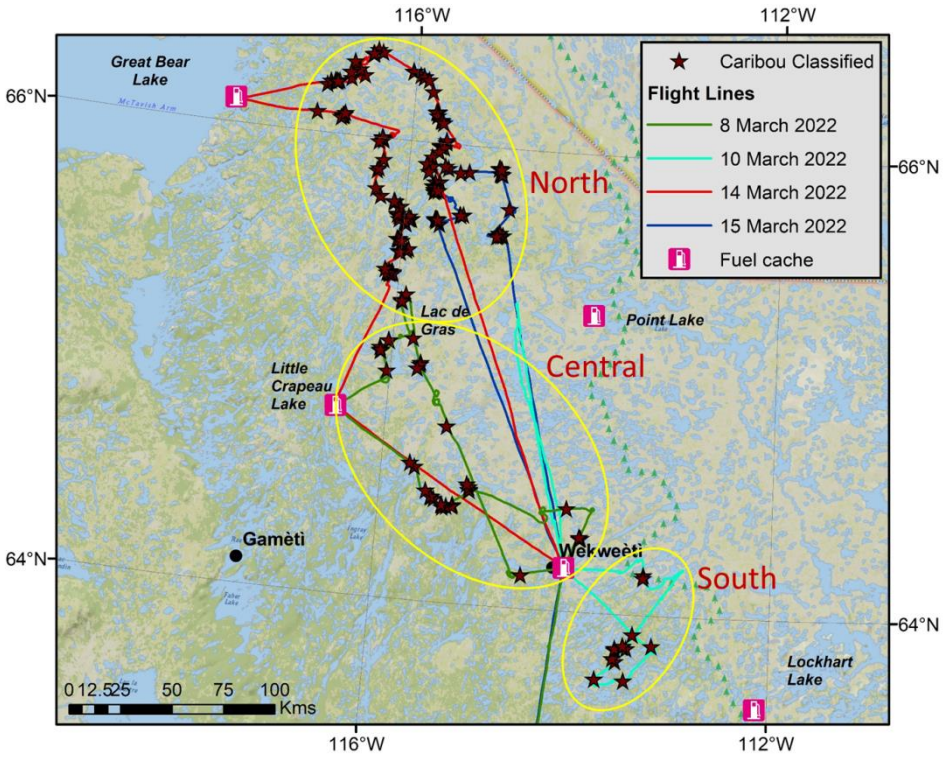

Figure 5. Locations of caribou groups classified March 8, 10, 14 and 15 on Bluenose-East composition survey. Composition was summarized for three regional sectors (North, Central and South) outlined in yellow.

The South sector was relatively small and had predominantly bull collars, while the North and Central sectors had predominantly female collars. Observations in the North sector made up 82.7% of the total, thus results for that sector in large part determined the overall ratios. This sector also had most of the collared Bluenose-East caribou collars and the numbers of caribou encountered were much greater than in the Central and South sectors.

Overall, the calf:cow ratio for the March 2022 Bluenose-East composition survey was 46.9 calves:100 cows (95% Confidence Interval, CI, 44.1-49.6) and the same ratio was found for the North sector with a similar 95% CI (Table 3). The Central sector had much smaller sample size but a very similar ratio of 48.1 calves:100 cows (95%CI 39.4-58.0) with a larger variance. There were very few cows or calves observed in the South sector.

Table 3. Results of March 2022 composition survey of Bluenose-East caribou herd. Overall totals and ratios are shown along with results from three regional sectors. SE = Standard Error; CIL = 95% Confidence Interval Lower; CIU = 95% Confidence Interval Upper.

Measurement	Overall	North	Central	South
# Caribou	2,844	2,351	360	133
# Cows	1,596	1,483	106	7
# Calves	748	695	51	2
# Young Bulls	232	160	59	13
# Prime Bulls	263	8	144	111
# Groups	194	146	35	13
Mean Group Size	14.7	16.1	10.3	10.2
Median Group Size	12	14	8	9
Calves: 100 Cows	46.9	46.9	48.1	28.6
SE Calves: 100 Cows	1.4	1.5	4.7	-
CIL & CIU Calf:Cow	44.1, 49.6	43.8, 49.9	39.4, 58.0	25.0, 33.3
Bulls: 100 Cows	31.0	11.3	191.5	1,771.4
SE Bulls: 100 Cows	4.6	1.3	82.8	-
CIL & CIU Bull:Cow	23.0, 41.1	8.9, 14.0	96.5, 413.4	646.8, 4,722.5

The South sector had by far the smallest sample of caribou, and 124 of 133 caribou classified were bulls, consistent with the presence of predominantly bull collars. Of the 124 bulls, 111 (89.5%) were prime bulls. Most of the groups observed were entirely prime bulls. The North sector had by far the lowest overall proportion of bulls (11.3 bulls:100 cows) and the lowest proportion of prime bulls (4.8%), while the Central sector had an intermediate bull:cow ratio of 191.5 bulls:100 cows and an intermediate proportion of prime bulls (70.9%). Although limited sample sizes in the South and Central sectors somewhat limit interpretation, there did appear to be a strong gradient from very few bulls in the North to increasing numbers of bulls southward, and a trend from predominantly prime bulls in the South to predominantly young bulls in the North. The overall proportion of prime bulls was 53.1% (263 of 495). Although we note trends in bull numbers and proportions, the overall bull:cow ratio should not be considered representative of the herd due to segregation of bulls and cows in the winter.

Beverly Survey Results

The Beverly collared caribou were distributed over a large landscape and some were beyond our flying range (too far east or north; Figures 6a and 6b). The areas flown had ten of 27 female collars (37.0%), ten of 17 male collars (58.8%) and 20 of 44 total collars (45.4%) in the Beverly herd at the time (Table 4).

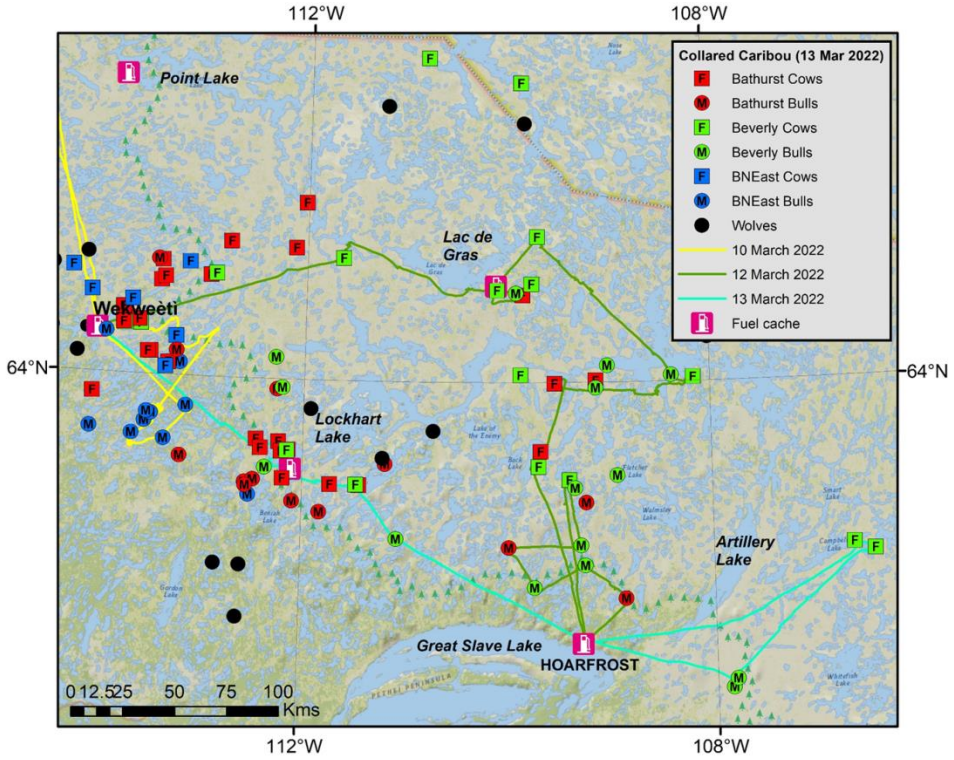

Figure 6a. Collared caribou locations, fuel caches, wolf sightings and flight lines March 10, 12 and 13 on Beverly composition survey. Collar locations are from March 13 and include Bathurst, Bluenose-East and Beverly collared caribou.

