Ontario Boreal Caribou Monitoring Program

2023 Aerial Survey Results

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Ministry of the Environment, Conservation and Parks

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EXECUTIVE SUMMARY

Through the Boreal Caribou Monitoring Program, Ontario is working to improve understanding of the current and projected status of Boreal Caribou in Ontario at a range-scale. The monitoring program includes the fourteen Boreal Caribou ranges in Ontario.

Ontario made a commitment to develop and implement the monitoring program under the five-year Agreement for the Conservation of Caribou, Boreal Population in Ontario (Caribou Conservation Agreement) signed by Ontario and Canada in 2022. Implementation is underway focused on providing information to improve understanding of the status of Boreal Caribou in the Lake Superior Coast Range and Discontinuous Distribution and support updating of Integrated Range Assessments for the Boreal Caribou ranges in the Continuous Distribution.

As part of the Boreal Caribou Monitoring Program, helicopter surveys using a stratified-transect distance sampling approach (herein referred to as the 2023 aerial surveys) were conducted in February and March 2023 in the Brightsand, Churchill, Kesagami and Kinloch Ranges of Boreal Caribou by WSP E&I Canada Ltd. (WSP) on behalf of the Ministry of the Environment, Conservation and Parks (MECP).

This document provides information on the purpose, methodology and results of the 2023 aerial surveys. It was prepared by MECP and the Ministry of Natural Resources and Forestry (MNRF).

The number of caribou observed during the aerial surveys for the Brightsand, Churchill and Kesagami Ranges were more than 100 in each range suggesting that these ranges have large enough populations that they are unlikely to become extirpated in the short term. More work is required to estimate the population size of these ranges and the Kinloch Range.

Caution is recommended in drawing conclusions from the 2023 aerial surveys which are single point-in-time estimates (several years of data is preferred) with small sample sizes and large confidence intervals. Further information on recruitment, survival and habitat state is required to improve understanding of the projected future status of Boreal Caribou in each of the four ranges surveyed.

1. INTRODUCTION

1.1 Purpose

The purpose of this document is to describe the context, goals, methodology and results of Boreal Caribou aerial surveys undertaken in 2023, as part of Ontario's Boreal Caribou Monitoring Program.

Specifically, helicopter surveys using a stratified-transect distance sampling approach (herein referred to as the 2023 aerial surveys) were conducted in February and March 2023 in the Brightsand, Churchill, Kesagami and Kinloch Ranges of Boreal Caribou by WSP E&I Canada Ltd. (WSP) on behalf of the Ministry of the Environment, Conservation and Parks (MECP). All observations and signs of Boreal Caribou were documented during the surveys.

This document was prepared by the MECP and the Ministry of Natural Resources and Forestry (MNRF) and is structured in the following manner:

- Part 1 provides the context for the 2023 aerial surveys including information about the Caribou Conservation Agreement, Boreal Caribou in Ontario, the Boreal Caribou Monitoring Program, and the Integrated Range Assessment Framework.
- Part 2 describes the methodology that was applied in the 2023 aerial surveys.
- Parts 3 to 6 describe the methods, results and analysis specific to each of the four ranges surveyed in 2023.
- Parts 7 to 9 include a glossary, references and appendices.

1.2 Context

1.2.1 Boreal Caribou in Ontario

Boreal Caribou is a threatened species at risk under Ontario's *Endangered Species Act, 2007* (ESA) and the federal *Species at Risk Act, 2002* (SARA). In Ontario, Boreal Caribou are generally found north of Sioux Lookout, Geraldton and Cochrane with a few isolated populations further south along the shoreline and islands of Lake Superior (Figure 1). Thirteen ranges have been delineated in what is called the Continuous Distribution of Boreal Caribou in Ontario. A fourteenth range, the Lake Superior Coast Range, is located farther south, along the northeast shore of Lake Superior. The Lake Superior Coast Range is separated from the northern ranges by an area called the Discontinuous Distribution.

Figure 1. Ontario's Boreal Caribou Ranges.

1.2.2 Ontario's Boreal Caribou Framework

The design and implementation of the Boreal Caribou Monitoring Program is consistent with Ontario's Boreal Caribou policy set out in Ontario's *Woodland Caribou Conservation Plan* and *Range Management Policy in Support of Woodland Caribou*

Conservation and Recovery. The Program is guided by the Integrated Assessment Protocol for Woodland Caribou Ranges in Ontario (2014) (herein referred to as the "Integrated Assessment Protocol").

Ontario's Woodland Caribou Conservation Plan sets out Ontario's approach to Boreal Caribou conservation and recovery and describes the Range Management Approach which is integral in ensuring the recovery and long-term persistence of Boreal Caribou in Ontario. The Range Management Policy outlines the approach to implementing Ontario's Range Management Approach to support Ontario's conservation goal for Boreal Caribou. Ranges serve as the ecological and spatial basis for evaluating caribou population and habitat states and managing cumulative effects at the landscape scale.

1.2.3 Caribou Conservation Agreement

On April 21, 2022, Ontario and Canada finalized a five-year (i.e., 2022 to 2027) Conservation Agreement for Boreal Caribou in Ontario (Caribou Conservation Agreement) that identifies outcomes, conservation measures, and actions for Boreal Caribou. The Caribou Conservation Agreement provides an overall framework for establishing collaborative commitments from both Canada and Ontario to undertake actions that support the maintenance or recovery of self-sustaining local populations of Boreal Caribou in Ontario.

Within the Caribou Conservation Agreement are thirteen conservation measures that outline the goals, actions and measures needed to achieve the desired outcomes of the agreement. Conservation Measure 1.1 Boreal Caribou Monitoring Program commits Ontario to:

- Develop an ongoing monitoring program for Boreal Caribou that builds on past investments (e.g., including criteria for range prioritization, timelines, methods, logistics, Indigenous engagement and participation, reporting) and provides opportunities to engage northern and Indigenous communities and enhance caribou conservation capacity in Indigenous communities.
- Implement a monitoring program starting in key ranges in 2022-23 and as identified through range prioritization that includes consideration of risk to the species.

1.2.4 Boreal Caribou Monitoring Program (2022 – 2027)

Following engagement of stakeholders and Indigenous communities and organizations, the design of a Boreal Caribou Monitoring Program under the Caribou Conservation Agreement was developed in 2023 and implementation is underway. It is anticipated there will be further refinements to the Boreal Caribou Monitoring Program as implementation progresses.

The program includes monitoring activities in all ranges such as aerial surveys, caribou collaring, fecal DNA studies and habitat analysis. Ontario is using the results of the

Boreal Caribou Monitoring Program to update Integrated Range Assessments including updated information on population size, population trend, cumulative disturbance, habitat amount and arrangement (where possible), and a risk assessment and range condition for each range in the Continuous Distribution. The program will also support improved understanding about the status of Boreal Caribou in the Lake Superior Coast Range and Discontinuous Distribution.

The 2023 aerial surveys were conducted in four ranges (Brightsand, Churchill, Kesagami and Kinloch) as part of the Boreal Caribou Monitoring Program, while the design of the Boreal Caribou Monitoring Program was being developed. Additional work is underway or planned under the monitoring program to generate information to support updated range assessments for these four ranges and the other ranges in Ontario.

1.2.5 Integrated Range Assessment Framework

The Integrated Range Assessment Framework guides the implementation of the Boreal Caribou Monitoring Program, including the 2023 aerial surveys. The following is a general overview of the Integrated Range Assessment Framework as set out in the Integrated Assessment Protocol.

An Integrated Range Assessment is a quantitative and qualitative analysis leading to a statement of range condition involving Boreal Caribou and their habitat. It includes consideration of four lines of evidence: population size, population trend, habitat disturbance, and habitat assessment (amount and arrangement of habitat).

The first three lines of evidence related to population size, population trend and habitat disturbance assessment contribute to an integrated risk assessment. The results of the integrated risk assessment are combined with the fourth line of evidence – habitat assessment, to inform the determination of range condition (i.e., whether a range condition is insufficient, sufficient, or uncertain to sustain caribou over the long-term).

Caribou population state is conventionally measured in terms of population size (i.e., the number of caribou) and population trend (i.e., increasing, stable or decreasing). Population trend is described by average rate of growth, referred to as lambda (λ). Under the Integrated Assessment Protocol, the best available data is used to estimate the number of caribou and the population trend within the range. For a given caribou range, the ability to calculate a reliable estimate of population trend improves with the collection of multiple annual estimates of survival and recruitment over a condensed time period (e.g., 3-5 years), so average estimates that account for between-year variation can be calculated for both survival and recruitment.

The process for conducting an Integrated Range Assessment is described in Figure 2 below.

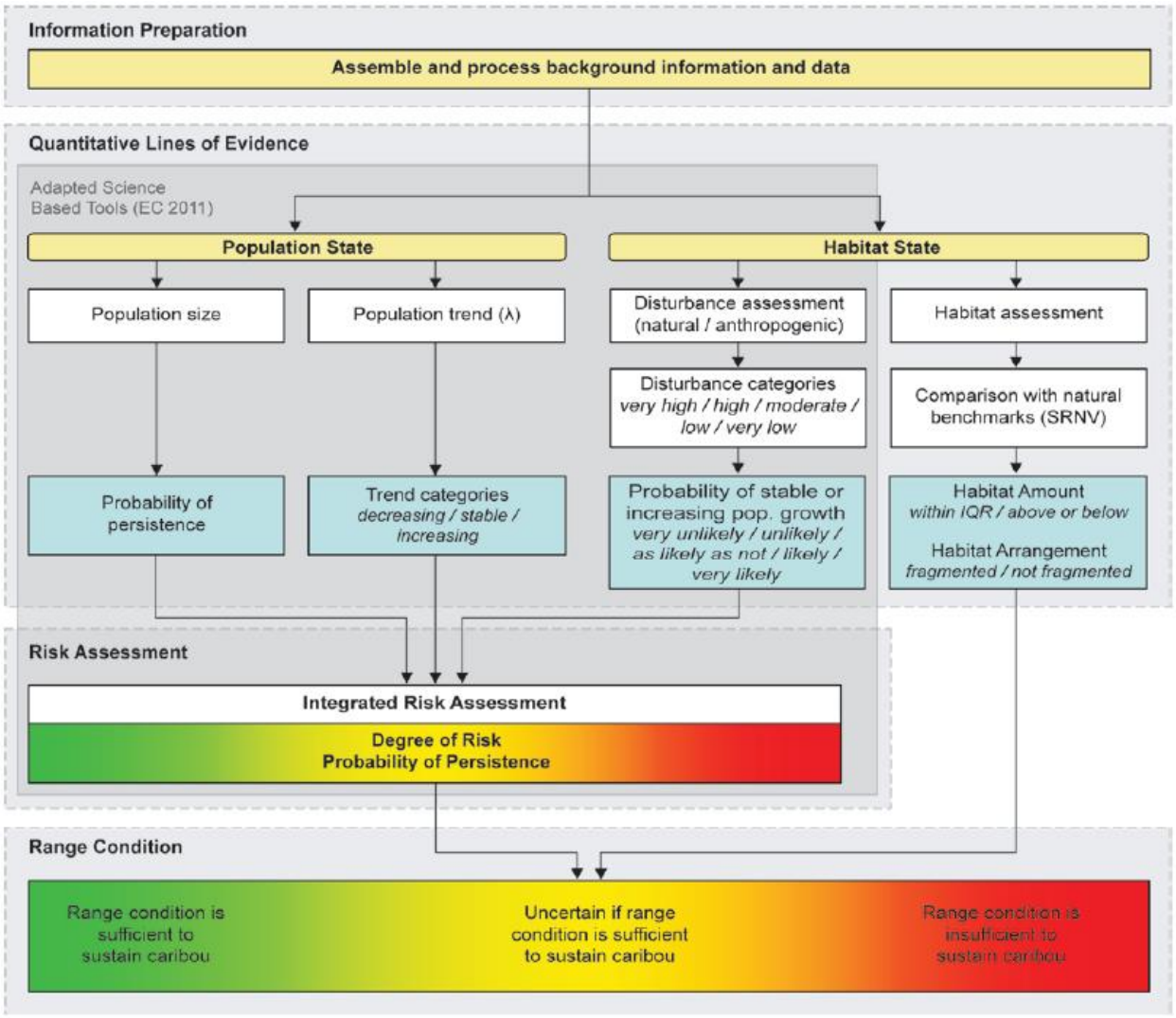

Figure 2. The Integrated Range Assessment Framework with four quantitative lines of evidence. The first three lines of evidence related to population size, population trend and habitat disturbance assessment contribute to an integrated risk assessment. The results of the integrated risk assessment are combined with the fourth line of evidence, habitat assessment, to inform the determination of range condition.

From 2008 to 2014, Integrated Range Assessments for Boreal Caribou were completed for all ranges in Ontario, except the Lake Superior Coast Range. The Integrated Assessment Protocol was not applied within the Lake Superior Coast Range due to the range's unique physical geography and the resulting differences in Boreal Caribou density and distribution. However, Ontario and others have led monitoring efforts in the range designed to assess population status and trend of Boreal Caribou and their primary predators.

1.2.5.1 Population Distribution

The 2014 Integrated Range Assessment Reports (IRARs) provided information on the spatial distribution of caribou across each range based on winter survey observations and occupancy modelling results. Changes in these patterns over time inform assessments of whether there is range recession or expansion.

Population-level aerial surveys are often used for long-term monitoring of species presence and probability of occupancy at coarse scales to examine potential range-scale changes in distribution and to identify areas of potentially higher use based on habitat associations. As aerial surveys are restricted to winter (i.e., because of improved ability to sight caribou), the survey data may not reflect the full extent of annual distribution (Poley et al. 2014).

Compilation of caribou observation data collected since 2014 and collection of additional information could support assessments of whether there is evidence for major changes in recent caribou distribution since the 2014 IRARs were completed (e.g., is there evidence of range recession/contraction or expansion). Additionally, spatial patterns in group sizes could be examined and compared to spatial patterns documented during previous monitoring efforts to determine whether there have been any general changes in relative abundance of caribou over time.

