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Caribou Sensory Disturbance Monitoring Report

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TEMP-2017-10







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KEEYASK

Manitoba Sustainable Development Client File 5550.00 Manitoba Environment Act Licence No. 3107

2016-2017

KEEYASK GENERATION PROJECT

TERRESTRIAL EFFECTS MONITORING PLAN

REPORT #TEMP-2017-10

CARIBOU SENSORY DISTURBANCE MONITORING **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.

The ranges of three migratory caribou herds extend into the Keeyask region: barren-ground caribou from the Qamanirjuaq herd, and forest-tundra woodland caribou from the Pen Islands and Cape Churchill coastal caribou herds. Groups of caribou from these herds occasionally overwinter in the Keeyask region and leave in spring to calve.

A fourth group of caribou occupies the Keeyask region in spring and summer (referred to as summer resident caribou), and is known to calve on the islands in Gull and Stephens lakes and in surrounding peatland complexes (raised treed areas surrounded by low, wet areas, which essentially act as islands). Summer resident caribou likely move within and beyond the Keeyask region in winter, but the extent of their core winter range is unknown. These caribou remain in the region to calve, but there is uncertainty about how many calve in the area in consecutive years.

Predicted Project effects on summer resident caribou include the loss of physical habitat from clearing and development, and the loss of effective habitat due to sensory disturbance (*e.g.*, noise and light from construction activities). Caribou may temporarily avoid otherwise suitable habitat near construction sites due to the sounds, odours, and sights caused by construction activities. A lesser effect may also occur near Project infrastructure and roads during operation. Caribou movement patterns in and through the Keeyask region could also be affected by the Project.

Why is the study being done?

Caribou calving on islands in lakes and in peatland complexes near the Project may be susceptible to the loss of effective habitat due to noise and light disturbance. The goal of this study is to monitor the effect of these disturbances on caribou distribution and relative abundance near Project infrastructure during construction and operation. Simultaneous monitoring of other large mammals may provide an indication of the effects of potential changes in the distribution of alternative prey (moose) and predators (black bear and gray wolf) on the caribou population.







What was done?

One to six trail cameras were deployed on 118 islands in lakes and on habitat islands in 34 peatland complexes in April 2016 to document the presence of caribou and other large mammals in spring and summer. Cameras were placed in areas where caribou activity was likely to be detected (*e.g.*, heavily used game trails, large openings). Cameras were removed in the fall, the photographs were reviewed, and the species and age (adult or juvenile) of the large mammals photographed were recorded. No ground tracking component was planned or carried out under this study in 2016.

The timing of ice breakup on Stephens Lake was also monitored using trail cameras deployed along the shoreline, to evaluate its influence on the use of the islands by caribou.

What was found?

Large mammals (caribou, moose, or black bear) were documented on sixty-four of the 111 islands in lakes for which photographs were available. No gray wolves were photographed. Caribou were documented on 17 islands, moose on 53 islands, and black bear on seven islands. All three species were documented on only one common island over the survey period. Caribou calves were photographed on six islands in lakes and moose calves were photographed on 25.

The percentage of surveyed islands in Gull and Stephens lakes on which caribou and calves were photographed declined throughout the pre-construction period of 2010 to 2014 and during the first full summer of construction in 2015, and then increased in 2016. The percentage of the surveyed islands on which moose and calves were photographed varied over the pre-construction and construction periods, with the greatest and lowest percentages of islands occupied before construction began. Of particular note and as predicted in the EIS, no caribou or calves were documented on the islands nearest the construction areas in 2016, including islands on which their presence was observed in 2015. Caribou were mainly distributed on islands in the north-central portion of Stephens Lake in 2016.

Beginning in mid-May, the ice cover on Stephens Lake appeared to decrease rapidly. Ice breakup was May 20, 12 days earlier than in 2015, and Stephens Lake was free of ice by May 22, 11 days earlier than in 2015.





Bull Moose Photographed on an Island in Stephens Lake

Large mammals were photographed on 12 of the 34 habitat islands surveyed in peatland complexes. Caribou were documented on four habitat islands, moose on five habitat islands, and black bear on four. No gray wolves were photographed. Trail cameras documented more than one large mammal species on only one habitat island. A caribou calf was photographed on one habitat island, while no moose calves were photographed.

