Estimating Ungulate and Predator Population Densities in Chinchaga and Caribou Mountains

NWSAR Final Report (2020-2023)

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Abstract

This report presents findings from a four-year remote camera monitoring project conducted in the Chinchaga and Caribou Mountains caribou ranges in northwestern Alberta. Led by the Northwest Species at Risk (NWSAR) Committee in collaboration with the Alberta Biodiversity Monitoring Institute (ABMI) and the Alberta Trappers Association (ATA), the study aimed to estimate population densities of key ungulate and predator species to inform woodland caribou management. Density estimates were generated for species including moose, woodland caribou, white-tailed deer, snowshoe hare, black bear, lynx, and gray wolf. Results revealed consistently low caribou densities, with higher concentrations in mid-latitude clusters, particularly in the Caribou Mountains. Moose were the most abundant ungulate. Predator densities varied, with black bear and lynx being most prominent, and wolf densities exceeding thresholds for caribou population stability in some areas. The study highlights spatial patterns in species distribution, potential impacts of wildfire history, and the need for continued monitoring to assess long-term trends and inform conservation strategies.

Introduction

The Alberta Northwest Species at Risk (NWSAR) Committee was created to ensure local interests are reflected as part of woodland caribou management. Among the recommendations generated by NWSAR, data collection to support woodland caribou management is identified as a priority. To support the acquisition of updated data related to caribou and the species in which they interact with, NWSAR worked with the Alberta Biodiversity Monitoring Institute (ABMI) and the Alberta Trappers Association (ATA) to deploy remote cameras to collect data on ungulates and predators for density estimation in two woodland caribou ranges in northwestern Canada. The goal with these cameras was to provide information on trends in mammal densities across time and space in an area where data are relatively sparse otherwise.

While many methods are available for species-specific monitoring, remote cameras are an ideal approach for surveying the abundance of multiple species simultaneously. The use of cameras allows for: i) density estimation for species of interest; ii) simultaneous data collection for all medium- to large-sized mammals (i.e., monitor a large component of the biotic community); iii) standardized protocols to allow for comparison with regional/provincial datasets; and iv) involvement of local hunters, trappers, and citizens in data collection.

In this report we present the results from 4 years (2020-2023) of remote camera data collection across six clusters of cameras in two caribou ranges in the northwest of Alberta: Chinchaga and Caribou Mountains. We report the estimated densities of multiple species of interest, both

predators and prey, across this timeframe, discuss the implications from these results, and suggest areas for further monitoring and research.

Methods

To align with the sampling design used by the ABMI Wildlife Science Centre's Ecosystem Monitoring Camera Program, camera locations were selected for three clusters of 25 sites in both the Chinchaga and Caribou Mountains caribou ranges (Figure 1); however, the northernmost cluster in Caribou Mountains was not successfully deployed due to access constraints. The Rainbow Lake grid is not included in this report due to it not being retrieved in time to be included in the final analysis.

Clusters were placed throughout each range to capture a latitudinal gradient and to approximately match habitat conditions within that range (e.g., fire prevalence, upland/wetland). Cameras were deployed in locations with reasonable access for monitoring station maintenance. Cameras were programmed to collect data year-round to increase the cumulative detection probability and were serviced once per year. The camera sites remained constant over time (Steenweg et al., 2016) and were deployed over four consecutive years, with the exception of the northern cluster in Chinchaga, which was only deployed for one year (2020).