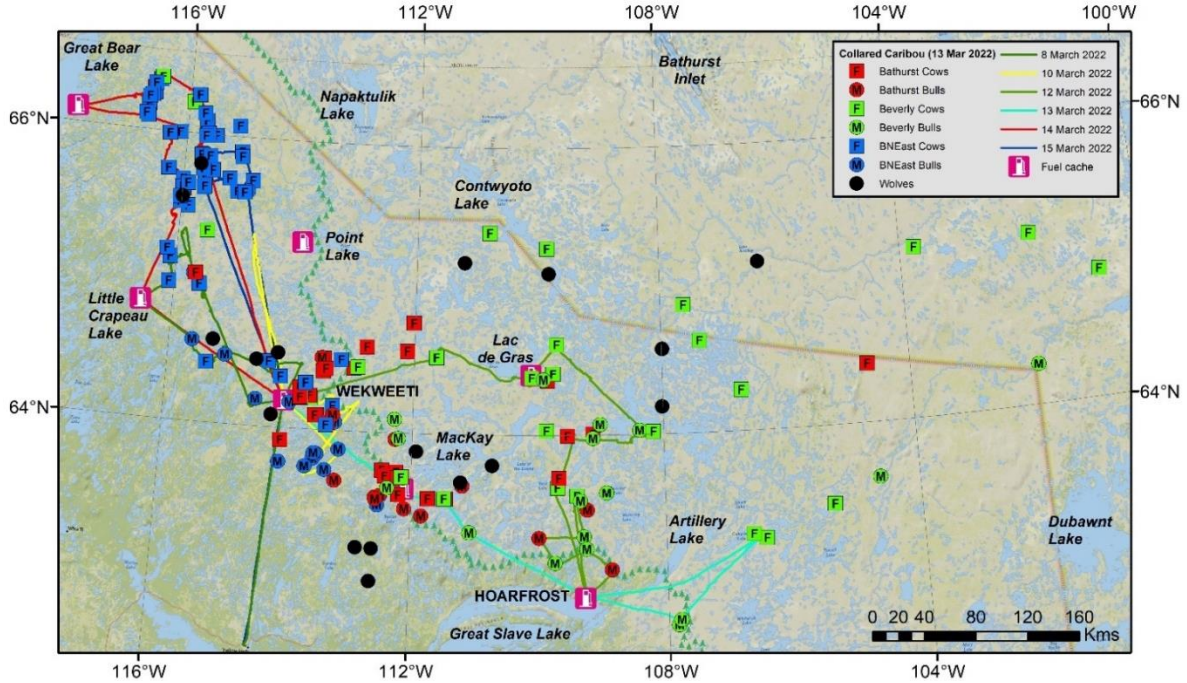

Figure 6b. Collared caribou locations, fuel caches, wolf sightings and flight lines March 10, 12 and 13 on Bluenose-East and Beverly composition surveys. This map is similar to Figure 6a but includes a larger area with all the Beverly collars, including the more remote ones that were not surveyed.

Table 4. Numbers of collared caribou available from the Beverly and Bathurst herds in March 2022 during Beverly survey, and numbers of collared caribou in surveyed areas.

Description	Female Collars	Male Collars	Total Collars
Beverly Collars in Survey Area	45	10	55
All Beverly Collars Available	51	14	65
Bathurst Collars in Survey Area	11	2	13
Bathurst Collars Available	30	13	43

Some caution should be used with these results, given that only about half the herd was sampled. There were 13 of 43 Bathurst collared caribou in the areas surveyed, thus some of the caribou were likely from the Bathurst herd. However, we estimate that the caribou classified were 95-96% Beverly in the areas surveyed (the remainder Bathurst), based on collar numbers and relative herd sizes[2].

As noted earlier, an area northeast of Wekweètì was not flown as it had a mix of Bluenose-East, Bathurst and Beverly collared caribou, which would have made interpretation of the results challenging.

A total of 3,953 caribou were classified and a ratio of 51.1 calves:100 cows (95% CI 48.7-53.6) was estimated for the Beverly herd (Table 5). Regional variation in composition was assessed by summarizing results for three regional sectors (Figure 7). The calf:cow ratio varied over a relatively small range in the three sectors: North 51.1, East 53.9 and Lockhart 48.8. The largest sample was from the North sector (2,103 caribou).

[2] Twenty of 44 Beverly collars were in the areas surveyed and the last estimate of Beverly herd size was 103,372, thus 20/44x103,372 is 46,987 Beverly caribou in the area. Thirteen of 43 Bathurst collars were in areas surveyed and the 2018 herd estimate was 8,207, thus 13/43x8,207 is 2,481 Bathurst caribou in the area. The total caribou in the area would be 46,987+2,481=49,468, and the proportion of Beverly caribou is 46,987/49,468x100 or 95.0%. Similar calculations using the Bathurst estimate of 6,243 for 2021 produce an estimate of 96.1% Beverly caribou. These calculations are approximations and a key assumption is that each collar represents an equal proportion of the herd.

Table 5. Results of March 2022 composition survey of Beverly caribou herd. Overall totals and ratios are shown along with results from three regional sectors. SE = Standard Error; CIL = 95% Confidence Interval Lower; CIU = 95% Confidence Interval Upper.

Measurement	Overall	North	East	Lockhart
# Caribou	3,953	2,103	927	888
# Cows	1,600	1,053	282	258
# Calves	818	538	152	126
# Young Bulls	597	318	120	155
# Prime Bulls	958	194	393	349
# Groups	193	80	56	53
Mean Group Size	20.5	26.3	16.6	16.8
Median Group Size	18	23	14	14
Calves:100 Cows	51.1	51.1	53.9	48.8
SE Calves:100 Cows	1.2	1.5	3.2	2.8
CIL & CIU Calf:Cow	48.7, 53.6	48.0, 54.1	48.2, 60.6	43.5, 54.5
Bulls:100 Cows	95.9	48.6	174.8	195.3
SE Bulls:100 Cows	12.0	6.9	52.4	56.8
CIL & CIU Bull:Cow	75.4, 122.4	37.1, 64.1	101.4, 306.1	118.5, 340.8

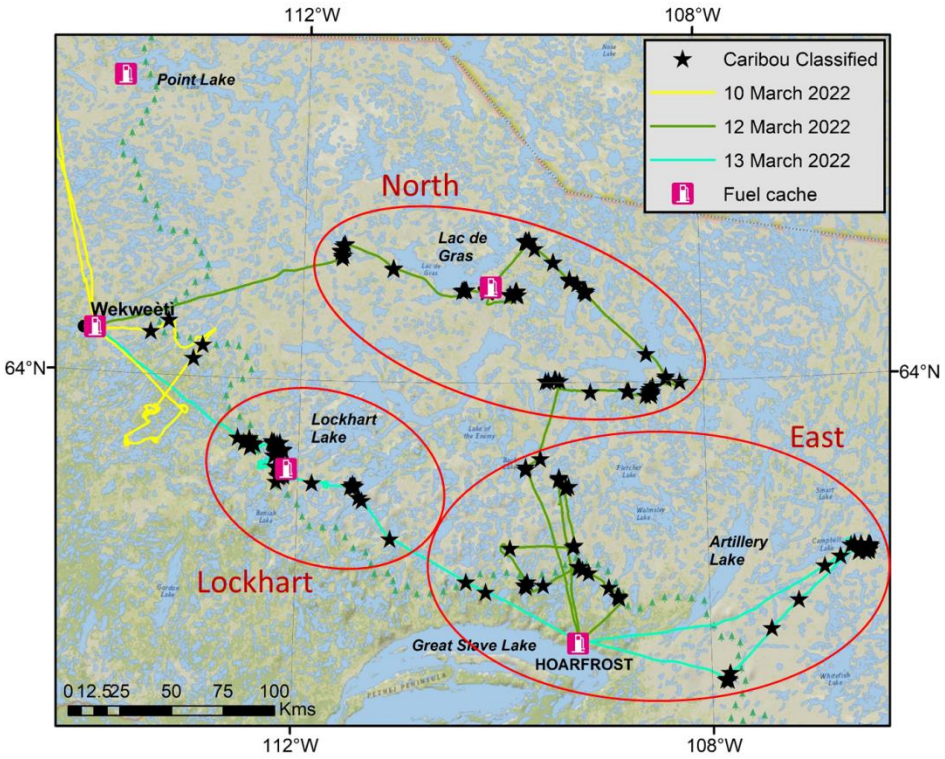

Figure 7. Locations of caribou groups classified March 8, 10, 14 and 15 on Beverly composition survey. Composition was summarized for three regional sectors (North, Lockhart and East) that are outlined in red.

The overall bull:cow ratio in the surveyed areas was 95.9 bulls:100 cows (95%CI 75.4-122.4) and there was substantial regional variation in this ratio: North 48.6, East 174.8 and Lockhart 195.3.

The proportion of prime bulls varied somewhat also: North 37.9%, East 76.6% and Lockhart 69.2%. While we note patterns in the bull:cow ratio and proportions of prime and young bulls, the bull:cow ratios recorded should not be considered representative of the herd, given segregation of cows and bulls in the winter and the fact that about half the herd was not sampled due to their remote distribution.

Incidental Sightings of Other Animals

There were nine wolves (two packs of three and six) seen on the Bluenose-East March 2022 survey and four wolves (a pack of three and a single animal) seen on the Beverly survey (Table 6). Other sightings included two moose on the Bluenose-East survey and 97 muskoxen in six groups on the Beverly survey.

Table 6. Incidental sightings of moose, muskoxen, and wolves during March 2022 barren-ground caribou composition surveys in North Slave region of NWT.