1.2.5.2 Population Density and Size

Population density estimates are expressed as the number of caribou per square kilometer (km^2), which is used to determine range-level population size estimates. The intent of this line of evidence is to infer a likelihood of persistence based on the number of caribou existing within the range. Studying population size is a way to understand how the number of caribou may influence the persistence of caribou populations under various demographic conditions.

In general, the smaller the population size, the more vulnerable the population is to extirpation due solely to random year-to-year variation in adult survival and recruitment rates (i.e., demographic stochasticity). Conversely, vulnerability to extirpation due to random demographic variation decreases with larger population sizes (Environment Canada 2011).

Boreal Caribou population size is generally not a concern for a stable population until the number of caribou falls below approximately 300 (Environment Canada 2008). Modelling work completed by Environment Canada in 2011 suggested that populations of 100 to 300 caribou with average vital rates (i.e., adult female survival of 85%, calf survival of 38%, recruitment rate of 37.7 calves per 100 adult females, and parturition rate of 76%) had relatively high probabilities of longer-term persistence (i.e., greater than 75%), while populations greater than 300 caribou had a greater than 90% probability of persistence. These thresholds were identified using populations with survival and recruitment rates that were generally consistent with a stable population.

If a population does not exhibit stable or positive population growth, the expected probability of persistence for those populations is lower. If a population is declining (e.g., due to low survival or recruitment), being above these minimum population size thresholds will not protect it from continued decline and eventual extirpation in the longer-term. However, populations will be more vulnerable to rapid decline as they get small enough to fall below these thresholds.

1.2.5.3 Population Trend

Population trend is an indicator of the self-sustainability of Boreal Caribou in a range. Commonly, population trend is determined based on adult female survival and recruitment data (i.e., the intrinsic rate of growth, lambda (λ)) (Caughley 1977; Hatter and Bergerud 1991). Population trend can also be estimated by comparing population size estimates through time.

Survival

Adult female survival rates are determined by collaring adult female caribou and calculating the proportion of collared animals alive after a one-year time period. Generally, a minimum of 35 collared adult female caribou is needed for medium-to-large sized populations (i.e., more than 100 individuals) or 20 to 30 collared adult female caribou for small populations (i.e., less than 100 individuals).

Recruitment

Recruitment is defined as the number of young produced that survive to adulthood. It is often determined for caribou when calves are 10-12 months old, as their survival by this time is thought to be similar to adults.

The recruitment rate is expressed as the number of calves per 100 adult females observed during late winter aerial surveys. During aerial surveys, observed caribou groups are classified by the number of adult males, adult females, adults of unknown sex, and calves. The observed sex ratio is calculated to estimate the number of adult females that are present within the uncategorized (unknown sex) adult caribou similar to Decesare et al. (2012); resulting in an improved estimate of the total adult female population (adjusted adult females) used in the recruitment calculation (number of calves per 100 adjusted adult females).

Reliable recruitment estimates with reasonable precision require a sample size of at least 50 adult females and calves combined, and ideally more than 80, based on re-sampling efforts previously undertaken by MNRF.

Recruitment rates exceeding approximately 28.9 calves per 100 adult females would suggest the population is increasing. Recruitment rates below that would suggest the population is decreasing based on assumed annual adult survival rates of 85% (Environment Canada 2008; Environment Canada 2011).

It is generally assumed that, in sedentary caribou, a stable population requires a mid-winter estimate of at least 13-15% calves in the total population (including male and female adults and calves) (Bergerud 1992; Bergerud 1996).

Demographic Structure

Assessment of demographic structure of a population is based on the classification of observed individuals with respect to sex (males (bulls) and females (cows)) and age class (adults and calves). These data are then converted into ratios to assess the demography of the population. Knowledge of demographic structure contributes to understanding of population trend through the determination of recruitment rates (calves/adult females) and calves/total population. It can also be used to assess whether adult sex ratios and age distributions are skewed in a direction that might be negatively associated with pregnancy or reproductive success rates. Knowledge of age distribution can also inform whether there are likely sufficient breeding males.

Determining the average sex structure can provide insight into the relative role of vital rates and population size in maintaining populations of Boreal Caribou. The average reported sex ratio of adults (adult females to adult males) across Canada from 1957 to 2005 was 0.610 and the average proportion of adults was 70% (Environment Canada 2008, 2011; Rudolph et al., 2017). The optimal sex ratio for a self-sustaining population is when it is skewed towards more adult females, than males (i.e., up to an upper threshold of 0.769).

Over longer periods of time (or in very small populations) adult sex ratios can change with a bias to either sex (Gunn et al., 2005). For example, a low sex ratio (i.e., more males than females) can occur when the population is increasing and recruitment is high. In this case, the proportion of adult males may increase due to a large cohort of calves and yearlings where younger males typically experience higher survival than older males (Bergerud and Elliot, 1986; Heard and Calef, 1986).

Sample Size

Smaller sample sizes (number of observed individuals) relative to population size, increase the likelihood that the sample of individuals may not be representative of the population's demographic composition. To increase representativeness of a population of approximately 100-500 individuals to within acceptable limits, a minimum sample size of 50 and 80 individuals, respectively, is recommended to achieve 95% confidence in a margin of error of no greater than 10% (Gill et al., 2010; Bartlett et al., 2001; Singh and Masuku, 2014; Serdar et al., 2021). Sample sizes that do not meet these minimums will likely produce sampling error and modelled estimates that have high variance from the mean (poor precision).

2. METHODOLOGY

This section describes the methodology applied to the 2023 aerial surveys completed in the Brightsand, Churchill, Kesagami and Kinloch Ranges.

The 2023 aerial surveys provide information to support two lines of evidence: population size and population trend. Updated Integrated Range Assessments for these four ranges require the collection of additional information to fully understand these two lines of evidence as well as the third and fourth lines of evidence (habitat disturbance and habitat (amount and arrangement)). Table 1 indicates how the 2023 aerial surveys contribute to the collection of information.

Table 1. The 2023 aerial surveys as they relate to the four lines of evidence.

	Line of Evidence	Measure relevant to 2023 aerial surveys	Details relevant to 2023 aerial surveys
Population state	Population size	Minimal Animal Count (MAC)	The number of caribou physically observed.
		Population density – not yet estimated	The number of caribou per square kilometer.
		Population size – not yet estimated	Based on population density which is used to determine range-level population size estimates.
	Population trend	Recruitment rate estimate	The number of calves per 100 adult females.
		Demographic structure	The number of adult females, adult males, adults of unknown sex, and calves.
		Group size	The number of caribou per group observed.
Habitat state	Habitat disturbance	Not Applicable	Not Applicable
	Habitat assessment (amount and arrangement)	Not Applicable	Not Applicable

The 2023 aerial surveys were conducted based on the methods provided in the *Boreal Caribou Monitoring Program Survey Design 2023* (Appendix 1). They consisted of searching for evidence of caribou presence including animals, tracks, slushing and cratering and determining the distance of caribou detected using those observations from stratified transect flight lines.

Transects (parallel east-west flight lines) were stratified by WSP into either 15 km, 7.5 km or 5 km spacing using the winter caribou occupancy figures within the 2014 Integrated Range Assessment Reports (IRARs) for each range. WSP used a preliminary stratification of each range according to three categories of probable occupancy: High: 0.7-1.0; Medium: 0.3-0.69; and Low: 0-0.29. Transect placement across the range was executed by first applying transects across the entirety of the range at 15 km spacing. In areas of high probable occupancy, two additional transects were placed at 5 km spacing. Where medium probable occupancy occurred, one additional transect was placed at 7.5 km spacing. Where low probable occupancy occurred, no additional transects were placed.

2.1 Population Distribution, Density and Size

Winter caribou distribution for each range was derived from the 2023 aerial surveys by recording accurate locations of observed caribou and their signs (i.e., fresh tracks, slushing, cratering). This single point-in-time information confirms winter occurrence of caribou, but due to the difficulty in detecting caribou cannot definitively determine the absence of caribou from areas of a range. Additional surveys within a relatively short timeframe (e.g., five years) can further support determination of winter caribou distribution as can location information gained through caribou collaring.

Population density and population size estimates have not yet been estimated using the observations of the 2023 aerial surveys. Work is underway to further consider the information collected during the surveys in this context.

2.2 Population Trend

Survival Rate

The surveys conducted in 2023 were not designed to update survival rates. As a result, population trend was assessed based on spectrum of potential adult female survival rates, specifically: 'low' (0.80), 'medium' (0.85) and 'high' (0.88) survival rates derived from Environment Canada (2008, 2011).

Recruitment Rate

The 2023 aerial surveys provided a single year of demographic data that were used to derive preliminary recruitment rate estimates. To estimate population trend, further efforts are required to estimate adult female survival rates and improve recruitment estimates (i.e., by collecting multiple years of data, to capture between-year variation in recruitment).

Demographic Structure

In the 2023 aerial surveys, caribou were classified by sex (males, females), general age class (adults, calves), and unknown/unclassified. Each group was photographed to visually verify classifications based on criteria that included body size, antler configuration, rump patch size, presence of vulva patch or penis sheath, and behaviour. Demographic outputs included total count, number of adult males, adult females, calves, adults with unknown sex, and unknown age/sex.

The age and sex of some of the observed caribou could not be determined through observation during the surveys. To estimate the total number of adult females (adjusted adult females), an observed sex ratio was first calculated using only caribou groups for which more than 50% of the individuals could be classified to age and sex. Then, following procedures established by MNRF (2014a), the observed sex ratio was used to estimate the number of adult females that were present within the caribou of unknown

sex. It was assumed that the sex ratio of unknown adults was proportional to the sex ratio in known adults. Finally, bootstrapping was used to derive 95% confidence intervals for the recruitment rate, specifying 1,000 bootstrap replicates where observed groups were resampled with replacement and the recruitment rate was recalculated for each bootstrapped dataset. A similar approach was taken to estimating calf ratios.

Group Size

In the 2023 aerial surveys, mean group size was estimated from direct observations of caribou groups. It was also estimated with a distance analysis that used direct observations of caribou combined with counts from caribou fresh tracks or fresh tracks that led to caribou.

3. BRIGHTSAND RANGE

3.1 Context

The Brightsand Range is located in northwestern Ontario and is approximately 22,000 km^2 in size. The landscape is largely characterized as boreal forest with a history of large and frequent fires and many small and medium sized lakes scattered throughout. The south is primarily dominated by jack pine and black spruce forest; the northern portion of the range is dominated by conifer and conifer-deciduous mixed forest. Historical occupancy shows that caribou occurred throughout the range and some of the highest concentrations of caribou activity in the area were within Wabakimi Provincial Park (8,920 km^2) where peatland complexes, lakes, and old conifer forests are abundant. Caribou are known to use many of the lakes around and within Brightsand River Provincial Park as well as Sturgeon and Savant lakes. Human settlements within the range are small and few, and there are currently few industrial development activities in the Brightsand Range. The most prominent ongoing human impact on the range is forest harvesting and the southern portion of the range in particular has been subjected to extensive harvest. In contrast, much of the northern half of the range is protected from major human activity within Wabakimi Provincial Park.

3.1.1 Integrated Range Assessment Report

This section provides a summary of the approach for the Integrated Range Assessment undertaken from 2011 to 2013 for the Brightsand Range, the results of which were published in 2014. Further information about the assumptions that support this summary is available in the report:
Integrated Range Assessment for Woodland Caribou and their Habitat - Brightsand Range 2011 (ontario.ca)

A two-stage (fixed-wing followed by rotary-wing) aerial winter survey for caribou was conducted during February and March 2011 in which observations of caribou and their signs (i.e., tracks, slushing and cratering) were recorded. During the rotary-wing flights,

caribou were identified as adults, males or females, calves, or unknown age and/or sex. Data collected during the survey were used to determine caribou distribution and estimate population state metrics including the minimum number of caribou in the range and calf recruitment rates. Additional aerial surveys were conducted during late winter 2012 and 2013 to further assess calf recruitment to support estimates of population trend. Twenty (20) adult female caribou were collared during March 2011 and monitored for two years allowing for estimates of survival to be determined.

In the aerial surveys, 224 caribou were observed in 30 groups. Most observations of caribou activity were recorded in the northern part of the range, specifically in Wabakimi Provincial Park. It is known that surveys of this nature typically only detect a portion of the caribou present and it was therefore concluded that the range was occupied by at least 250 caribou and possibly substantially more.

Recruitment rates from 2011, 2012 and 2013 (18.2, 22.9 and 25.5 calves per 100 adjusted adult females respectively) were below the threshold for maintaining a stable population (28.9 calves per 100 adult females, assuming an adult female survival rate of 85%, Environment Canada 2008, Environment Canada 2011) and indicated low recovery potential within the Brightsand Range. The data indicated that the current number of calves was likely inadequate to maintain the population unless adult female survival was above the 85% threshold. However, annual adult female survival within the Brightsand Range during the 2011 and 2012 biological years was only 77% and 80%, respectively. The resulting average population growth rate (λ) from 2011 to 2013 was in decline (0.87).

The 2014 IRAR included the results of a geospatial analysis which estimated 43.5% of the Brightsand Range was characterized as natural and anthropogenic disturbances in 2010. The resulting likelihood of stable or increasing population growth was estimated to be 45%, at that time, and at that level it was uncertain whether the Brightsand Range would be capable of sustaining the caribou population.

Analysis of the amount of caribou habitat (which included refuge habitat and winter habitat), indicated alignment with that expected in a natural landscape based on Simulated Ranges of Natural Variation (SRNV). Winter habitat was fragmented, and refuge was not fragmented relative to what would be expected in a natural landscape, based on expected SRNV outcomes.

The Integrated Range Assessment concluded that risk to caribou persistence was intermediate within the Brightsand Range and it was uncertain whether range condition would be sufficient to sustain caribou.

