Coal River Caribou Herd Population Estimate

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Executive Summary

- We conducted the first formal population survey on the Coal River caribou herd northeast of Watson Lake, Yukon in 2022. The purpose of this survey was to provide information on the current size of the population, and to examine possible effects of planned upgrades to the Nahanni Range Road, which bisects the herd's range.

- We classified 516 caribou to estimate the herd's composition. We estimated an adult sex ratio of 29 bulls per 100 cows and a recruitment ratio of 9 calves per 100 cows.

- The 2022 population estimate of the Coal River herd is 1,203 (95% CI = 914–1,586) animals. This result is higher than the previous estimate in 2008 of approximately 900 animals; however, this comparison should be interpreted with caution as the 2008 estimate was based on a minimum count, not a formal population survey.

- The fall calf recruitment estimates from 2020, 2021 and 2022 were all lower than what is considered necessary for a stable population; however, the 2023 recruitment estimate was above the recommended level, resulting in an average of 17.2 calves per 100 cows across all four years. An additional year of fall calf recruitment data in 2024 will help to increase our confidence in the herd's trend.

- We suggest fall composition surveys continue for the Coal River caribou herd every other year to monitor long-term trends.

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Introduction

The Coal River caribou herd (CRCH) is part of the Northern Mountain (NM) population of woodland caribou (*Rangifer tarandus caribou*), which are currently listed as Special Concern under the federal *Species at Risk Act*. Located north of Watson Lake, around the Nahanni Range Road (NRR) and eastwards into the Northwest Territories (NWT), this herd's range is located within the Greater Nahanni ecosystem, and is an important cultural, subsistence and ecological resource. The Coal River herd range overlaps with the South Nahanni and LaBiche herds, and the degree of distinctiveness of these herds has been a topic of ongoing study.

Mineral exploration and ease of access to this herd by hunters via the NRR have raised conservation concerns and prompted the need for updated population and demographic studies. The Coal River herd was last studied from 2008–2011, in conjunction with the South Nahanni herd; however, no formal population estimate was done. The herd was assumed to be around 900 animals, based on minimum counts obtained from composition surveys, expert opinion, and an assumed re-sighting rate similar to the South Nahanni herd (Hegel, 2016). At that time, there was also concern that the harvest rate of the CRCH may be exceeding recommended levels, based on previously reported licensed and estimated subsistence harvest numbers in the Yukon and NWT (Hegel, 2016).

Since then, the Yukon Resource Gateway Project proposed upgrades to the NRR from its junction with the Robert Campbell Highway to the Yukon/NWT border, which provided project funding to examine potential effects of these upgrades on wildlife in the region. While the CRCH has co-existed with the NRR since 1965, proposed improvements could magnify any existing effects of the road on caribou, including direct effects from collision mortalities and habitat degradation, and indirect effects such as increased harvest and changes in caribou movement patterns and range use due to avoidance behaviours. Given the known sensitivities of caribou to linear features, part of this funding was applied to a multi-year study to update information on the CRCH, including a collaring program, mark-resight population estimate, and five years of composition surveys. This report summarizes the results of a mark-resight population survey of the CRCH, conducted from 19–26 September 2022 to update the population estimate of the herd as well as the first four years (2020–2023) of annual fall composition surveys.

The mark-resight population survey was originally intended to be conducted in fall 2021; however, due to early and deep snowfall conditions, the animals started moving eastwards, moving off rutting areas much sooner than anticipated. To ensure confidence in the population estimate, we decided to suspend the mark-resight survey and postpone until 2022.

Harvest

Caribou harvest in the Yukon is managed using the *Science-based Guidelines for Management of Northern Mountain Caribou in Yukon*, which states that if a herd is stable, then a bull-only harvest rate of up to 2% of the total population size is likely sustainable, while a herd in decline or with limited or outdated information can sustain a bull-only harvest of up to 1% of the total population (Environment Yukon, 2016).

