



R2-MVEIRB-14

Topic: Caribou and Moose - Maps

Preamble from the Mackenzie Valley Environmental Impact Review Board:

The GNWT brought new caribou maps to the technical sessions in Yellowknife in November. It seemed to be a compilation of all collar data and key habitat values for caribou.

During the Technical Session, (19 Nov, p. 127, lines 19-27; p. 128, lines 1-2), James Hodson, GNWT, indicated that collars put out on boreal caribou for the MVH assessment and recent data up to this year were not included in the DAR.

Request from the Mackenzie Valley Environmental Impact Review Board:

Please provide copies of all caribou maps presented at the technical sessions, along with any updated technical assessments and relevant information.



Response from the Government of the Northwest Territories (GNWT)

The GNWT posted several of its public engagement posters on the wall in the Technical Sessions venue (December 19-21, 2024). The map of “Boreal Caribou Range and Collar Locations”, included in the engagement poster titled *Potential Effects on Caribou, Moose, and other Wildlife*, was from engagement activities completed in November-December, 2022. The collar data presented in this aforementioned figure was current to June 2022. Subsequent to this, Figure 3.1 of Appendix 10A (Caribou and Moose Technical Data Report [TDR]), included in the Developer’s Assessment Report (DAR) used collar locations from 2003–2023 (created August 10, 2023), so there was approximately one more year of collar data included in Figure 3.1 presented in the DAR, compared to the map on the engagement poster.

During the Technical Sessions, the Review Board’s technical expert on caribou, John Nishi, referred to and displayed Figure 45-1 provided in the GNWT’s response to Round 1 MVEIRB Information Request (IR)#45. He inquired about the "gap" in caribou locations between Tulita and Wrigley. As supplemented by the data shown in Table MVEIRB 45-1 provided in the same IR response, this figure only showed seasonal home ranges of collared caribou from 2019–2023 during early/mid-winter, late winter, and post-calving as part of the supplementary movement analysis in EDI (2024).

Figure 3.1 in the TDR, and Figure 45-1 in the Round 1 MVEIRB IR#45 response therefore represent the information referred to and presented at the Technical Sessions, and the data used to support the predictions and conclusions made in the DAR about the potential effects on boreal caribou from changes to movement.

The GNWT continues to collect and analyze data from deployed boreal caribou collars. A recent report titled *Summary of Mackenzie Valley Highway Boreal Caribou Collaring Program 2019–2024* (Hodson et al., 2024), included as an attachment to this response, provides an overview of more recently analyzed collar data. All collared caribou locations (2019–2024) are visualized in Figure 7 and Figure 8 of that report. These figures support the predictions/conclusions made in the DAR regarding boreal caribou space use and movement. Most caribou remain distant from the Mackenzie Valley Winter Road (MVWR) and the Project alignment route and occur east of the Franklin Mountains. When/where caribou do interact with the MVWR and Project route, crossings are limited.

References

Hodson, J., Gast, M., Depot-Bernier, A. 2024. Summary of Mackenzie Valley Highway Boreal Caribou Collaring Program 2019-2024. Government of the Northwest Territories Internal Report.

Summary of Mackenzie Valley Highway Boreal Caribou Collaring Program 2019-2024

Report prepared by the following GNWT-ECC staff: James Hodson, Michael Gast, Arianne Depot-Bernier. Special thanks to Chloe Beaupre (State University of New York) for vital rate calculations.

Executive Summary

The Mackenzie Valley Highway (MVH) Project is obligated to assess and monitor the impact the all-season road construction has on boreal caribou in the area. The MVH project aims to maintain 20 radio collars on adult female caribou to monitor population trend and movement patterns. To date, 28 collars have been deployed on caribou, 8 have died, 15 have released on schedule. Population (Lambda) estimates trend downward from 2019 to 2024 but averaged across the study time indicates a stable population. A total of 3 collared caribou have crossed the road since 2019 on 5 separate occasions. There are 5 collars deployed on adult female caribou in the MVH study area.

Background

To gather baseline data to support the Environmental Assessment of the Mackenzie Valley Highway Project ([EA1213-02](#)), the Government of Northwest Territories (GNWT) Department of Environment and Climate Change (ECC) initiated a boreal caribou (t̥ɔdz̥ɪ) monitoring program in 2019. GPS collars were deployed on adult female boreal caribou to monitor and gather more information on the interaction of boreal caribou with the proposed Mackenzie Valley Highway (MVH) Project and indicators of population trend of boreal caribou in the region. This collaring program is designed to compare boreal caribou movements around the MVH before, during and after construction of the approximately 281 kilometer long all-season road. This program was conducted under Wildlife Research Permits, WL500843 (2020), WL00898 (SSR), and WL500905 (Dehcho) in 2021, as well as WL501121, WL501122, WL501129 in 2023, and WL501256 in 2024. All procedures for the capture and handling of boreal caribou to deploy collars were reviewed and approved on an annual basis by the NWT [Wildlife Care Committee](#) and followed the [Standard Operating Procedure for the Capture, Handling and Release of Caribou](#).

Information from this monitoring program has been used in [Volume 2](#) of the [Developer's Assessment Report](#) (DAR) for the MVH Project. [Appendix 10A](#) of DAR Volume 2 includes a map (see Figure 3.1 in Appendix 10A) that displays collar data from the current MVH boreal caribou monitoring program, as well as older collar data collected during the environmental assessment of the Mackenzie Gas Project. The DAR Volume 2 and Appendix 10A summarize available baseline information about boreal caribou within the Sahtú and Dehcho regions, and discuss predicted impacts to boreal caribou and their habitat from the project as well as proposed mitigation measures to avoid or minimize those impacts. Location data from the collars deployed between 2019-2023 within the MVH study area were also used in a supplemental report entitled [Mackenzie Valley Highway Project: Inferring the Potential Barriers to Boreal Caribou Movement](#). The report looks at collared boreal caribou interactions with the existing Mackenzie Valley winter road network, and uses habitat selection and movement models to assess whether existing winter road and proposed all-season MVH Project might act as a barrier to movements.

It is proposed that the collar-based monitoring program for boreal caribou continue as part of the Wildlife Management and Monitoring Plan (WMMP), which is required during construction and operation of the MVH. A draft of the WMMP is included in [Volume 5](#) of the DAR.

Collar Deployment

Between 2019 and 2024 a total of 28 Telonics TGW-4677-4 GPS/Iridium collars weighing around 1100 grams were deployed by GNWT-ECC. These GPS collars were deployed on adult female boreal caribou in the Dehcho and Sahtú regions along the MVH study area (Figure 1). The MVH study area is just to the north of the existing North Dehcho boreal caribou study area, and west of the Mackenzie River. The study area boundaries are periodically updated to better capture the extent of collared caribou movements, and to reflect natural and human barriers to movement between study areas, and boundaries between ecozones.

Collars were programmed to record GPS location every 2 hours and were set to drop off after 3-4 years. Captures were conducted in February and March of each year. An A-Star B2 helicopter was used with a sliding door and skids to enable caribou capture. Caribou were captured following the NWT "[Capture, Handling and Release of Caribou - Standard Operating Procedure](#)", using a net-gun. The capture methods are approved by the NWT Wildlife Care Committee each capture year. Caribou were restrained with leg hobbles and a blindfold was placed over the eyes to help calm the animal. Collared animals were monitored daily for the first month after deployment to detect if a collar became stationary as soon as possible. Afterwards, collars are continually monitored for any malfunctions or suspect mortalities and investigated when possible.