3.1.2 Monitoring Activities since the 2014 IRAR

Annual winter caribou surveys have been conducted in Wabakimi Provincial Park since 2005, with the objective to collect spatial and temporal data on caribou activity and to identify changes to winter habitat occupancy within the park. Data from this monitoring program is used to advise management planning activities for Wabakimi Provincial Park. The survey follows, in part, the Moose Aerial Inventory (MAI) surveys, however a single line transect through the park is flown. This line was established in 2005 based on a need for a standardized approach to efficiently monitor within the park. Additional areas outside of the pre-determined transect are surveyed when time, conditions, and resources are available. While results from these surveys do not provide estimates of recruitment, survival, or population size or trend, they do provide additional sub-range context of distribution and winter use.

3.2 Results and Discussion

Boreal Caribou aerial surveys within the Brightsand Range were completed from March 2 - 8, 2023. During that time fifty transects totaling 3,688 km were flown in the Brightsand Range. Figure 3 shows the stratified flight lines along transects within the Brightsand Range.

During the 2023 surveys, 153 Boreal Caribou were observed, belonging to 21 groups. The number of caribou observed is higher than the critical threshold of 100 for a minimal viable population size (Environment Canada 2011).

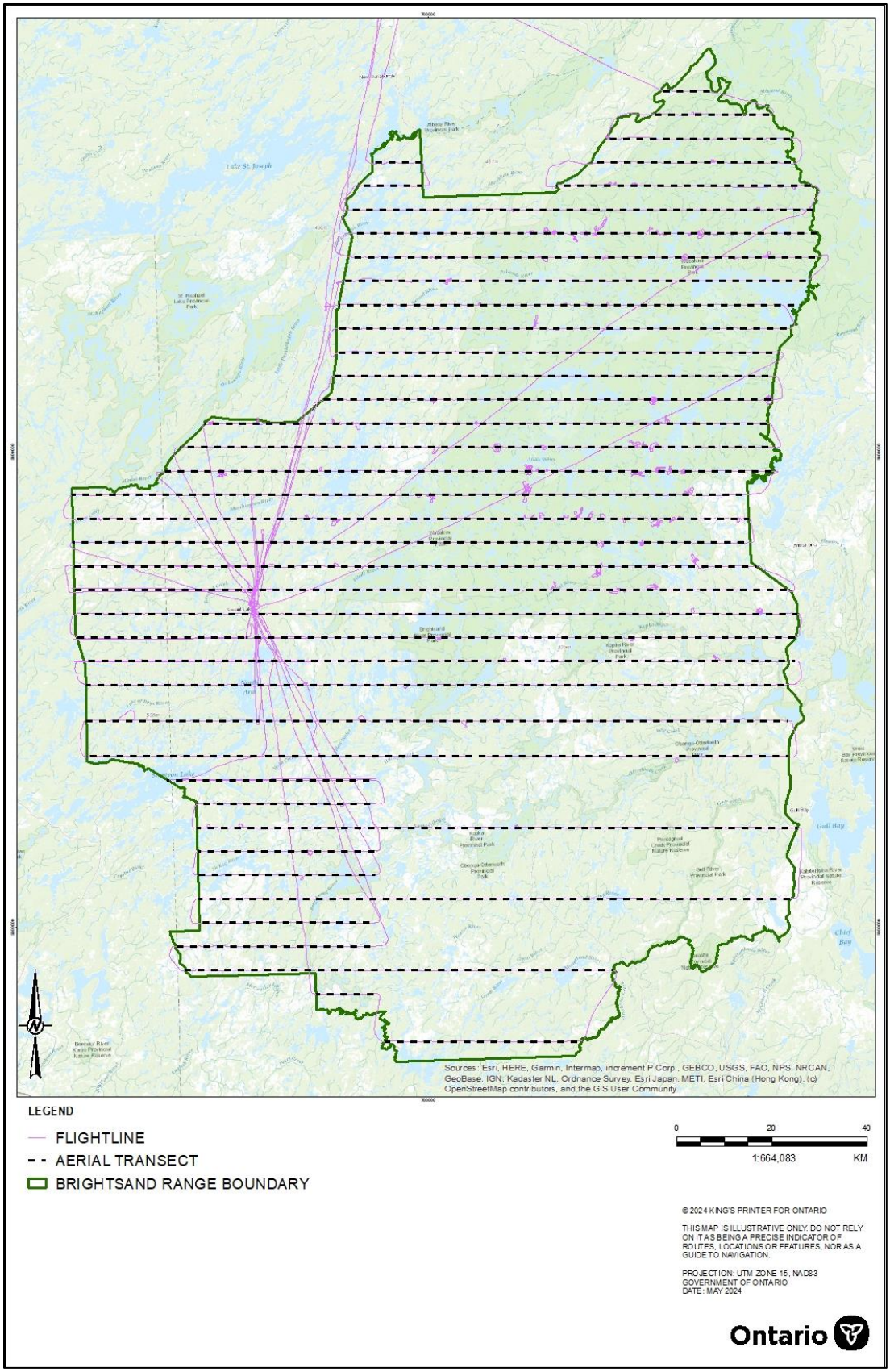

Figure 3. Flightlines for the 2023 aerial surveys in the Brightsand Range.

3.2.1 Population Distribution

Distribution mapping for observations of Boreal Caribou and their signs (i.e., tracks, slushing, cratering) during the Brightsand Range survey (including intentional and incidental observations) are shown in Figure 4. The map may not reflect the full winter distribution of caribou in the range due to the difficulty of detecting caribou and the spacing of flight transects which did not allow complete visual surveying of the entire range (i.e., there were areas between transects where caribou and their signs would not have been seen).

The observed distribution of caribou in the Brightsand Range was predominately in Wabakimi Provincial Park, with a few exceptions east and west of the park boundary. This is consistent with observations included in the 2014 IRAR for Brightsand Range. The information garnered by the 2023 aerial surveys may help inform future characterization of winter distribution patterns. The data could also be used with other recent and future distribution data to inform an assessment of changes in distribution since the last major monitoring effort in Ontario (2009 to 2015 IRARs). The 2023 aerial survey in the Brightsand Range is limited in its ability to provide a comprehensive understanding of distribution patterns because it includes information from one point in time and greater survey coverage in areas of the range where caribou are more likely to occur.

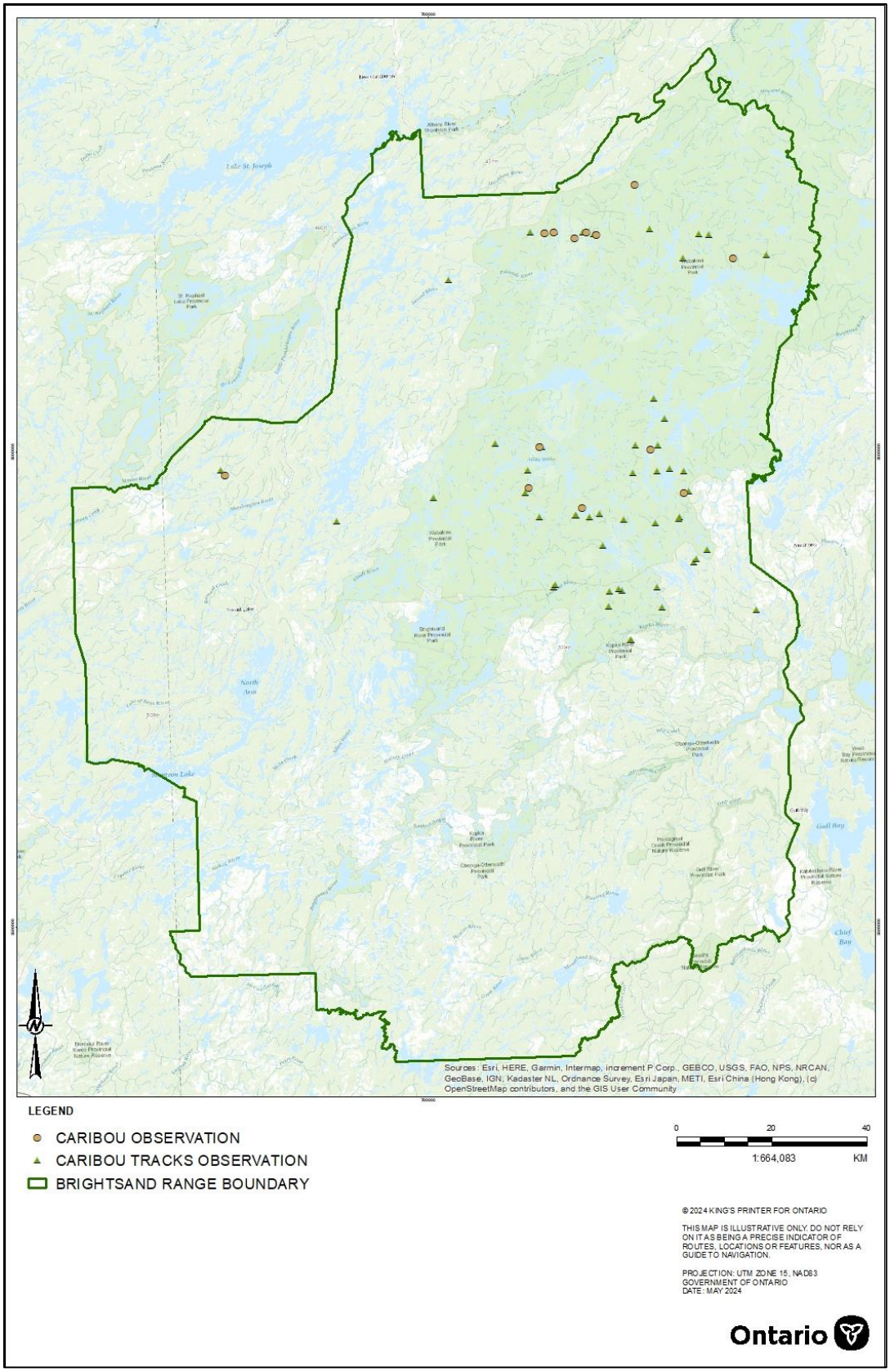

Figure 4. Observed caribou and caribou signs in the Brightsand Range.

3.2.2 Population Trend

3.2.2.1 Recruitment and Survival

The recruitment rate was estimated to be 42.9 ± 26.4 (i.e., 16.5 to 69.3) calves per 100 adjusted adult females with 95% confidence (sample size of 34 including 12 calves, 22 adjusted adult females). This sample size is low which decreases the level of confidence in the estimate.

A current survival rate for adult females is not available. However, population trend can be estimated based on three survival rate scenarios (low, medium, high) and the estimated recruitment rate from the 2023 surveys (see Table 2).

Table 2. Population trend estimates (λ) derived using 2023 recruitment estimates and a range of assumed survival rates (low, medium, high scenarios) for adult female caribou in the Brightsand Range.

Survival Scenario	S	R	R_{LL}	λ	λ_{LL}	n
Low	0.80	42.9	16.5	**1.02**	**0.87**	34
Med	0.85	42.9	16.5	**1.08**	**0.93**	34
High	0.88	42.9	16.5	**1.12**	**0.96**	34

S = assumed survival rate of adult females (Environment Canada, 2008, 2011); R = recruitment rate (calves: 100 adjusted adult females) from the 2023 survey; R_{LL} = lower confidence interval of the recruitment rate from the 2023 survey; λ = estimated population growth rate; λ_{LL} = estimate of population growth calculated using lower confidence interval of the recruitment rate; n = sample size.

Using the estimated recruitment rate (42.9) from the 2023 surveys, an increasing population trend is estimated in all survival scenarios (λ = 1.02 (low), 1.08 (medium), 1.12 (high)) (see Table 2). Recognizing the degree of uncertainty with the estimated recruitment rate because of the sample size (34), a conservative approach using the lower confidence limit of the recruitment rate (16.5) indicates that population growth is declining in all survival scenarios (λ = 0.87 (low), 0.93 (medium), 0.96 (high)). Additional survey effort would be required to increase the sample size to a level that would support a reasonable degree of confidence in the recruitment estimates.

3.2.2.2 Demographic Structure

The estimated proportion of calves was 14.8% based on caribou that were classified by age. A confidence interval was not calculated. The sample size was 12 calves and a total of 81 caribou classified by age. This is within the range required for a stable population (13-15% calves in the population (Bergerud 1992; Bergerud 1996)). However, without a confidence interval, there is low certainty in this estimate.

The ratio of 46 adult females to 100 adult males (i.e., 31.5% adult females and 68.5% adult males) was determined and is unusually low. The sample size of adult caribou that were classified by sex was 41 males and 19 females. While the sample sized used (60) is considered adequate, there is uncertainty associated with this ratio due to a proportionately high number of unclassified observed individuals (72).

The demographic breakdown of the observed animals is provided in Table 3.

Table 3. Observed caribou demographics in the Brightsand Range.

Adults, Sex Unknown	Adult Males	Adult Females	Calves	Unknown Age and Sex	Total
9	41	19	12	72	153

3.2.2.3 Group size

The average group size based only on direct caribou observations (including incidental observations) was 7.3 ± 3.8 (i.e., 3.5 to 11.1). Modeled estimates (using both direct observations and observations of caribou tracks) of group size was 6.9 ± 0.7 (i.e., 6.2 – 7.6).

The mean group size estimate in 2023 is above other reported group sizes in Boreal Caribou groups across Canada for mid-late winter (Jung et al. 2019; Stuart-Smith et al. 1997; Rettie and Messier, 1998 all reported from 4.8 to 5.5) and is higher than the mean group size derived from the 2014 IRAR. This could indicate a declining population size as group size has been shown to increase with decreasing density (Webber and Vander Wal, 2021). Boreal Caribou exhibit this increased grouping behaviour to increase vital rates (survival and recruitment), known as the Allee effect (Stephens and Sutherland, 1999; Angulo et al. 2017). Boreal Caribou also increase grouping in winters with above-average snowfall which reduces energy expenditure while breaking trail and digging for food. Northern Ontario had above-average snowfall during the winter of 2022-23. For the Thunder Bay area, the 2021-22 and 2022-23 winters were the highest on record in the last 10 years with December of 2022 having the most snowfall out of any month during that span. Furthermore, the snow depth in December of 2022 nearly doubled the average snow depth for Decembers in the last 20 years and was the deepest of any December during that span (ECCC, 2024). After the fall rut in mid-late October, caribou start grouping and using travel corridors to reach their preferred winter habitats. Very deep snow conditions early in the winter may have necessitated the need for groups to combine while they navigated the most optimal travel corridors.

