# Keeyask Generation Project

## Terrestrial Effects Monitoring Plan

# Caribou Winter Abundance Estimates Report

**TEMP-2016-06**

KEEYASK

Manitoba Conservation and Water Stewardship Client File 5550.00
Manitoba Environment Act Licence No. 3107

**2015 -2016**

# KEEYASK GENERATION PROJECT

## TERRESTRIAL EFFECTS MONITORING PLAN

REPORT #TEMP-2016-06

## CARIBOU WINTER ABUNDANCE ESTIMATES REPORT

Prepared for

Manitoba Hydro

By

Wildlife Resource Consulting Services MB Inc.

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# SUMMARY

## BACKGROUND

Construction of the Keeyask Generation Project (the Project) at Gull Rapids began in July 2014. The Keeyask Hydropower Limited Partnership (KHLP) was required to prepare a plan to monitor the effects of construction and operation of the generating station on the terrestrial environment. Monitoring results will help the KHLP, government regulators, members of local First Nation communities, and the general public understand how construction and operation of the generating station will affect the environment, and whether or not more needs to be done to reduce harmful effects.

This survey was designed as part of the Keeyask Terrestrial Effects Monitoring Plan (TEMP). The objective of this survey was to evaluate how the Project may be affecting patterns and trends in caribou distribution, abundance, and population characteristics in Study Zone 5 (the Keeyask region). Three migratory caribou herds occasionally occupy the Keeyask Region in winter: barren-ground caribou (*Rangifer tarandus groenlandicus*) from the Qamanirjuaq herd; and two coastal caribou (*R. t. caribou*) herds, the Pen Islands and Cape Churchill herds, which are forest-tundra migratory woodland caribou ecotypes. A fourth group of caribou may be present in the Keeyask Region year round, and are referred to as summer residents. This report describes the results of aerial surveys conducted for migratory caribou in the winter of 2015/16.

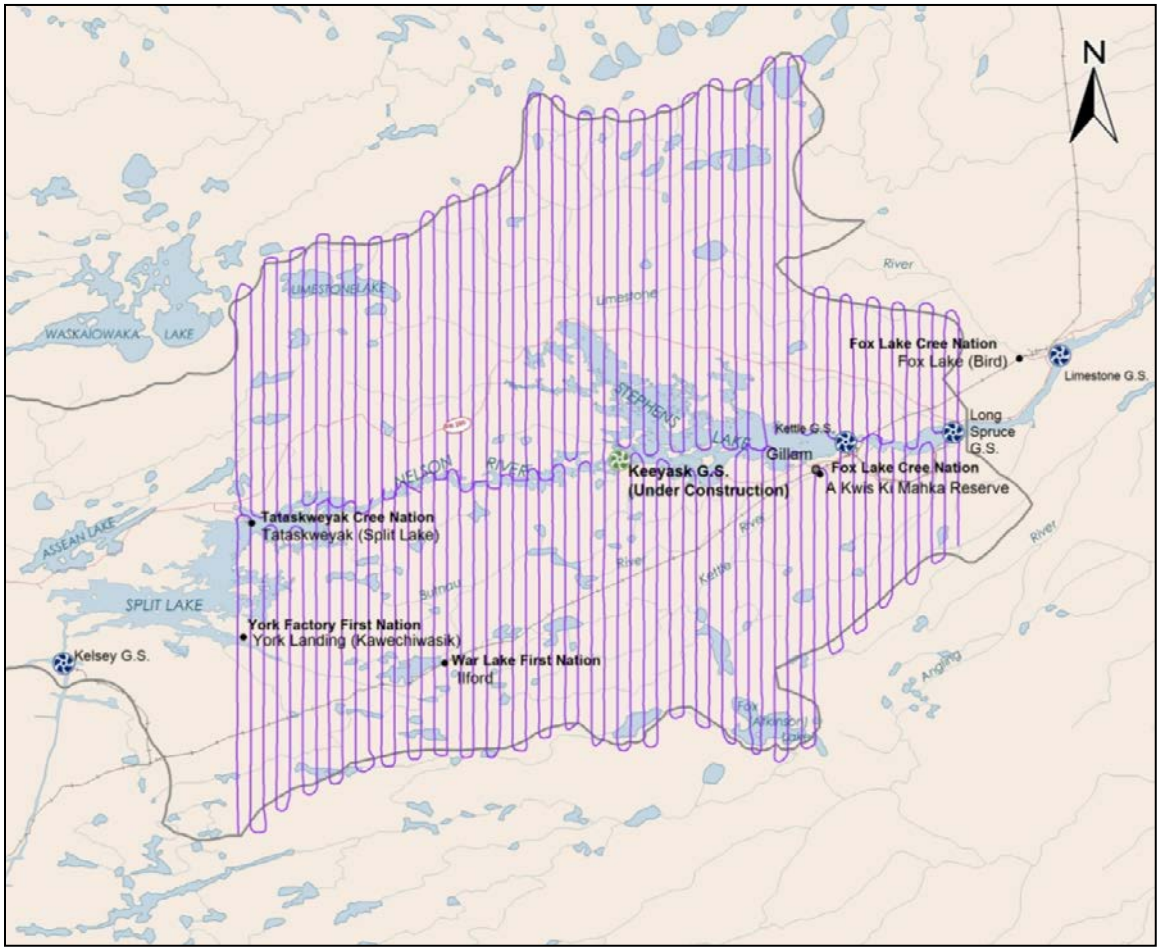
## WHY IS THE STUDY BEING DONE?

Caribou are widely distributed and occasionally abundant in the Keeyask region. Caribou monitoring is being done because the species is important in the Keeyask region, having ecological, cultural, and economic value. There is a potential for some small adverse Project effects on caribou populations, with a moderate degree of uncertainty concerning the effects predictions, as described in the Project's Environmental Impact Statement (EIS). There is a high degree of certainty and confidence in the Project effects predicted for caribou habitat availability, existing core areas, and regional intactness.