Overall, caribou and moose were relatively common on islands in lakes and in peatland complexes. No caribou were documented on the islands nearest the construction areas, including some islands on which their presence was observed in 2015. While the spring and summer distribution of caribou in Gull and Stephens lakes can vary from year to year, the potentially unoccupied islands nearest the construction areas may indicate some avoidance due to construction-related sensory disturbances. Moose and caribou calves appeared to be less abundant than adults, and caribou calves in particular were less widely distributed. The percentage of islands on which caribou were photographed more than doubled from 2015 to 2016. Moose and black bear also occupied more islands in 2016 than the previous year. The percentage of habitat islands in peatland complexes on which caribou and moose were photographed decreased from 2015 to 2016. Black bear occupied a greater percentage of habitat islands in 2016 than the previous year. No gray wolves were photographed in peatland complexes either year.

What does it mean?

Caribou and moose were photographed on many islands throughout Gull and Stephens lakes and in peatland complexes in 2016, and these species continued to calve in the Keeyask region. However, there appears to be a zone of disturbance immediately around the Project site, and caribou calving activities near construction areas have declined. Predators were relatively



sparse. The extent of predator influence on the caribou population is unknown in the Keeyask region; however, the relatively small number of islands where trail cameras documented both predators and caribou or moose suggests that it may be fairly minor.

In 2016, ice breakup on Stephens Lake was in late May, slightly overlapping the general calving period of May 1 to June 30 and earlier than the first caribou calf photographed (June 19). The occupancy of only one island by both caribou and black bear was documented, and no gray wolves were detected by trail cameras. Islands in lakes likely provided caribou and their calves with some protection from predators during the calving period.

What will be done next?

Trail cameras will be placed in the same locations on islands in lakes and in peatland complexes in 2017 to monitor their use by caribou and other large mammals. Ground tracking surveys and trail camera surveys that began in 2015 will be repeated in 2017.

Information from this caribou monitoring study will be provided to the Keeyask Caribou Coordination Committee (KCCC) to support the Keeyask Hydropower Limited Partnership's monitoring activities and collaborate, if requested, in the development of broader common research goals and perspectives with Manitoba Hydro, Manitoba Sustainable Development, and local stakeholders. Synthesis reports will provide an integrated evaluation of Project effects on caribou distribution and abundance as well as the availability of suitable and effective habitat using results from this monitoring study and relevant information from other Project monitoring programs.



STUDY TEAM

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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 (the EIS), completed in June 2012, 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). The Terrestrial Effects Monitoring Plan (TEMP) was developed as part of the licensing process for the Project. Monitoring activities for various components of the terrestrial environment were described, including the focus of this report, caribou (Rangifer tarandus), and their use of calving and calfrearing ("calving and rearing") habitat in the Keeyask region during the construction and operation phases.

The ranges of three migratory caribou herds extend into the Keeyask region: barren-ground caribou (*R. t. groenlandicus*) from the Qamanirjuaq herd, and forest-tundra woodland caribou (*R. t. caribou*) from the Pen Islands and Cape Churchill coastal caribou herds. Small numbers of caribou from the Qamanirjuaq herd occasionally migrate from Nunavut into the Keeyask region in winter, although large numbers (10,000) have been infrequently recorded (Keeyask Hydropower Limited Partnership [KHLP] 2012). Caribou from the Cape Churchill and Pen Islands herds migrate from northern Manitoba and northern Ontario into parts of the Keeyask region in winter and return to the Hudson Bay coast in spring to calve. Larger groups of Pen Islands caribou, numbering in the hundreds, have been observed in the Keeyask region on occasion, but there are generally fewer than about 50 individuals in a typical winter (KHLP 2012).

A fourth group of caribou occupies the Keeyask region in spring and summer (herein referred to as summer resident caribou). This group of caribou is known to calve on the islands in Gull and Stephens lakes and in peatland complexes comprised of treed islands (*i.e.*, raised areas of land) surrounded by expansive, treeless wetlands. These habitats (hereafter referred to as calving habitat) provide a physical barrier from the surrounding area and provide some protection from predators such as gray wolf (*Canis lupus*) and black bear (*Ursus americanus*). Summer resident caribou likely move within and beyond the Keeyask region, but their herd association and the extent of their core range are not certain. These caribou remain in the Keeyask region to calve, but it is unclear how many of the same individuals calve in the area in consecutive years. Research has indicated that at least four of the caribou that calve in the Keeyask region also migrate to the calving grounds in northern Ontario (Berglund *et al.* 2014).