4. CHURCHILL RANGE

4.1 Context

The Churchill Range is located in northwestern Ontario and is approximately 21,300 km^2 in size. The landscape is largely characterized as boreal forest with an aggressive fire regime and many small-to-large lakes scattered throughout. Historical occupancy shows that caribou occurred across much of the range but have been scarce from southern areas around Lac Seul and Sioux Lookout for decades due to persistent or permanent human activity. There are a number of regionally significant calving lakes

within the range including DeLesseps, Churchill, Birch, Confederation, Lac Seul, and Lake St. Joseph. Collaring evidence shows that a connection exists in the northern part of the Churchill Range with areas north of the Cat River system in the Kinloch Range. The most prominent ongoing human impact on the range is forest harvesting and the southern portion of the range in particular has been subjected to extensive harvest in the past. Other developmental activities include ongoing mineral exploration throughout the range, including a road to access the proposed mine development in the Springpole Lake area and associated proposed transmission line, the recent construction of the Wataynikaneyap transmission line that extends south to north across the range, and a proposal for an associated all-season road.

4.1.1 Integrated Range Assessment Report

This section provides a summary of the approach for the Integrated Range Assessment undertaken from 2012 to 2013, the results of which were published in 2014. Further information about the assumptions that support this summary is available in the report: Integrated Range Assessment for Woodland Caribou and their Habitat - Churchill Range 2012 (ontario.ca)

A two-stage (fixed-wing followed by rotary-wing) aerial winter distribution survey for caribou was conducted during February and March 2012 in which observations of caribou and their signs (i.e., tracks, slushing and cratering) were recorded. During the rotary-wing flights, caribou were identified as adults, males or females, calves, or unknown age and sex. Data collected during the survey work was used to estimate population state metrics including the minimum number of caribou in the range and calf recruitment rates. An additional aerial survey was conducted during late winter 2013 to further assess calf recruitment to support estimates of population trend. Twenty (20) adult female caribou were collared during the 2012 survey and monitored for one year allowing for estimates of survival to be determined.

During the aerial survey in the winter of 2012, 262 caribou were observed. During the fixed-wing portion of the survey, no caribou were observed in the southern or northern portions of the range and signs of caribou activity were scarce in the south. Although no caribou were observed in the northern portion of the range, signs of caribou activity were much more abundant. Caribou were only sighted in a few locations, all in the central portion of the range.

Recruitment rates from 2012 and 2013 (15.4 and 24.7 calves per 100 adjusted adult females respectively) were below the threshold for maintaining a stable population (28.9 calves per 100 adult females, assuming an adult female survival rate of 85%, Environment Canada 2008, Environment Canada 2011) and indicated low recovery potential within the Churchill Range.

Annual survival of adult female caribou from April 2012 to March 2013 was 87%, suggesting survival was good. However, the short-term population trend was likely declining with a geometric mean of $\lambda = 0.96$. This estimate suggested a declining trend

and was the result of comparatively low calf recruitment and was supported by other long-term trend indicators.

A geospatial analysis estimated that 41.3% of the range was characterized as natural and anthropogenic disturbance. The resulting likelihood of stable or increasing population growth was estimated to be 0.47 and at this level it was uncertain whether the Churchill Range could sustain the caribou population. Analysis of the amount and arrangement of caribou habitat indicated alignment with that expected in a natural landscape.

The Integrated Range Assessment concluded risk to caribou was intermediate within the Churchill Range and it was uncertain whether range condition was sufficient to sustain caribou.

Integrated Range Assessment: Churchill Range 2017 Addendum

Additional recruitment surveys were conducted in the winters of 2014 and 2015. During the 2014 recruitment survey, 76 caribou were observed, 9 of which were calves. The sex ratio of observed known adult females to known adult males was 0.758. Using this sex ratio to determine the number of adjusted adult females resulted in a recruitment estimate of 19.1 calves per 100 adjusted adult females. The 2015 recruitment survey observed 66 caribou, 8 of which were calves. The sex ratio was 0.618, resulting in a recruitment estimate of 23.8 calves per 100 adjusted adult females.

The recruitment values for the 2012 to 2015 surveys were low and comparable to studies in which populations were known to be in decline (Rettie and Messier 1998; McLoughlin et al. 2003; Environment Canada 2008).

Conclusions from the 2014 IRAR and 2017 addendum of the Churchill Range suggested the short-term population trend was likely declining (geometric mean λ = 0.93). Other long-term trend indicators suggested range recession had occurred within the Churchill Range and some areas in the southern portion of the range were no longer occupied by caribou.

4.1.2 Monitoring activities since 2014 IRAR

In 2023, a caribou collaring study (50 collars), including aerial surveys, was initiated in parts of the Churchill, Berens and Kinloch ranges to potentially support Effectiveness Monitoring of the Springpole Gold Mine project. Data will continue to be collected until March 2028 as part of this study. This study is not meant to produce range-level population estimates and will provide sub-range information.

4.2 Results and Discussion

Boreal Caribou aerial surveys within the Churchill Range were completed from February 28 to March 7, 2023. During that time forty-five transects totalling 3,797 km were flown

in the Churchill Range. Figure 5 shows the stratified flight lines along transects within the Churchill Range,

During the surveys, 193 Boreal Caribou were observed, belonging to 31 groups. The number of caribou observed is higher than the critical threshold of 100 for minimal viable population size (Environment Canada 2011).

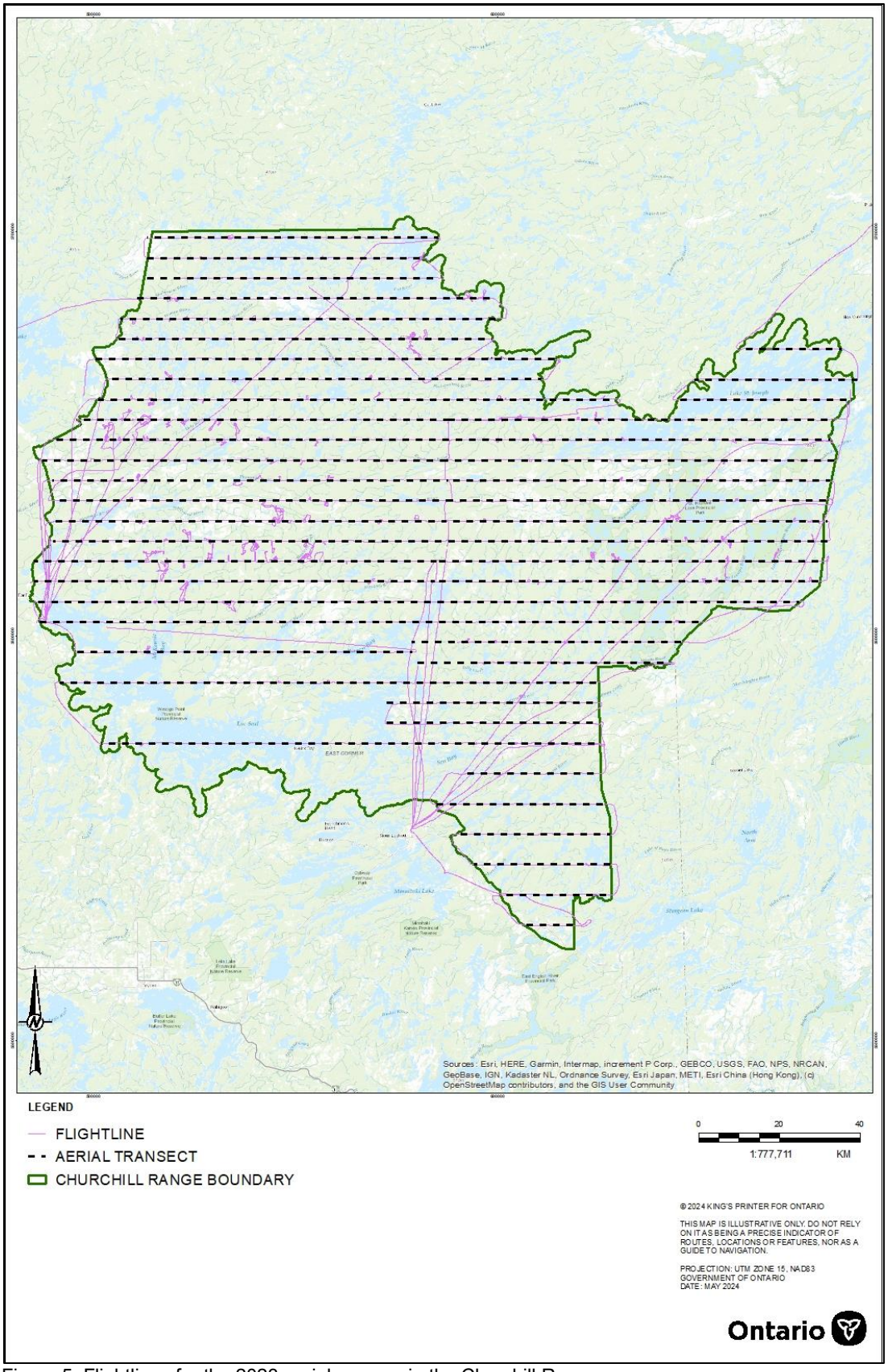

Figure 5. Flightlines for the 2023 aerial surveys in the Churchill Range.

4.2.1 Population Distribution

Distribution mapping for observations of Boreal Caribou and their signs (i.e., tracks, slushing, cratering) during the Churchill Range survey (including intentional and incidental observations) are shown in Figure 6. The map may not reflect the full distribution of caribou in the range due to the difficulty of detecting caribou and the spacing of flight transects which did not allow complete visual surveying of the entire range (i.e., there were areas between transects where caribou and their signs would not have been seen).

The observed distribution of caribou in the Churchill Range was relatively even across the northern and central portions of the range, while the southern portion did not yield any observations. This is generally consistent with observations included in the 2014 IRAR for Churchill Range. This information may help inform future characterization of winter distribution patterns. The data could also be used with other recent and future distribution data to inform an assessment of changes in distribution since the last major monitoring effort in Ontario (2014 IRAR). The 2023 aerial survey is limited its ability to provide comprehensive understanding of distribution patterns because it includes information from one point in time and greater survey coverage in areas of the range where caribou are more likely to occur.

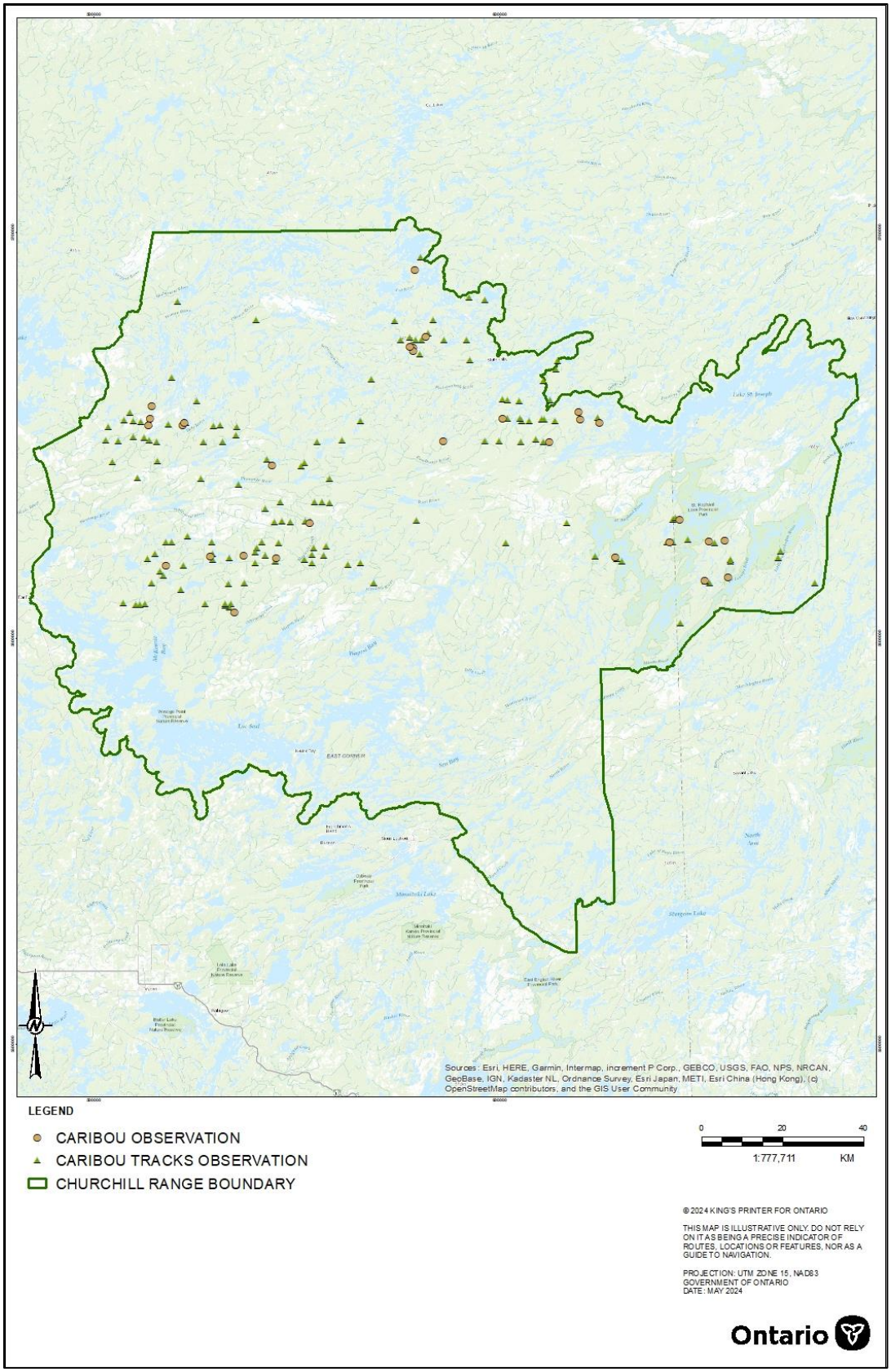

Figure 6. Observed caribou and caribou signs in the Churchill Range.