Herd Surveyed	Species	Total & Group Size
Bluenose-East	Moose	2 (1,1)
Bluenose-East	Wolf	9 (3,6)
Beverly	Muskox	97 (1,8,14,23,23,28)
Beverly	Wolf	4 (1,3)

DISCUSSION

Bluenose-East Herd: Survey Considerations

The March 2022 Bluenose-East composition survey likely provided a sample that was representative of the herd, based on the numbers of collars in surveyed areas, limited mixing with other herds, and sampling that considered relative numbers of caribou seen (more caribou classified where there were more caribou). The survey included flying in areas with 55 of 65 (84.6%) satellite collared caribou in the herd. A few Bluenose-East collared caribou were mixed with Beverly and Bathurst collared caribou but these areas were not flown; there were three Beverly collared caribou east of Great Bear Lake with larger numbers of Bluenose-East collars but these three collars were omitted from the survey. There was little variation in the calf:cow ratio between the North and Central sectors.

The regional variation in proportions of Bluenose-East bulls present and the variation in proportions of prime and young bulls confirms previous observations that suggest widespread segregation of bulls and cows in the winter, although the survey was not designed to quantify spatial patterns in distribution of male and female caribou. The high proportion of prime bulls in the South sector suggests that they tend to be near the southern end of the winter distribution and in some areas they may be found in groups having only prime bulls.

Bluenose-East Herd Population Trend

Late winter calf:cow ratios have been estimated for the Bluenose-East herd in most years since 2008 (Figure 8). The calf:cow ratio in March 2022 of 46.9 calves:100 cows was very similar to the March ratio a year earlier of 46.7:100 and slightly higher than the estimate of 39.1:100 from March 2020. Over the last three years the average calf:cow ratio has been 44.2:100; these numbers suggest three consecutive years of healthy calf recruitment. Calf:cow ratios between 2012 and 2016 were generally lower and ranged from 21-32:100. The trend from 2016-2022 has been an increasing one.

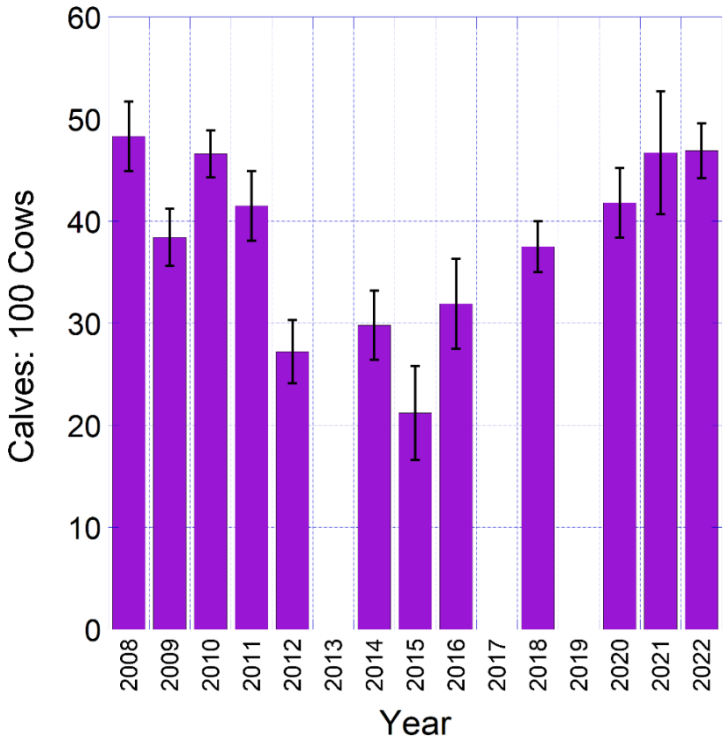

Figure 8. Late-winter calf:cow ratios (with 95% CI) in the Bluenose-East caribou herd 2008-2022.

The March 2022 ratio was slightly lower than the 49.6 calves:100 cows (95% CI 45.6-53.0) estimated in the Bluenose-East herd in October 2021 (Adamczewski et al. 2022b). Late winter calf:cow ratios in this herd have often been similar to, or slightly lower than, calf:cow ratios estimated the preceding fall (Adamczewski et al. 2022c), which suggests that calf mortality rates over winter have been relatively low.

The trend toward higher March calf:cow ratios in 2020, 2021 and 2022 is consistent with other demographic indicators in the Bluenose-East herd that showed higher values for 2018-2021 compared to 2015-2018, including the proportion of breeding females in June, collar-based cow survival, fall bull:cow ratios, and fall calf:cow ratios (Boulanger et al. 2022). The estimates of breeding females, adult females and overall herd size all indicated that the herd was stable from 2018-2021 and this represented a major change from the rapid decline of about 20%/year estimated from 2010-2018 (Boulanger et al. 2022).

Beverly Herd: Survey Considerations

Although the March 2022 Beverly composition survey likely provided a reasonably representative sample of the herd, some caution should be used based on the numbers of Beverly collars in areas that were not surveyed. In total 20 of 44 total Beverly collars (45.4%) were in surveyed areas, thus less than half the herd was surveyed. There was also a portion of the Bathurst herd in the surveyed areas, but we estimated that 95-96% of the caribou classified were Beverly caribou, thus

the presence of a limited number of Bathurst caribou likely had little influence on the estimated Beverly calf:cow ratio.

Beverly Herd Population Trend

Late winter calf:cow ratios have been estimated for the Beverly herd in most years since 2008 (Figure 9). The lowest calf:cow ratio was 31:100 in 2009 and the 2010, 2011, 2021 and 2022 estimates were all over 50:100. Overall, the calf:cow ratios in the herd since 2018, when the last population survey was completed (Campbell et al. 2019), have been over 40:100 and this suggests several years of healthy calf recruitment in the herd.

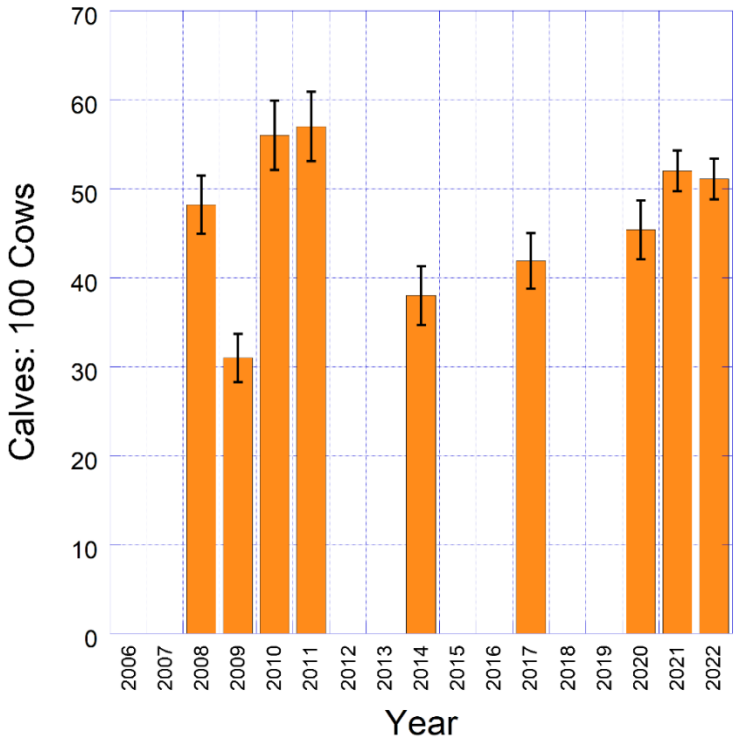

Figure 9. Late-winter calf:cow ratios (with 95%CI) for the Beverly herd 2008-2022. Missing years of late-winter composition surveys mostly reflect the herd's remote and scattered winter distribution in those years.

We note that late winter calf:cow ratios are an index of calf survival from birth to nine to ten months, however ratios are affected by changes in the denominator (cow numbers) as well as the numerator (calf numbers). High calf:cow ratios in late winter reflect good calf recruitment as long as cow survival rates are relatively high and do not vary greatly.

Whether a fall or late-winter calf:cow ratio is linked to a stable population depends on the adult survival rate (Crête et a. 1996, Boulanger et al. 2011, Boulanger and Adamczewski 2016). In population modeling summarized by Boulanger and Adamczewski (2016; Table 1), at a cow survival rate of 85%, fall calf:cow ratios needed to be 49-51 calves:100 cows and late-winter ratios needed to be 38-45 calves:100 cows for stability. At a higher cow survival rate of 90%, fall calf:cow

ratios of 44 calves:100 cows and late-winter calf:cow ratios of 29 calves:100 cows were associated with stability (Boulanger and Adamczewski 2016). Although the recent calf:cow ratios in March have been very good for the Beverly herd, population trend will also depend strongly on survival rates of adult caribou, particularly the adult cows.

ACKNOWLEDGEMENTS

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Appendix 1A. Observations of caribou groups on Beverly (mixed) survey in March 2022

S Bulls = Small Bulls; P Bulls = Prime Bulls; Lock = Lockhart; Wpt = Waypoint Number.