Portions of the herd's range have considerable access via the NRR, and there is harvest from resident, non-resident, and First Nation hunters. The herd is also transboundary, shared with the NWT, where harvest levels are not known. Since 1995, licensed harvest has ranged from 3–24 caribou per year, averaging 11 caribou per year across all years (**Figure 1**). Resident harvest is generally higher than non-resident harvest, with an average of 5.8 and 4.8 caribou harvested per year, respectively. Over the last five years (2019–2023), the average licenced harvest of the CRCH was 10.2 caribou per year, subsistence harvest was estimated to be 4.8 caribou per year (equal to licenced resident harvest), totalling 1.7% of the previously estimated population size (900 animals). At that rate, harvest of the CRCH may have been higher than the 1% recommended harvest rate for herds in decline or with limited information.
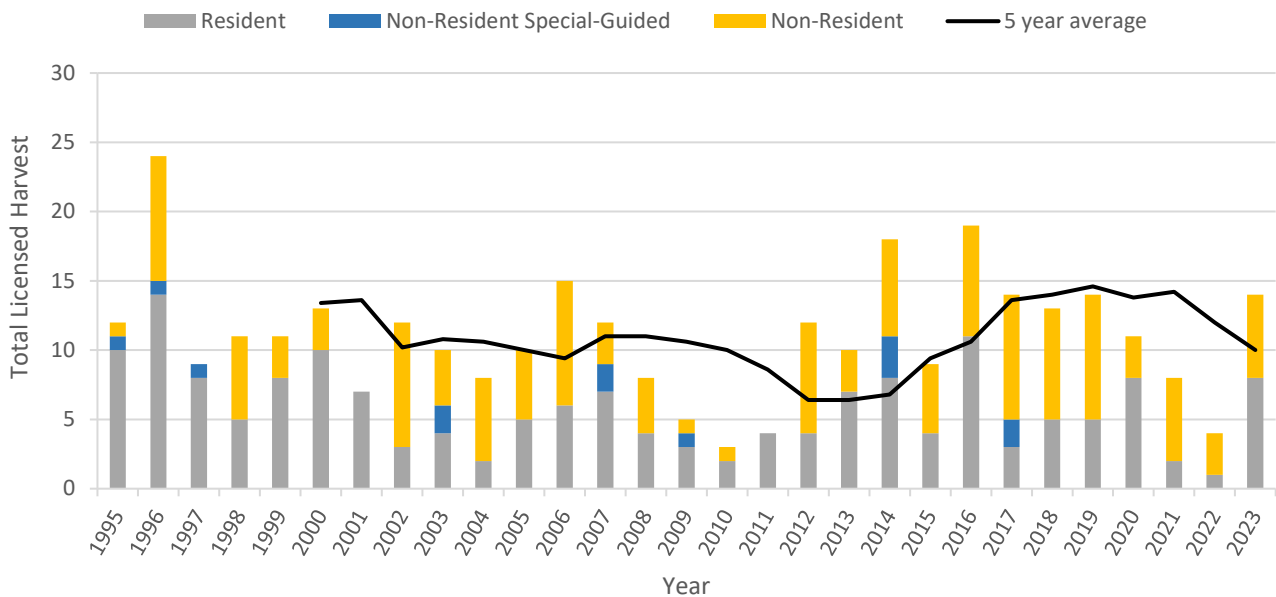
Figure 1.   Total reported licensed harvest of caribou from the Coal River herd from 1995–2023.

Study Area

The Coal River caribou herd range is in the southern Yukon, within the unceded territory of the Kaska people, north of Watson Lake and extending into the Northwest Territories (NWT) and the Nahanni National Park Reserve (NNPR). The herd primarily winters within the NNPR, migrating during spring to calving and summer ranges in the mountainous areas around the NRR in the Yukon. Rutting areas

overlap with summer ranges in the Yukon, extending from the foothills east of Frances Lake, across the NRR, to the mountainous border region in the NWT (**Figure 2**).

In the Yukon, the Coal River herd range lies within the Hyland Highland ecoregion. The range is bisected from north to south by the NRR and the Hyland and Little Hyland Rivers, flanked on either side by the Logan (Selwyn) mountains and high elevation plateaus. Low-lying areas of the ecoregion are dominated by open boreal forest, with a rich understory of shrubs. White spruce is commonly found along major rivers, and black spruce can be found in poorly drained bog areas. Balsam poplar is a common canopy species, especially in younger stands, with lodgepole pine inhabiting drier sites. Mean annual temperatures in this region are near -4°C, with averages ranging from near -20°C in January to 13°C in July. Summers are warm, with prolonged cold spells expected during the winter months. Precipitation is moderate in this area with annual amounts of 500–600 mm (Yukon Ecoregions Working Group, 2004).