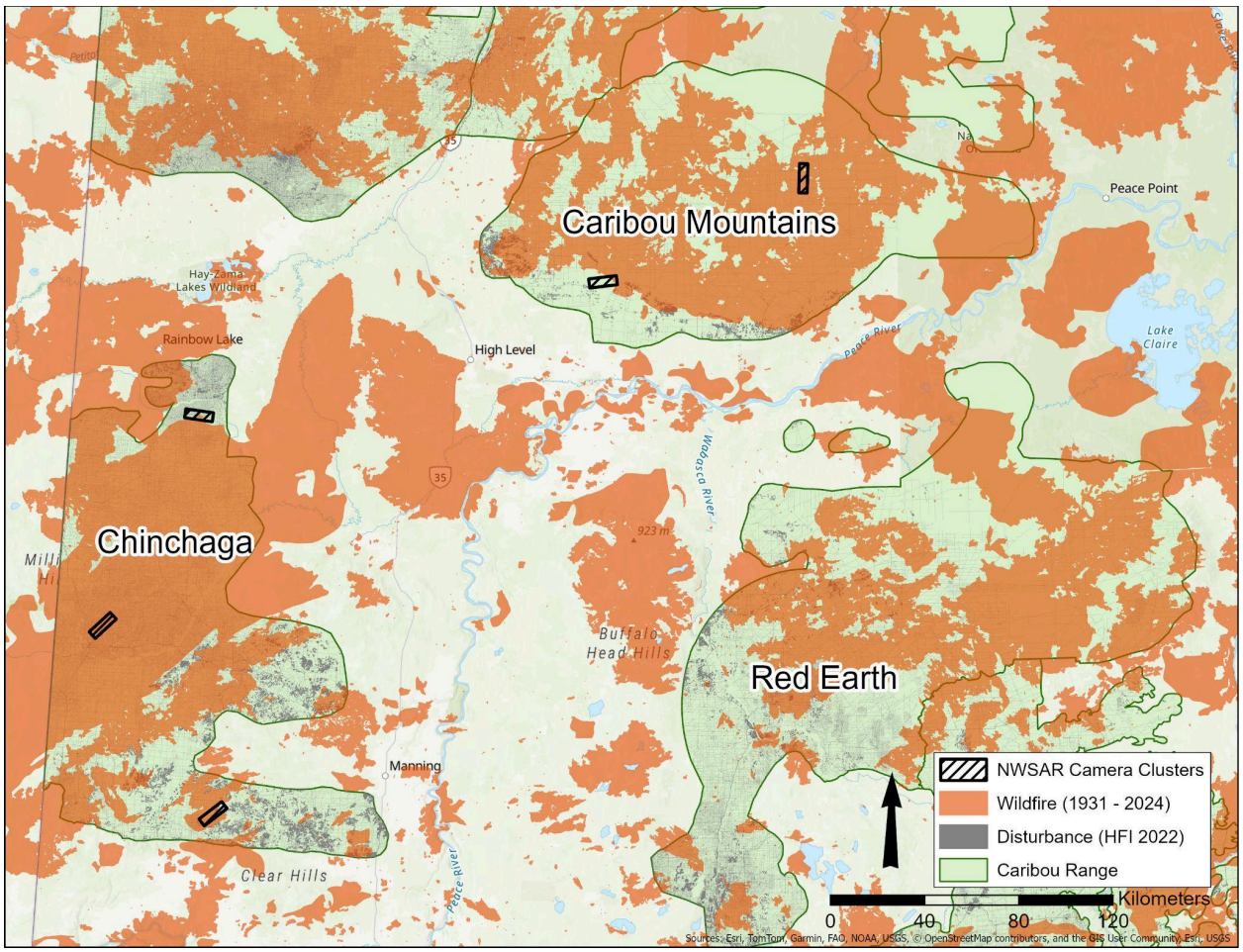

Figure 1. Study area map depicting camera clusters in the Caribou Mountains and Chinchaga caribou ranges. Wildfires from 1931 to 2024 are shown in orange. Dark grey depicts disturbance from human habitat-alteration.

Clusters were placed within reasonable access from roads or established trails. Within each cluster, cameras were randomly placed in a 12.5 x 4 km area, with a minimum separation of 1 km between cameras. Each grid study area was a total of 50 km^2, making a combined total study area of 250 km^2. For the Caribou ranges, the Caribou Mountains total area is 20,659 km^2 and the Chinchaga range total area is 17,644 km^2. While this design biases clusters towards areas with roads, there is no a priori knowledge that this will be problematic for the metrics of interest. However, bias from other habitat factors such as land cover, linear feature density, road traffic levels, and planned industrial developments that would result in drastic changes over the monitoring period was explicitly avoided in site selection.

The remote camera clusters collect an index of use and abundance as a sample of each range, from which we can extrapolate throughout the range. We calculated the relative density of

prominent mammal species using the Time in Front of Camera (TIFC) method (Becker et al., 2022). This metric can be considered an index of relative density and conceptualized as an unknown, but constant, proportion of the true density. TIFC counts the number of animals observed within a defined area over time and divides by the area and time monitored, using the formula:

$$D = \frac{\sum(N \times T_F)}{(A_F \times T_O)}$$

Density (D) at each camera is calculated as the total number of animals observed (N) multiplied by the time in front of the camera field-of-view (T_F), divided by the area of the camera field-of- view (A_F) multiplied by the total camera operating time (T_O). The units are animal-seconds per area-seconds, which equates to the number of animals per unit area. Additional methodological details are described in Becker et al (2022). This value is calculated first at an individual camera level, then an average density value is calculated across the 25 cameras of each cluster.