Date Time	Lat Deg	Long Deg	Wpt	Cows	Calves	S Bulls	P Bulls	All Bulls	All Total	Region	Notes
3/12/2022 9:52:03 AM	64.5393687	-111.615123	8	6	4	14	4	18	28	North	
3/12/2022 9:53:30 AM	64.5477645	-111.618369	9	3	2	4	0	4	9	North	
3/12/2022 9:54:31 AM	64.55035145	-111.603119	11	19	13	6	0	6	38	North	
3/12/2022 9:56:39 AM	64.56610519	-111.626573	12	0	0	7	10	17	17	North	
3/12/2022 9:58:11 AM	64.57083127	-111.628952	13	6	3	18	18	36	45	North	
3/12/2022 10:02:19 AM	64.59177149	-111.608497	15	6	3	5	5	10	19	North	
3/12/2022 10:03:51 AM	64.59757507	-111.587881	16	14	8	1	0	1	23	North	
3/12/2022 10:04:07 AM	64.59986379	-111.592103	17	6	2	0	0	0	8	North	
3/12/2022 10:14:11 AM	64.49519997	-111.097148	18	5	3	7	0	7	15	North	
3/12/2022 10:14:55 AM	64.49872443	-111.093335	19	6	3	6	8	14	23	North	
3/12/2022 10:28:51 AM	64.40262422	-110.39773	20	18	5	5	6	11	34	North	
3/12/2022 10:30:27 AM	64.40375399	-110.397949	21	5	3	3	8	11	19	North	
3/12/2022 10:31:31 AM	64.40743614	-110.380057	22	5	3	7	4	11	19	North	
3/12/2022 10:32:15 AM	64.40534102	-110.368909	23	10	7	4	4	8	25	North	
3/12/2022 10:32:38 AM	64.40712508	-110.357307	24	5	3	0	0	0	8	North	
3/12/2022 10:37:32 AM	64.40202519	-110.150352	25	8	6	5	1	6	20	North	
3/12/2022 10:38:21 AM	64.40775297	-110.149989	26	18	10	3	0	3	31	North	
3/12/2022 10:39:17 AM	64.41074251	-110.147812	27	10	4	4	0	4	18	North	
3/12/2022 10:40:15 AM	64.40832741	-110.143897	28	13	6	3	0	3	22	North	
3/12/2022 10:44:26 AM	64.4117852	-110.135987	31	9	3	4	0	4	16	North	
3/12/2022 10:46:09 AM	64.40631651	-110.13754	32	29	19	7	1	8	56	North	
3/12/2022 10:47:20 AM	64.40332844	-110.136823	33	12	5	2	0	2	19	North	
3/12/2022 10:48:20 AM	64.40031105	-110.143673	34	5	3	2	0	2	10	North	
3/12/2022 10:48:58 AM	64.40003777	-110.148614	35	10	6	0	0	0	16	North	
3/12/2022 10:50:31 AM	64.40178562	-110.148059	36	20	13	11	11	22	55	North	
3/12/2022 10:55:45 AM	64.38722373	-109.914334	37	10	4	4	5	9	23	North	
3/12/2022 10:57:06 AM	64.38525177	-109.919251	38	13	5	10	1	11	29	North	
3/12/2022 10:58:57 AM	64.38312215	-109.915291	39	17	6	5	0	5	28	North	collar cow no calf
3/12/2022 11:05:05 AM	64.38370899	-109.846008	40	8	6	3	0	3	17	North	
3/12/2022 11:05:57 AM	64.38588432	-109.838902	41	11	3	0	0	0	14	North	
3/12/2022 11:08:29 AM	64.3980949	-109.856487	42	30	17	5	3	8	55	North	
3/12/2022 11:08:50 AM	64.39707307	-109.863791	44	4	3	1	0	1	8	North	
3/12/2022 11:10:32 AM	64.39530036	-109.863424	45	14	4	1	0	1	19	North	
3/12/2022 11:12:28 AM	64.4031987	-109.852038	46	38	19	9	0	9	66	North	
3/12/2022 11:13:26 AM	64.40150754	-109.856127	47	12	4	2	0	2	18	North	
3/12/2022 12:32:19 PM	64.42280356	-110.111635	49	23	12	2	0	2	37	North	

Date Time	Lat Deg	Long Deg	Wpt	Cows	Calves	S Bulls	P Bulls	All Bulls	All Total	Region	Notes
3/12/2022 12:33:11 PM	64.61724367	-109.762685	50	21	11	2	0	2	34	North	
3/12/2022 12:33:54 PM	64.62070642	-109.753524	51	2	1	0	0	0	3	North	
3/12/2022 12:35:24 PM	64.61842121	-109.753326	52	20	11	9	2	11	42	North	collar cow no calf
3/12/2022 12:36:04 PM	64.61751721	-109.753439	53	10	5	3	0	3	18	North	
3/12/2022 12:37:43 PM	64.61633622	-109.748455	54	25	13	5	1	6	44	North	
3/12/2022 12:39:10 PM	64.62250064	-109.75507	56	16	6	5	2	7	29	North	
3/12/2022 12:40:17 PM	64.62440037	-109.72402	57	16	10	1	0	1	27	North	
3/12/2022 12:44:00 PM	64.617568	-109.731637	58	24	11	3	4	7	42	North	
3/12/2022 12:48:47 PM	64.58691091	-109.666398	59	14	8	3	0	3	25	North	
3/12/2022 12:49:42 PM	64.52689709	-109.478732	60	18	10	1	0	1	29	North	
3/12/2022 12:54:38 PM	64.52645121	-109.483833	61	8	6	2	0	2	16	North	
3/12/2022 12:57:15 PM	64.45276365	-109.316167	62	43	19	11	1	12	74	North	
3/12/2022 1:00:00 PM	64.44634475	-109.315724	63	7	4	0	0	0	11	North	
3/12/2022 1:02:36 PM	64.43392719	-109.240678	64	15	7	4	0	4	26	North	
3/12/2022 1:03:58 PM	64.40413751	-109.170876	65	9	4	1	0	1	14	North	
3/12/2022 1:05:23 PM	64.401227	-109.165753	66	34	10	3	0	3	47	North	
3/12/2022 1:07:27 PM	64.40417303	-109.178142	67	13	5	6	0	6	24	North	1000s
3/12/2022 1:07:44 PM	64.39766505	-109.152698	68	5	0	1	0	1	6	North	
3/12/2022 1:08:57 PM	64.39906772	-109.154138	69	14	9	4	0	4	27	North	
3/12/2022 1:10:07 PM	64.39842793	-109.152643	70	26	12	1	1	2	40	North	
3/12/2022 1:24:06 PM	64.39003585	-109.157826	71	25	15	0	0	0	40	North	
3/12/2022 1:29:57 PM	64.12285608	-108.559578	72	11	8	0	9	9	28	North	collar bull prime
3/12/2022 1:30:41 PM	64.0226673	-108.369448	73	0	0	4	5	9	9	North	
3/12/2022 1:33:39 PM	64.01416029	-108.372008	74	0	0	3	6	9	9	North	
3/12/2022 1:42:00 PM	63.99806518	-108.230869	75	12	6	4	0	4	22	North	
3/12/2022 1:43:34 PM	63.97058139	-108.525873	76	4	2	1	3	4	10	North	
3/12/2022 1:45:01 PM	63.98044267	-108.502831	77	7	2	1	0	1	10	North	
3/12/2022 1:46:23 PM	63.96150011	-108.528254	78	26	12	5	1	6	44	North	
3/12/2022 1:47:40 PM	63.9557523	-108.509044	79	2	0	10	10	20	22	North	1000s
3/12/2022 1:48:25 PM	63.94587557	-108.518948	80	4	1	3	7	10	15	North	
3/12/2022 1:49:21 PM	63.94075499	-108.517938	81	12	7	1	0	1	20	North	
3/12/2022 1:51:10 PM	63.9457187	-108.530525	82	19	14	2	0	2	35	North	
3/12/2022 1:53:00 PM	63.95785198	-108.540655	83	22	9	9	0	9	40	North	
3/12/2022 1:55:14 PM	63.95611322	-108.530143	84	9	5	2	0	2	16	North	
3/12/2022 2:00:24 PM	63.94118639	-108.575337	85	23	14	6	1	7	44	North	
3/12/2022 2:01:53 PM	63.96073794	-108.757395	86	30	15	3	0	3	48	North	
3/12/2022 2:09:11 PM	63.9626375	-108.742963	87	0	0	0	6	6	6	North	bull collar
3/12/2022 2:18:27 PM	63.95945518	-109.121516	88	0	0	1	21	22	22	North	
3/12/2022 2:21:47 PM	64.00785137	-109.5653	89	23	14	7	6	13	50	North	1000s
3/12/2022 2:23:30 PM	64.00953472	-109.537169	90	0	0	0	4	4	4	North	