## WHAT WAS DONE?

Aerial surveys were conducted in early January, 2016, to estimate the abundance of caribou in the Keeyask region. Surveys were initiated shortly after local community members and Project site workers began reporting the arrival of migratory caribou. A crew of three observers and a pilot flew regularly-spaced survey lines over the survey area in an airplane, recording all caribou observed. Line transect distance sampling techniques, and the computer program DISTANCE, which are widely used for estimating animal density and abundance, were used. This method assumes that caribou directly on the line transect are observed, and that the probability of

observing caribou decreases farther away from the line transect. Ideally, this method provides a reliable population estimate.




**Area covered by the 2015 caribou winter abundance survey**

## WHAT WAS FOUND?

A total of 81 caribou were observed. These caribou likely originated from the Pen Islands herd. No barren-ground caribou were observed. As only 12 small groups of caribou were recorded on the survey transects, it was not possible to provide a reliable caribou population estimate using the distance sampling analytic methods. Observations made during the aerial survey suggest that the majority of caribou observed moved into the Keeyask region from the east and headed west, staying south of the Nelson River. Smaller numbers of caribou crossed the Nelson River between the Kettle GS and the Long Spruce GS and headed north and northwest before returning eastward.

**Caribou observed south of the Nelson River during the aerial survey**

## WHAT DOES IT MEAN?

A low number of migratory caribou entered the Keeyask region in the winter of 2015/2016. It is likely that some of the caribou observed during the survey were summer residents, which were estimated at 24 individuals during a separate survey in November 2015. As only a few groups of caribou were found across the survey area, a reliable population estimate could not be calculated. A second aerial survey was not conducted in 2016 because continued low numbers of caribou were reported in the Keeyask region between January and March.

## WHAT WILL BE DONE NEXT?

Aerial surveys to determine winter caribou abundance will occur in the Keeyask region every second year while the Project is being constructed and during the first six years of operation. If large numbers of caribou are reported to be present in the survey area during the winter of 2016/17, an aerial survey will be conducted. Following the sixth year of operation, the results of all caribou population monitoring to date will inform the need for further monitoring.

# STUDY TEAM

We would like to thank Pat Chartier of Gillam Air, Sherrie Mason, Rachel Boone, and Caroline Walmsley of Manitoba Hydro and Ron Bretecher of North/South Consultants Inc., for logistical assistance in the field. We would also like to thank Dr. James Ehnes, ECOSTEM Ltd., for study design, GIS support and cartography.

Biologists, technicians and other personnel who designed, participated in, and drafted the survey results included:

Robert Berger, M.N.R.M., Design, analysis, and reporting

- Nicholas LaPorte, M.N.R.M., Analysis, reporting, and survey personnel
- Peter Hettinga, M.N.R.M., Survey personnel
- Gordon MacDonald, B.Sc., Survey personnel
- Morgan Zaretski, B.Sc., Survey personnel
- Eugene Spence (TCN), Survey personnel
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# 1.0 INTRODUCTION

Construction of the Keeyask Generation Project (the Project), a 695 megawatt hydroelectric generating station (GS) and associated facilities, began in July 2014. The Project is located at Gull Rapids on the lower Nelson River in northern Manitoba where Gull Lake flows into Stephens Lake, 35 km upstream of the existing Kettle GS.

The *Keeyask Generation Project: Response to EIS Guidelines* (EIS) (KHLP 2012a), provides a summary of predicted effects and planned mitigation for the Project. Technical supporting information for the terrestrial environment, including a description of the environmental setting, effects and mitigation, and a summary of proposed monitoring and follow-up programs is provided in the Keeyask Generation Project Environmental Impact Statement: Terrestrial Environment Supporting Volume (TE SV) (KHLP 2012b). The Keeyask Hydropower Limited Partnership (KHLP) was required to prepare a plan to monitor the effects of construction and operation of the generating station on the terrestrial environment. A Terrestrial Effects Monitoring Plan (TEMP) was developed detailing the monitoring activities of various components of the terrestrial environment including the focus of this report, winter caribou abundance, for the construction and operation phases of the Project. This study was conducted to meet the requirements of Environment Act Licence No. 3107 to monitor caribou winter abundance, as described in Section 6.2.2 of the TEMP.