Each animal was initially examined to assess the condition and to check for any capture-related injuries. Samples collected from each animal included approximately 15 mL of blood (from the cephalic vein in the foreleg), approximately 50 g of feces (either from the ground after defecation, or from the rectum), and a sample of hair (with roots; taken from between the shoulders). Any winter tick related hair loss was documented and associated ticks collected. A

body condition score was used following CircumArctic Rangifer Monitoring and Assessment (CARMA) Network protocols, initially developed for barren-ground caribou (Gerhart, et al. 1996). The following was also recorded for each capture event: age class based on tooth wear, struggle index, capture location, chase and handling times, presence of a calf at heel, lactation status, neck girth, average snow depths and snow condition and pertinent information pertaining to observations of the health (signs of disease, previous injury, etc.). No immobilization drugs were used during the capture program. All collars were fit snugly around the neck, allowing for an open-palmed hand to move freely between the neck and the collar material. Blood collected was stored for genetic analysis and serum was used to investigate pregnancy status and general health. Fecal matter will be analyzed for parasites.

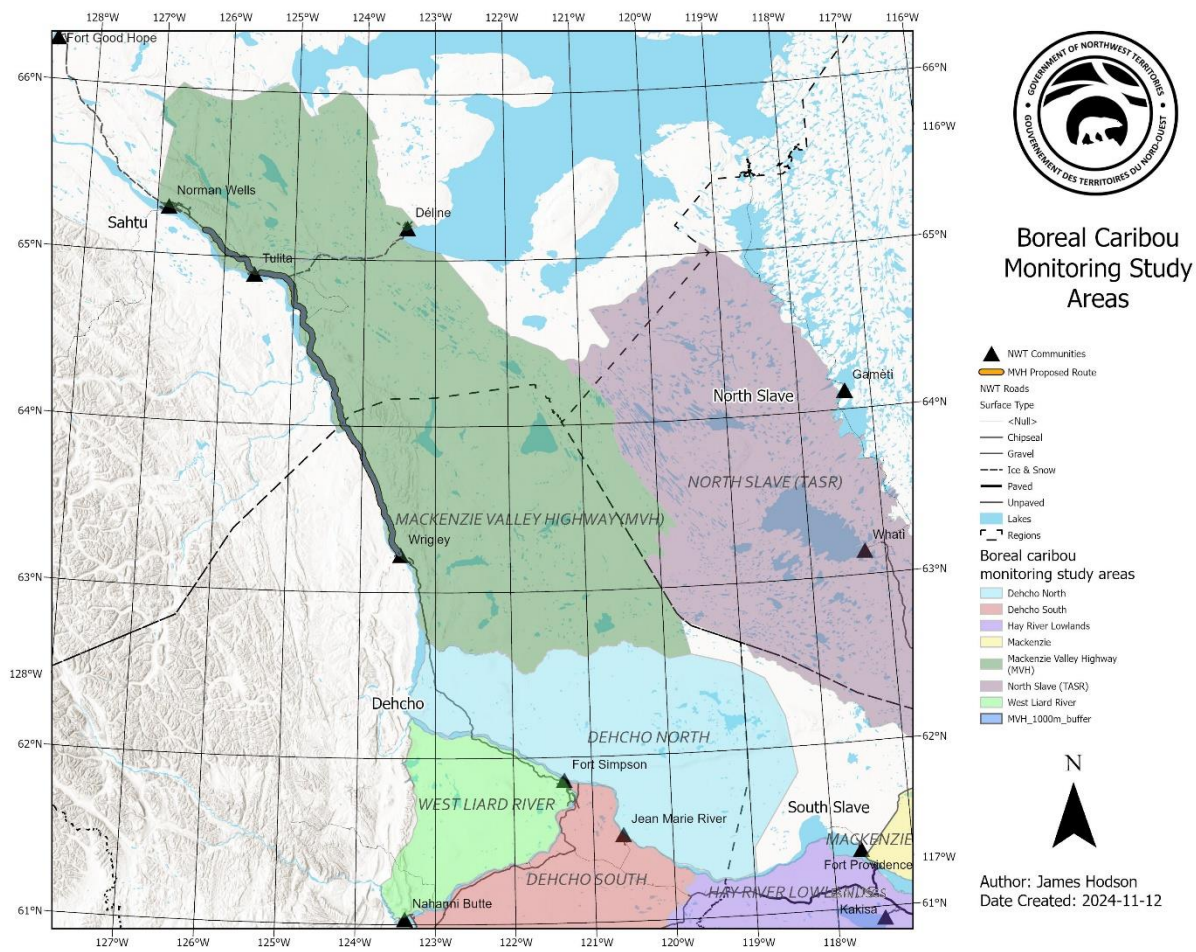


Figure 1. Current boundary for the Mackenzie Valley Highway boreal caribou monitoring study area, and adjacent study areas where collar-based boreal caribou monitoring is ongoing as of 2024.

Starting in 2019, collars were deployed opportunistically on caribou while out flying the MVH study area. A reconnaissance flight was flown in 2019 to assist caribou capture efforts. Collars continued to be deployed annually, except for 2022 when the crew was grounded due to COVID-19. The collars scheduled to be put out in 2022 were deployed the following year in 2023. A total of 28 collars have been deployed to date, split evenly between the Dehcho and Sahtú regions (Table 1). All collars that have been deployed are on the East side of the MVH alignment (Figure 2).

Table 1. Collars deployed on female boreal caribou in the Dehcho and Sahtú regions between 2019-2023.

Region	Year						Total
	2019	2020	2021	2022	2023	2024	
Dehcho	1	9	0	0	4	0	14
Sahtú	0	4	6	0	4	1	14
Total	1	13	6	0	8	1	28