In addition to caribou, the Coal River area supports other ungulate species including moose, sheep, and goats. It also supports large predator species including grizzly and black bear and wolves. Smaller fur-bearers such as marten, fisher, lynx, and hares are also found in the region, as well as many migratory waterfowl and songbirds (Yukon Ecoregions Working Group, 2004).

The survey area for the 2022 population survey focused on known rutting areas within the Coal River herd range. These areas were identified through historical monitoring work and fall collar locations from the previous two years. Many of the known rutting areas were located on high plateaus in rugged mountain terrain near the NWT border. The total survey area was 7,058 km^2, and within that area 28 survey blocks were delineated across the herd's range. Survey blocks ranged in size from 35 km^2 to 547 km^2 and were delineated to follow natural terrain features as much as possible (**Figure 2**). Survey blocks were also designed to cover the distribution of the GPS collared caribou (marks) as best as possible to ensure that they were available for detection during the survey.
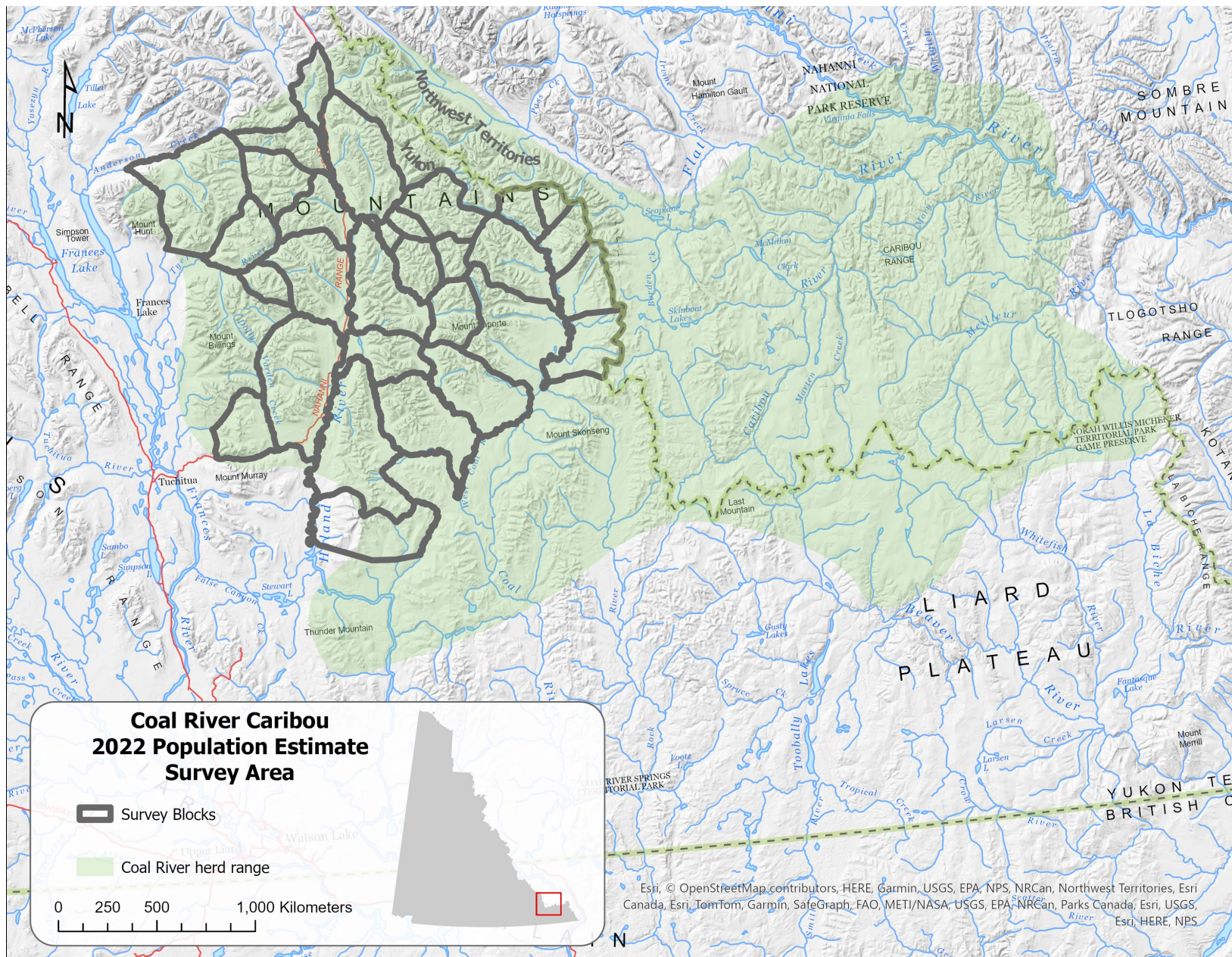
Figure 2. Coal River caribou 2022 population estimate survey area.