4.2.2 Population Trend

4.2.2.1 Recruitment and Survival

The recruitment rate was estimated to be 32.2 ± 14.7 (i.e., 17.5 – 46.9) calves per 100 adjusted adult females with 95% confidence (sample size of 120 including 29 calves, 91 adjusted adult females).

The sample size is above the recommended minimum 50-80 caribou threshold, meaning that the margin of error for demographics in the Churchill Range should be 10% or less (assuming actual population of adult females and calves is greater than 340).

A current survival rate for adult females is not available. However, population trend can be estimated based on three survival rate scenarios (low, medium, high) and the estimated recruitment rate from the 2023 surveys (see Table 4).

Table 4. Population trend estimates (λ) derived using 2023 recruitment estimates and a range of assumed survival rates (low, medium, high scenarios) for adult female caribou in the Churchill Range.

Survival Scenario	S	R	R_{LL}	λ	$λ_{LL}$	n
Low	0.80	32.2	17.5	**0.95**	**0.88**	120
Med	0.85	32.2	17.5	**1.01**	**0.93**	120
High	0.88	32.2	17.5	**1.05**	**0.96**	120

S = assumed survival rate of adult females (Environment Canada, 2008, 2011); R = recruitment rate (calves: 100 adjusted adult females) from the 2023 survey; R_{LL} = lower confidence interval of the recruitment rate from the 2023 survey; λ = estimated population growth rate; $λ_{LL}$ = estimate of population growth calculated using lower confidence interval of the recruitment rate; n = sample size.

Using the recruitment rate (32.2) from the 2023 surveys, a decreasing trend in the low survival scenario is indicated and an increasing trend in medium and high survival scenarios are indicated (λ = 0.95 (low), 1.01 (medium), 1.05 (high)) (see Table 4). Recognizing the degree of uncertainty with this estimated recruitment rate, a conservative approach using the lower confidence limit of the recruitment rate (17.5) indicates that population growth is declining in all survival scenarios (λ = 0.88 (low), 0.93 (medium), 0.96 (high)).

Conversely, using the 2014 IRAR as an indicator of current survival in the Churchill Range (0.87), the high survival scenario may be appropriate to consider for estimating population growth. Under this scenario, population growth is estimated to be increasing. Caution must be exercised with this assumption because the assumed survival rate derived from the IRAR is associated with very wide confidence intervals (0.75 to 1.00) and is an estimation from over 10 years ago.

4.2.2.2 Demographic Structure

The estimated proportion of calves was 18.3% based on caribou that were classified by age. A confidence interval was not calculated. The sample size was 29 calves and a

total of 158 caribou classified by age. This is within the range required for a stable population (13-15% calves in the population (Bergerud 1992; Bergerud 1996)). However, without a confidence interval, there is low certainty in this estimate.

The ratio of 238 adult females to 100 adult males (i.e., 70.4% adult females and 29.6% adult males) was determined, which is high. The sample size of adult caribou that were classified by sex was 37 males and 88 females.

The demographic breakdown of the observed animals is provided in Table 5.

Table 5. Observed caribou demographics in the Churchill Range.

Adults, Sex Unknown	Adult Males	Adult Females	Calves	Unknown Age / Sex	Total
4	37	88	29	35	193

4.2.3.3 Group Size

The average group size based only on direct caribou observations (including incidental observations) was 6.2 ± 3.7 (i.e., 2.5 to 9.9).

Modelled estimates (using both direct observations and observations of caribou tracks) of group size was 6.5 ± 0.8 (i.e., 5.7 to 7.3).

The mean group size estimate in 2023 is above other reported group sizes in Boreal Caribou groups across Canada for mid-late winter (Jung et al. 2019; Stuart-Smith et al. 1997; Rettie and Messier, 1998 all reported from 4.8 to 5.5) and it is unknown if it is higher or lower than group size observed in the IRAR as the number of groups is not provided. This could indicate a declining population as group size has been shown to increase with decreasing density (Webber and Vander Wal, 2021). Boreal Caribou exhibit this increased grouping behaviour to increase vital rates (survival and recruitment), known as the Allee effect (Stephens and Sutherland, 1999; Angulo et al. 2017). Boreal Caribou also increase grouping in winters with above-average snowfall which reduces energy expenditure while breaking trail and digging for food. Northern Ontario had above-average snowfall during the winter of 2022-23. For the Thunder Bay area, the 2021-22 and 2022-23 winters were the highest on record in the last 10 years with December of 2022 having the most snowfall out of any month during that span. Furthermore, the snow depth in December of 2022 nearly doubled the average snow depth for Decembers in the last 20 years and was the deepest of any December during that span (ECCC, 2024). After the fall rut in mid-late October, caribou start grouping and using travel corridors to reach their preferred winter habitats. Very deep snow conditions early in the winter may have necessitated the need for groups to combine while they navigated the most optimal travel corridors.

In the 2014 IRAR, 262 caribou were observed during the 2012 aerial surveys. The number of groups and group size were not reported.

5. KESAGAMI RANGE

5.1 Context

The Kesagami Range is located in northeastern Ontario and is approximately 47,400 km^2 in size. The landscape is largely characterized as James Bay Lowlands with extensive wetland complexes in the north and boreal forest in the south with many rivers and few small lakes throughout. There is high caribou occurrence in the northern part of the range where quality refuge habitat is provided by open fens, conifer forests, linear riparian forest stands, and disturbance is low. In contrast, the south is highly impacted by human activity most notably timber harvest and settlement and caribou occurrence is minimal.

Collaring data shows a strong connection to adjacent habitat in Quebec indicating that the Kesagami Range of Ontario is a piece of what appears to be a larger geography used by caribou in the area.

5.1.1 Integrated Range Assessment Report

This section provides a summary of the approach for the Integrated Range Assessment undertaken from 2010 to 2013 for the Kesagami Range, the results of which were published in 2014. Further information about the assumptions that support this summary is available in the report:
Integrated Range Assessment for Woodland Caribou and their Habitat - Kesagami Range 2010 (ontario.ca)

A two-stage (fixed-wing followed by rotary-wing) aerial winter distribution survey for caribou was conducted during January, February, and March 2010 in which observations of caribou or their signs (i.e., tracks, slushing and cratering) were recorded. During the rotary-wing flights, caribou were identified as adult males or females, calves, or caribou of unknown age and sex. Data collected during the survey work as well as Moose Aerial Inventory survey data was used to estimate population state metrics including the minimum number of caribou in the range and calf recruitment rates. Additional aerial surveys were conducted during late winter 2011, 2012 and 2013 to further assess calf recruitment to support estimates of population trend. Twenty-four (24) adult female caribou were collared as part of the range assessment in 2010 and 2011 and another 69 were collared as part of another research project between 2010 and 2012. Collars were monitored for three years allowing for estimates of survival to be determined.

The number of caribou observed occupying the Kesagami Range during winter of 2010 was 178. No caribou were physically observed in the southern half of the range, roughly south of Pierre Lake. Caribou signs or sightings were observed in the vicinity east and southeast of Kesagami Lake to the Quebec border.

Recruitment rates from 2010, 2011, 2012 and 2013 (14.2, 12.9, 14.0 and 15.3 calves per 100 adjusted adult females respectively) were below the threshold for maintaining a stable population (28.9 calves per 100 adult females, assuming an adult female survival rate of 85%, Environment Canada 2008, Environment Canada 2011) and indicated low recovery potential within the Churchill Range.

The geometric mean annual survival of adult female caribou from 2010 to 2012 was 88%, suggesting survival was good. However, the short-term population trend was likely declining with a geometric mean of $\lambda = 0.94$. This estimate suggested a declining trend and was the result of comparatively low calf recruitment and was supported by other long-term trend indicators.

A geospatial analysis estimated that 43.8% of the range was characterized as natural and anthropogenic disturbances. The resulting likelihood of stable or increasing population growth was estimated to be 0.45 and at that level it was uncertain whether the Kesagami Range was capable of sustaining the caribou population. Analysis of the amount and arrangement of caribou habitat did not align with that expected in a natural landscape.

The Integrated Range Assessment concluded risk to caribou was uncertain within the Kesagami Range and the range condition was insufficient to sustain caribou.

5.1.2 Monitoring activities since 2014 IRAR

The government of Quebec completed a two-stage aerial survey over the majority of the northern portion of Ontario's Kesagami Range in February 2022 (Szor et al. 2023). Forty-one groups (255 caribou) were located in the Ontario portion of the study area and a corrected abundance of 348 caribou in Ontario was reported. Additionally, the report also included: a recruitment rate of 43.5 calves per 100 adult females; 24.6% calves in the population; and a sex ratio of 33.0 adult males to 100 adult females.

An overall benefit permit was issued to Kirkland Lake Gold Ltd. (Agnico Eagle Mines Limited) in 2022 under the *Endangered Species Act*, 2007, which includes as a requirement to conduct aerial surveys for presence/absence of caribou in part of the range. A collaring baseline data collection program will commence involving deployment of 20-30 collars every six years until 10 years after project completion. This project was scheduled to commence in February of 2024, however, due to low snow conditions, it has been postponed until winter 2024-25.

5.2 Results and Discussion

Boreal Caribou aerial surveys within the Kesagami Range were completed from February 27 to March 8, 2023. Eighty-six transects totalling 6,851 kms were flown in the Kesagami Range. Figure 7 shows the stratified flight lines along transects within the Kesagami Range.

During the surveys, 167 Boreal Caribou were observed, belonging to 18 groups. The number of caribou observed is higher than the critical threshold of 100 for minimal viable population size (Environment Canada 2011).

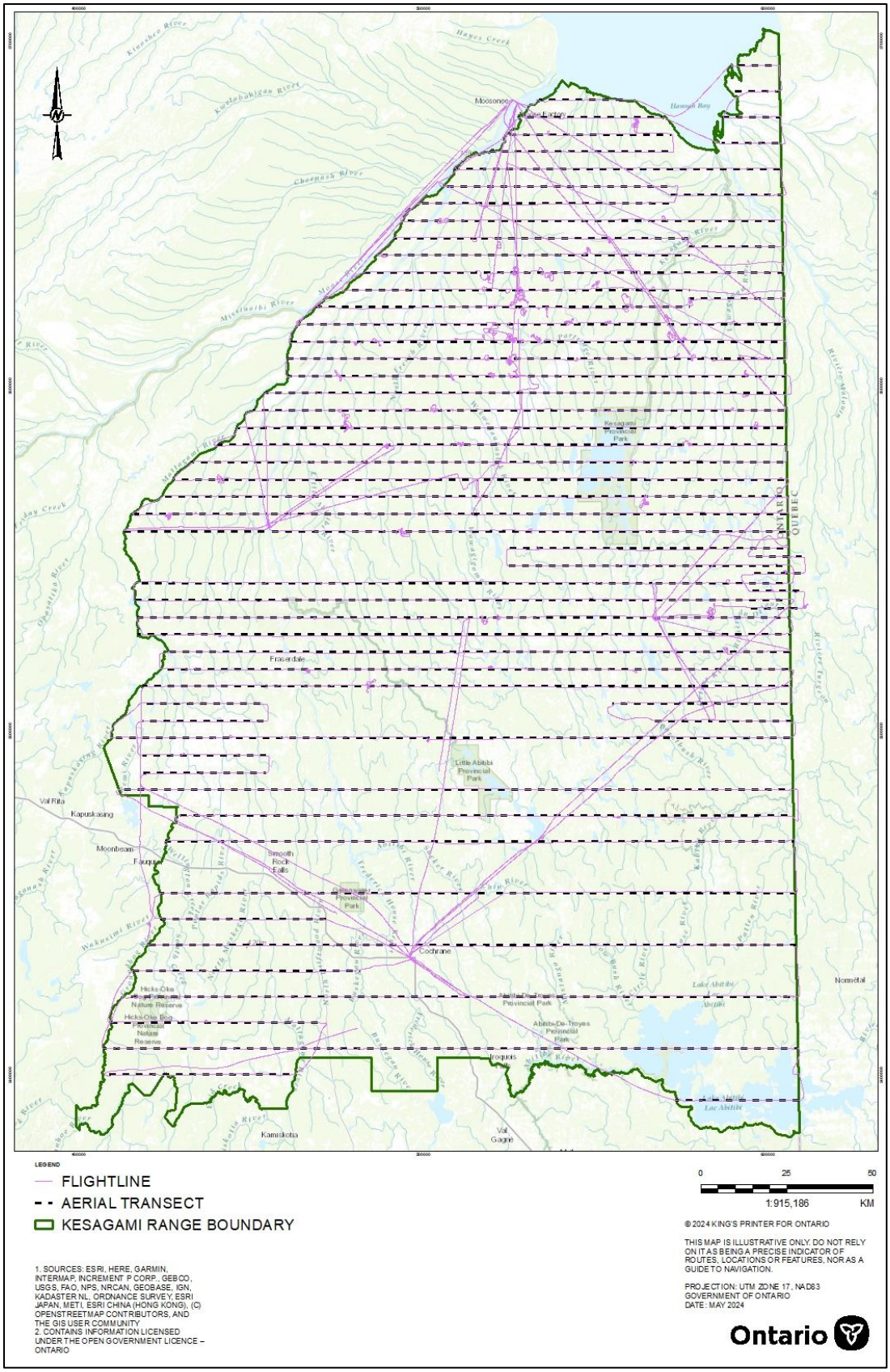

Figure 7. Flightlines for the 2023 aerial surveys in the Kesagami Range.