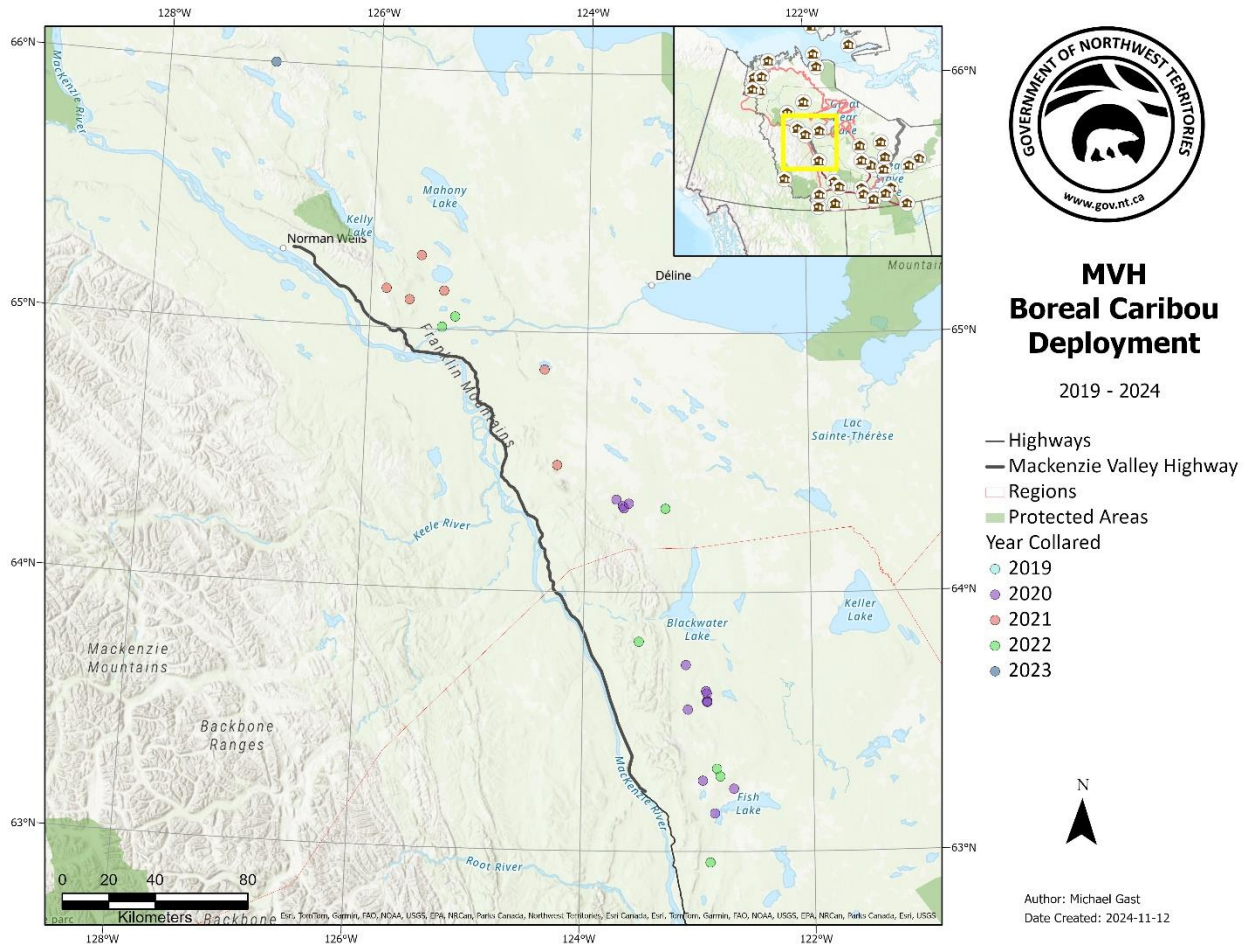


Figure 2. Mackenzie Valley Highway (MVH) boreal caribou collar deployment locations 2019-2024. Points are collaring deployment locations and colours indicate the year of deployment. Some animals were captured in close proximity to each other resulting in less circles visible on the map than expected.

Capture data and samples collected

An annual summary of capture data can be found in Table 2, with numbers representing the average of the data collected. Chase times ranged between 29 seconds to 190 seconds, with an average of 125 seconds. Handling times ranged between 11 minutes to 20 minutes, with an average of 15 minutes. Temperatures ranged between -27°C and -10°C with an average of -22°C. No caribou were observed to have ticks, or tick-related hair loss in any capture event. One capture mortality occurred in 2020, the capture team found the right foreleg broke during netting resulting in the animal not being able to get up. This caribou was euthanized, sampled, and meat distributed to the local community.

Table 2. Annual summary (averages) of capture data.

Year	Temp (°C)	Snow Depth (Cm)	Estimated Age (Teeth wear)	Chase (minutes)	Handling (minutes)	Lactating (%)	Body Condition Score (1-4)	Hair Loss (1-4)
2019	-10	43	8	2	13	0	-	0
2020	-15.1	56.4	6.8	1.4	14.9	66.7	2.6	0
2021	-22.3	36.2	4.2	-	15.3	83.3	-	0
2022	-	-	-	-	-	-	-	-
2023	-21	40.4	5.3	2.5	2.1	28.6	2.8	0.28
2024	-27	41	-	0.18	28.5	0	2.5	1

Pregnancy is determined by assessing the concentration of a hormone called progesterone, which is produced by pregnant female caribou. Pregnancy rates are calculated from the number of blood serum samples tested. Annual pregnancy rates from 2019-2024 show high adult female pregnancy ranging from 83%-100% (Table 3). Only one female was collared in 2019 and was pregnant (100%). In 2020, the serum of 8 of the collared female caribou were tested for progesterone. Of those 8 tested, 8 were pregnant. The remaining 5 captured cows were not tested. In 2021, the crew was able to obtain blood samples from all 6 of the females captured. However only five of those samples could be used, of those five sampled caribou, all five were pregnant (83%). For 2022, NA is listed in Table 3 because no collaring took place that year. In 2023, six out of six, boreal caribou that were sampled were pregnant (100%), and one caribou did not get blood samples. In 2024 only one animal was collared, and samples have not yet been sent out for testing. There is overall, a high rate of pregnancy in boreal caribou within the MVH study area.

Table 3. Mackenzie Valley Highway collared caribou pregnancy rates at time of capture. “N/A” represents samples that were collected but not tested for a given year.

Pregnancy Rates						
Year	Yes	No	Borderline	Total	Percent Pregnant	N/A
2019	1	0	0	1	100%	0
2020	8	0	0	8	100%	5
2021	5	1	0	6	83.3%	0
2022	0	0	0	0	NA	0
2023	6	0	0	6	100%	1
2024	0	0	0	0	NA	1

Collar releases and mortality investigations

Attempts are made to retrieve all deployed collars either after the collar is released from the animal on schedule, or in the event of a mortality. Mortality investigations are described further below. When collars release on their scheduled drop-off date, we attempt to retrieve the collar when flying in the area. There are a few reasons to pick released collars up. First, to download any missing data stored on the device, second, to remove the device from the landscape, and third, to refurbish the collar for future use. To date, 13 collars have been retrieved, 7 are irretrievable, 3 have released but not yet been retrieved, and 5 currently deployed for a total of 28 collars that have been deployed during this program (Table 4). Irretrievable collars, occur when we cannot get to the last known location. This could be because of daylight constraints, water levels in wetlands at the collar release location, time of year, mountainous terrain, or dense treed habitat with no suitable location to land. Of the thirteen collars that have released on schedule, 10 released in August 2023, and 3 released in August 2024. The three from 2024 have yet to be retrieved.

Table 4. Status of 28 collars deployed on boreal caribou between 2019-2024 in the Mackenzie Valley Highway study area.

Collar status	Number
Released	3
Retrieved	13
Irretrievable	7
Deployed	5
Total	28

When collars send a mortality signal, we attempt to go out as soon as possible to investigate cause of death. Of the 28 collars, only 8 deaths have been confirmed, with suspected causes of death from wolves (2), harvest (1), bears (2). Three (3) mortalities are due to unknown causes (Table 5). Of the three unknown causes one mortality was suspected to have been killed by an unknown predator. The other two unknowns were due to the mountainous terrain making landing impossible and therefore it could not be investigated. Determining cause of death is important because survival rates are estimated from whether we can confirm the animal has in fact died or if the collar released, malfunctioned, or otherwise failed.

Table 5. Annual breakdown (2019-2024) of total boreal caribou mortalities and cause of death.

Cause of Death						
Year	Wolf	Bear	Harvest	Natural	Unknown	Total
2019	-	-	-	-	-	-
2020	-	-	-	-	-	-
2021	-	-	-	-	-	-
2022	2	1	-	-	1	4
2023	-	-	1	-	2	3
2024	-	1	-	-	-	1

Four mortalities occurred in the Dehcho region and four in the Sahtú region. The last recorded locations of collars are spread across the MVH study area (Figure 3). A final collar status is determined once we are able to fly out to the collar, or when collars go stationary on their expected released date. Figure 4 shows the duration that each collar was deployed on an individual, and the fate of each caribou.