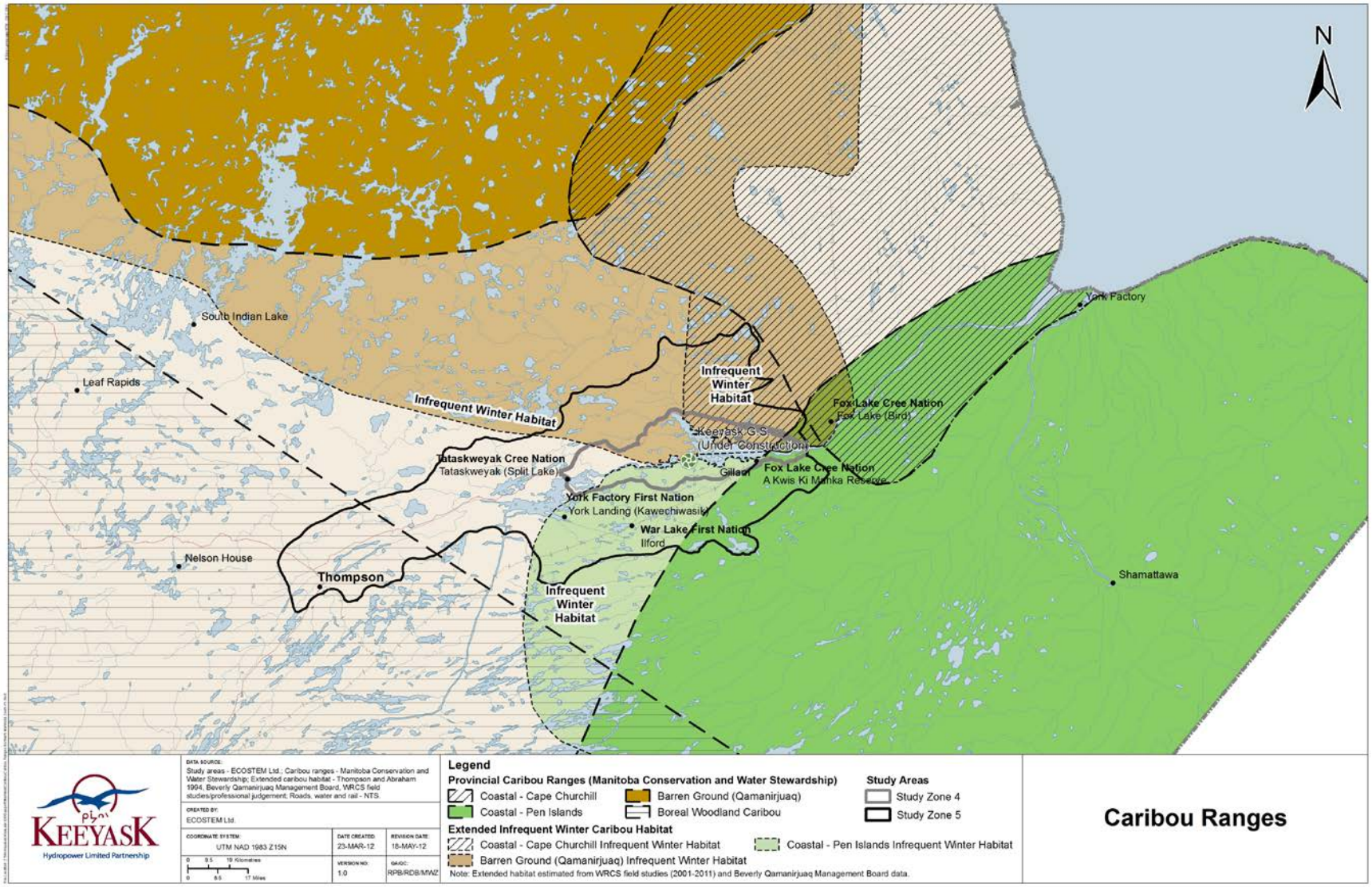
The goal of this study is to characterize the variability in caribou abundance in the winter and to evaluate how the Project may be affecting movement patterns. The objectives of this study are to:

- Estimate the variability in the number of caribou in Study Zone 5 during the winter; and,
- Evaluate whether there is any suggestion that winter habitat use, and/or river crossings in the context of highly variable winter distribution patterns, are affected by the Project.

Four groupings of caribou are described for the Keeyask Region: barren-ground caribou (*Rangifer tarandus groenlandicus*); two herds of coastal caribou (*R. t. caribou*), a forest-tundra migratory woodland caribou ecotype; and, summer resident caribou (summer residents), a type of woodland caribou whose exact range and herd association is uncertain.

Barren-ground caribou from the Qamanirjuaq herd migrate from Nunavut in autumn to overwinter in Manitoba's northern forests and then leave in spring to calve. On occasion, a small fraction of the herd may reach Study Zone 5 (Map 1-1). About 10,000 animals migrated this far south once in the last 10 years (in 2004). An estimated 264,000 animals were in the herd in 2014 (Vicki Trim pers. comm. 2016). Coastal caribou from the Cape Churchill and Pen Islands herds occur within the Keeyask region in the winter and leave in spring to calve near the Hudson Bay coast. The Pen Islands coastal caribou herd migrates from Ontario to the area south of the Nelson River (FLCN 2010 Draft), through Shamattawa to the Atkinson Lake area (WLCN 2002), as far west as the Nelson River at York Landing and as far south as Oxford House (Map 1-1). The rutting period of Pen Islands caribou is from mid-September to mid-October, when most of the herd is near the Hudson Bay coast (Abraham and Thompson 1998). Animals from the Pen Islands herd were first reported in the Keeyask region in the 1990s (Thompson 1994; Thompson and Abraham 1994; Abraham and Thompson 1998; Abraham *et al.* 2012). In the mid-1990s, the Pen Islands herd was estimated at 10,800 individuals (Abraham and Thompson 1998; Abraham *et al.* 2012). Although larger migrations into the Keeyask region were observed in the winter in 2001, 2005, and 2013, less than 300 animals believed to be Pen Islands caribou are observed during most winters. In the winter of 2011/12, less than 30 caribou were observed in the Keeyask region during field studies. All caribou observed in the winter of 2011/12 were observed approximately 10 km due south of Birthday Rapids (WRCS unpubl. data). In February 2013, an estimated 13,985 (±18.17%, 95% CI) Pen Islands caribou were present in the Keeyask region (LaPorte *et al.* 2013).

The Cape Churchill coastal caribou herd is currently estimated at 3,500 to 5,000 individuals and indications are that the population is likely stable (Joro 2012). Although a large migration into the Keeyask region was observed in winter 2010 (Manitoba Hydro 2011), there are generally fewer than 50 animals in most winters.