As a coarser indicator of abundance, we also calculated the number of 'independent detections' by species, which was defined as a detection (image capture) of the species separated by at least 30 minutes from another image of the same species at the same camera location. This calculation groups the images collected into separate events, which can be useful for understanding how many instances the cameras encountered a species.

Results

The mean sampling effort (number of days cameras were active) per camera across all camera clusters and years was just under a year at 331 days, ranging from a minimum of 231 to a maximum of 431 days.

Across all years of sampling and all clusters, the highest number of independent detections was captured of snowshoe hare (2,643), followed by red squirrel (444), black bear (431), moose (345), and lynx (303). Wolverines were detected a total of 56 times throughout the study time period, with an even split of approximately 15 detections per year. The data were too sparse to infer population trends for this species, and more specialized monitoring would be required. The species' with the lowest total number of independent detections were elk (1), cougar (2), bison (3), and grizzly bear (4). Further estimation of trends and densities were not possible for these species. The Appendix displays the number of independent detections captured for each species across each cluster and caribou range.

Predators

The 3 most prominent predator species were black bear, lynx, and gray wolf (Figure 1). Black bear density was the highest in 2023 in the South-Caribou Mountains cluster at 0.6 individuals per km^2. The 3 years previous (2020-2022) all recorded density estimates with values between 0.2 and 0.4 individuals per km^2. Black bear densities in other camera clusters were relatively stable throughout the study period, generally estimated between 0.1 and 0.3 bears per km^2. Similarly, lynx in the Mid-Chinchaga cluster was highest in 2020, estimated at 0.35 individuals per km^2, but was much lower and stable in clusters across the study area and time period. Wolves were present in only very low densities (<0.005 wolves per km^2) in Chinchaga, but were more prevalent in the South-Caribou Mountains cluster (~ 0.0075-0.01 per km^2). Wolves were also detected in the Mid-Caribou Mountains, with more variability across years (ranging from 0 in 2023 to 0.018 wolves per km^2 in 2022).

No clear year-over-year trends (increases or decreases in density) were observed in any of these three species because either confidence intervals of yearly estimates overlapped or successive increases/decreases in density estimates were negated by a change in direction in subsequent years. The one exception was lynx in Mid-Chinchaga, which decreased in estimated abundance from 0.35 in 2020 to 0.08 in 2021, 0.03 in 2022, and finally 0.007 lynx per km^2 in 2023. While this was a dramatic change, lynx populations are known to cycle naturally in conjunction with their primary prey, the snowshoe hare (Krebs et al 2018). While a similar trend was not observed for snowshoe hare (Figure 3 below), there often is a lag between the two species that may not be appropriately captured by this study's timeframe. The population cycle of the two species is generally around 10 years between peaks (Krebs et al 2018).