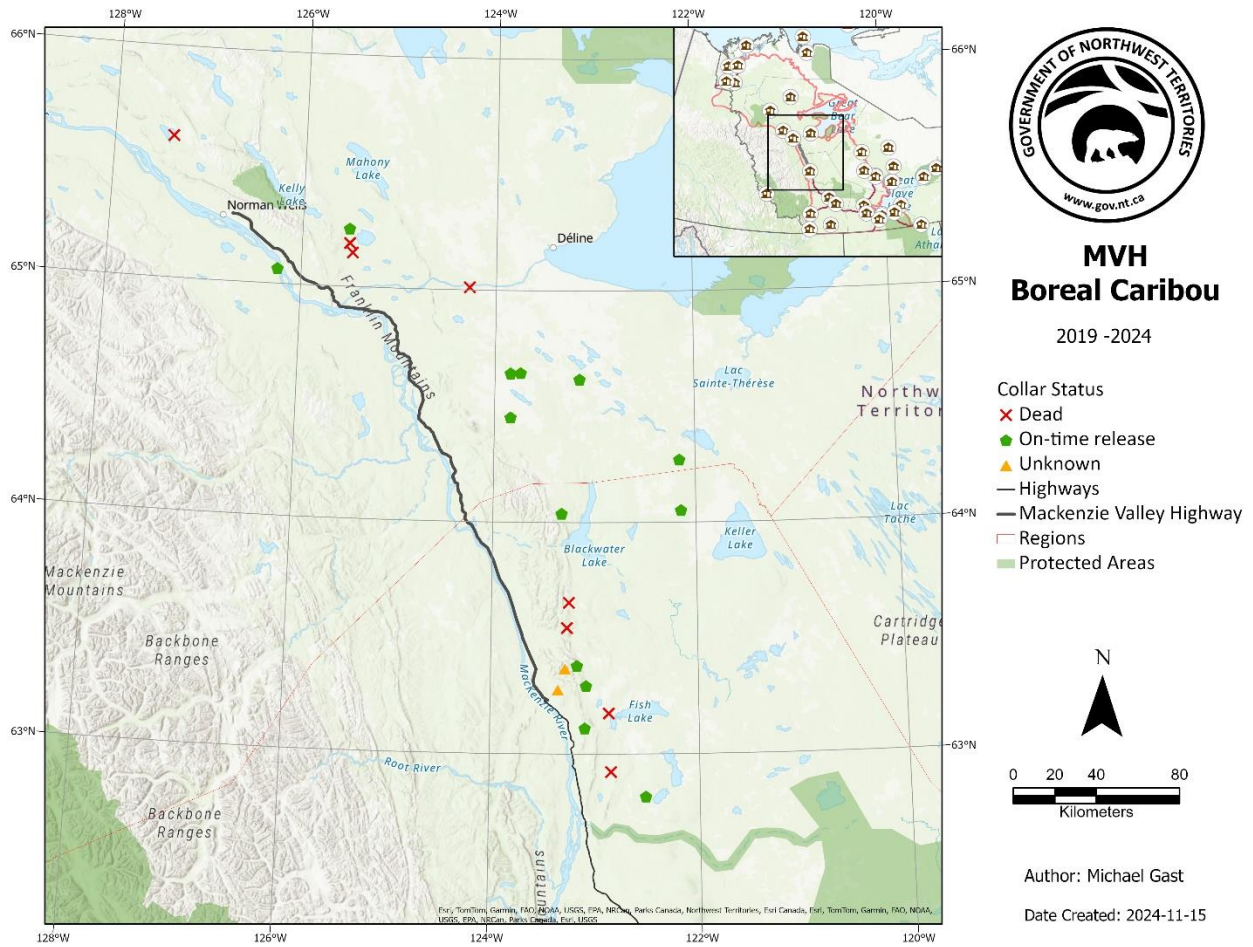


Figure 3. Final locations of collared boreal caribou at the time of mortality or collar release. Caribou with confirmed deaths are symbolized with a red “X”, collars that have released on schedule are symbolized with green pentagons, and collars with unknown fate are marked with orange triangles.

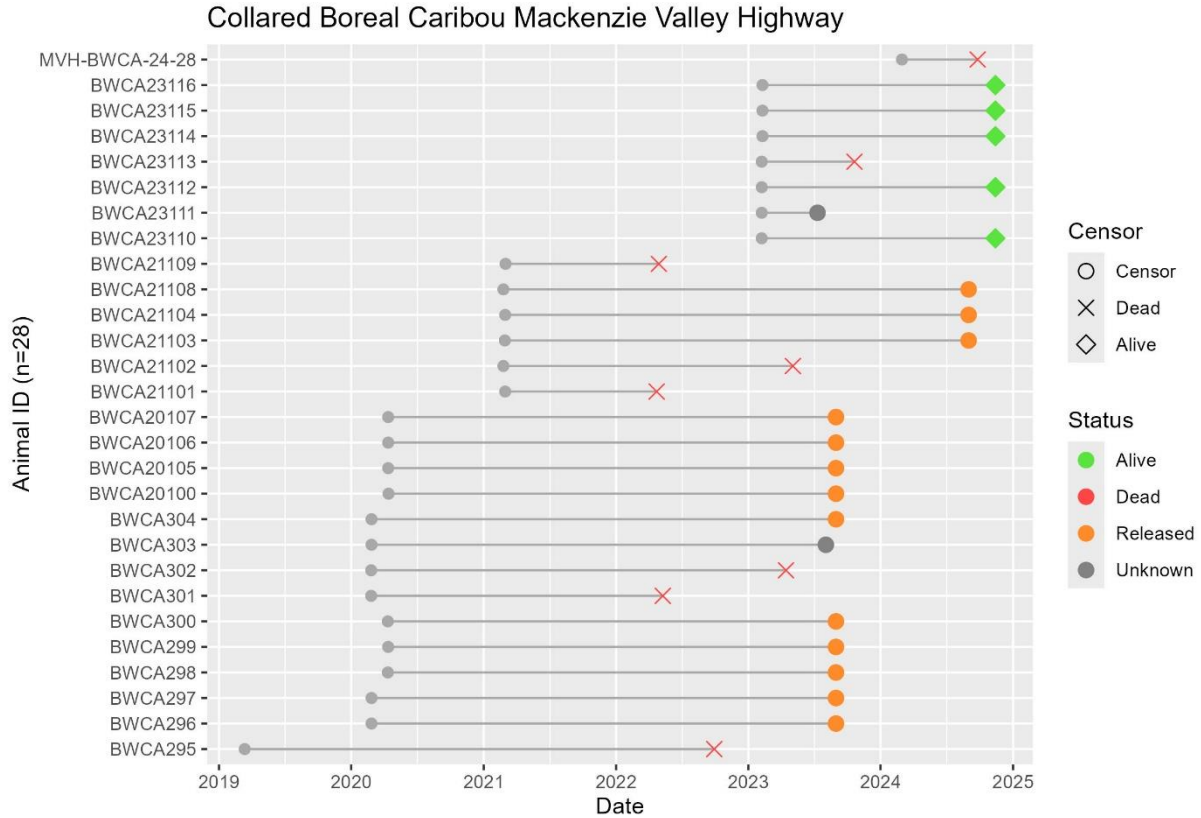


Figure 4. Survival data for boreal caribou collared from 2019-2024 in the Mackenzie Valley Highway area. The grey horizontal bars indicate the duration that each caribou was monitored for. The shape of symbols at the end of each caribou’s monitoring period indicates the fate of each animal, which is used in estimating annual survival rates. The circles (“O”) are censored animals, which represent collars for which we cannot confirm the status of the animal after the collar dropped off; the crosses (“X”) indicate a confirmed mortality for that caribou; diamond symbols represent active collars on caribou that are still alive. The colour is related to the status of the animal: Green means caribou is alive (collar is still active); Red means the animal is confirmed dead; Orange means we know the collar released on time (and the animal was alive at the time of release); Grey is unknown status of the animal, this is a status for collars where it is unclear if an animal had died or collar released.