Methods

We used a mark-resight method to estimate the number of caribou in the Coal River herd, with GPS satellite-collared animals serving as the "marked" animals. Prior to the resighting surveys, a total of 45 GPS satellite-collars were deployed on the herd between 2020 and 2022. The first 35 collars were Vectronics Vertex Lite-3D Iridium collars deployed during winter of 2020/21, with ten Vectronics Survey Iridium collars deployed in the winter of 2021/22. All collars were programmed to take a GPS location every five hours and 50 minutes and locations were sent daily via the Iridium satellite to the Vectronics Inventa web service for viewing and download. All collared animals were also fitted with coloured visibility-bands with unique numbers on them to facilitate identification of marked individuals during the survey.

Three discrete resight session were conducted with either a Bell 206 L4 or Bell 206 L3 helicopter, with three separate crews, from 19–26 September 2022. The 28 survey blocks were used to guide survey efforts across the herd's range. To ensure each survey crew had roughly the same effort, each block was allocated a proportion of the total survey time based on block size as well as the relative number of groups observed in the blocks during previous years' fall composition surveys. Each survey block was to be flown by each crew. Within each survey block, crews focused survey efforts on subalpine and alpine habitats, assumed to have a relatively high probability of caribou occurrence.

When a group of caribou was located, the numbers of marked and unmarked animals were recorded, and a waypoint taken using a handheld GPS unit. Marked animals were identified by their unique vis-bands, where possible. During the third session, animals were also classified as calves, cows, or immature and mature bulls to estimate herd composition.

Data analysis

To derive a population estimate for the Coal River herd, the analysis was conducted in Program MARK (McClintock & White, 2012). Both an open immigration-emigration logit normal model and a closed mixed logit normal model were considered for these data, as two marked animals moved outside the survey area immediately before the survey, thus it was likely the population was geographically and demographically open. However, upon further exploration of the immigration-emigration models (which included the encounter histories for the two animals that left the survey area), the top-selected model did not indicate a change between sessions in the population within the survey area (i.e., α, the parameter representing the change in the survey area population size, was constant), thus the super-population estimate was the same as the population estimate within the survey area. Results of the immigration-emigration models are presented for completeness in **Appendix A**; however, ultimately a

mixed logit normal was chosen to represent the survey data, which censored the two animals that left the survey area before the survey began.

The mixed logit normal model allows for individual heterogeneity in resighting probabilities by treating each animal as a random effect; however, if this parameter was not supported during model selection, the data was considered to have no individually identifiable marks and was fixed at zero (McClintock B., 2018).

This mark-resight model has three estimable parameters:

- **p** – resighting rate;
- **σ** – individual heterogeneity in resighting rate; and
- **N** – population size.

A set of four candidate models were developed by varying p *and* σ, and comparing each using Akaike's Information Criterion difference (Δi AIC_c; Akaike, 1973) adjusted for small sample sizes (AIC_c; Burnham, 1998) and Akaike weights ($AIC_c w_i$) to select the model(s) with the fewest predictor variables that explained the greatest variation in the data (*i.e.*, the most parsimonious model). All models with a Δi AIC_c of ≤2.00 were considered plausible (Richards, 2005; Symonds, 2011).

Results and Discussion

Survey conditions were variable and ranged from sunny and clear, to light rain and overcast skies throughout the three sessions. There was no snow cover for several of the earlier survey days, and snow was patchy for the remaining days, which made spotting animals challenging (**Photo 1**). Caribou groups were primarily distributed in rugged alpine and subalpine rutting areas, on either side of the Hyland River and the NRR (**Figure 3**). Most of the animals observed were in small groups of 1–10 animals, with a few groups between 15–20 animals. Group size ranged from 1-23 and averaged five animals. Caribou were often spotted in the trees or at tree line, indicating that not all animals had formed rut groups yet. Caribou groups were found throughout the survey area, with a greater concentration of observations in some of the eastern blocks, next to the Yukon/NWT border.