Date Time	Lat Deg	Long Deg	Wpt	Cows	Calves	S Bulls	P Bulls	All Bulls	All Total	Region	Notes
3/12/2022 2:24:01 PM	64.01429618	-109.476361	91	5	3	5	3	8	16	North	
3/12/2022 2:24:53 PM	64.01584627	-109.474792	92	16	9	2	0	2	27	North	
3/12/2022 2:27:47 PM	64.01652432	-109.46542	93	24	12	10	12	22	58	North	
3/12/2022 2:41:13 PM	64.01004156	-109.425882	94	11	8	4	0	4	23	North	
3/12/2022 2:45:21 PM	63.67060014	-109.622052	95	11	6	1	1	2	19	East	
3/12/2022 2:46:27 PM	63.63446927	-109.766394	96	10	4	0	0	0	14	East	
3/12/2022 4:25:31 PM	63.62365373	-109.767041	97	0	0	3	25	28	28	East	bull collar
3/12/2022 4:25:45 PM	63.05923797	-108.869633	98	0	0	0	15	15	15	East	
3/12/2022 4:28:13 PM	63.06048016	-108.871045	99	0	0	1	10	11	11	East	
3/12/2022 4:28:51 PM	63.06874493	-108.88594	100	0	0	0	13	13	13	East	
3/12/2022 4:32:42 PM	63.06723457	-108.87194	101	0	0	8	23	31	31	East	
3/12/2022 4:37:15 PM	63.10739034	-108.968999	103	0	0	0	2	2	2	East	
3/12/2022 4:40:06 PM	63.17190198	-109.159949	104	0	0	3	17	20	20	East	
3/12/2022 4:42:30 PM	63.1850752	-109.220643	105	0	0	0	18	18	18	East	
3/12/2022 4:42:49 PM	63.19578965	-109.252586	106	1	1	0	0	0	2	East	
3/12/2022 4:44:20 PM	63.19874034	-109.2492	107	0	0	3	11	14	14	East	
3/12/2022 4:50:52 PM	63.19962942	-109.262314	108	0	0	0	3	3	3	East	
3/12/2022 4:55:34 PM	63.11994945	-109.60083	109	0	0	2	9	11	11	East	
3/12/2022 4:56:21 PM	63.11156487	-109.765878	110	0	0	1	5	6	6	East	
3/12/2022 4:56:54 PM	63.12065943	-109.769051	111	0	0	0	4	4	4	East	
3/12/2022 4:59:06 PM	63.12091054	-109.780672	112	0	0	1	31	32	32	East	
3/12/2022 5:11:33 PM	63.13493155	-109.755293	113	0	2	0	4	4	6	East	
3/12/2022 5:22:21 PM	63.28099279	-109.92038	114	0	0	4	30	34	34	East	
3/12/2022 5:24:12 PM	63.2923955	-109.296889	115	6	2	15	29	44	52	East	
3/12/2022 5:38:40 PM	63.28580827	-109.309674	116	15	5	9	8	17	37	East	
3/12/2022 5:39:33 PM	63.54620778	-109.371264	117	20	8	3	0	3	31	East	
3/12/2022 5:41:11 PM	63.54249434	-109.376605	118	27	12	3	0	3	42	East	
3/12/2022 5:44:19 PM	63.54884606	-109.34658	119	4	2	0	6	6	12	East	
3/12/2022 5:44:27 PM	63.57913769	-109.440574	120	0	0	4	4	8	8	East	
3/12/2022 5:45:42 PM	63.58068292	-109.441498	121	11	4	10	6	16	31	East	
3/12/2022 5:47:00 PM	63.58507853	-109.439689	122	23	13	1	0	1	37	East	
3/12/2022 5:47:25 PM	63.58936101	-109.43907	123	8	4	3	0	3	15	East	
3/13/2022 11:06:51 AM	62.69048073	-107.841612	126	2	2	3	24	27	31	East	2 bull collars
3/13/2022 11:07:19 AM	62.69714844	-107.845227	127	0	0	2	11	13	13	East	
3/13/2022 11:08:31 AM	62.69780188	-107.859313	128	0	0	6	6	12	12	East	
3/13/2022 11:09:22 AM	62.69244929	-107.868496	129	0	0	1	7	8	8	East	
3/13/2022 11:12:58 AM	62.72269016	-107.826091	130	0	0	0	18	18	18	East	
3/13/2022 11:22:52 AM	62.91157787	-107.413103	131	0	0	0	3	3	3	East	
3/13/2022 11:30:20 AM	63.03182135	-107.142072	132	2	0	0	0	0	2	East	
3/13/2022 11:43:09 AM	63.22596014	-106.547404	134	7	5	1	1	2	14	East	

Date Time	Lat Deg	Long Deg	Wpt	Cows	Calves	S Bulls	P Bulls	All Bulls	All Total	Region	Notes
3/13/2022 11:44:03 AM	63.23037526	-106.538344	135	16	6	3	0	3	25	East	
3/13/2022 11:45:50 AM	63.22680282	-106.474953	136	4	3	0	0	0	7	East	
3/13/2022 11:46:53 AM	63.22938594	-106.448002	137	6	3	1	0	1	10	East	
3/13/2022 11:47:30 AM	63.23304855	-106.44435	139	6	5	0	0	0	11	East	
3/13/2022 11:48:22 AM	63.23285547	-106.456019	140	9	5	3	2	5	19	East	
3/13/2022 11:48:50 AM	63.236662	-106.462206	141	1	1	0	0	0	2	East	
3/13/2022 11:49:28 AM	63.23707852	-106.451508	142	15	10	0	0	0	25	East	
3/13/2022 11:51:07 AM	63.24228561	-106.44549	143	17	10	5	1	0	33	East	
3/13/2022 11:52:57 AM	63.24641064	-106.44013	144	10	7	12	0	0	29	East	
3/13/2022 11:54:23 AM	63.25026152	-106.424899	145	13	9	1	0	0	23	East	collar cow w calf
3/13/2022 11:54:40 AM	63.255726	-106.433184	146	3	0	0	0	0	3	East	
3/13/2022 11:55:08 AM	63.25624336	-106.438553	147	6	2	1	0	0	9	East	
3/13/2022 11:57:15 AM	63.25711387	-106.446685	148	8	6	2	0	2	16	East	
3/13/2022 11:59:19 AM	63.26065637	-106.519103	149	7	6	0	0	0	13	East	
3/13/2022 12:00:31 PM	63.26479674	-106.58141	150	0	0	0	7	7	7	East	
3/13/2022 12:04:02 PM	63.25817799	-106.616068	151	9	6	1	0	1	16	East	
3/13/2022 12:13:22 PM	63.21232619	-106.722311	153	2	1	0	0	0	3	East	
3/13/2022 12:13:41 PM	63.1733332	-106.879004	154	3	2	1	0	1	6	East	
3/13/2022 2:49:25 PM	63.09001084	-110.156863	158	0	0	0	22	22	22	East	
3/13/2022 3:08:40 PM	63.13362341	-110.347534	159	0	0	2	17	19	19	East	bull collar
3/13/2022 3:19:35 PM	63.31761956	-111.088794	160	2	0	0	21	21	23	Lock	
3/13/2022 3:21:21 PM	63.48255306	-111.370025	161	2	2	5	12	17	21	Lock	
3/13/2022 3:25:23 PM	63.49603883	-111.403386	162	1	2	2	5	7	10	Lock	
3/13/2022 3:26:56 PM	63.54595041	-111.453229	164	1	1	6	21	27	29	Lock	
3/13/2022 3:28:21 PM	63.54795052	-111.46076	165	0	0	8	18	26	26	Lock	
3/13/2022 3:29:32 PM	63.55363838	-111.461037	166	0	0	0	3	3	3	Lock	
3/13/2022 3:33:17 PM	63.54289151	-111.485535	167	0	0	11	21	32	32	Lock	
3/13/2022 3:38:33 PM	63.54396265	-111.478535	168	0	0	0	14	14	14	Lock	
3/13/2022 3:40:13 PM	63.54352485	-111.442278	169	0	0	5	14	19	19	Lock	
3/13/2022 3:40:28 PM	63.54405242	-111.436881	170	0	0	0	7	7	7	Lock	
3/13/2022 4:04:32 PM	63.55469806	-111.862444	172	0	0	3	12	15	15	Lock	
3/13/2022 4:07:14 PM	63.55543121	-112.212267	173	4	2	2	6	8	14	Lock	
3/13/2022 4:07:50 PM	63.57674032	-112.184096	174	5	4	1	6	7	16	Lock	
3/13/2022 4:08:09 PM	63.57777467	-112.188602	175	5	3	2	0	2	10	Lock	
3/13/2022 4:09:43 PM	63.57945842	-112.189941	176	5	2	3	10	13	20	Lock	
3/13/2022 4:10:26 PM	63.58713396	-112.156205	177	6	2	1	0	1	9	Lock	
3/13/2022 4:11:09 PM	63.59034413	-112.149464	178	0	0	4	15	19	19	Lock	
3/13/2022 4:12:33 PM	63.59468282	-112.153074	179	0	0	1	5	6	6	Lock	
3/13/2022 4:13:13 PM	63.59323643	-112.13979	180	0	0	0	10	10	10	Lock	
3/13/2022 4:15:21 PM	63.60022152	-112.138345	181	10	5	5	0	5	20	Lock	