Population Trend

An annual index of population growth rate (“lambda”) can be calculated from the annual survival rates of collared adult females, and from calf recruitment rates (cow:calf ratios) measured from annual spring composition surveys. Because a sample size of at least 20 adult female per year is typically required to calculate an accurate estimate of annual female survival rates (and subsequently rate of population growth), information from collars deployed in the MVH study area was combined with information from collars deployed in the adjacent North Dehcho study area to provide adequate annual sample sizes.

Adult female survival

Survival is estimated from collared cows that contribute data from when they are collared until a mortality event or until the collar releases or is otherwise censored. The survival of collared females is used to represent the mean adult female survival of caribou in the study area. Adult female survival is calculated each year with Pollock et al.'s (1989) staggered-entry modification of Kaplan and Meier's (1958) survivorship model. The staggered-entry period interval is annual starting in April 01 of each year until March 31 of the next year (e.g. when we refer to the 2019 survival year, it encompasses 01 April 2018 to 31 March 2019). Collars are tracked via satellite and assigned a status (alive, dead, or censored) each month. "Censored" means the collar was removed from the study with caribou fate unknown after that time (i.e. the collar released as scheduled (most common) or failed).

Monthly survival was estimated using the survival R package. Annual survival is the product of all monthly survival estimates, and the standard error (SE) is the square root of the annual survival squared multiplied by the sum of monthly survival variances, as shown in Equations 1 and 2:

Eq 1:

$$\begin{aligned}\hat{\varphi}_1 &= \text{monthly survival} \\ \hat{a}s \text{ (annual survival)} &= \hat{\varphi}_1 \times \hat{\varphi}_2 \times \hat{\varphi}_3 \times \dots \times \hat{\varphi}_{12}\end{aligned}$$

Eq 2:

$$se = \sqrt{\hat{a}s^2 \times \sum (var\varphi_1, var\varphi_2, \dots, var\varphi_{12})}$$

Annual survival rates for the combined MVH and North Dehcho study areas varied between 0.79 and 0.96 between 2019-2024, with the two lowest survival rates occurring in 2023 and 2024. Annual survival rates are further summarized in Table 7 and Figure 6.

Boreal Caribou Composition Surveys

An annual composition survey is flown by helicopter in late-winter, typically in late February or early March. The purpose of this survey is to classify caribou into age (Calf, Yearling, Adult) and sex classes (Male, Female). Using this data, we can calculate the number of calves per 100 cows observed. Caribou mortality is highest during the first year of life, and calves that survive until the time of survey (when calves are approximately 10 months old), are assumed to be "recruited" into the adult population and are assumed to have a higher survival rate. The estimated calf to cow ratios are then used in another equation ("Recruitment and Mortality (R-M) equation");

Hatter and Bergerud 1991) to derive the annual population growth rate to compare population trend.

When analyzing the data from a recruitment survey, we assume a 50:50 Male:Female sex ratio to assign a sex to any yearlings and adults of unknown sex observed. When yearlings can be identified by sex as male or female, they are assigned to that adult class in the field. Calf to Cow ratios from the recruitment survey are expressed as number of calves per 100 adult cows (Eq. 3). The standard error (SE) of annual calf:cow ratios are determined using Eq 4 - Standard error of binomial data from Cochran (1977, p. 52, Eq 3.11), see also Krebs (1999; Eq 8.13, excluding sampling). This uses the number of animals observed to calculate SE (more females observed means lower SE) rather than variance among groups observed.

Eq 3:

$$\text{derived cows} = \text{cows} + 0.5 * (\text{unknown adults} + \text{yearlings})$$

$$\text{calf} : \text{cow} = \frac{\text{calves of both sexes}}{\text{derived cows}}$$

Eq 4:

$$se = \sqrt{\frac{\text{calf} : \text{cow} * (1 - \text{calf} : \text{cow})}{\text{derived cows} + \text{calves}}}$$

Composition surveys were flown in the late-winter of each year from 2019 to 2024. An A-Star B-2 helicopter was used to conduct the surveys. Groups of boreal caribou were located by flying towards the last known location of collared females present in the study area. Once the helicopter was within ~5 km of each location, radio telemetry was used to locate the group with the collared female. Additional groups of collared caribou that were encountered but did not contain a collared female were also classified. These unknown groups are called incidental observations and add to a larger sample size for classification results. Boreal caribou were classified as calves (9-10 months old), yearlings (21-22 months old), females (≥ 32 months old) and males (≥ 32 months old), based upon antler size and shape, animal size, and presence of a black vulva patch.

Within the MVH and the Dehcho North study areas, spanning the years from 2019 to 2024, there was a total of 239 bulls, 672 cows, 196 calves and 18 individuals of unknown sex observed in 234 groups during the composition surveys, for a total of 1,125 boreal caribou classified (Table 6; Figure 5). Individuals of unknown sex were split 50/50 amongst adult males/females to calculate calf:cow ratios.

Table 6. Results of the composition survey of boreal caribou in the Mackenzie Valley Highway and the North Dehcho study areas from 2019-2023. Analysis of 2023-24 has not been updated yet.

	Bulls	Cows	Calves	Unknown	Total	Groups
2018-19						
MVH	25	59	25	0	109	21
North Dehcho	15	52	26	0	93	18
Combined	40	111	51	0	202	39
2019-20						
MVH	25	39	8	2	74	16
North Dehcho	24	78	26	5	133	35
Combined	49	117	34	7	207	51
2020-21						
MVH	33	132	37	2	204	42
North Dehcho	31	50	18	0	99	21
Combined	64	182	55	2	303	63
2021-22						
MVH	12	74	17	4	107	23
North Dehcho	41	56	12	0	109	14
Combined	53	130	29	4	216	37
2022-23						
MVH	12	70	20	3	105	28
North Dehcho	21	62	7	2	92	16
Combined	33	132	27	5	197	44