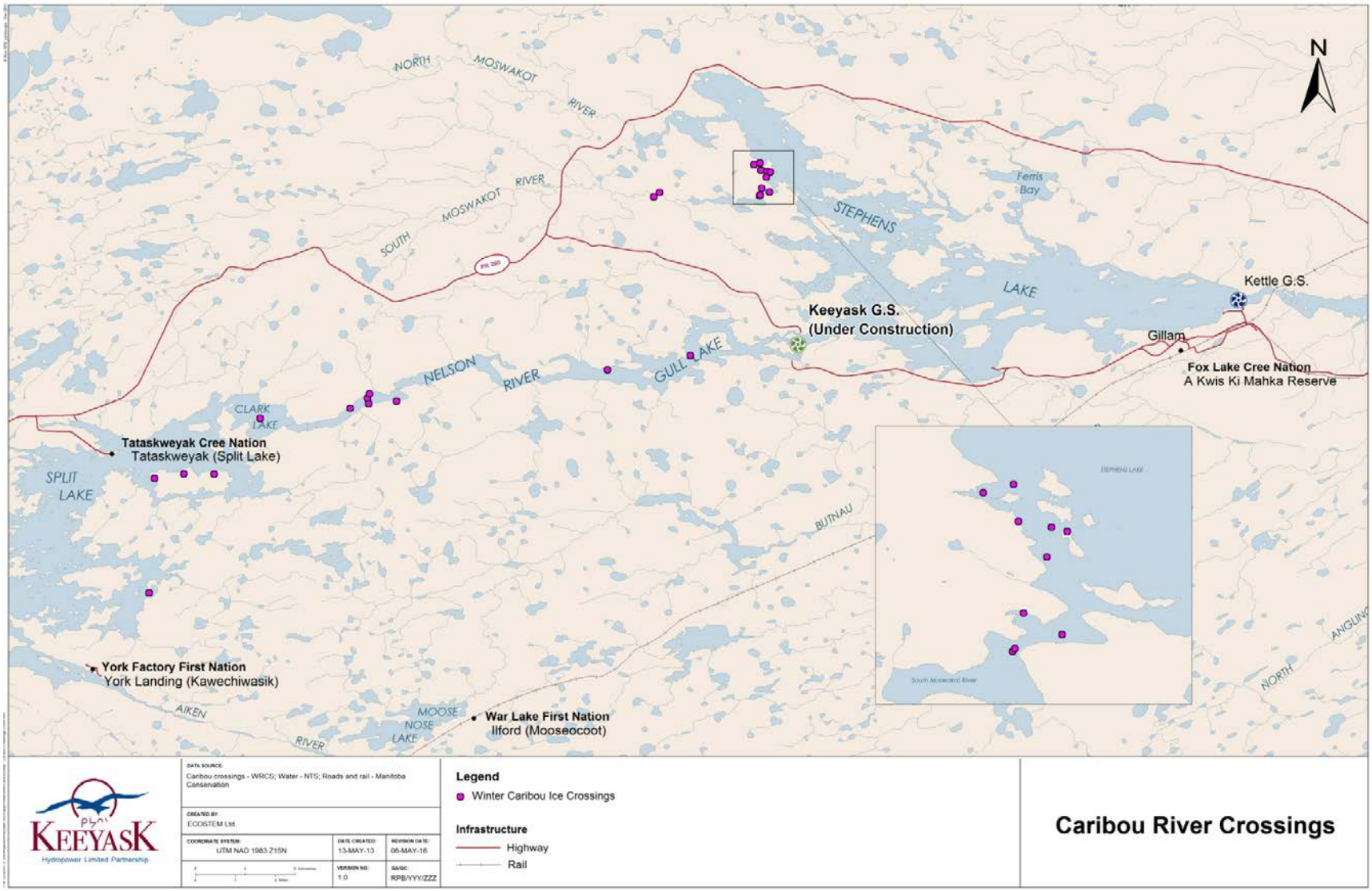



**Map 1-1. Caribou Ranges in the Lower Nelson River Area.**

While the Nelson River serves as a physical boundary for both Pen Islands and Cape Churchill caribou in the Keeyask region, river crossing locations have been reported for the Nelson River and Stephens Lake (FLCN 2010 Draft) (Map 1-2). Genetic studies indicated that coastal caribou genotypes were found both north and south of the Nelson River between 2004 and 2006. Recent radio-collaring data indicate that most of the Cape Churchill herd's activity is north of the Nelson River and do not typically cross the Nelson River to the south while the majority of Pen Islands herd's activity is south of the river (Manitoba Conservation unpubl. data; Manitoba Hydro 2011).

Abundance estimates are essential for the management of wildlife and for developing a robust understanding of conservation and population dynamics. Wildlife managers require survey techniques that (1) allow completion of surveys in a cost and time effective manner, (2) provide a reasonably accurate estimate of population size, and (3) provide indicators to assess confidence in the estimate (Guenzel 1994). Consequently, various techniques have been developed to estimate the size of ungulate populations. There are a number of methods available (reviewed in Heard 1985), with mark-recapture and distance sampling being the most widely employed (Williams *et al.* 2002). Strip transect distance sampling and related techniques have been successfully used to survey many species of wildlife (Thomas *et al.* 2010) and have been used to estimate caribou populations as far back as the 1950s (Banfield *et al.* 1955) and also more recently for woodland caribou by the Ontario government in Slate Islands Provincial Park (Carr *et al.* 2012) and to the Peary herd of barren-ground caribou on Baffin Island by the Nunavut government (Jenkins *et al.* 2011). Distance sampling uses the perpendicular distances from the observer to a cluster of objects (*e.g.,* caribou) to obtain a measure of detection probability as a function of distance (Buckland *et al.* 2001).

Distance sampling is more cost and time efficient in larger study areas with sparsely distributed animal populations (Buckland *et al.* 2001; Nielson *et al.* 2006). This study attempts to estimate the relative density, and thus abundance, of caribou in the eastern portion of Study Zone 5 in northern Manitoba.




**Map 1-2. Winter Caribou Ice Crossing Sites.**

# 2.0 METHODS

## 2.1 FIELD METHODS

The timing of caribou winter abundance estimates surveys varies year to year, and are based on local reports that caribou are moving into Study Zone 5. Regular contact with local First Nations resource users, Manitoba Hydro staff, and locally based airplane and helicopter pilots was maintained to watch for indications of caribou in the Keeyask region. This information was used to inform Manitoba Hydro on when aerial surveys for caribou were warranted.