Date Time	Lat Deg	Long Deg	Wpt	Cows	Calves	S Bulls	P Bulls	All Bulls	All Total	Region	Notes
3/13/2022 4:16:51 PM	63.58184986	-112.138991	182	5	3	0	0	0	8	Lock	cow collar w calf
3/13/2022 4:19:08 PM	63.58083154	-112.169987	183	3	0	7	22	29	32	Lock	
3/13/2022 4:27:13 PM	63.58460987	-112.198892	184	6	2	0	0	0	8	Lock	collar cow no calf
3/13/2022 4:27:37 PM	63.61918018	-112.217074	185	2	0	0	0	0	2	Lock	
3/13/2022 4:47:12 PM	63.62266439	-112.217035	187	0	0	8	24	32	32	Lock	
3/13/2022 4:49:19 PM	63.66898779	-112.242585	188	24	11	1	0	1	36	Lock	
3/13/2022 4:51:12 PM	63.68381727	-112.201093	189	4	2	3	3	6	12	Lock	
3/13/2022 4:52:03 PM	63.69054339	-112.221066	190	1	1	8	7	15	17	Lock	
3/13/2022 4:55:17 PM	63.68458836	-112.229372	191	19	9	6	3	9	37	Lock	
3/13/2022 5:01:01 PM	63.69414254	-112.216486	192	9	6	1	0	1	16	Lock	
3/13/2022 5:01:52 PM	63.68110651	-112.188681	193	4	3	0	4	4	11	Lock	
3/13/2022 5:03:43 PM	63.68776731	-112.186053	194	10	4	2	6	8	22	Lock	collar cow calf maybe
3/13/2022 5:04:34 PM	63.69684825	-112.163149	195	1	1	1	0	1	3	Lock	
3/13/2022 5:05:27 PM	63.69570832	-112.167652	196	6	4	1	0	1	11	Lock	
3/13/2022 5:05:44 PM	63.69256695	-112.154156	197	1	1	0	0	0	2	Lock	
3/13/2022 6:04:14 PM	63.69458476	-112.151834	198	1	1	0	0	0	2	Lock	
3/13/2022 6:05:19 PM	63.67496346	-112.190888	199	0	0	2	0	2	2	Lock	
3/13/2022 6:09:01 PM	63.66837525	-112.192731	200	8	3	0	0	0	11	Lock	
3/13/2022 6:09:49 PM	63.7221713	-112.257083	201	1	1	3	0	3	5	Lock	
3/13/2022 6:12:13 PM	63.7288698	-112.242745	202	17	7	2	0	2	26	Lock	
3/13/2022 6:16:36 PM	63.72576066	-112.185865	205	2	0	3	0	3	5	Lock	
3/13/2022 6:19:49 PM	63.72077264	-112.212709	206	24	13	8	0	8	45	Lock	
3/13/2022 6:20:57 PM	63.72353284	-112.248963	207	1	1	3	0	3	5	Lock	
3/13/2022 6:27:26 PM	63.73302274	-112.263723	208	2	2	2	3	5	9	Lock	
3/13/2022 6:36:06 PM	63.71714203	-112.433733	209	26	12	3	0	3	41	Lock	
3/13/2022 6:37:15 PM	63.74145105	-112.487349	210	13	2	4	1	5	20	Lock	
3/13/2022 6:42:41 PM	63.73274188	-112.492075	211	0	0	4	15	19	19	Lock	
3/13/2022 6:43:55 PM	63.71996134	-112.455298	212	0	0	3	7	10	10	Lock	
3/13/2022 6:45:05 PM	63.70945909	-112.47599	213	0	0	0	24	24	24	Lock	
3/13/2022 6:45:27 PM	63.7041996	-112.476257	214	0	0	1	7	8	8	Lock	
3/13/2022 6:48:43 PM	63.70521109	-112.480869	215	12	7	17	11	28	47	Lock	
3/13/2022 6:51:35 PM	63.72267017	-112.540269	216	15	7	1	0	1	23	Lock	collar cow
3/13/2022 6:56:49 PM	63.74255769	-112.603231	217	0	0	2	12	14	14	Lock	

Appendix 1B. Observations of caribou groups on Bluenose-East (mixed) survey in March 2022

S Bulls = Small Bulls; P Bulls = Prime Bulls; Wpt = Waypoint Number.

Date Time	Lat Deg	Long Deg	Wpt	Cows	Calves	S Bulls	P Bulls	Tot Bulls	All Total	Region	Comments
3/8/2022 1:26:56 PM	64.19289103	-114.0779403	1	2	2	2	0	2	6	Central	
3/8/2022 1:27:20 PM	64.32329101	-113.9237516	2	2	1	0	0	0	3	Central	
3/10/2022 1:51:53 PM	64.17808498	-113.2727369	56	0	0	0	0	0	0	South	
3/14/2022 5:19:56 PM	66.36198116	-116.4965991	133	0	0	0	0	0	0	North	
3/14/2022 5:24:44 PM	66.38242907	-116.4424707	134	0	0	0	0	0	0	North	
3/14/2022 5:25:30 PM	66.37367063	-116.393939	135	0	0	0	0	0	0	North	
3/15/2022 1:06:44 PM	65.64797996	-115.6215841	205	0	0	0	0	0	0	North	
3/8/2022 1:27:57 PM	64.32198913	-113.9333484	3	7	2	2	0	2	11	Central	
3/8/2022 1:30:01 PM	64.32886834	-113.9391788	4	19	11	0	5	5	35	Central	
3/8/2022 1:42:17 PM	64.45058721	-114.0844773	5	0	0	0	2	2	2	Central	
3/8/2022 2:08:08 PM	64.49956338	-115.0800459	6	0	0	1	8	9	9	Central	
3/8/2022 2:08:20 PM	64.50301332	-115.0859826	7	0	0	0	3	3	3	Central	
3/8/2022 2:10:21 PM	64.51517932	-115.0892773	8	2	2	9	23	32	36	Central	
3/8/2022 2:11:47 PM	64.52767833	-115.1100479	9	0	0	0	6	6	6	Central	
3/8/2022 2:20:25 PM	64.43118833	-115.2395585	10	0	0	0	13	13	13	Central	
3/8/2022 2:21:05 PM	64.42517367	-115.2461041	11	0	0	1	4	5	5	Central	
3/8/2022 2:23:10 PM	64.42338931	-115.3045103	12	0	0	4	17	21	21	Central	
3/8/2022 2:24:31 PM	64.41750006	-115.3450702	13	0	0	1	4	5	5	Central	
3/8/2022 2:25:26 PM	64.42733169	-115.3494335	14	0	0	1	3	4	4	Central	
3/8/2022 2:25:36 PM	64.42915268	-115.3560565	15	0	0	1	0	1	1	Central	
3/8/2022 2:28:55 PM	64.45157977	-115.4360358	16	1	1	0	4	4	6	Central	
3/8/2022 2:29:34 PM	64.4580723	-115.4623792	17	0	0	1	1	2	2	Central	
3/8/2022 2:31:50 PM	64.46009508	-115.4718415	18	0	0	5	11	16	16	Central	
3/8/2022 2:39:01 PM	64.48474174	-115.5252303	19	1	0	3	0	3	4	Central	
3/8/2022 2:39:52 PM	64.58400055	-115.6570636	20	2	1	2	0	2	5	Central	
3/8/2022 2:46:05 PM	64.59966191	-115.7054837	21	0	0	6	8	14	14	Central	
3/8/2022 3:52:46 PM	64.99132964	-116.031092	22	1	0	0	5	5	6	Central	
3/8/2022 3:53:16 PM	65.07521816	-116.112954	23	5	4	0	0	0	9	Central	
3/8/2022 3:54:51 PM	65.09197907	-116.1210327	24	2	2	1	1	2	6	Central	
3/8/2022 3:57:22 PM	65.08006333	-116.114575	25	5	3	0	0	0	8	Central	
3/8/2022 4:02:02 PM	65.12229716	-116.0333868	26	2	1	0	0	0	3	Central	
3/8/2022 4:02:56 PM	65.12443191	-116.0403748	27	15	5	0	0	0	20	Central	