Of the 45 collars that were deployed on the herd, only 26 collars were available to be used as marks during the survey. This was due to 12 mortalities, two malfunctioning collars and five animals that were outside the survey blocks (in NWT) at the time of the survey. This availability was determined by examining GPS locations after surveys were complete. Crews did not know which marked animals were present in a block during their survey and no telemetry equipment was used to locate animals, as that would bias the resighting rates high. During the re-sighting surveys, whenever a group of caribou was observed a total count was obtained and the number of marked animals recorded (**Photo 2**, **Table 1**).

Table 1. Mark-resight survey results for the Coal River caribou herd, 19–26 September 2022.

Session #	Survey effort (km/min)	Total marked animals available	Total marked animals observed	Total animals observed	Resighting rate
1 (19–22 September)	2.86	26	9	419	0.35
2 (21–25 September)	2.68	26	11	462	0.42
3 (23–26 September)	3.14	26	10	516	0.38

Photo 1. Survey conditions were relatively poor, given the lack of snow cover, 19 September 2022.

Photo 2. Marked caribou #13, observed on 19 September 2022.

Population Estimate

The top model (**Table 2**) included a time-constant parameter for resighting probability, indicating differences among sessions were not significant. This is supported by the relatively consistent survey conditions across sessions, limited time between sessions, and session-specific resighting rates (**Table 1**). The top-selected model did not include the parameter σ (individual heterogeneity), suggesting there were no differences among marked individuals that made them more or less challenging to detect. The final 2022 population estimate for Coal River caribou herd is **1,203 (95% CI = 914–1,586)** animals (**Table 3**).

Table 2. Candidate models for the 2022 Coal River caribou population estimate with model selection values.

Model	Rank	K[a]	AICc	Δi AICc	AICc weight
N, p., σ = 0	**1**	**2**	**116.668**	**0.00**	**0.660**
N, p., σ_t	2	3	118.819	2.15	0.225
N, p_t, σ = 0	3	4	120.721	4.05	0.087
N, p_t, σ_t	4	5	122.986	6.32	0.028

[a] *Number of model parameters including the intercept.*

Table 3. Estimates of model parameters of the Coal River caribou herd from the most supported mark-resight model.

Top model	Parameter	Value	SE	95% Confidence Interval
N, p., σ = 0	**N (population size)**	**1,203**	**170**	**914–1,586**
	p. (μ or mean resighting probability)	0.387	0.056	0.286–0.499