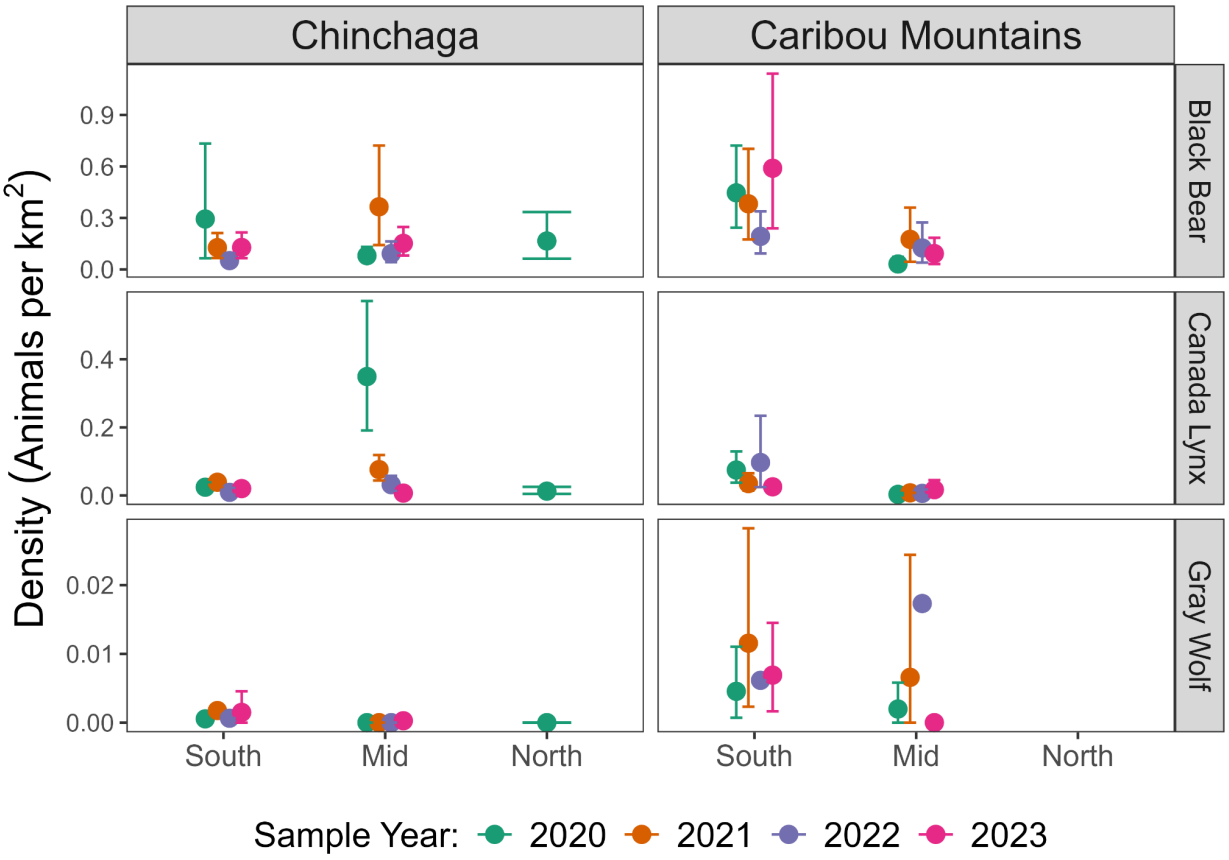

Figure 2. Density (# of animals per km^2) with 90% confidence intervals of black bear, lynx, and gray wolf in the Chinchaga and Caribou Mountains caribou ranges. Densities are provided for each range, arranged from south to north, with year depicted in colour. Note the y-axis scale differs between species. The northern grid in Chinchaga was only deployed in 2020.

Prey

Of the ungulate prey species, moose density was higher than that of woodland caribou and white-tailed deer across all cluster locations (Figure 3). The highest observed moose density occurred in South-Caribou Mountains in 2020 (0.21 moose per km^2), followed by similarly elevated values in South-Chinchaga in 2021 (0.39 moose per km^2). In contrast, densities in Mid-Caribou Mountains dropped to a low of 0.01 moose per km^2 in 2022 before partially recovering to 0.14 in 2023.

Overall, white-tailed deer densities were low across the clusters and range. The highest observed densities were in the South-Chinchaga cluster, which was estimated to be 0.23 deer per km^2. However, there was wide uncertainty with this estimate, and the estimated deer density in subsequent years in that cluster was between 0 and 0.1 deer per km^2. In 2020 the

estimated deer density at South-Chinchaga was 0.1, but dipped to below 0.03 in the subsequent 3 years. Deer density was either 0 or negligible (<0.01 deer km^2) in the Mid and North cluster of both Chinchaga and Caribou Mountains.

Estimated densities of woodland caribou were low across all monitoring clusters and years, varying between 0.09 and 0.22 caribou per km^2. In both caribou ranges, the mid cluster had higher estimated densities than the southern or northern clusters. The highest mean density was observed in Mid-Caribou Mountains in 2020 (0.22 caribou per km^2), though densities were lower in 2022 (0.09 caribou per km^2) and 2023 (0.17 caribou per km^2). The confidence intervals of these estimates substantially overlapped with one another, reducing confidence in any trend in caribou population over time. South- and North-Chinchaga consistently reported near-zero detections. There were no collared caribou detected on the wildlife cameras and were therefore not taken into account in the analysis.

Snowshoe hare densities were generally higher than those of all other prey species. Peak values were observed in Mid-Chinchaga in 2022 (1.07 hares per km^2), but densities in both the South and Mid clusters of Chinchaga consistently exceeded 0.35 hares per km^2 throughout the study period. However, a latitudinal pattern was observed with hare density, with the Caribou Mountains range having consistently lower hare densities. This pattern was also observed within-ranges, as the South cluster within Caribou Mountains had less snowshoe hare than the Mid cluster. In the Chinchaga range, the one year of monitoring in the North cluster revealed a far lower density of snowshoe hares than the two clusters to the south.