Surveys for caribou in the Study Zone 5 (Map 3-1) were conducted over four days, from January 9 to 12, 2016. As a complete census of all animals is not possible, abundance and density estimates are based on distance sampling methods. Standard aerial survey techniques and distance sampling methods (Buckland *et al.* 2001) were followed. Surveys were conducted during high visibility weather and complete snow coverage with two Britten Norman BN2A Islander twin propeller airplanes. Systematic north-south transects were established every 2 km. Transects were flown at approximately 100 m AGL and at a speed of 140 km/h, depending on topography and forest cover density.

In order to generate reliable population estimates through distance sampling techniques, there are three key assumptions to meet (Buckland *et al.* 2001):

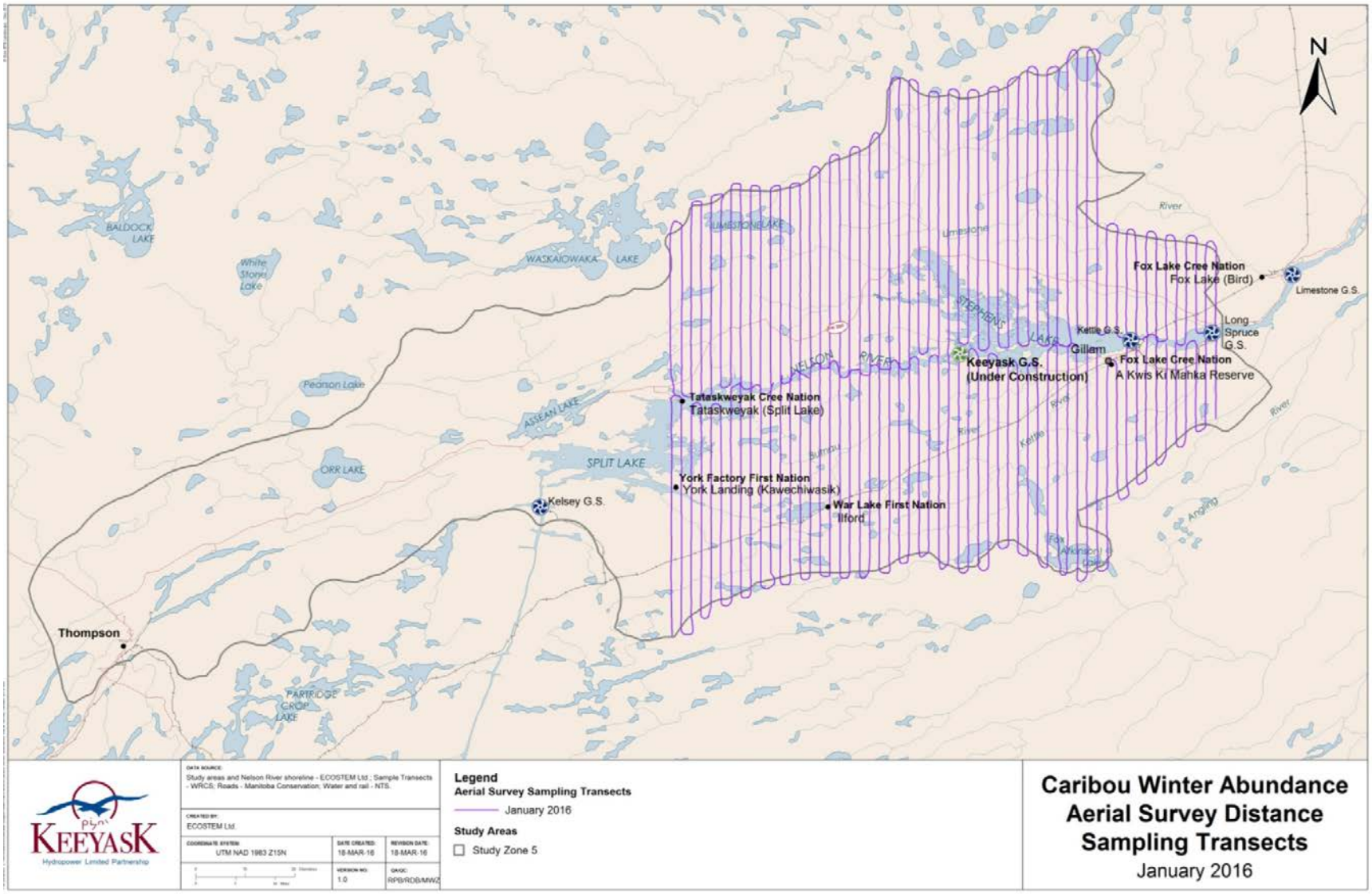
1. All objects (caribou clusters) are detected with certainty on the transect line ($G(0)$);
2. Objects do not move; and
3. Measurements are exact.

However, these assumptions can be relaxed (Buckland *et al.* 2001; Thomas *et al.* 2010). Although there are other minor assumptions to be met (Buckland *et al.* 2001), they are seldom of great practical significance (Thomas *et al.* 2010). It is assumed that caribou locations are independent of the position of the transect lines, which is ensured by having an adequate sample of lines, and by randomizing their locations (Buckland *et al.* 2001; Thomas *et al.* 2010). It is also assumed that detections are independent events, though distance sampling methods are very robust to failures of this assumption (Thomas *et al.*

2010). By defining the cluster, and not individual caribou, as the object of interest, violations of the independent detections assumption are of minor importance (Buckland *et al.* 2001).