The Coal River caribou herd was previously studied from 2008–2011 in conjunction with the South Nahanni herd; however, no formal population survey was conducted. Fall composition surveys found ~450–650 animals, based on minimum counts at that time, and the population was estimated at approximately 900 animals, using a similar re-sighting rate as the South Nahanni herd (Hegel, 2016). Given the length of time between estimates and differing methodology, more information is needed to determine the herd's status (*i.e.*, increasing, decreasing, or stable). By examining long-term trends in fall calf recruitment indices and adult sex ratios, we can gain a more comprehensive understanding of the herd's overall trajectory, as annual estimates may vary considerably from year-to-year.
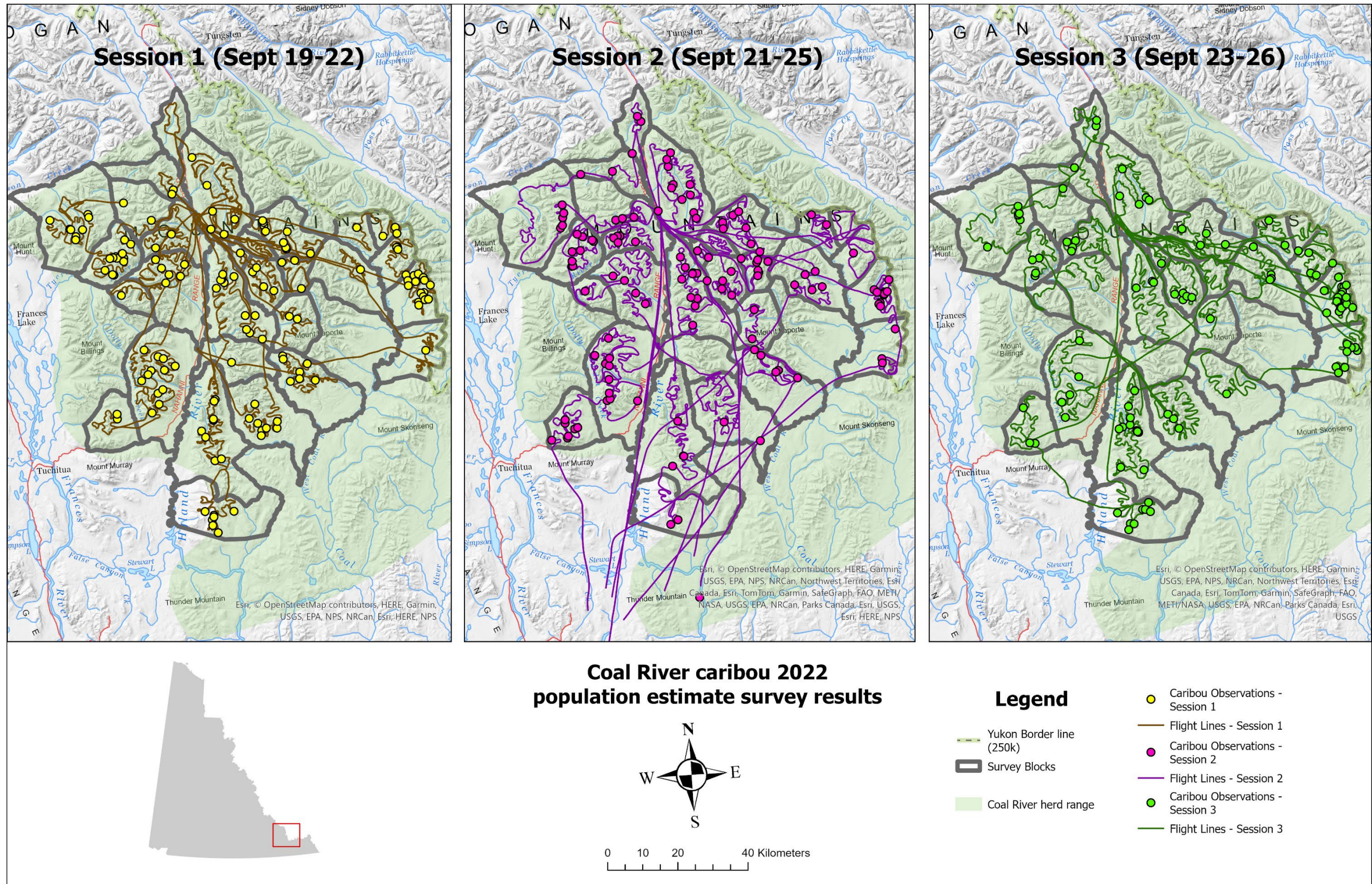
Figure 3.   Flight lines and caribou observations from all three sessions of the 2022 mark-resight population survey of the Coal River caribou herd, 19–26 September 2022.

Herd Composition

During the third session, animals were also classified as calves, cows, immature bulls and mature bulls, as per a typical fall composition survey. A total of 516 caribou were observed, and all but one were classified (**Table 5**). The 2022 fall calf recruitment ratio was estimated to be nine calves for every 100 cows, which is below the minimum fall recruitment ratio necessary for a stable population growth rate (20–25 calves per 100 cows) as outlined in the *Science-based guidelines for management of Northern Mountain caribou in Yukon* (Environment Yukon, 2016). The recruitment estimates from 2020, 2021, and 2022 were all lower than what is considered necessary for a stable population; however, the 2023 recruitment estimate was above the recommended level, resulting in an average of 17.2 calves per 100 cows across all four years (**Figure 4**). The recruitment ratios from earlier surveys done from 2008–2011 are variable, with the 2008 estimate below the minimum recommended level, and the 2009, 2010 and 2011 estimates either at or above the minimum recommended level, and averaging 27.5 calves per 100 cows across all four years (**Figure 4**).

The 2022 adult sex ratio was estimated to be 29 bulls for every 100 cows, which is just below what is considered adequate to ensure reproduction and maximized genetic diversity (30 bulls per 100 cows) (Environment Yukon, 2016). The adult sex ratios from the most recent surveys (2020–2023), average 34.1 bulls per 100 cows, above what is considered adequate for a stable population (**Figure 4**).