5.2.1 Population Distribution

Distribution mapping observations of Boreal Caribou and their signs (i.e., tracks, slushing, cratering) during the Kesagami Range survey are shown in Figure 8. The map may not reflect the full distribution of caribou in the range due to the difficulty of detecting caribou and the spacing of flight transects which did not allow complete visual surveying of the entire range (i.e., there were areas between transects where caribou and their signs would not have been seen).

The observed distribution of caribou in the Kesagami Range was patchy with the majority of observations occurring in the northern portion of the range and some within the central portion. No observations were made in the southern portion of the range. This is generally consistent with observations included in the 2014 IRAR for Kesagami Range. The information garnered by the survey may help inform future characterization of winter distribution patterns. The data could also be used with other recent and future distribution data to inform an assessment of changes in distribution since the last major monitoring effort in Ontario (2014 IRAR). The 2023 aerial survey is limited in its ability to provide a comprehensive understanding of distribution patterns because it includes information from one point in time and greater survey coverage in areas of the range where caribou are more likely to occur.

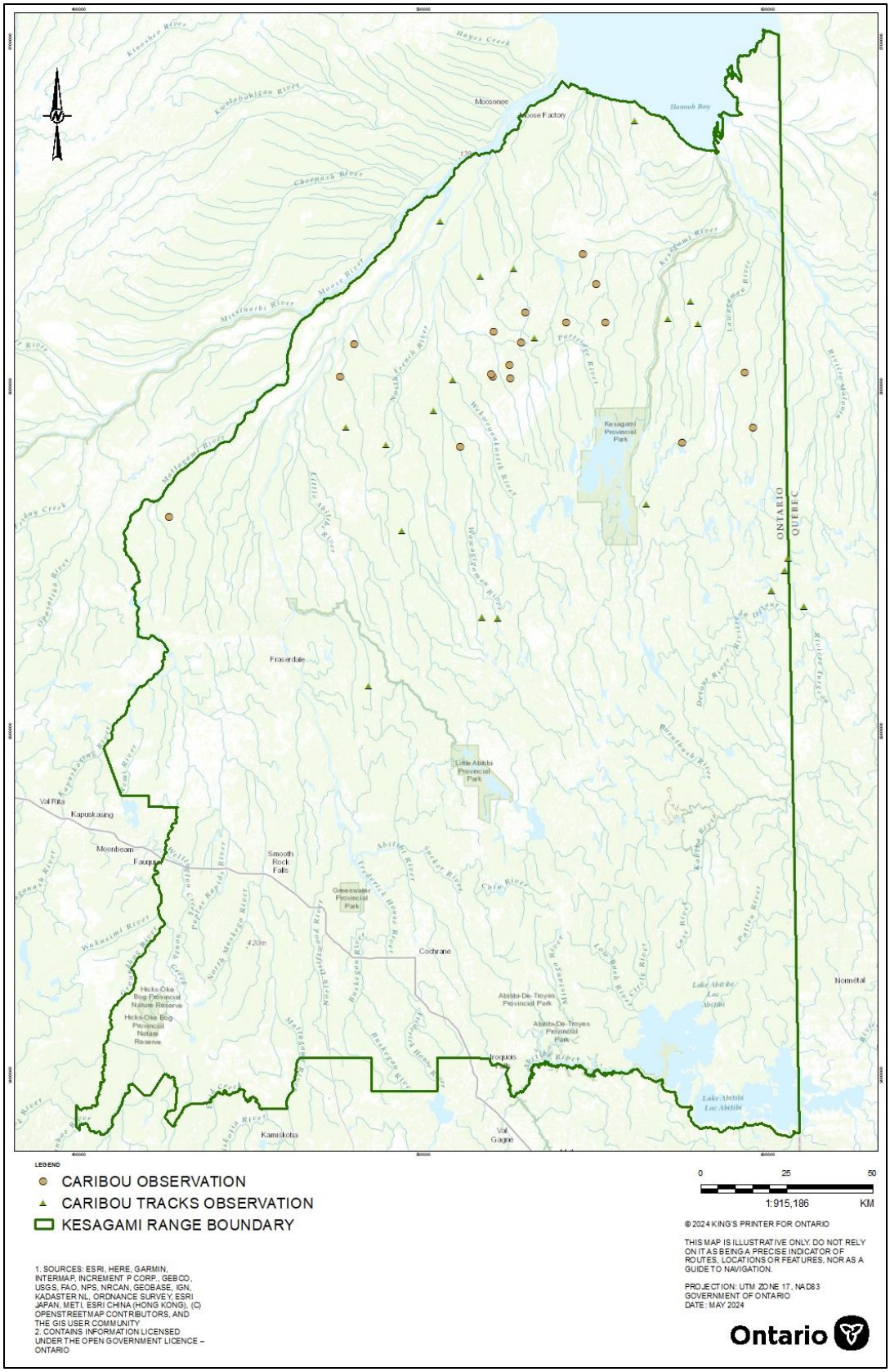

Figure 8. Observed caribou and caribou signs in the Kesagami Range.

5.2.2 Population Trend

5.2.2.1 Recruitment and Survival

The recruitment rate was estimated to be 40.0 ± 15.5 (i.e., 24.5 – 55.5) calves per 100 adjusted adult females with 95% confidence (sample size was 104, including 30 calves, 74 adjusted adult females).

This sample size exceeds the minimum size (50 – 80) that is recommended. This means that the margin of error for demographics in the Kesagami Range should be 10% or less (assuming actual population of adult females and calves is approximately equal to 270).

A current survival rate for adult females is not available. However, population trend can be estimated based on three survival rate scenarios (low, medium, high) and the estimated recruitment rate from the 2023 surveys (see Table 6).

Table 6. Population trend estimates (λ) derived using 2023 recruitment estimates and a range of hypothetical survival rates (low, medium, high) for adult female caribou in the Kesagami Range.

Survival Scenario	S	R	R_{LL}	λ	$λ_{LL}$	n
Low	0.80	40.0	24.5	1.00	0.91	104
Med	0.85	40.0	24.5	1.06	0.97	104
High	0.88	40.0	24.5	1.10	1.00	104

S = assumed survival rate of adult females (Environment Canada, 2008, 2011); R = recruitment rate (calves: 100 adjusted adult females) from the 2023 survey; R_{LL} = lower confidence interval of the recruitment rate from the 2023 survey; λ = estimated population growth rate; $λ_{LL}$ = estimate of population growth calculated using lower confidence interval of the recruitment rate; n = sample size.

Using the estimated recruitment rate (40.0) from the 2023 survey, an increasing population trend is estimated in all survival scenarios (λ = 1.00 (low), 1.06 (medium), 1.10 (high)) (see Table 6). Recognizing the degree of uncertainty with this estimated recruitment rate, a conservative approach using the lower confidence limit of the recruitment rate (24.5) indicates that population growth is declining in the low and medium scenarios and stable in the high scenario (λ = 0.91 (low), 0.97 (medium), 1.00 (high)).

Using the 2014 IRAR as an indicator of current survival (0.88) in the Kesagami Range, the high survival scenario may be the most appropriate to consider for estimating population growth. Under this scenario, population growth is assumed to be stable or increasing, even using the lowest possible recruitment rate that was reported (24.5 per 100 adult females) in 2023, which infers a population growth rate of 1.00. Caution must still be exercised with this assumption because the assumed survival rate derived from the IRAR is associated with very wide confidence intervals (0.69 to 1.00) and is an estimation from over 10 years ago.

5.2.2.2 Demographic structure

The estimated proportion of calves was 24.0% based on caribou that were classified by age. A confidence interval was not calculated. This is greater than the range required for a stable population (13-15% calves in the population (Bergerud 1992; Bergerud 1996)), however, without a confidence interval there is low certainty in this estimate.

The sample size was 30 calves and a total of 126 caribou classified by age.

The ratio of 340 adult females to 100 adult males (i.e., 77.3% adults females and 22.7% adult males) was determined. The sample size of caribou that were classified by sex was 20 males and 68 females.

The demographic breakdown of the observed animals is provided in Table 7.

Table 7. Observed caribou demographics in the Kesagami Range.

Adult Sex Unknown	Adult Males	Adult Females	Calves	Unknown Age/Sex	Total
8	20	68	30	41	167

5.2.2.3 Group Size

The average group size based only on direct animal observations (including incidental observations) was 9.3 ± 5.1 (i.e., 4.2 to 14.4). Modeled estimates (using both direct observations and observations of caribou tracks) of group size was 7.4 ± 0.9 (i.e., 6.5 to 8.3).

The mean group size estimate in 2023 is above other reported group sizes in Boreal Caribou groups across Canada for mid-late winter (Jung et al. 2019; Stuart-Smith et al. 1997; Rettie and Messier, 1998 all reported from 4.8 to 5.5) and is higher than the derived mean group size (5.9) from the IRAR. This could indicate a declining population as group size has been shown to increase with decreasing density (Webber and Vander Wal, 2021). Boreal Caribou exhibit this increased grouping behaviour to increase vital rates (survival and recruitment), known as the Allee effect (Stephens and Sutherland, 1999; Angulo et al. 2017), particularly in highly disturbed areas like the Kesagami Range. Boreal Caribou also increase grouping in winters with above-average snowfall which reduces energy expenditure while breaking trail and digging for food. Northern Ontario had above-average snowfall during the winter of 2022-23.

6. KINLOCH RANGE

6.1 Context

The Kinloch Range is approximately 26,700 km^2 and is associated with the northern portion of the Lake St. Joseph Ecoregion. The range is located within the Ontario Shield

ecozone and has an aggressive fire regime, abundant lakes, and many isolated peatlands and peatland complexes. The forests are dominated by jack pine and black spruce of various ages with a common but minor component of aspen where soils and other site conditions support it. This range has an aggressive fire regime, high frequency of natural disturbance events (e.g., blowdown). Calving and nursery activities appear to be associated with large lakes with islands, lake and river systems, or peatland complexes.

6.1.1 Integrated Range Assessment Report

The Integrated Range Assessment for the Kinloch Range was reported in 2014 as part of the IRAR for the Far North of Ontario, which also included five other ranges: Swan, Spirit, Ozhiski, Missisa and James Bay. Further information about the assumptions that support this summary is available in the report:
Integrated Range Assessment for Woodland Caribou and their Habitat - The Far North of Ontario 2013

A two-stage (fixed-wing followed by rotary-wing) aerial winter distribution survey for caribou was conducted during winter 2010 in which observations of caribou and their signs (i.e., tracks, slushing and cratering) were recorded. During the rotary-wing flights, caribou were identified as adults, males or females, calves, or unknown age and sex. Data collected during the survey work was used to estimate population state metrics including the minimum number of caribou in the range and calf recruitment rates. Additional aerial surveys were conducted during late winter 2011, 2012 and 2013 to further assess calf recruitment to support estimates of population trend. Twenty (20) adult female caribou were collared during the 2010 survey and an additional 30 adult female caribou were collared in the vicinity of the Kinloch Range in 2010 and 2011 as part of a related research project. Collared caribou were monitored for three years allowing for estimates of survival to be determined.

The number of caribou observed in the Kinloch Range was 113 based on the combined observations from the Northern Boreal Initiative surveys from 2008 and 2009, and the winter aerial survey in 2010. It was concluded that the range was occupied by at least 332 caribou and possibly substantially more.

Recruitment rates from 2011, 2012 and 2013 (7.59, 14.01 and 20.62 calves per 100 adjusted adult females, respectively) were below the threshold for maintaining a stable population (28.9 calves per 100 adult females, assuming an adult female survival rate of 0.85, Environment Canada 2008, Environment Canada 2011) and indicated low recovery potential within the Kinloch Range.

Annual survival of adult female caribou from April 2010 to March 2012 was 89%, suggesting survival was good. However, the short-term population trend was likely declining with a geometric mean of $\lambda = 0.95$. This estimate suggested a declining trend and was the result of comparatively low calf recruitment and was supported by other long-term trend indicators.

A geospatial analysis estimated that 19.6% of the range was characterized as natural and anthropogenic disturbance. The resulting likelihood of stable or increasing population growth was estimated to be 0.80 and at this level it was likely the Kinloch Range could sustain the caribou population.

The Integrated Range Assessment concluded that risk to caribou was intermediate in the Kinloch Range and it was uncertain whether the range condition was sufficient to sustain caribou.

6.1.2 Monitoring activities since 2014 IRAR

In February and March 2023, a caribou collaring study (50 collars), including aerial surveys, was initiated in parts of the Kinloch, Churchill and Berens Ranges to potentially support Effectiveness Monitoring of the Springpole Gold Mine project. Data will continue to be collected until March 2028 as part of this study. This study is not meant to produce range-level population estimates but will provide sub-range information.

6.2 Results and Discussion

Boreal Caribou aerial surveys within the Kinloch Range were completed from February 28 to March 10, 2023. During that time 62 transects totalling 4,997 km were flown in the Kinloch Range. Figure 9 shows the stratified flight lines along transects within the Kinloch Range.

During the surveys, 63 Boreal Caribou were observed, belonging to 12 groups. This is lower than the critical threshold of 100 for minimal viable population size (Environment Canada 2011).