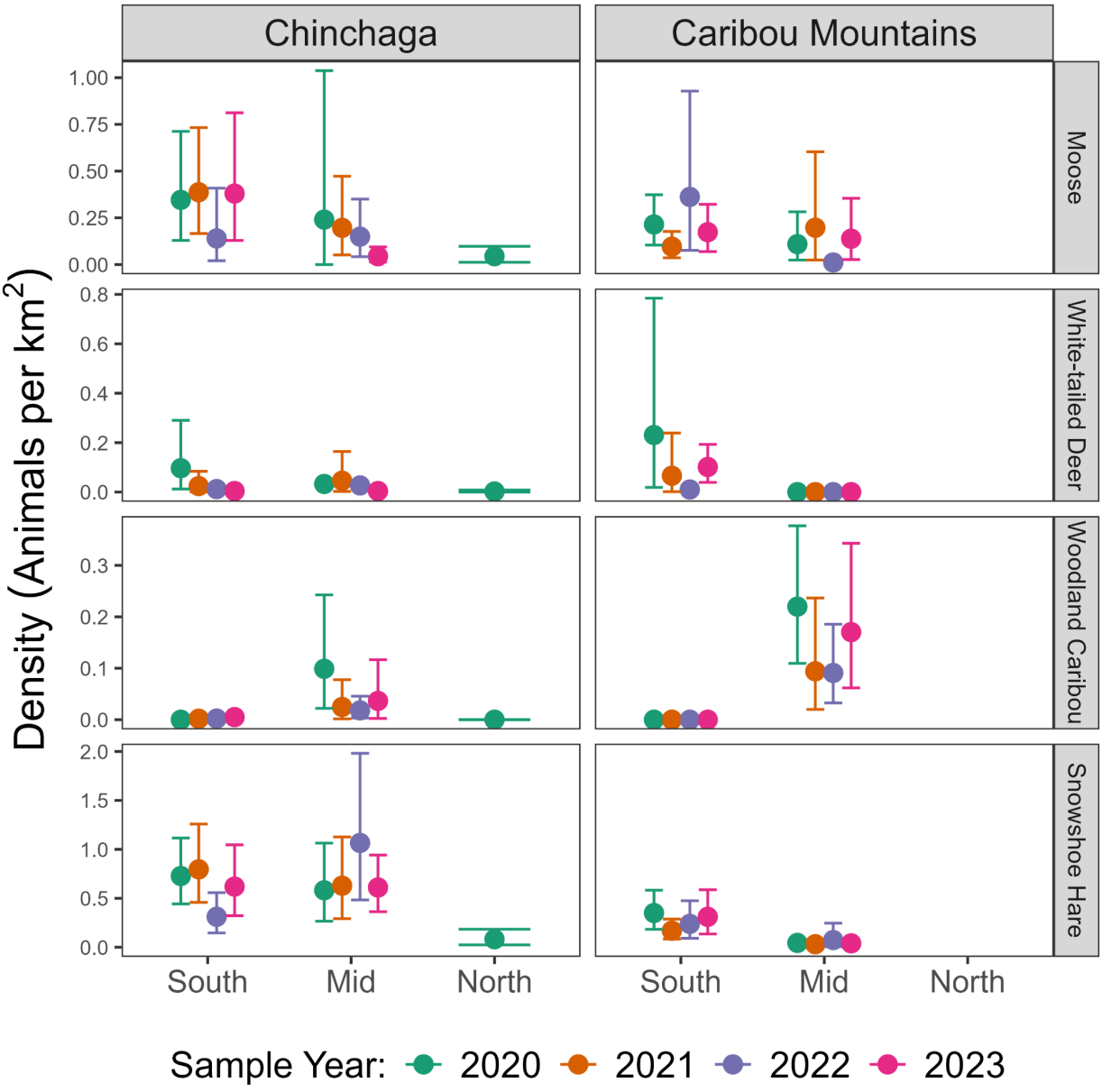

Figure 3. Density (# animals/km2) with 90% confidence intervals of moose, white-tailed deer, woodland caribou, and snowshoe hare in the Chinchaga and Caribou Mountains caribou ranges. Densities are provided for each range, arranged from south to north, with year depicted by color. Note the y-axis scale differs between species. The North cluster of Chinchaga was only deployed in 2020.

Discussion

Woodland caribou continued to be detected at low densities in both the Chinchaga and Caribou Mountains ranges. Across the four-year period, detections were most consistently observed in the Mid-Caribou Mountains cluster, with densities ranging from 0.09 caribou per km² in 2022 to 0.22 in 2023. No caribou were detected in South-Caribou Mountains, South-Chinchaga, or North-Chinchaga for any year of monitoring, reinforcing spatial variation in caribou densities within the ranges, as observed in earlier years. Densities in Mid-Caribou Mountains were comparable to the lower end of those observed in the Richardson caribou range (0.01–1.08 caribou per km²).. The limited year-over-year change and overlapping confidence intervals suggest patterns in estimated densities may reflect spatial structure rather than strong interannual trends, though continued monitoring will be necessary to determine long-term trajectories.