Date Time	Lat Deg	Long Deg	Wpt	Cows	Calves	S Bulls	P Bulls	Tot Bulls	All Total	Region	Comments
3/8/2022 4:18:27 PM	65.14268719	-115.787052	28	1	1	5	6	11	13	Central	
3/8/2022 4:44:34 PM	65.03907449	-115.6890245	33	8	3	0	0	0	11	Central	
3/8/2022 4:47:26 PM	65.0311034	-115.6926144	34	9	4	3	5	8	21	Central	
3/8/2022 4:28:13 PM	65.33012335	-115.9036937	29	1	1	0	0	0	2	North	
3/8/2022 4:29:28 PM	65.306186	-115.9471746	30	1	1	0	0	0	2	North	
3/8/2022 4:31:13 PM	65.29718307	-115.939064	31	13	6	0	0	0	19	North	
3/8/2022 4:32:31 PM	65.30018491	-115.9389117	32	12	6	0	1	1	19	North	
3/8/2022 4:51:42 PM	65.01381089	-115.7184677	35	8	3	6	2	8	19	Central	
3/8/2022 5:11:02 PM	64.7708983	-115.3647729	36	0	0	5	4	9	9	Central	
3/8/2022 5:38:52 PM	64.14811397	-114.5040634	39	0	0	0	7	7	7	Central	
3/10/2022 12:22:27 PM	63.91666242	-113.353816	42	3	1	1	4	5	9	South	
3/10/2022 12:29:53 PM	63.87005003	-113.1583128	43	0	0	1	8	9	9	South	
3/10/2022 12:38:57 PM	63.7138365	-113.4201609	44	0	0	0	4	4	4	South	
3/10/2022 12:50:51 PM	63.71471453	-113.7076459	46	0	0	0	10	10	10	South	
3/10/2022 12:55:38 PM	63.71480903	-113.7066012	47	0	0	0	10	10	10	South	bull collar
3/10/2022 1:01:13 PM	63.79642	-113.5119072	48	0	0	0	3	3	3	South	
3/10/2022 1:04:36 PM	63.80942795	-113.5401949	49	0	0	0	6	6	6	South	
3/10/2022 1:09:44 PM	63.84659055	-113.5219748	50	0	0	0	6	6	6	South	
3/10/2022 1:11:04 PM	63.85320857	-113.5214186	51	0	0	0	11	11	11	South	
3/10/2022 1:13:41 PM	63.86027023	-113.4484883	52	0	0	3	17	20	20	South	
3/10/2022 1:15:18 PM	63.85481611	-113.4090625	53	0	0	0	9	9	9	South	
3/10/2022 1:22:14 PM	63.86611051	-113.4422241	54	0	0	3	17	20	20	South	
3/10/2022 1:51:17 PM	64.16535808	-113.2750708	55	4	1	5	6	11	16	South	
3/14/2022 12:39:36 PM	64.81709835	-116.5234518	57	8	4	0	1	1	13	Central	
3/14/2022 12:42:25 PM	65.41499601	-116.088546	58	4	0	0	0	0	4	North	
3/14/2022 12:43:24 PM	65.41852532	-116.0922896	59	27	16	3	0	3	46	North	
3/14/2022 12:44:08 PM	65.42225883	-116.0764679	60	3	1	0	0	0	4	North	
3/14/2022 12:44:14 PM	65.42277749	-116.0713252	61	1	1	0	0	0	2	North	
3/14/2022 12:45:28 PM	65.42184125	-116.066741	62	11	5	1	0	1	17	North	
3/14/2022 12:45:54 PM	65.4177954	-116.0681345	63	10	5	2	0	2	17	North	
3/14/2022 12:46:21 PM	65.41439843	-116.0657335	64	5	3	1	0	1	9	North	
3/14/2022 12:48:24 PM	65.42294201	-116.0999253	65	8	3	1	0	1	12	North	
3/14/2022 12:49:49 PM	65.42535435	-116.1045739	66	17	13	10	0	10	40	North	
3/14/2022 12:51:04 PM	65.41980726	-116.1102233	67	18	7	6	0	6	31	North	
3/14/2022 12:51:39 PM	65.417171	-116.0994078	68	9	4	2	0	2	15	North	
3/14/2022 12:52:35 PM	65.41519509	-116.100565	69	14	8	3	0	3	25	North	
3/14/2022 12:54:53 PM	65.41783285	-116.1241903	70	13	7	4	0	4	24	North	

Date Time	Lat Deg	Long Deg	Wpt	Cows	Calves	S Bulls	P Bulls	Tot Bulls	All Total	Region	Comments
3/14/2022 12:56:41 PM	65.43363109	-116.1493208	71	4	1	0	0	0	5	North	
3/14/2022 1:04:39 PM	65.52161764	-115.9400555	72	24	14	0	0	0	38	North	
3/14/2022 1:05:31 PM	65.52861136	-115.9231787	73	3	1	0	0	0	4	North	
3/14/2022 1:09:53 PM	65.51366189	-116.0087451	74	17	11	0	0	0	28	North	
3/14/2022 1:12:28 PM	65.51639937	-116.0249659	75	5	2	0	0	0	7	North	
3/14/2022 1:15:55 PM	65.511272	-116.0103408	76	8	0	0	0	0	8	North	
3/14/2022 1:19:48 PM	65.56808721	-116.0437224	77	22	7	3	0	3	32	North	
3/14/2022 1:20:28 PM	65.56914475	-116.0530519	78	8	4	0	0	0	12	North	
3/14/2022 1:21:29 PM	65.5669533	-116.0318766	79	8	2	0	0	0	10	North	
3/14/2022 1:22:33 PM	65.5613107	-116.0055863	80	6	0	1	0	1	7	North	
3/14/2022 1:26:33 PM	65.64009687	-115.9888142	81	1	1	0	0	0	2	North	
3/14/2022 1:27:07 PM	65.64181193	-115.9837575	82	2	3	0	0	0	5	North	
3/14/2022 1:30:55 PM	65.64206942	-115.9925041	83	13	7	1	0	1	21	North	
3/14/2022 1:32:11 PM	65.63734902	-115.9748227	84	10	4	0	0	0	14	North	
3/14/2022 1:35:43 PM	65.65936079	-115.9316834	85	11	7	0	0	0	18	North	
3/14/2022 1:36:35 PM	65.66068408	-115.9245148	86	7	4	1	0	1	12	North	
3/14/2022 1:36:48 PM	65.65949359	-115.923441	87	2	0	1	0	1	3	North	
3/14/2022 1:38:15 PM	65.6587285	-115.9468534	88	11	5	3	0	3	19	North	
3/14/2022 1:40:00 PM	65.66971786	-115.9511702	89	6	3	0	0	0	9	North	
3/14/2022 1:42:53 PM	65.6506051	-115.9930393	90	11	7	5	0	5	23	North	
3/14/2022 1:44:46 PM	65.65556311	-116.0510108	91	6	4	1	0	1	11	North	
3/14/2022 1:48:25 PM	65.66798404	-116.0582652	92	17	10	4	0	4	31	North	
3/14/2022 1:49:22 PM	65.6751436	-116.0725656	93	7	6	0	0	0	13	North	
3/14/2022 1:50:06 PM	65.67801249	-116.0707892	94	17	7	4	0	4	28	North	
3/14/2022 1:52:56 PM	65.71024211	-116.0493673	95	6	4	0	0	0	10	North	
3/14/2022 1:53:47 PM	65.71087971	-116.0537941	96	16	5	1	0	1	22	North	
3/14/2022 1:56:55 PM	65.70753259	-116.0639422	97	5	4	0	0	0	9	North	
3/14/2022 1:58:01 PM	65.72909066	-116.1110311	98	11	5	0	0	0	16	North	
3/14/2022 1:58:34 PM	65.72772152	-116.1181077	99	6	5	0	0	0	11	North	
3/14/2022 1:59:33 PM	65.73213081	-116.1213507	100	12	8	1	0	1	21	North	
3/14/2022 2:06:07 PM	65.74833549	-116.270204	101	4	2	0	0	0	6	North	
3/14/2022 2:09:15 PM	65.78051142	-116.3284408	102	7	5	8	0	8	20	North	
3/14/2022 2:12:46 PM	65.85882422	-116.3329287	103	2	1	0	0	0	3	North	
3/14/2022 2:13:38 PM	65.86822923	-116.3182269	104	4	2	0	0	0	6	North	
3/14/2022 2:15:59 PM	65.90685457	-116.2748388	105	3	2	1	0	1	6	North	
3/14/2022 2:33:49 PM	65.999056	-116.3007429	106	24	11	1	0	1	36	North	
3/14/2022 2:34:05 PM	65.99217618	-116.297472	107	3	1	0	0	0	4	North	