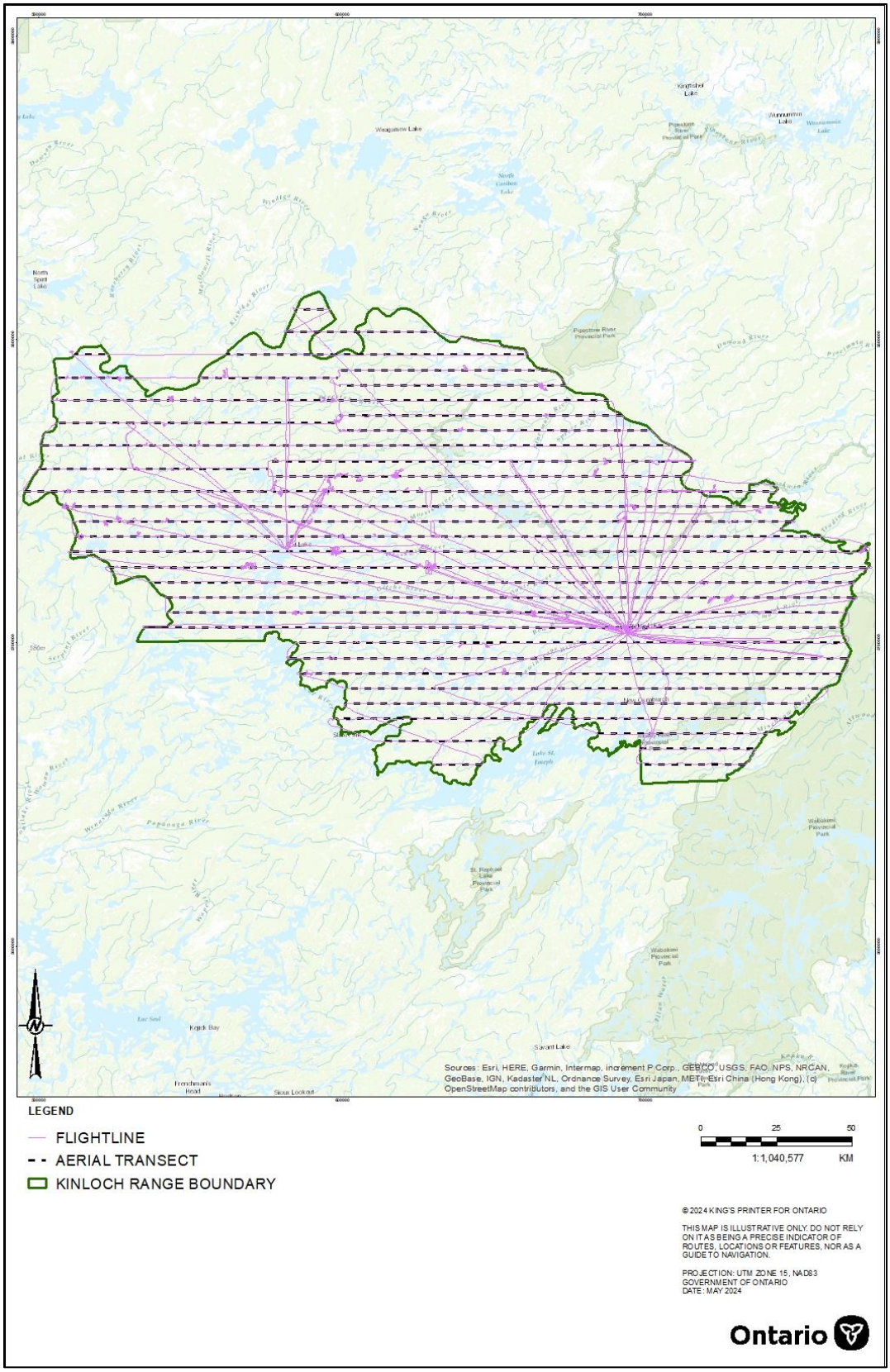

Figure 9. Flightlines for the 2023 aerial surveys in the Kinloch Range.

6.2.1 Population Distribution

Distribution mapping for observations of Boreal Caribou and their signs (i.e., tracks, slushing, cratering) during the Kinloch Range survey (including intentional and incidental observations) are shown in Figure 10. The map may not reflect the full distribution of caribou in the range due to the difficulty of detecting caribou and the spacing of flight transects which did not allow complete visual surveying of the range (i.e., there were areas between transects where caribou and their signs would not have been seen).

Observed distribution of caribou in the Kinloch Range was relatively even across the range. This is generally consistent with observations included in the 2014 IRAR for Kinloch Range. The information garnered by the survey may help inform future characterization of winter distribution patterns. The data could also be used with other recent and future distribution data to inform an assessment of changes in distribution since the last major monitoring effort in Ontario (2014 IRAR). The 2023 aerial survey is limited its ability to provide comprehensive understanding of distribution patterns because it includes information from one point in time and greater survey coverage in areas of the range where caribou are more likely to occur.

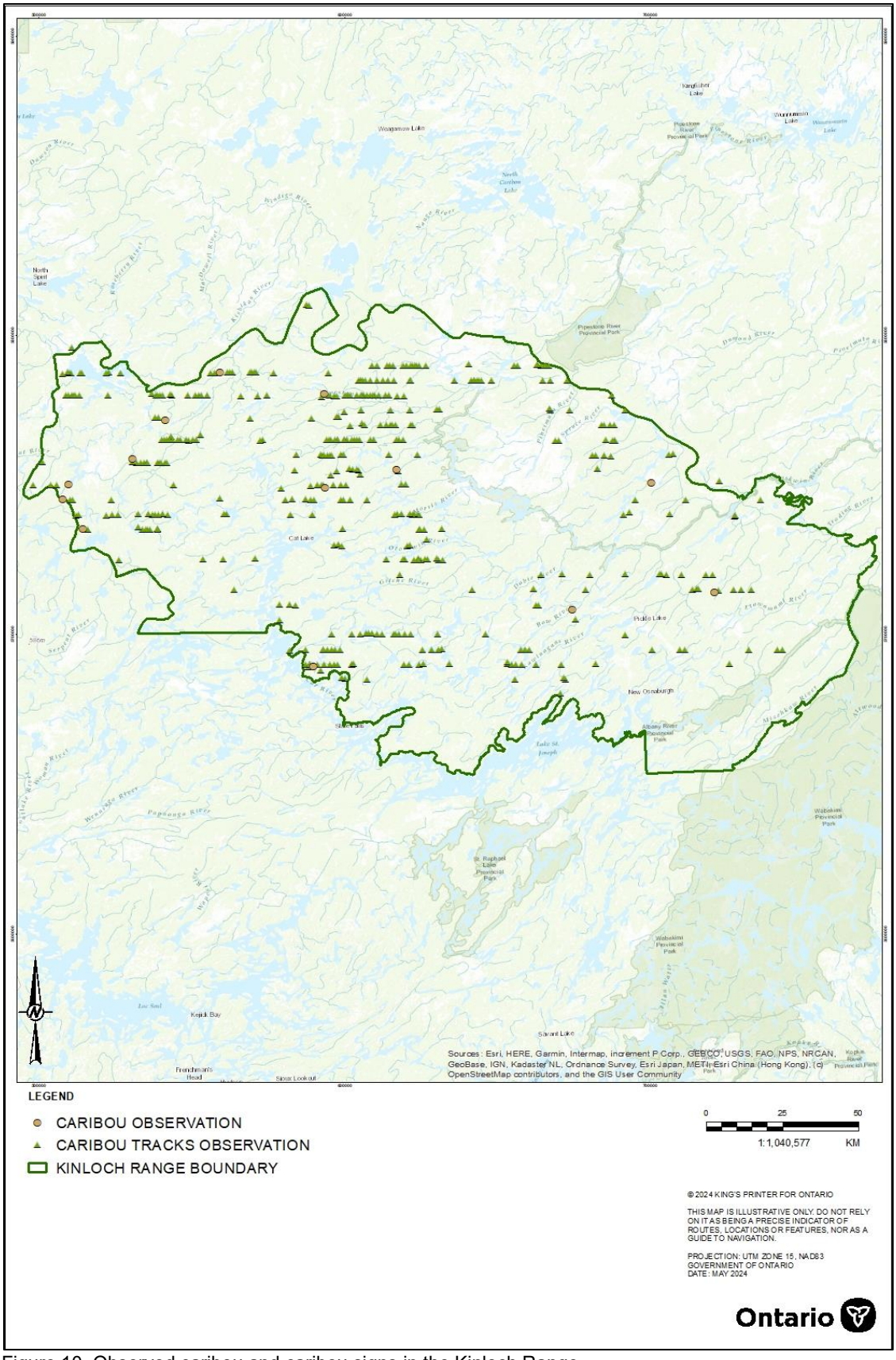

Figure 10. Observed caribou and caribou signs in the Kinloch Range.

6.2.2 Population Trend

6.2.2.1 Recruitment and Survival

The recruitment rate was estimated to be 6.67 ± 11.48 (i.e., -4.81 – 18.15) calves per 100 adjusted adult females with 95% confidence (sample size of 32 including 2 calves and 30 adjusted adult females).

The sample size is lower than the minimum recommended sample size of 50-80 which means that the margin of error for demographics in the Kinloch Range are high (assuming actual population of adult females and calves is approximately equal to 500).

Of the total observed and classified caribou (54) during the 2023 survey in the Kinloch Range, 4% were calves. This means that the total calves are below what is required in mid-winter for a stable population. This assumes other vital rates (survival and recruitment) and disturbance are near average levels. Additionally, the small sample size is increases uncertainty in the estimate.

A current survival rate for adult females is not available. However, population trend can be estimated based on three survival rate scenarios (low, medium, high) and the estimated recruitment rate from the 2023 surveys (see Table 8).

Table 8. Population trend estimates (λ) derived using 2023 recruitment estimates and a range of assumed survival rates (low, medium, high) for adult female caribou in the Kinloch Range.

Survival Scenario	S	R	R_{LL}	λ	$λ_{LL}$	n
Low	0.80	6.7	0	**0.83**	**0.80**	32
Med	0.85	6.7	0	**0.88**	**0.85**	32
High	0.88	6.7	0	**0.91**	**0.88**	32

S = assumed survival rate of adult females (Environment Canada, 2008, 2011); R = recruitment rate (calves: 100 adjusted adult females) from the 2023 survey; R_{LL} = lower confidence interval of the recruitment rate from the 2023 survey; λ = estimated population growth rate; $λ_{LL}$ = estimate of population growth calculated using lower confidence interval of the recruitment rate; n = sample size.

Using the recruitment rate (6.67) from the 2023 surveys, a decreasing population trend is estimated in all survival scenarios (λ = 0.83 (low), 0.88 (medium), 0.91 (high)) (see Table 8). Recognizing the degree of uncertainty with this estimated recruitment rate, including as a result of the sample size (34), a conservative approach using the lower confidence limit of the recruitment rate (16.5) indicates that population growth is declining in all survival scenarios (λ = 0.80 (low), 0.85 (medium), 0.88 (high)

6.2.2.2 Demographic Structure

The proportion of calves was 4% based on caribou that were classified by age. A confidence interval was not calculated. The sample size was 2 calves and a total of 54 caribou classified by age.

The ratio of 133 adult females to 100 adult males (i.e., 57.1% adult females and 42.9% adult males) was determined. The sample size of caribou that were classified by sex was 21 males and 28 females. Given the low sample size, there is uncertainty associated with this sex ratio.

The demographic breakdown of the observed animals is provided in Table 9.

Table 9. Observed caribou demographics in the Kinloch Range.

Adults Sex Unknown	Adult Males	Adult Females	Calves	Unknown Age Sex	Total
3	21	28	2	9	63

The proportion of age-classified individuals that were calves was 4% which is lower than the range required for a stable population (13-15% calves in the population (Bergerud 1992; Bergerud 1996)), however without a confidence level there is low certainty in this estimate. This estimate is unrealistically low and is likely the result of sightability challenges that led to a lower than recommended sample size.

The reported sex ratio of the Kinloch Range of 133 adult females to 100 adult males (0.571) is low, however, definitive conclusions cannot be drawn from this ratio because the sample size is too low.

6.2.2.3 Group Size

The average group size based only on direct animal observations (including incidental observations) was 5.5 ± 3.2 (i.e., 2.3 to 8.7).

Modeled estimates (using both direct observations and observations of caribou tracks) of group size was 4.7 ± 0.9 (i.e., 3.8 to 5.6).

The mean group size estimate in 2023 is similar to other reported group sizes in Boreal Caribou groups across Canada for mid-late winter (Jung et al. 2019; Stuart-Smith et al. 1997; Rettie and Messier, 1998 all reported from 4.8 to 5.5) and it is unknown if it is higher or lower than group size observed in the 2014 IRAR as the 2014 IRAR does not provide the number of groups. This could indicate a stable population as group size is at the lower range of the reported group sizes. The Kinloch Range has a low disturbance rate (compared to the other three ranges) which suggests caribou would not prioritize increasing vital rates and therefore are not increasing group size above normal.

7. NEXT STEPS

Implementation of the Boreal Caribou Monitoring Program is ongoing to update Integrated Range Assessments for each range in the Continuous Distribution and improve understanding about the status of Boreal Caribou in the Lake Superior Coast Range and Discontinuous Distribution.

As part of the implementation of the monitoring program, aerial surveys using a stratified-transect distance sampling approach were conducted in February and March 2024 of the Berens and Sydney Ranges by WSP on behalf of the MECP. The results of 2024 surveys and further analysis of information from the 2023 surveys, where appropriate, are anticipated to be shared publicly in 2024.

8. GLOSSARY

Adjusted adult females – The observed sex ratio is calculated to estimate the number of adult females that are present within the uncategorized (unknown sex) adult caribou. The purpose of this is to obtain a better estimate of the total adult female population used in the recruitment calculation (calves:100 adjusted adult females). The assumption is made that the sex ratio of unknown adults is proportional to the calculated sex ratio. This assumption may or may not be valid depending on the survey conditions and survey crew experience.

Bulls – Adult male caribou.

Bootstrapping – Bootstrapping is a resampling procedure that uses data from one sample to generate a sampling distribution by repeatedly taking random samples from the known sample, with replacement.

Cratering – Refer to holes or depressions left by caribou in the snow when foraging.

Calves – Individuals estimated to be under the age of one year.

Cows – Adult female caribou.

Confidence interval (CI) – The confidence interval shows the range of values you expect the true estimate to fall between if you redo the study or survey many times. The upper and lower limits of confidence intervals depend on the confidence level (95% is commonly used) and margin of error that are assigned to the estimate. The higher the confidence level is, and the lower the margin of error is, the narrower the confidence interval range will be.