Across both ranges, moose remained the most abundant ungulate species, with the highest observed densities in South-Caribou Mountains (0.21 moose per km² in 2020) and South-Chinchaga (0.39 moose per km² in 2021). These southern areas consistently supported higher densities than northern and mid-latitude clusters, a pattern that may reflect broader latitudinal gradients in habitat productivity and climate severity. In the Mid-Caribou Mountains cluster, moose density dropped from 0.2 per km^2 in 2021 to 0.01 per km² in 2022, but partially rebounded in 2023 to 0.14 per km^2. White-tailed deer densities were generally very low across both ranges, with the exception of the southern-most clusters (particularly in the Caribou Mountains). This suggests that, while there is some encroachment of the species occurring in the southern latitudes of these ranges, white-tailed deer have not yet established populations in these regions. This is potentially due to the combination of low anthropogenic habitat alteration and severed winters (Dicke et al., 2024). Continued monitoring of this species at the northern edges of its distribution is important for understanding drivers of their expansion, and the repercussions to the boreal food web.

Black bear densities were also highly variable, with outlying year-cluster combinations (e.g., 2021 Mid-Chinchaga, 2020 South-Chinchaga) carrying high uncertainty in density estimates. Neither increasing or decreasing trends over time were observed in black bear densities across any of the clusters. While caribou are not a primary prey of black bear, opportunistic and incidental predation (particularly of neonate calves) has been shown to be an important source of mortality and risk to stable caribou populations in other parts of the province (Horne et al., *in review*). While the rate of predation may not be high, the absolute numbers of black bears can lead to an unsustainable number of caribou mortality events.

Spatial patterns remained consistent with those described in earlier reports: southern clusters generally supported higher densities of moose, deer, and black bear, while northern areas (especially within Chinchaga) supported few large herbivores and predators. The exception to this pattern was caribou, who were more abundant in environments with lower densities of

other primary prey (deer). These patterns align with expectations based on regional gradients in climate and primary productivity, with southern areas benefiting from higher forage availability and milder winters (Dawe et al., 2014; Laurent et al., 2020; Dickie et al., 2024). While anthropogenic habitat alteration remains a potential confounding factor, it is relatively low in Caribou Mountains and uniformly high in Chinchaga, allowing for some separation of climate and disturbance effects across the study area.

Two sampling areas in the Chinchaga region overlap historical fires: the Mid-Chinchaga cluster lies within a large 1950 burn, and the South-Chinchaga cluster intersects a smaller fire. In the Caribou Mountains, one sampling area intersects a more recent 2003 burn, located farther north. Despite the prevailing view that wildfire disturbs caribou habitat—supported by the federal recovery strategy and empirical studies (e.g., Johnson et al. 2020)—we observed the highest caribou densities in both the Mid-Chinchaga and northernmost Caribou Mountains grids. This pattern runs counter to the commonly documented avoidance of recently burned areas by caribou, suggesting that older burns, such as the 1950 Chinchaga fire, may have undergone sufficient habitat recovery to once again support caribou populations. This is consistent with the relatively low moose densities in the area, which further indicates a lack of young seral forest that might otherwise support early-successional browsers (DeMars & Boutin 2018). Even the younger (~20-year-old) Caribou Mountains fire appears to support relatively high caribou densities. While it remains possible that caribou are still avoiding recently burned patches within these areas or that fire has reduced biophysical habitat suitability in some respects, these results indicate that relatively high caribou densities can occur in landscapes with a history of fire, particularly where time since disturbance is sufficient for partial recovery. However, it remains unclear how increasing fire frequency and severity under a changing climate may affect caribou populations, especially if post-fire landscapes become more favorable to other ungulates such as white-tailed deer expanding northward.