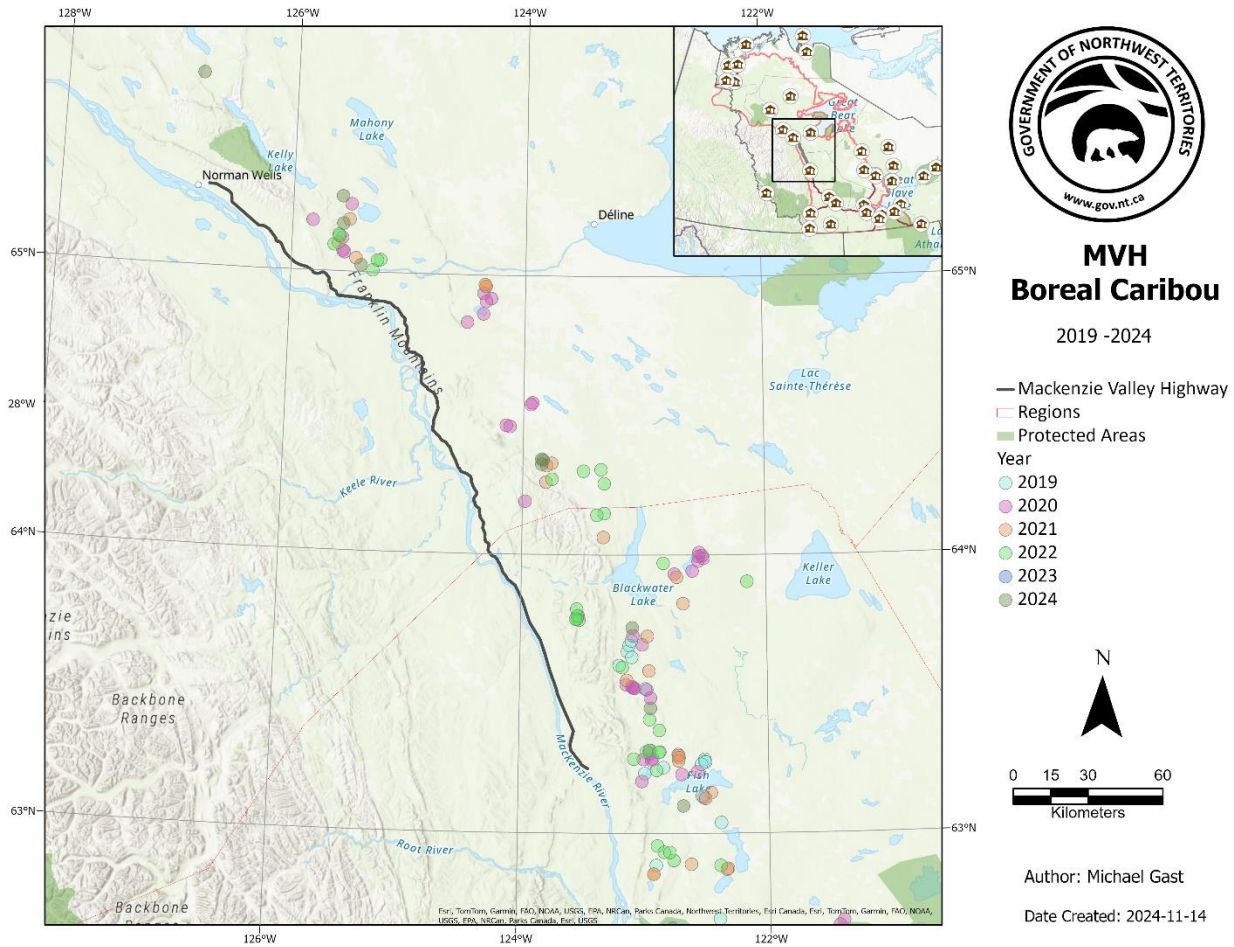


Figure 5. Locations of where boreal caribou groups were recorded during spring composition surveys in the North Dehcho and Mackenzie Valley Highway study areas from 2019-2024.

Annual Population Growth (Lambda)

For each year, the annual population growth (also known as lambda) is estimated using the adult female survival data obtained from collared cows, and the calf recruitment data obtained from late-winter composition surveys. Only female calves are included, with a female: male calf sex ratio of 50:50 used to estimate number of female calves. The ratio of female calves to total females (female calves + female cows) (R_m) is used to calculate the annual population trend.

Lambda (λ) is calculated using Hatter and Bergerud's (1991) equation:

Eq 5:

$$\lambda = \frac{\textit{survival}}{(1 - R_{rm})}$$

Eq 6:

$$R_{rm} = \frac{\textit{recruited females}}{1 + \textit{recruited females}}$$

where $\textit{recruited females} = \frac{\textit{calves} * .5}{\textit{derived cows}}$

Lambda values >1 indicate an increasing population, and Lambda values <1 indicate a decreasing population. Error estimates are generated around λ by randomly drawing from annual survival and recruitment distributions (i.e., mean x and SD) 10,000 times, using an algorithm called “Markov-Chain Monte Carlo” (MCMC). Survival rates are drawn from a beta distribution (continuous numbers, truncated between at zero and one) and recruitment rates are drawn from a lognormal distribution (continuous numbers, truncated values at zero to positive infinity; see Morris and Doak 2002). We report the stochastically (random) simulated errors around the finite lambda estimates rather than the mean stochastic lambda which changes with each simulation run.

The calf:cow ratio, along with the adult female survival rates from each year, was used to calculate the annual finite population growth rate (λ). The average population growth rate (λ) over the last five years (2019-2024) for the combined MVH and North Dehcho area was found to be 1.112 [1.013, 1.21] (Table 7; Figure 6). This indicates a growing population, on average, when considering both MVH and North Dehcho study areas together.

Table 7. Vital rates (Calf:Cow, Survival, and Lambda) of boreal caribou in the Mackenzie Valley Highway and North Dehcho area from 2018-2024 Sample size (n) represents the number of collared adult females present in each study area. Numbers inside square brackets represent 95% confidence intervals.

	Calf:Cow	Survival	Lambda	Sample size (n)
2018-19				
MVH	0.42 [0.32, 0.53]	1 [1, 1]	-	1
North Dehcho	0.5 [0.39, 0.61]	0.85 [0.69, 1.01]	1.06 [0.88, 1.24]	24
Combined	0.46 [0.38, 0.54]	1 [1, 1]	1.23 [1.22, 1.24]	24
2019-20				
MVH	0.2 [0.09, 0.31]	1 [1, 1]	-	1
North Dehcho	0.32 [0.23, 0.41]	1 [1, 1]	1.16 [1.15, 1.17]	25
Combined	0.28 [0.21, 0.35]	1 [1, 1]	1.14 [1.13, 1.15]	26
2020-21				
MVH	0.28 [0.21, 0.35]	1 [1, 1]	-	14
North Dehcho	0.36 [0.25, 0.47]	0.89 [0.77, 1.01]	1.05 [0.91, 1.18]	27
Combined	0.3 [0.24, 0.36]	1 [1, 1]	1.15 [1.15, 1.15]	41
2021-22				
MVH	0.22 [0.14, 0.31]	1 [1, 1]	1.11 [1.1, 1.12]	20
North Dehcho	0.21 [0.12, 0.31]	0.92 [0.81, 1.03]	1.01 [0.89, 1.14]	25
Combined	0.22 [0.16, 0.28]	1 [1, 1]	1.11 [1.1, 1.12]	45
2022-23				
MVH	0.28 [0.19, 0.37]	0.84 [0.68, 1.01]	0.96 [0.78, 1.14]	20
North Dehcho	0.11 [0.04, 0.18]	0.87 [0.73, 1.01]	0.92 [0.77, 1.06]	24
Combined	0.2 [0.14, 0.26]	0.84 [0.68, 1.01]	0.93 [0.75, 1.1]	44
2023-24				
MVH	0.24 [0.16, 0.32]	0.73 [0.52, 0.95]	0.82 [0.59, 1.06]	23
North Dehcho	0.3 [0.15, 0.44]	0.9 [0.71, 1.09]	1.03 [0.83, 1.23]	10
Combined	0.25 [0.18, 0.33]	0.79 [0.63, 0.95]	0.89 [0.71, 1.06]	33