Table 4. Observed composition of the Coal River caribou herd, 19–26 September 2022.

Survey	Calves per 100 cows	Percent calves	Bulls per 100 cows	Number of caribou classified	Number of caribou unclassified
Sept 2022, session #3	9.4	6.8	29.4	516	1

Table 5. Estimated composition of the Coal River caribou herd based on estimated age and sex ratios and the 2022 population estimate.

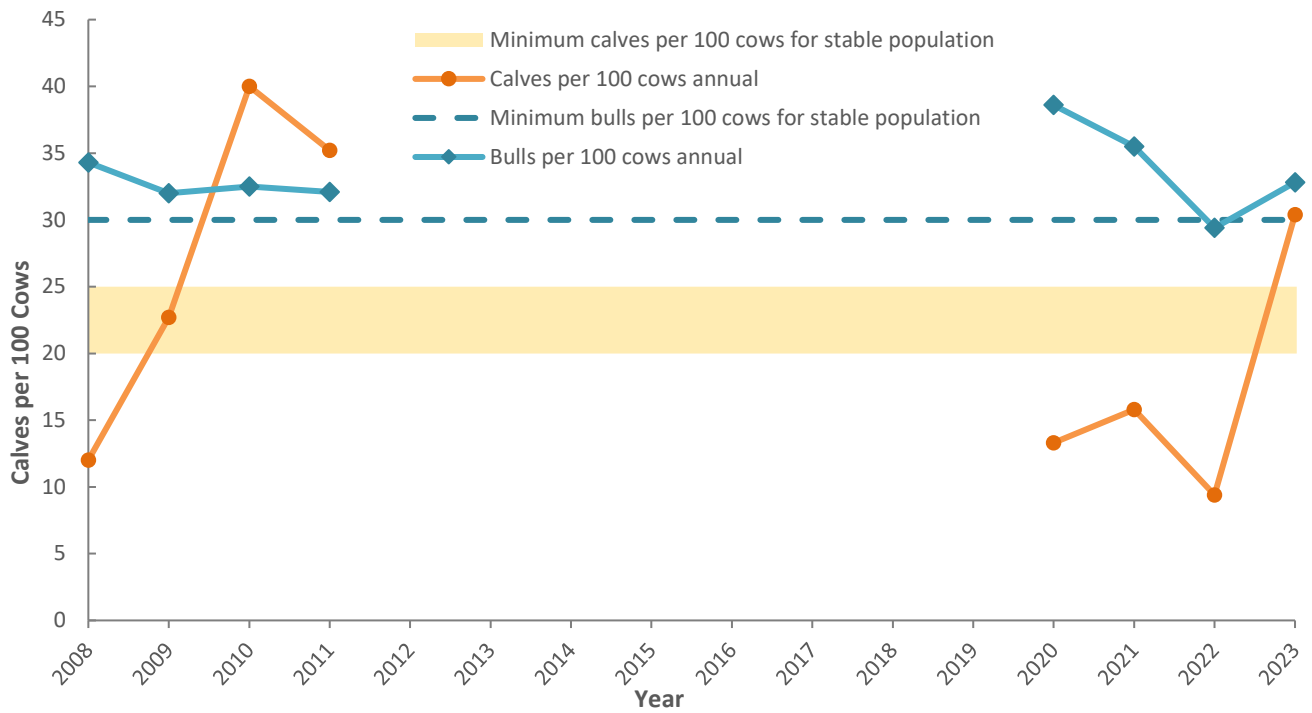| Estimated herd size	Calves	Cows	Bulls
1,203	82	867	254

Figure 4. Index of fall calf recruitment as number of calves per 100 adult cows and adult sex ratio as number of bulls per 100 adult cows, estimated from fall composition surveys, 2008–2011 and 2020–2023.

Management Implications

The first formal population survey conducted on the Coal River caribou herd north of Watson Lake, Yukon has provided much needed insights into the current population size of the herd. The estimated population size of 1,203 (95% CI = 914–1,586) animals is likely a positive result as it is higher than the previous estimate of 900 animals based on minimum counts. Since this is the first formal population estimate for the CRCH, herd trend is unknown. Recent (2020–2023) trends in fall calf recruitment are concerning (17.2 calves per 100 cows), as they are indicative of a decline; however, a full five years of composition data is needed to better understand trend as annual estimates are highly variable.