Gray wolf detections increased modestly over the four years, particularly in South- and Mid-Caribou Mountains, where average densities reached up to 0.018 wolves/km^2 in 2021 — equivalent to 18 wolves per 1000 km^2. This exceeds the 1.8 wolves/1000 km^2 threshold proposed by Serrouya et al (2021) for maintaining stable caribou populations by a factor of 10 and even surpasses the 6.3 wolves/1000 km^2 reference point identified by Bergerud and Elliot (1996). The lowest estimated density in the South cluster, 4 wolves per 1000 km^2 in 2020, did not exceed the Bergerud and Elliot (1996) recommendation, but was higher than that proposed by Serrouya et al (2021). In the Mid cluster, several years of monitoring (2020, 2023) indicated that wolf density was at a level congruent with maintaining caribou populations (Serrouya et al 2021). It is important to note there was wide uncertainty associated with these estimates, as single outlier camera values can have a large impact on the estimate for a cluster/range. In contrast, wolf detections remained sparse in Chinchaga, with only a handful of cameras recording presence across all years. These low densities likely reflect the provincial predator reduction efforts in that region. However, without baseline data from before the onset of predator control, it remains difficult to directly attribute these patterns to management interventions. If sustained, the disparity in wolf density between the two ranges — despite

lower prey availability in Caribou Mountains — could point to differences in predator movement, source-sink dynamics, or localized productivity. Evaluating wolf, moose, and caribou interactions in Caribou Mountains will be important for future assessments of whether predator-prey dynamics are limiting caribou recovery despite habitat relatively undisturbed from development.

Over a longer monitoring horizon, comparisons between Chinchaga (with active predator reductions) and ranges without such interventions may help clarify the effectiveness of wolf control in supporting caribou recovery. Camera-based density estimates — alongside aerial surveys and collaring data — provide a foundation for these evaluations. As wolf reductions continue and restoration actions progress, documenting how predator and prey populations shift will be critical for guiding management decisions and assessing both the ecological and social impacts of these actions (Myers et al., 2007; Doherty and Ritchie, 2017).

Future Considerations

The northern cluster of cameras in Caribou Mountains was not deployed in any of the 4 years or monitoring, limiting inference about mammal communities in the most remote and northern portion of the range. Given the continued low densities of moose, white-tailed deer, and black bear observed in Mid- and South-Caribou Mountains, deploying this northern cluster would help determine whether these patterns persist or shift farther north. It would also provide critical context for the consistently higher wolf densities observed in Caribou Mountains relative to Chinchaga, despite the limitations of availability of certain prey, in many deployed clusters. Confirming whether wolves are present and abundant in North-Caribou Mountains would help test hypotheses about predator-prey decoupling in landscapes with little anthropogenic disturbance. However, these potential data gains must be balanced against the logistical and ecological costs of deployment in this difficult-to-access area. Increased human activity and trail establishment in a currently low-disturbance region could introduce new impacts. If the original site remains inaccessible, alternate cluster locations may be considered, but care must be taken to avoid the boundary and potential confounds introduced by Wood Buffalo National Park, which differs ecologically and jurisdictionally from the surrounding region.

The existing dataset has laid a foundation to investigate several pressing ecological and management questions in the northwest region of Alberta. For instance, assessing the potential northward expansion and persistence of white-tailed deer, which has implications for predator dynamics and disease risk, is of paramount importance to the balance of the current mammal community in the northwest of the province. A recent study (Dickie et al., 2024) has pointed to climate change as being a primary driver of increased white-tailed deer densities northward into the boreal region. The data presented here indicate that white-tailed deer have not yet established a foothold in this portion of the province. While these deer densities may not remain low indefinitely considering ongoing climate change, these current levels are likely

not having the same impact on caribou-wolf dynamics as in caribou ranges in other parts of the province.

Acknowledgements

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Appendix

Species	Range	Cluster	No. Independent Detections
Black Bear	Chinchaga	South	97
		Mid	89
		North	23
	Caribou Mountains	South	178
		Mid	44
Canada Lynx	Chinchaga	South	78
		Mid	121
		North	7
	Caribou Mountains	South	85
		Mid	12
Gray Wolf	Chinchaga	South	5
		Mid	1
		North	0
	Caribou Mountains	South	19
		Mid	6
Moose	Chinchaga	South	151
		Mid	56
		North	12
	Caribou Mountains	South	75
		Mid	51
Snowshoe Hare	Chinchaga	South	1,090