Surveys were conducted by two crews comprised of three experienced observers and the pilot per airplane. The front right observer was responsible for spotting caribou clusters on and near the transect line through the front window of the aircraft, while the rear observers were responsible for spotting caribou on either side. The pilots also assisted with spotting caribou near the transect line. A Global Positioning System (GPS) Receiver (Garmin GPSMAP 60 CSx) was used to collect caribou location data. The unit of observation was clusters of caribou, where a cluster refers to an individual or group of caribou that were closely spatially aggregated (*i.e.,* <50 m apart) to ensure independence of observations (Buckland *et al.* 2001). The front right observer recorded cluster locations and recorded cluster size and perpendicular distance from the aircraft. Exact distance measurements were not taken, but were grouped by 50 m distance intervals from 0 to 500 m. Animal care and safety was a high priority, and to minimize disturbance, wildlife were never circled by the aircraft. Incidental observations that were detected while ferrying between transects were also recorded, but such observations were excluded from the final analysis in the program DISTANCE.

To gather information on the distribution of caribou in Study Zone 5, caribou track sets were recorded using a GPS. Track sets were categorized as fresh or old. Fresh track sets are clearly visible tracks that haven't been obscured by snow drifting, and are likely to have been left within the last few days (Appendix A, Photo A-1). Old track sets are all other tracks (Appendix A, Photo A-2). As there was heavy snowfall from January 3 to 7, 2016 (Environment Canada 2016), all fresh tracks were made after January 7, 2016 (*i.e.,* tracks seen on January 9 were approximately two days old, while tracks observed on January 12 were approximately five days old).




**Map 2-1. Distance Sampling Transects Followed during the January 2016 Caribou Winter Abundance Aerial Survey.**

## 2.2 DATA ANALYSIS

Distance sampling data were analysed in the program DISTANCE v. 6.2 (Thomas *et al.* 2010) to model the line transect data and estimate density and abundance of caribou in the Project area. As larger clusters of caribou are easier to detect than smaller groups further from the transect line (Drummer and McDonald, 1987), a size bias leading to overestimation of density is potentially introduced (Buckland *et al.* 2001). A size bias regression estimator is commonly used in the program DISTANCE by regressing the log of caribou cluster size against the probability of detection at distance *x*. This method estimates expected cluster size on the transect line, where size bias should be negligible (Buckland *et al.* 2001). Expected cluster size is commonly used to estimate the caribou population density rather than the mean cluster size, which positively biases the estimator (Buckland *et al.* 2001). Density of caribou was estimated in the program DISTANCE as:

$$D = n*g(0)/2L$$

where *L* is the sum of all transect lengths, *n* denotes the number of detected caribou clusters and *g*(0) is the probability density function of observed perpendicular distances evaluated at zero distance. The probability density function is a function of three model components, the estimated detection probability, the encounter rate, and cluster size (Buckland *et al.* 2001).

To model detection functions, combinations of three key functions and three adjustment terms are commonly considered, following recommendations of Buckland *et al.* (1997 and 2001). *A priori* candidate models are commonly a half-normal key function with the option of cosine or hermite adjustment terms, a uniform key function with the option of cosine or polynomial adjustments, and a hazard-rate key function with cosine adjustments. The best model is selected based on Akaike's Information Criterion (AIC), where the model with the lowest AIC value is considered the most parsimonious (*i.e.,* the simplest model with the least assumptions and variables but with the greatest explanatory power) (Anderson *et al.* 1998). Goodness-of-fit tests ($\chi^2$ GOF) and qq-plots (especially at distance 0), are used to detect assumption violations (Buckland *et al.* 2001). Estimates for all models are produced with the objective of obtaining a coefficient of variation (CV) less than 20% (Otis *et al.* 1978; White *et al.* 1982). Robson and Regier (1964) recommend an accuracy of ±25% for management studies that estimate the size of animal populations. In addition, variance is estimated using a weighted average of several plausible models (Buckland *et al.* 2001; Burnham and Anderson 2002) in a non-parametric

bootstrap method that estimated variance from 1,000 bootstrap resamples, which requires fewer assumptions than parametric methods (Buckland *et al.* 2001).

## 2.3 ICE CROSSING SITES

Locations of caribou trails detected on the Nelson River and Stephens Lake during distance sampling surveys were recorded to identify locations where caribou crossed large frozen waterbodies (*i.e.,* Nelson River, Stephens Lake, Split Lake, Clark Lake).

# 3.0 RESULTS

## 3.1 DENSITY AND POPULATION SIZE

Approximately 50 caribou were observed crossing Provincial Road (PR) 280 near the Hudson Bay Railway (HBR) line on December 13, 2015 (Photos 3-1and 3-2) by Manitoba Hydro staff (Caroline Walmsley pers. comm. 2015). Tataskweyak Cree Nation (TCN) members also reported seeing caribou along PR280 in the vicinity of North Moswakot and South Maswakot rivers in the few days before December 13, 2015 (Ron Bretecher pers. comm. 2015). In February 2016, TCN members reported harvesting a few caribou north of the PR 280. Overall, few animals were reported in Study Zone 5 by local First Nations resource users, Manitoba Hydro staff, and local airplane and helicopter pilots between January and March 2016. Due to these low numbers, a second aerial survey was not conducted in 2016.


**Photo 3-1. Caribou crossing PR 280 on December 13, 2015.**


**Photo 3-2. Caribou crossing the HBR line west of PR 280 on December 13, 2015.**

Fifty-six transects were flown, covering an area of 8,400 km$^2$ in the eastern half of Study Zone 5 in mid-January with a total transect length of 4,463 km. In total, 81 caribou in 13 clusters were observed during the survey, although 2 clusters were observed off-transect (Table 3-1). On the distance sampling line transects, 49 caribou in 11 clusters were observed. Mean cluster size was 6.2 caribou and ranged from one to 30 individuals. All but one caribou were observed south of the Nelson River.

The program DISTANCE returned an output message of "*Number of observations is small. Do not expect reasonable results*". As such, estimating caribou density and abundance in Study Zone 5 using distance sampling analytic methods would not be expected to produce estimates with acceptable confidence intervals. Thus, abundance estimates based on distance sampling for the January 2016 survey are not provided in this study.