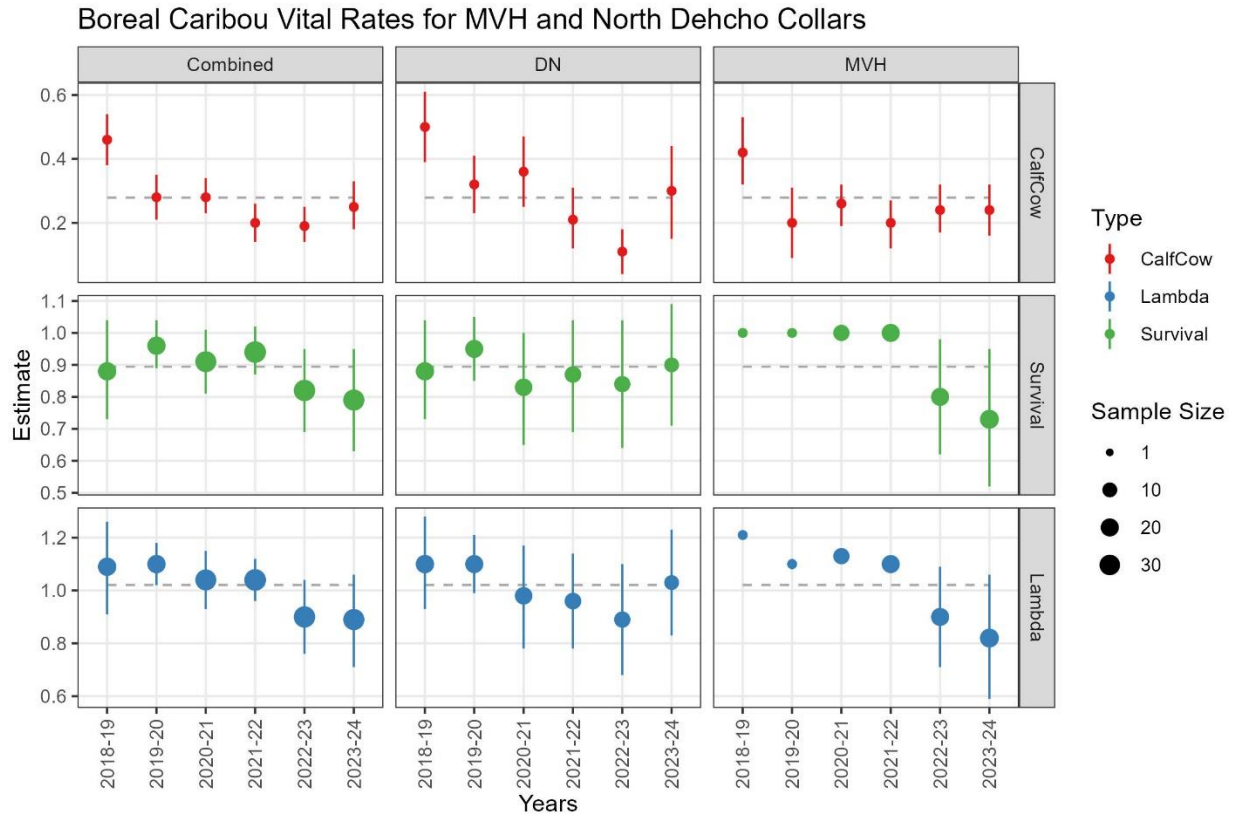


Figure 6. Boreal Caribou vital rates of Mackenzie Valley Highway (“MVH”), North Dehcho (“DN”) and Combined (“MVH” + “DN”) study areas from 2018-2024. The three vital rates estimated include Calf-Cow ratios (“Red”), Adult Female Survival Rate (“Green”), and Lambda (“Blue”). The size of the points for Survival and Lambda are based on the number of collared animals used in the analysis (“Sample Size”). Vertical bars represent 95% confidence intervals; note that confidence intervals for Survival and Lambda cannot be calculated when Survival = 1 (100%) in a given year. The mean across years for each vital rate (Calf-Cow ratio, Survival, Lambda) is indicated by the grey dashed line in each panel.

Boreal caribou movements and interactions with the proposed Mackenzie Valley Highway

To assess movements of collared boreal caribou with respect to the MVH alignment, GPS point locations were converted into movement paths by connecting successive locations from the same individual. The movement paths were then evaluated to see whether any movement path segments intersected the proposed MVH.

Figure 7 shows the movement paths of collared boreal caribou from the MVH study area and North Dehcho study areas between March 01, 2019, and November 11, 2024. Between Wrigley and Norman Wells, collared caribou have generally stayed to the east of the Franklin Mountains, which is well to the east of the MVH alignment. There were 5 instances of collared caribou crossing the proposed MVH alignment (indicated by stars on Figure 7; crossing dates provided in Table 8). Two individuals crossed the alignment twice (BWCA23113 and BWCA295) and one individual crossed only one time (BWCA21103). All individuals that crossed the road were from collars deployed in the MVH study area. Some of the boreal caribou collared in the North Dehcho study area used areas to the north of Wrigley but did not cross the proposed MVH alignment (Figure 7). Figure 8 displays the same movement paths, but with each individual caribou's movement path symbolized by a different colour. One boreal caribou that crossed the MVH (BWCA21103) also crossed the Mackenzie River and spent most of her time on the west side of the river. She later crossed the Mackenzie River and the MVH north of Norman Wells but then quickly crossed back to the west side of the river again and remained there until her collar dropped off.

Table 8. Instances of collared boreal caribou movement paths that crossed the MVH alignment between March 2019 and November 2024.

Animal ID	Study Area	Gender	Region	Date	Season
BWCA21103	MVH	Female	Sahtú	2021-05-01	spring dispersal
BWCA23113	MVH	Female	Dehcho	2023-08-09	summer
BWCA23113	MVH	Female	Dehcho	2023-08-10	summer
BWCA295	MVH	Female	Dehcho	2020-07-24	summer
BWCA295	MVH	Female	Dehcho	2020-07-24	summer

Overall, there were very few individuals and occasions where boreal caribou from the MVH study area came within close proximity to the proposed alignment. Out of the 292,131 collar locations recorded from the 28 collared caribou between March 2019 and November 2024, there were only 29 locations from 5 different individuals (including those that crossed the alignment) that occurred within 1 km of the proposed MVH alignment. This represents 0.01% of all collar locations recorded and suggests that the caribou collared during the study so far are spending the majority of their time >1 km away from the existing Mackenzie Valley Winter Road and the proposed MVH corridor.