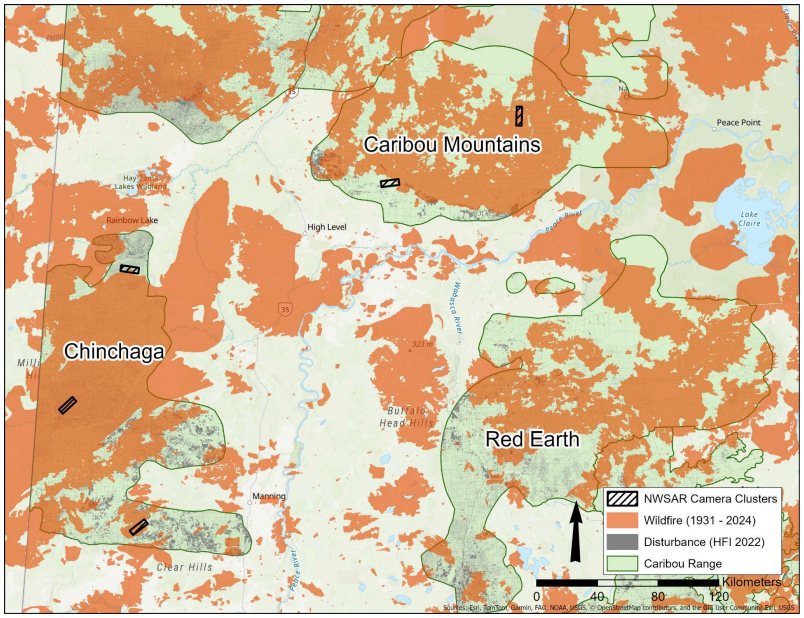
		Mid	980
		North	42
	Caribou Mountains	South	434
		Mid	97
White-tailed Deer	Chinchaga	South	36
		Mid	18
		North	3
	Caribou Mountains	South	134
		Mid	0
Woodland Caribou	Chinchaga	South	3
		Mid	54
		North	0
	Caribou Mountains	South	0
		Mid	95

Executive Summary

The Alberta Northwest Species at Risk (NWSAR) Committee, in collaboration with the Alberta Biodiversity Monitoring Institute (ABMI) and the Alberta Trappers Association (ATA), initiated a multi-year remote camera monitoring program to improve data availability for woodland caribou and associated species in northwestern Alberta. Between 2020 and 2023, over 100 remote cameras were deployed across six clusters within the Chinchaga and Caribou Mountains caribou ranges to estimate mammal densities, identify spatial and temporal trends, and support evidence-based management for species at risk.

Study Design and Approach

The program used standardized ABMI camera protocols to enable comparison with broader regional datasets. Cameras were placed across latitudinal gradients to represent the diversity of habitats within each range, while ensuring accessibility for maintenance. The monitoring design captured data continuously throughout the year, generating a comprehensive dataset of detections for both prey and predator species. Species densities were estimated across sites and years using the camera images.



Key Findings

- Predators:
    - *Black bears* were consistently detected across both ranges, with densities typically between 10-30 individuals per 100km^2.
    - *Gray wolves* were scarce in Chinchaga (likely reflecting ongoing predator reduction programs) but were more common in Caribou Mountains (up to 1

wolves per 100km²).

- *Lynx* exhibited marked interannual variation, declining sharply in Mid-Chinchaga from 2020–2023, consistent with cyclic prey–predator dynamics with snowshoe hare.

- Prey Species:
  - *Moose* were the most abundant ungulate, peaking at 39 individuals per 100km² in South-Chinchaga.
  - *White-tailed deer* densities were generally low, suggesting the species has not yet expanded significantly into these northern ranges.
  - *Woodland caribou* were consistently detected at low densities (9–22 individuals per 100km²), with higher concentrations in the Mid-Caribou Mountains cluster and near-zero detections elsewhere.

Implications

Caribou detections remained sparse and localized, emphasizing the species' uneven distribution within these ranges. The spatial contrast between caribou-rich mid-latitude clusters and more predator- and prey-rich southern clusters aligns with broader boreal ecological gradients where warmer, more productive areas support higher other ungulate and predator densities.

Wolf densities in Caribou Mountains exceeded thresholds associated with stable caribou populations (Serrouya et al. 2021), suggesting predation pressure may still impede recovery even in relatively undisturbed landscapes. Meanwhile, consistently low wolf detections in Chinchaga likely reflect ongoing predator management. The divergence between these ranges presents an opportunity to assess the long-term ecological outcomes of predator control.

Future Directions

Expanding monitoring to the northern Caribou Mountains cluster remains a key priority to address current data gaps. Continued monitoring will be essential to:

- Evaluate long-term trends in predator–prey dynamics and their implications for caribou recovery.
- Track potential northward expansion of white-tailed deer and its cascading effects on predator abundance and disease risk.

- Assess the ecological outcomes of predator control programs and habitat restoration in supporting caribou persistence.
- Assess the impact of wildfires on wildlife in these caribou ranges over time.

Overall, this program demonstrates the value of standardized, community-engaged remote camera monitoring for understanding multi-species interactions and supporting adaptive management in Alberta's boreal region.