Moose and grey wolves were observed incidentally in Study Zone 5 during the aerial survey. A total of 177 moose were observed; 107 moose were observed north of, and 70 moose were observed south of the Nelson River. Grey wolves were only observed south of the Nelson River.

**Table 3-1. Numbers of caribou observed during the January 2016 aerial survey**

| Date | Stratum | Wpt. | # Adult caribou | # Caribou calves |
|---|---|---|---|---|
| 12-Jan-16 | North | 161 | 1 | 0 |
| 10-Jan-16 | South | 22 | 2* | 0 |
| 09-Jan-16 | South | 6 | 9 | 0 |
| 09-Jan-16 | South | 69 | 2 | 1 |
| 09-Jan-16 | South | 74 | 2 | 0 |
| 10-Jan-16 | South | 91 | 1 | 0 |
| 11-Jan-16 | South | 278 | 4 | 0 |
| 11-Jan-16 | South | 286 | 5 | 0 |
| 11-Jan-16 | South | 412 | 1 | 0 |
| 11-Jan-16 | South | 424 | 13 | 4 |
| 12-Jan-16 | South | 447 | 9 | 0 |
| 12-Jan-16 | South | 461 | 2 | 0 |
| 12-Jan-16 | South | 462 | 30* | 0 |
| Total | | | 81 | 5 |

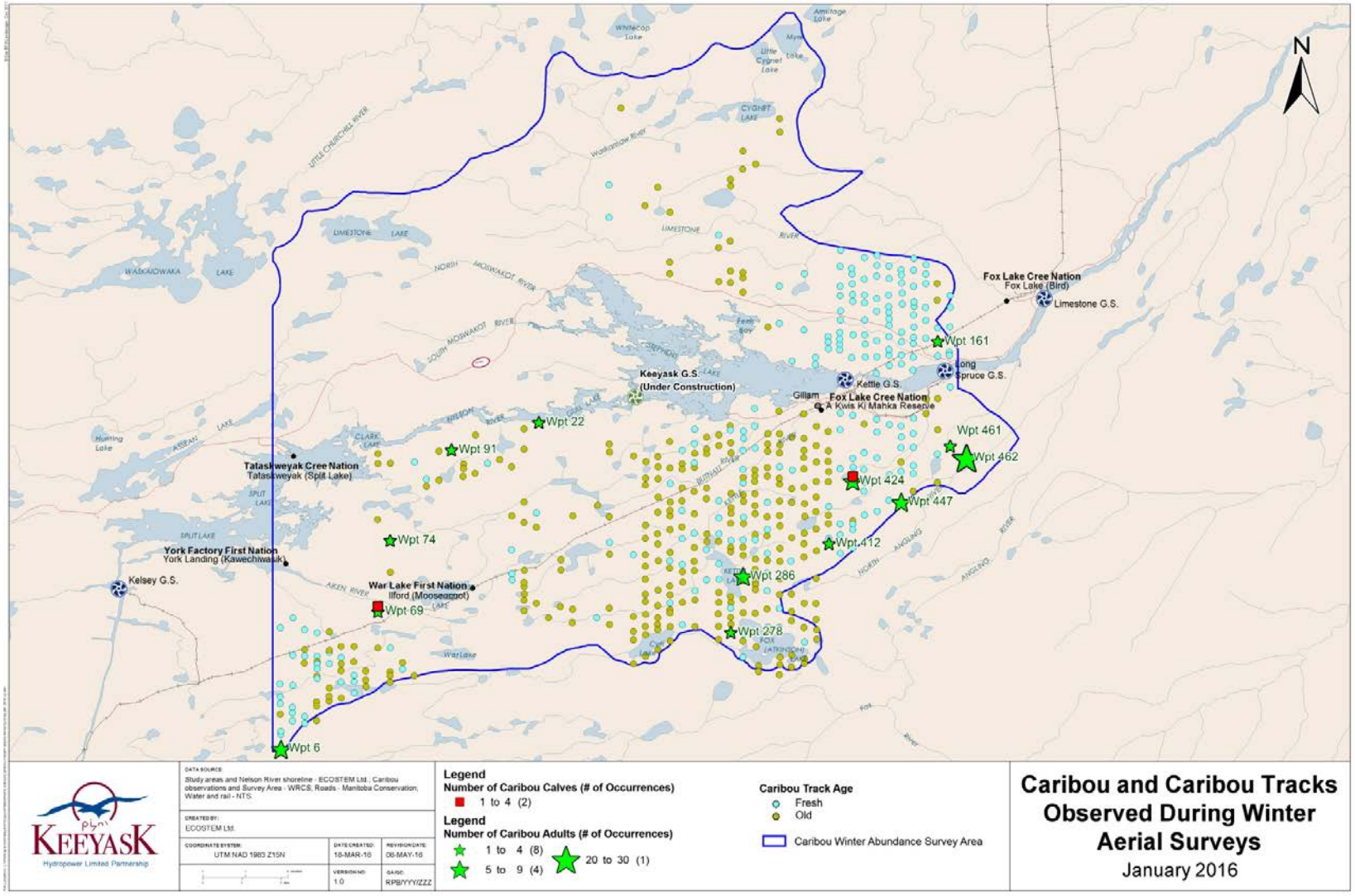
*Caribou observed incidentally off-transect

One lone grey wolf was observed 15 km southeast of Birthday Rapids, two were observed 10 km southeast of Gull Rapids near the Project's South Access Road, and two were observed at Atkinson Lake.

## 3.2 DISTRIBUTION

The distribution of caribou and their tracks was not uniform during the 2016 winter aerial survey in Study Zone 5. The majority of caribou observed during the aerial survey were south of the Nelson River (Map 3-1). Of the caribou observed south of the Nelson River, most were located south of the town of Gillam. Fewer caribou observed south of the Nelson River were located in the western portion of the surveyed area, south of Clark Lake. Only one caribou was observed north of the Nelson River. It was located about 5 km north of the Long Spruce GS. While ferrying between Gillam and the line transects, two caribou were incidentally observed on the

frozen Nelson River, approximately 18 km to the west of Gull Rapids. These two animals were about 200 m from the southern shore and remained stationary while the airplane flew by.