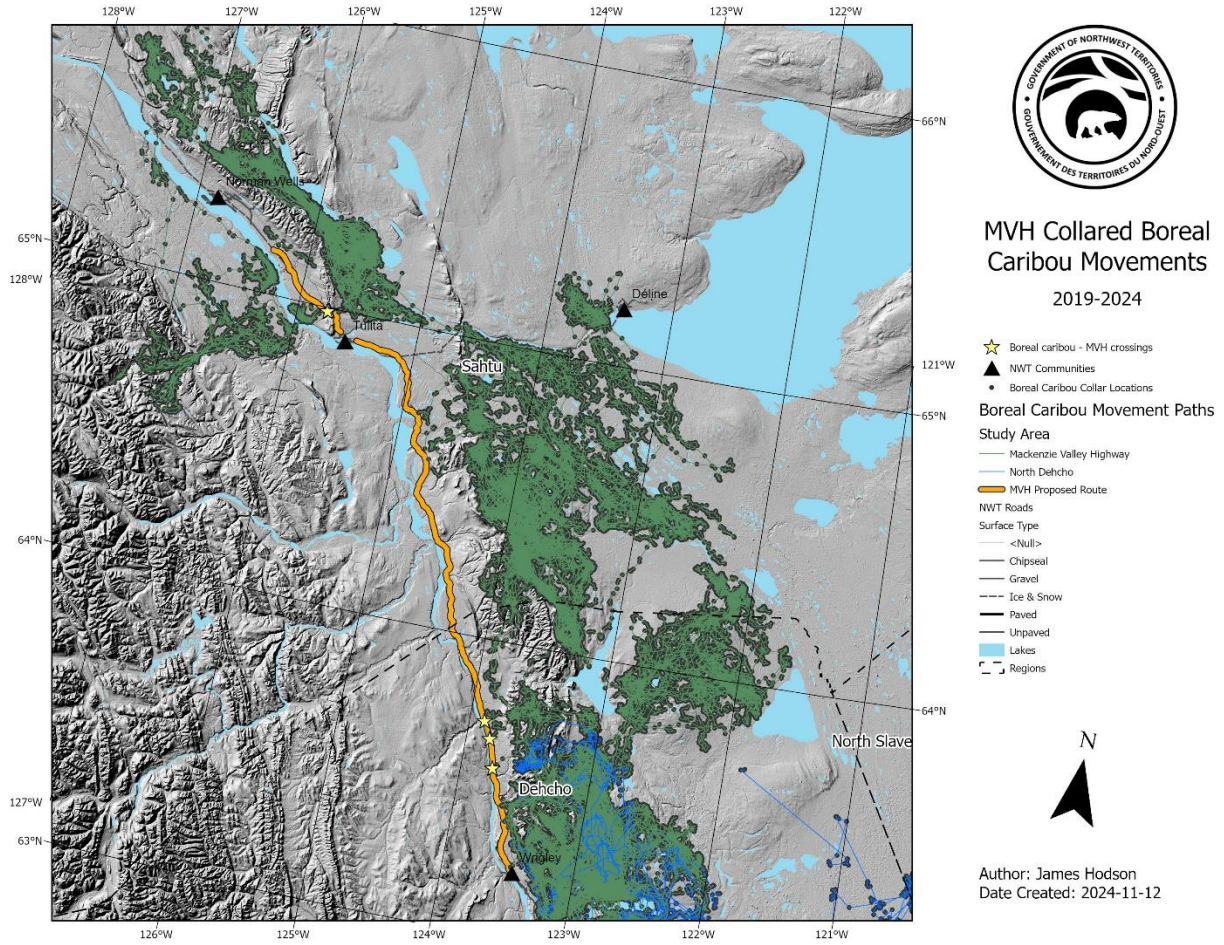


Figure 7. Movement paths of boreal caribou collared in the Mackenzie Valley Highway (MVH) study area (green lines) and individuals from the North Dehcho study area (blue lines) that overlapped with the MVH study area. Grey dots represent individual collar locations that were connected to create movement paths.

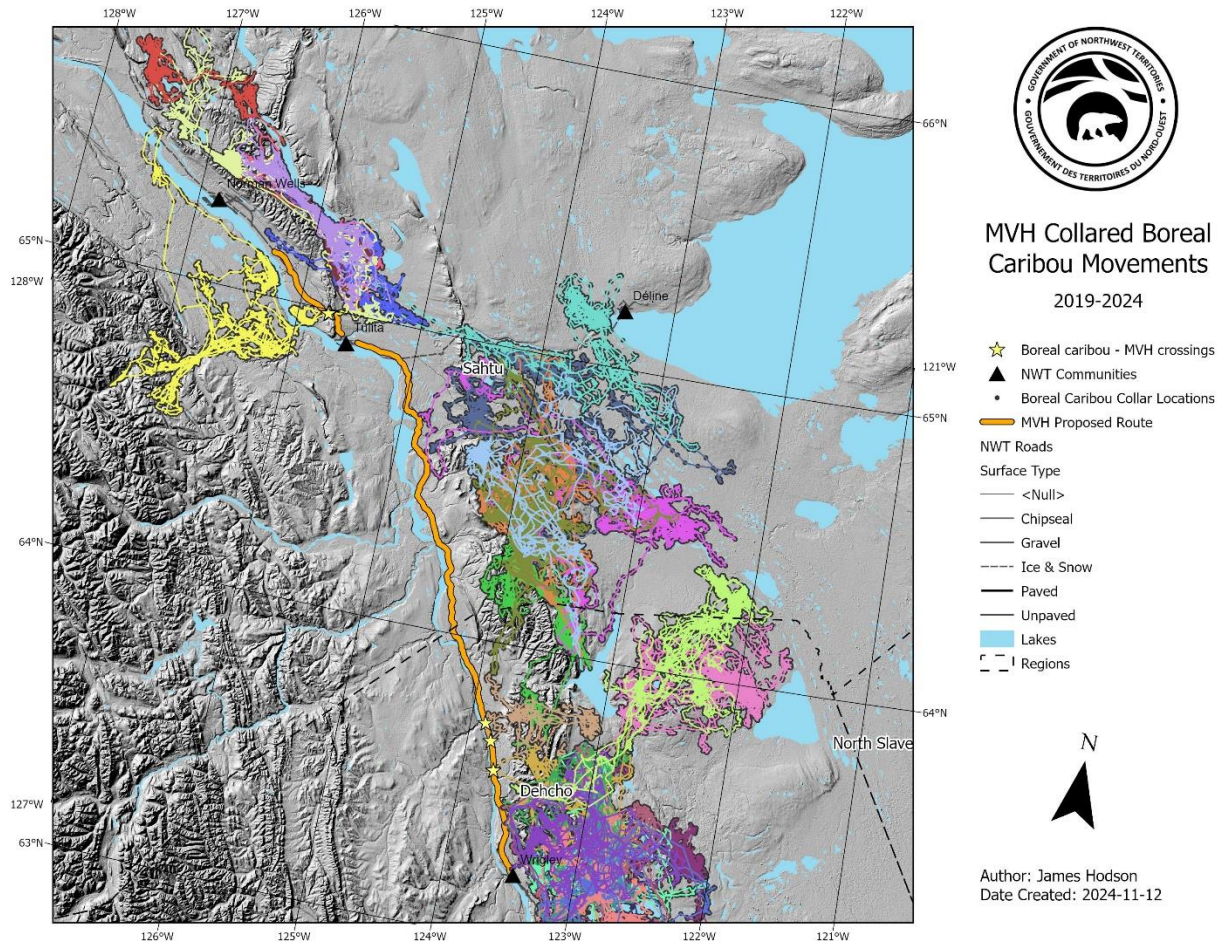


Figure 8. Movement paths of individual boreal caribou collared within the Mackenzie Valley Highway (MVH) study area between March 2019 and November 2024. Each unique individual is represented by a different coloured line.

Acknowledgements

Mortality Investigations were performed by Kevin Chan, Jules Fournel, Michael Gast, Eve Lamontagne, Hamsha Pathmanathan, and Mark Wasiuta.

Allicia Kelly performed annual late winter composition surveys.

Chloe Beaupre performed data analysis for vital rates.

References

Cochran, W.G. 1977. *Sampling Techniques*. 3rd Edition, John Wiley & Sons, New York.

Gerhart, K.L., White, R.G., Cameron, R. and Russell, D.E., 1996. Estimating fat content of caribou from body condition scores. *The Journal of Wildlife Management* 60(4): 713-718.

Hatter, I.W., and W.A. Bergerud. 1991. Moose recruitment, adult mortality, and rate of change. *Alces* 27: 65-73.

Kaplan, E.L., and P. Meier. 1958. Nonparametric estimation from incomplete observations. *Journal of the American Statistical Association* 53: 457-481.

Krebs, C.J. 1999. *Ecological Methodology*, 2nd ed. Addison-Wesley Educational Publishers, Inc.

Morris, W.F. and Doak, D.F. 2002. *Quantitative Conservation Biology: Theory and Practice of Population Viability Analysis*. Sinauer. 480 pp.

Pollock, K.H., S.R. Winterstein, C.M. Bunck, and P.D. Curtis. 1989. Survival analysis in telemetry studies: the staggered entry design. *Journal of Wildlife Management* 53: 7-15.