Recent adult sex ratios, while sufficient (*i.e.,* above 30 bulls per 100 cows), are near the minimum recommended threshold, low compared to other Northern Mountain caribou herds in the Yukon, and may correspond with concerns of overharvest of this herd. The total harvest rate is currently estimated to be 1.2% of the 2022 population estimate. Pending results of the 2024 fall composition survey, this harvest rate may need to be revisited to determine if it is within sustainable levels.

Further work will include a fifth year of composition surveys in the fall of 2024, and we suggest composition surveys occur every other year after that, which will help to increase confidence in herd trend over time. Potential effects from upgrades to the NRR will be examined more closely once the collaring program is complete and we can conduct an evaluation of animal movements and range use in relation to the road and other landscape features.

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Appendix A

Both an open immigration-emigration logit normal model and a closed mixed logit normal model were considered for this survey, and ultimately a closed mixed logit normal model was chosen for the final population estimate as it best represents the survey data. However, two marked animals moved outside the survey blocks immediately before the survey began, thus it was likely that in reality, animals were moving in and out of the survey area, thus we wanted to explore a model that considered the population to be geographically and demographically open. This represents a super-population approach in which our survey "population" represented a portion of the overall super-population. This model also allows for individual heterogeneity in resighting probabilities by treating each animal as a random effect; however, if this parameter was not supported during model selection, the data was considered to have no individually identifiable marks and was fixed at zero (McClintock B. , 2018).

This mark-resight model has five estimable parameters:

- **p** – resighting rate;
- **σ** – individual heterogeneity in resighting rate;
- **N** – population size in the survey area;
- **N*** – super-population size, and
- **α** – change in **N** between resighting sessions.

A set of eight candidate models were developed by varying p, $σ$, and/or $α$ and comparing each using Akaike's Information Criterion difference ($Δi$ AIC_c; Akaike 1973) adjusted for small sample sizes (AIC_c; Burnham, 1998) and Akaike weights ($AIC_c w_i$) to select the model(s) with the fewest predictor variables that explained the greatest variation in the data (*i.e.*, the most parsimonious model). All models with a $Δi$ AIC_c of ≤2.00 were considered plausible (Richards 2005; Symonds and Moussalli 2011).

The top-selected model (**Table 6**) included p (resighting probability) varying by session, a constant $α$, suggesting that expected population size within the study area did not change between sessions, and $σ$ (individual heterogeneity) fixed at 0, suggesting there were no differences among marked individuals that made them more or less challenging to detect. The immigration-emigration modelled population estimate for Coal River caribou herd is 1,191 (95% CI = 936–1,606) animals (**Table 7**), which is within the bounds of the closed mixed logit normal model (1,203 animals; 95% CI = 914–1,586).

Table 6. Candidate models for the 2022 Coal River caribou population estimate with model selection values.

Model	Rank	K^a	AICc	Δi AICc	AICc weight
N, N*, p_t, α.	**1**	**4**	**134.914**	**0.00**	**0.585**
N, N*, p_t, σ_t, α.	2	5	137.141	2.23	0.192
N, N*, p_t, α_t	3	5	137.490	2.58	0.162
N, N*, p_t, σ_t, α_t	4	6	139.540	4.63	0.058
N, N*, p., α.	5	2	146.722	11.81	0.002
N, N*, p., σ_t, α.	6	2	146.722	11.81	0.002
N, N*, p., α_t			*Model convergence not achieved*		
N, N*, p., σ_t, α_t			*Model convergence not achieved*		

^{a} *Number of model parameters including the intercept.*

Table 7. Estimates of model parameters of the Coal River caribou herd from the most supported mark-resight model.

Top model	Parameter	Value	SE	95% Confidence Interval
N, N*, p_t, α.	**N** (population within survey area)	**1,191**	**167**	**936–1,606**
	p_1 (session 1 resighting rate)	0.352	0.051	0.259–0.457
	p_2 (session 2 resighting rate)	0.388	0.056	0.285–0.502
	p_3 (session 3 resighting rate)	0.433	0.062	0.317–0.557
	N* (super-population)	1,191	0.004	-
	α (change in N between sessions)	-	-	-

*Note: the top-selected model included the **α** parameter fixed at 0, indicating emigration-immigration in the study area was constant and random, thus resulting in a super-population estimate equal to that of the population within the study area.*