Date Time	Lat Deg	Long Deg	Wpt	Cows	Calves	S Bulls	P Bulls	Tot Bulls	All Total	Region	Comments
3/14/2022 2:35:06 PM	65.99983994	-116.3063971	108	8	4	0	0	0	12	North	
3/14/2022 2:37:36 PM	66.00443254	-116.311988	109	3	1	0	0	0	4	North	
3/14/2022 2:38:46 PM	65.985581	-116.3420529	110	23	17	2	0	2	42	North	
3/14/2022 2:59:03 PM	66.0841473	-116.7461273	111	13	6	2	0	2	21	North	
3/14/2022 2:59:19 PM	66.0824626	-116.7512651	112	1	0	0	0	0	1	North	
3/14/2022 3:00:32 PM	66.08185367	-116.7596098	113	9	3	0	0	0	12	North	
3/14/2022 3:00:50 PM	66.07977879	-116.7588457	114	3	3	1	0	1	7	North	
3/14/2022 3:02:25 PM	66.07401861	-116.7750505	115	12	7	1	0	1	20	North	
3/14/2022 3:04:18 PM	66.0934859	-116.7371121	116	3	2	0	0	0	5	North	
3/14/2022 4:24:51 PM	66.08786207	-117.0385673	117	31	15	3	0	3	49	North	
3/14/2022 4:25:49 PM	66.2114853	-116.9611415	118	17	6	4	0	4	27	North	
3/14/2022 4:29:29 PM	66.2264247	-116.9258558	119	16	6	4	0	4	26	North	
3/14/2022 4:31:04 PM	66.23082281	-116.8773359	120	9	2	0	0	0	11	North	
3/14/2022 4:32:38 PM	66.23035916	-116.8341136	122	3	0	0	0	0	3	North	
3/14/2022 4:33:34 PM	66.22810843	-116.8568352	123	4	2	0	0	0	6	North	
3/14/2022 4:34:57 PM	66.22596267	-116.8687023	124	12	6	1	0	1	19	North	
3/14/2022 4:35:31 PM	66.22710448	-116.8498927	125	3	0	0	0	0	3	North	
3/14/2022 4:40:17 PM	66.24825395	-116.7057467	126	11	3	1	0	1	15	North	
3/14/2022 4:52:00 PM	66.26688878	-116.5657249	127	12	3	3	1	4	19	North	
3/14/2022 4:56:49 PM	66.28964988	-116.6247042	128	10	4	2	0	2	16	North	
3/14/2022 5:04:31 PM	66.32172318	-116.6848766	129	5	2	2	0	2	9	North	
3/14/2022 5:09:28 PM	66.27504084	-116.7188063	130	8	6	1	0	1	15	North	
3/14/2022 5:18:44 PM	66.36064153	-116.4919325	131	23	7	4	0	4	34	North	
3/14/2022 5:19:56 PM	66.36481609	-116.4894632	132	15	1	0	0	0	16	North	
3/14/2022 5:31:54 PM	66.30372283	-116.0401892	136	13	4	1	0	1	18	North	
3/14/2022 5:33:01 PM	66.30262618	-116.0423857	137	6	2	0	0	0	8	North	
3/14/2022 5:34:09 PM	66.30117071	-116.0404567	138	16	3	5	0	5	24	North	
3/14/2022 5:37:00 PM	66.28800101	-115.9621243	139	8	3	1	0	1	12	North	
3/14/2022 5:38:18 PM	66.2836687	-115.925541	140	2	1	0	0	0	3	North	
3/14/2022 5:38:37 PM	66.28330923	-115.9224137	141	10	3	2	0	2	15	North	
3/14/2022 5:39:14 PM	66.28173243	-115.9195698	142	6	4	1	0	1	11	North	
3/14/2022 5:41:58 PM	66.27113326	-115.8676653	143	17	2	2	0	2	21	North	
3/14/2022 5:45:20 PM	66.22117784	-115.8110282	144	7	2	0	0	0	9	North	
3/14/2022 5:50:18 PM	66.13336115	-115.7363701	145	20	9	1	0	1	30	North	
3/14/2022 5:50:28 PM	66.13474187	-115.7427809	146	2	1	0	0	0	3	North	
3/14/2022 5:51:19 PM	66.13586062	-115.7447951	147	6	4	0	0	0	10	North	
3/14/2022 5:52:50 PM	66.13396782	-115.7562767	148	22	12	1	0	1	35	North	

Date Time	Lat Deg	Long Deg	Wpt	Cows	Calves	S Bulls	P Bulls	Tot Bulls	All Total	Region	Comments
3/14/2022 5:54:05 PM	66.11863185	-115.7420832	149	7	2	0	0	0	9	North	
3/14/2022 5:56:25 PM	66.09964661	-115.6996068	150	14	7	2	0	2	23	North	
3/14/2022 5:57:27 PM	66.09699779	-115.6902706	151	23	7	2	0	2	32	North	
3/14/2022 5:58:37 PM	66.09071917	-115.6713694	152	2	0	1	0	1	3	North	
3/14/2022 5:59:05 PM	66.08945986	-115.6705648	153	9	3	0	0	0	12	North	
3/14/2022 6:09:24 PM	66.00549477	-115.620061	154	5	0	0	0	0	5	North	
3/14/2022 6:13:24 PM	66.01427722	-115.6202927	155	22	8	2	0	2	32	North	
3/14/2022 6:16:01 PM	65.99066693	-115.6854401	156	1	1	0	0	0	2	North	
3/14/2022 6:17:36 PM	65.98536953	-115.6765375	157	7	3	0	0	0	10	North	
3/14/2022 6:19:27 PM	65.98231104	-115.6400369	158	10	5	0	0	0	15	North	
3/14/2022 6:21:46 PM	65.96212377	-115.6899625	159	5	0	0	0	0	5	North	
3/14/2022 6:25:08 PM	65.93739031	-115.759243	160	18	8	1	0	1	27	North	
3/14/2022 6:31:22 PM	65.89696222	-115.7505627	161	4	3	0	0	0	7	North	
3/14/2022 6:37:26 PM	65.83104262	-115.6560034	162	2	2	0	0	0	4	North	
3/15/2022 11:12:19 AM	64.20867774	-114.0926974	163	6	1	0	1	1	8	North	
3/15/2022 11:14:27 AM	65.61873251	-114.9878883	164	7	3	0	0	0	10	North	
3/15/2022 11:15:35 AM	65.62797961	-114.980925	165	0	0	1	4	5	5	North	
3/15/2022 11:19:40 AM	65.62001895	-114.9410686	166	6	3	1	1	2	11	North	Collar cow with calf
3/15/2022 11:20:04 AM	65.61997144	-114.9627549	167	6	2	0	0	0	8	North	
3/15/2022 11:21:01 AM	65.63055564	-114.975985	168	1	1	0	0	0	2	North	
3/15/2022 11:22:17 AM	65.61919103	-115.0016614	169	6	3	0	0	0	9	North	
3/15/2022 11:22:55 AM	65.61529039	-115.0039102	170	9	5	0	0	0	14	North	
3/15/2022 11:34:12 AM	65.73713039	-114.8925412	171	13	7	0	0	0	20	North	collared cow with calf
3/15/2022 11:44:30 AM	65.88713487	-115.0117893	172	18	9	2	0	2	29	North	
3/15/2022 11:46:06 AM	65.88940702	-115.0196014	173	40	21	1	0	1	62	North	
3/15/2022 11:47:13 AM	65.88574852	-115.0004997	174	16	5	0	0	0	21	North	
3/15/2022 11:47:52 AM	65.88635121	-114.9941585	175	17	8	1	0	1	26	North	
3/15/2022 11:50:18 AM	65.91019416	-115.0344568	176	18	9	1	0	1	28	North	
3/15/2022 11:51:46 AM	65.91328208	-115.0260236	177	33	15	3	0	3	51	North	
3/15/2022 11:53:22 AM	65.90861195	-115.0081822	178	15	8	1	0	1	24	North	
3/15/2022 12:00:12 PM	65.8854649	-115.3490458	179	7	6	0	0	0	13	North	
3/15/2022 12:02:26 PM	65.87915091	-115.4423249	180	10	4	0	0	0	14	North	
3/15/2022 12:10:00 PM	65.89351216	-115.5755823	181	21	12	2	0	2	35	North	
3/15/2022 12:11:21 PM	65.90223645	-115.6085768	182	10	5	0	0	0	15	North	
3/15/2022 12:15:57 PM	65.9066158	-115.8098522	183	7	4	3	0	3	14	North	
3/15/2022 12:18:28 PM	65.87331129	-115.783159	184	7	7	1	0	1	15	North	
3/15/2022 12:22:19 PM	65.81247154	-115.7094664	185	12	6	5	0	5	23	North	

Date Time	Lat Deg	Long Deg	Wpt	Cows	Calves	S Bulls	P Bulls	Tot Bulls	All Total	Region	Comments
3/15/2022 12:23:36 PM	65.81236637	-115.7250425	186	11	4	1	0	1	16	North	
3/15/2022 12:25:11 PM	65.82981014	-115.7024191	187	8	3	2	0	2	13	North	
3/15/2022 12:29:12 PM	65.78683661	-115.7067348	188	4	3	1	0	1	8	North	
3/15/2022 12:32:22 PM	65.80928244	-115.7165953	189	11	6	1	0	1	18	North	
3/15/2022 12:33:22 PM	65.80633705	-115.7067249	190	11	3	0	0	0	14	North	
3/15/2022 12:35:20 PM	65.79346706	-115.6905804	191	17	7	0	0	0	24	North	
3/15/2022 12:36:31 PM	65.79190258	-115.6949217	192	16	11	0	0	0	27	North	
3/15/2022 12:37:41 PM	65.79498909	-115.701292	193	11	7	0	0	0	18	North	
3/15/2022 12:38:10 PM	65.79685218	-115.7013125	194	10	2	0	0	0	12	North	
3/15/2022 12:40:07 PM	65.79324962	-115.664363	195	12	5	3	1	4	21	North	
3/15/2022 12:50:35 PM	65.69693724	-115.3750447	196	19	9	2	0	2	30	North	
3/15/2022 12:53:41 PM	65.69598729	-115.4125084	197	11	9	3	0	3	23	North	
3/15/2022 12:54:09 PM	65.69358767	-115.403946	198	5	2	0	0	0	7	North	
3/15/2022 1:00:15 PM	65.66295937	-115.6574706	199	7	2	0	0	0	9	North	
3/15/2022 1:00:27 PM	65.66114512	-115.6611211	200	2	1	0	0	0	3	North	
3/15/2022 1:02:33 PM	65.66814671	-115.6708502	201	12	8	1	0	1	21	North	
3/15/2022 1:03:46 PM	65.67054968	-115.6641333	202	16	9	0	0	0	25	North	
3/15/2022 1:04:34 PM	65.66940716	-115.6510501	203	6	3	2	0	2	11	North	
3/15/2022 1:04:41 PM	65.66709589	-115.6441374	204	1	1	0	0	0	2	North	