**Map 3-1. Caribou and Caribou Tracks Observed During the January 2016 Caribou Winter Aerial Survey**

## 3.3 ICE CROSSING SITES

Very few locations where caribou crossed the Nelson River and/or Stephens Lake were identified while surveying line transects from January 9 to 12, 2016. During the survey, only one caribou ice crossing site was recorded between the Kettle GS and the Long Spruce GS. Two sites where caribou tracks crossed PR 280 were recorded during the survey. One site was at the intersection of PR 280 and PR 290, whereas the other site was 7 km north of this intersection. Tracks from the two caribou observed on the frozen Nelson River emerged from the forested area along the southern shore and headed north.

# 4.0 SUMMARY AND CONCLUSIONS

Only 81 caribou were detected during the survey, with all but one observed south of the Nelson River. A requirement of distance sampling techniques is that a reasonable number of detections are needed for adequate analysis (Marsden 1999) and a minimum of 60-80 clusters of animals is recommended for fitting the detection function (Buckland *et al.* 1993). As only 12 clusters of caribou were observed on the survey transect, it was not possible to fit a detection function to the data to generate a reliable caribou population estimate for the survey area in the winter of 2015/2016. In years when small numbers of caribou are present, line transect distance sampling may not generate reliable population estimates. Paradoxically, it cannot be known if the population is too low to generate reliable population estimates using distance sampling until distance sampling is well underway or complete. Line transect distance sampling continues to be an appropriate method to determine presence/absence of caribou herds in the Keeyask region and to estimate populations, when numbers are sufficient.

Some of the caribou observed during the survey were likely summer resident caribou, a type of woodland caribou whose exact range and herd association is uncertain. In November 2015, a systemic aerial survey was conducted under the TEMP to look at the winter range of the summer resident caribou present within Study Zone 5. This survey located a herd of 25 caribou 10 km southeast of Birthday Rapids. Caribou scat was collected from these caribou for DNA analysis in order to investigate herd association and to estimate this herd's population (see Report #TEMP-2016-07). Summer resident caribou likely contributed to the counts of caribou recorded south of the Nelson River during the January 2016 aerial survey.

Caribou track sets left since the last heavy snow fall (in the days immediately preceding the start of the aerial survey) suggest that the caribou population that migrated into the survey area was greater south of the Nelson River compared to the group of caribou that left track sets north of the Nelson River. Track observations also suggest that the group of caribou migrating north of the Nelson River came from the Nelson River area south of the Kettle GS and the Long Spruce GS, and migrated north and northwest and then to the east. Caribou movements through the survey area will be confirmed in future monitoring years as radio-collaring data for the Pen Islands herd becomes available from Manitoba Conservation and Water Stewardship. Radio-collar data from individuals identified as Pen Islands coastal caribou indicate that the caribou observed both south and north of the Nelson River were almost certainly from the Pen Islands herd (V. Trim pers. comm. 2016). Furthermore, caribou observed during the survey closely

resembled coastal caribou as opposed to barren-ground caribou. Observations of caribou and many caribou track sets south of Study Zone 5, made by airplane pilots engaged in unrelated activities (Pat Chartier pers. comm. 2016), suggest that the majority of the Pen Islands herd remained south of the Keeyask region in their frequent winter range (KHLP 2012).

No barren-ground caribou (Qamanirjuaq herd) were observed during the survey, and no tracks originating from the north were observed. There is a possibility that Qamanirjuaq caribou migrated into the survey area north of the Nelson River after the January aerial survey was completed. Winter caribou abundance surveys are triggered by observations by local resource users, Manitoba Hydro staff, and others. However, the portion of Study Zone 5 north of PR 280 is rarely visited, and local resource users that may report sightings might not venture as far as the northern boundary of Study Zone 5. Without a second aerial survey later in the winter, due to low numbers of Pen Islands caribou being present, it is not possible to know for certain whether or not Qamanirjuaq caribou entered the area. In future years when winter caribou abundance is being estimated, more than one aerial survey is recommended to investigate presence/absence of caribou herds and to estimate caribou populations in Study Zone 5.

Very few sites where caribou crossed major waterbodies were observed. Caribou track sets suggest that caribou crossed PR 290 from south of the Nelson River between the Kettle GS and the Long Spruce GS. Caribou likely crossed the Nelson River on ice downstream of the open-water tailrace of the Kettle GS. Flat light during the aerial survey, which produced little contrast or shadows, and drifting snow likely obscured tracks that may have been left on the frozen river. Additionally, the two caribou seen on the Nelson River between Birthday Rapids and Gull Rapids may have crossed the river and the site may be considered a crossing site.

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## 5.2 PERSONAL COMMUNICATIONS

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Caroline Walmsley. 2015. Site Environmental Lead, Manitoba Hydro Keeyask Engineering and Construction. Email conversation with Robert Berger, Wildlife Resource Consulting Services MB Inc., Winnipeg, Manitoba, December 14, 2015.

Vicki Trim. 2016. Wildlife Biologist, Northeast Region, Manitoba Conservation and Water Stewardship, Thompson, Manitoba. Email conversation with Robert Berger, Wildlife Resource Consulting Services MB Inc., Winnipeg, Manitoba, January 19, 2016.

Pat Chartier. 2016. Owner, Gillam Air, Gillam, Manitoba. Telephone conversations with Gordon Macdonald, Wildlife Resource Consulting Services MB Inc., Winnipeg, Manitoba, February 1 to March 15, 2016.

# APPENDIX A: Photographs of Caribou Track Sets

**Photo A-1. Caribou tracks categorized as "Fresh".**

**Photo A-2. Caribou tracks and craters categorized as "Old".**

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