Confidence level – The probability with which the true population is within the range of the confidence intervals of the estimate.

Conventional distance sampling – Conventional distance sampling assumes the observer is located either at a point or moving along a line and will observe all objects that occur at the point or on the line. The further away an object is from the point or line (more generally, the sampler or transect) the less likely it is that the observer will see it. The distances to each of the detected objects from the line or point can be used to build a model of the probability of detection given distance from the sampler — the detection function. The detection function can be used to infer how many objects were missed and thereby produce estimates of density and/or abundance (Miller et al., 2019).

Group size estimate – The number of observed individuals gathering or interacting together in a set area.

Incidental observation – The location of Boreal caribou groups pursued from sign that drew the helicopter off the transect.

Margin of error – a permissible or tolerable degree of deviation from the correct value (commonly 1-10%). Or more broadly, the degree of error in the results from sampling surveys. A higher margin of error will yield wider confidence intervals and results that are less likely to be relied on, which means the confidence of representing a population will be lower.

Minimum viable population size - The smallest size required for a population or species to have a predetermined probability of persistence for a given length of time (Shaffer, 1981).

Slushing - A technique used by caribou in which they mush up snow and ice on a lake with their front hooves in order to drink water.

Simulated Ranges of Natural Variation (SRNV) – A simulation model that estimates the ‘natural’ range of conditions (i.e., composition and pattern) in a landscape without anthropogenic influences.

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APPENDIX 1 – SURVEY DESIGN

Boreal Caribou Monitoring Program
Survey Design 2023
Adapted from
Ozhiski 2018 Caribou Aerial Survey, Operating Procedures and Background
November 2022

1.0 Overview and Background

Range-level aerial Boreal Caribou *(Rangifer tarandus caribou*) surveys are required in four Ontario Boreal Caribou Ranges in Winter 2023. This is to meet commitments under the Conservation Agreement between Ontario and Canada to implement a monitoring program starting in key Boreal Caribou Ranges.

1.1 Context: Ozhiski 2018 Protocol

Recent Boreal Caribou Range-level surveys in Ontario have followed the operating procedures included in the Ozhiski 2018 protocol, which is comprised of a two-stage aerial survey design including Fixed Wing (FW) and Rotary Wing (RW) portions.

- The FW portion involved flying parallel transects on a North-East to South-West orientation through the centroids of 10,000 ha hexagonal grid cells that were used as sampling units in the 2010 Far North Occupancy survey.
- The RW portion relocated animal groupings initially identified in the FW portion, allowing the survey crew to estimate the total number of animals in the group, sex ratio and the proportion of calves in the group.
- Caribou collaring was conducted as part of the protocol to generate estimates of survival rate and map distributions, movements and habitat use.
- Caribou pellet samples for fecal DNA analysis were also identified as a component of the RW portion of the protocol for purposes of genetic mark - re-capture to potentially generate population estimates. To date, analyses for population estimates have not been completed for Ontario's Boreal Caribou Ranges in the continuous distribution. Analyses for population estimation from DNA fecal collections has been conducted for some of the Lake Superior island populations.

This survey protocol included a number of components designed to yield Minimum Animal Counts (MAC), annual recruitment rate (calf/adult female ratios), course distributions, within Range habitat identification (e.g., winter use areas) and estimates of probability of occupancy. As part of the aerial surveys, ancillary information was also collected on moose (*Alces alces)* occurrence and demography, and coarse occurrence of wolves (*Canis lupus*) and wolverine *(Gulo gulo)*.

1.2 Context: 2023 Survey Design

1.2.1 Objective

The Conservation Agreement identifies the goal of gaining an improved understanding of the current and projected future status of Boreal Caribou at a Range-scale.

Advancing from Range-level MACs that are currently available for the Ranges that will be surveyed in 2023, to Range-level population estimations is a key information improvement and 2023 monitoring program objective. Population estimates will bolster existing Range-level knowledge and provide additional empirical evidence upon which to inform conservation planning and decision making.

The Vendor must follow the *Boreal Caribou Monitoring Program Survey Design 2023* to produce Range-level population estimates and recruitment data. This data will be used by the Ministry to undertake future analysis using population trend and survival data that will be generated through future monitoring work. These data will provide the Ministry with the ability to assess Range-level population status to support the goal of moving towards the maintenance and recovery self-sustaining local Boreal Caribou populations.

1.2.2 Survey Design Assessment

In considering survey design requirements to generate reliable Range-level population estimates, two survey design and analytical approaches were considered including (1) distance sampling using high precision distances from transect line and (2) strip / width sampling using observations occurring within a specified distance of the transect line.

This assessment included consideration of how, and to what level of effectiveness, a two-stage approach (as used in the Ozhiski 2018 Protocol) could be used as part of either survey design approach. This included considering how observations from both FW and RW components could be linked in order to increase sample sizes and improve detection function. For example, consideration was given to whether linking FW and RW observations could allow for the addition of any “missed” animals on the FW flight and additional off-line tracking.

Despite some potential applications of linking FW and RW observations, a number of logistical challenges and analytical complexities were identified. These included:

- Rapid (same or next day) follow up of RW aircraft could present challenges with respect to availability and timing departure of both FW and RW aircraft (e.g., commercial contracting availability, maintenance schedules, flying conditions suitable for low-level observations).
- Possibility of RW being unable to find and revisit animals located by FW. Also, additional tracking, search time, effort, distance and fuel consumption would be required to achieve documentation of any additional “missed” animals.
- Additional data recording requirements would be needed to support linkages between FW and RW observations (e.g., RW crew would have to distinguish observations linked to initial FW observations by recording associated waypoint number). Distinguishing between FW and RW identified Boreal Caribou groups is

likely to be logistically difficult depending on amount of time for RW follow-up arrival. These difficulties are compounded by small caribou group sizes, heavy forest cover, movements and or mixing of animals before arrival of RW, snow / tracking conditions, and aircraft flying conditions (e.g., high winds precluding low-level searching).
- Limited detection capability with FW is likely as previous MACs and density estimations indicate overall low Range-wide density and abundance of Boreal Caribou as well as small mean group sizes (particularly in the southern Ranges in the contiguous continuous distribution) and frequently thick forest cover.
- Use of FW aircraft would reduce the capacity to accurately record precise perpendicular distances (i.e., waypoint) of Boreal Caribou from the transect line.
- Aerial use of lasers for demarking animal distances has generally proven difficult in forested systems.

1.2.3 2023 Survey Approach Rationale

The Vendor must use the single-stage distance sampling survey approach outlined in the *Boreal Caribou Monitoring Program Survey Design 2023* to generate Range-level population estimates using RW aircraft.

This single-stage RW approach is expected to result in a higher number of observations within each stratum and per transect in comparison to a non-stratified approach. This will improve the reliability of estimates of density and population.

2.0 2023 Single-Stage Distance Sampling Design

Range-level population estimations are required for each of the four Ranges that will be surveyed in 2023 (Churchill, Brightsand, Kesagami, and one Range in the Far North). The Vendor must prepare one Range-level population estimate in each single survey period.

2.1 Stratification Approach

Cumulative information on Boreal Caribou distributions, abundance, density and probability of occupancy is available from previous surveys (i.e., aerial searches, collar data, observational data) conducted under the Ontario Integrated Assessment Protocol and most recently following the Ozhiski 2018 Protocol. The Vendor must use this distribution and abundance-based information to stratify the Boreal Caribou Ranges that will be surveyed in 2023 into high, medium and low search intensity stratum in support of the single-stage distance sampling design. This must be applied as uniform placement of transects / flight lines within each strata. Strata must be applied based on the following criteria:

- High: narrowest transect spacing at 5km;
- Medium: 7.5km spacing; and
- Low: widest transect spacing at 15km.

This stratified sampling approach is broadly consistent with other Provincial cervid monitoring approaches (e.g., Moose Area Inventory) and should improve survey

efficiency relative to unstratified sampling (e.g., uniform 10 km spacing), as was applied in the Ozhiski 2018 Protocol.

These density-based stratification requirements direct more intensive sampling efforts in higher density strata to improve precision of density and population estimation. This will result in more geographically focused sampling effort in comparison to that conducted in Ozhiski 2018. This further increases the likelihood of achieving sufficient observations to calculate robust density and population estimates.

2.2 Survey Steps

The Vendor must carry out the survey through a single-stage flight using RW aircraft by undertaking the follow steps:

1. Search for, and observe, Boreal Caribou using experienced survey crew members provided by the Vendor. One Vendor survey crew member must be seated on either side of the helicopter.
    - If an Indigenous community member chooses to participate in the survey, then they will be the fourth member of the survey crew.
2. Determine GPS locations of Boreal Caribou observations and precise distance in relation to the transect line.
    - Record precise perpendicular distance of animals from the transect line by departing the line to count animals and record the GPS location of where animals were first sighted for calculation of distance to the transect line.
    - This allows for inclusion of all observed animals in the density estimate, including those tracked.
3. Conduct demographic classifications once perpendicular distance from transect line is recorded and animals counted.
    - Document classifications and recruitment level via low-level visual observation and verbal call out as per standard aerial recording procedures.
    - Record the number of bulls, cows, calves, unknown adults, and unknown caribou (e.g., juveniles) in each group. This information will be used to determine annual recruitment rate, demographic composition and group size.
    - Take high resolution photographs for use as a general record of groups classified. Survey crews must assess the independence of groups (i.e., distinguish between loosely scattered animals in a general area vs. cohesive groups that are deemed to be separate associations of animals).
4. Return to exact transect line departure point and resume transect.
5. Record GPS location distances for application of mark – recapture observation analysis for estimation of density.
6. Use density estimates to extrapolate numbers of Boreal Caribou in each stratum.

2.3 Additional Survey Requirements

- For each observation, the Vendor must record categorical forest cover levels and light / snow conditions as multiple co-variates to be used as part of the distance sampling analysis.
- The Vendor must assess additional animal observation opportunities based on the presence of high-quality fresh tracks. If the Vendor determines that high quality fresh tracks are present, then they must use the analytical approach that was applied for the 2016 Lake Superior Coast Range survey to undertake observations[1]. These track-based observations must be separately recorded on datasheets that will be provided by the Ministry so they can be distinguished from direct animal observations. Track-based observations must also record that animals were not first detected by direct observation. The Vendor must also apply criteria on maximum search distance for travel off the transect line when undertaking track-based observations.
    - Maximum search distance:
        - Standardized maximum search distance of 2.5 km perpendicular to flight line = half 5 km between-transect distance interval for high density stratum. This maximum 2.5 km search distance off transect to be applied uniformly in all strata.
        - This standard maximum off transect search distance should result in additional Boreal Caribou confirmations while at the same time putting a limit on additional time expenditure and fuel consumption.

2.4 Aircraft Considerations

- The Vendor must conduct the single-stage survey using RW aircraft with experienced survey crew members provided by the Vendor. One Vendor survey crew member must be seated on either side of the helicopter.
- The Vendor must ensure that the aircraft used are suitable for, and capable of, carrying out the single-stage distance survey approach, including recruitment and classification requirements outlined in the *Boreal Caribou Monitoring Program Survey Design 2023*.
    - Upon observation of Boreal Caribou groups, the Vendor must circle at lower altitudes and slower speed passes and / or hover to document, track, count and classify groups or individuals. Depending on terrain, light / snow conditions, wind speed and direction, these activities often require significant engine power to be safely and effectively conducted.
    - The Vendor must also undertake survey procedures in accordance with an approved Animal Care Committee protocol, for example by following required helicopter chase or herding times for Boreal Caribou.
- The Vendor is responsible for all logistics planning including, but not limited to, base locations, accommodations for crew members, meals, transportation, aircraft hangar storage and fuel availability and purchase.

[1] Recommended by S. Buckland (pers. Comm to N. Asselin, 2016)

- The Vendor is responsible for determining any fuel cache requirements including locations and making any necessary fuel cache arrangements.

2.5 Flying Considerations

- To ensure consistency in observations for comparability:
    - Aircraft cruising altitude should generally be maintained at 100m AGL (325 Ft) but can vary depending on tail winds, ground speed, terrain, forest type / patterns, and snow and light conditions.
    - Cruising air speed should generally be maintained at 80 knots or 120 km per hour with higher speeds across large lakes.
- Aircraft weight restrictions are not anticipated as survey work will be conducted as day trips and with only crew, up to one observer, survival gear and day packs (lunch) on board. Ferrying of gear or supplies together with crew to remote camps is not anticipated.
- Optimal snow conditions for detectability of Boreal Caribou tracks are three days since last snowfall of more than 15 cm.
- Light conditions and drifting snow are to be considered and recorded when conducting all flights with respect to safety and detectability of Boreal Caribou.

2.6 Recording Moose Observations

The distribution, general density and habitat selection of moose is important to the winter spatial organization and habitat selection of Boreal Caribou. However, conducting moose classifications at the same as time as recording Boreal Caribou and conducting distance sampling as part of a single-stage approach adds to search time and effort, additional fuel usage, additional data recording requirements, and cost inefficiencies.

Therefore, the Vendor must record GPS locations on the line (when the observation is made) and document estimated position of animals within binned buffer distances off the transect line (e.g., 250 m, 500 m), and record total number of animals seen. If crews are able to record whether moose are within / outside of the strip / belt, there is no need to leave the flight line to record specific GPS locations of the sightings. Crews may determine it is necessary to depart the flight line to better place the binned distance off the line.

2.7 Recording Wolverine and Wolf Observations

2.7.1 Wolverine

- Record GPS locations for all observed animals. The sex of the animal does not need to be recorded.
- Confirm tracks by low-level observation near all suspected wolverine tracks.
- Take a photograph of suspected wolverine tracks (with window open for a clear photo).

2.7.2 Wolf

- When a wolf or pack has been identified, record waypoint and map information. Record all wolves seen.
- If it is necessary to confirm tracks or get a pack count, do so. Do not circle to try to detect additional sign.

3.0 Data sheets

The Vendor will record data using data sheets to be provided by the Ministry.