The Project may affect the distribution of caribou and their use of calving habitat due to the loss or alteration of habitat, sensory disturbance, and changes to the predator community. Predicted Project effects on caribou included the loss or alteration of winter habitat and calving and rearing habitat, and a reduction in habitat intactness (the degree to which habitat remains unaltered by fire and human disturbances) in the Keeyask region. In addition to the loss of physical habitat, a loss of effective habitat due to sensory disturbance was anticipated. Noise generated by construction activity, blasting, and vehicle traffic may cause a loss of effective habitat (*i.e.*, the temporary avoidance of otherwise suitable habitat) near these disturbances. Effective habitat loss for summer resident caribou was predicted to occur within 2 km of the north and south access roads and within 4 km of the GS site (KHLP 2012).

Caribou are particularly vulnerable to sensory disturbance during the calving period and the loss of physical or effective calving habitat could result in reduced reproduction if calving habitat becomes limited. Calving habitat in the Keeyask region typically consists of islands in lakes and in peatland complexes, which comprise a relatively small proportion of available habitat on the landscape. Combined with the tendency of some caribou to calve solitarily and in low densities on the landscape, the presence of undisturbed calving habitat is critical for successful reproduction (Leclerc *et al.* 2014).

Habitat alteration may also affect the vulnerability of caribou calves and calving cows to predators such as gray wolf and black bear. Habitat alteration, including the clearing of land for trails and roads, may change or facilitate predator movement and can increase predation risk (James and Stuart-Smith 2000). Habitat alteration may also result in more alternative prey such as moose (*Alces alces*), potentially increasing the population of predators in the region and affecting caribou mortality and reproduction (James *et al.* 2004; Peters *et al.* 2012).

As part of the TEMP, caribou ground tracking and trail camera surveys began in 2015 to identify changes in caribou distribution near the Project due to sensory disturbance or to changes in the predator community. The distribution of moose, gray wolf, and black bear were also documented as indicators of predator and alternative prey activity. The timing of ice breakup on Stephens Lake was monitored using trail cameras as it can affect the use of islands in lakes by calving caribou. The trail camera surveys were continued in 2016 and the ground tracking surveys will continue in 2017. Sensory disturbance data from audio recorders and vehicle, manpower, and blasting data were not available at the time of writing this report; as such, only generalized findings are reported here.



2.0 METHODS

2.1 SURVEY METHODS

2.1.1 TRAIL CAMERAS

One hundred and sixty-four Reconyx[™] PM35C31 trail cameras were placed on 118 islands in lakes (Map 1) and on habitat islands in 34 peatland complexes (Map 2) on April 7 to 12, 2016. A single camera was deployed on most islands in lakes, and two to six cameras were placed on seven larger islands. Cameras were placed at 154 of the 158 locations surveyed in 2015 (Appendix A, Table A-1). Cameras were not replaced on islands that had been cleared or that were inaccessible due to conditions such as low water in 2016. Ten more cameras were deployed in 2016 than in the previous year, including five on islands in lakes and two in peatland complexes that were not surveyed in 2015. One additional camera was placed on each of three larger islands in lakes surveyed the previous year.

Cameras were placed where caribou activity would most likely be detected (*e.g.*, heavily used game trails, large openings). Batteries and memory cards were exchanged on June 20 to 25, and the cameras were removed on September 8 to 19. Photographs were reviewed by an observer, and the species, number, and age (adult or juvenile) of photographed animals were determined, where possible. A second observer reviewed the photographs to verify the information recorded.

2.1.2 TIMING OF ICE BREAKUP

Four trail cameras were placed on the shores of Stephens Lake on April 27 to 29, 2016 to monitor the timing of ice breakup (Map 3), which may influence the use of islands by caribou for calving. The trail cameras were set to take a picture of the lake every four hours during daylight hours. Ice coverage was estimated at 25% increments in each photograph from each camera. Ice breakup was defined as the date when all four cameras indicated 25% ice coverage or less in the photo view.







Map 1: Trail Cameras on Islands in Lakes: 2016



4



Map 2: Trail Cameras on Peatland Complexes: 2016









Camera 1



June 2017

3.0 RESULTS

3.1 TRAIL CAMERAS

3.1.1 ISLANDS IN LAKES

Large mammals (caribou, moose, or black bear) were documented on sixty-four of the islands surveyed were (Appendix A, Table A-2). No photos were available for five of the cameras, corresponding to five islands. Four of these cameras went missing and one took no photos; these islands were excluded from the results. Two cameras took no photos and were replaced with two cameras that were set to take a picture every four hours during daylight hours and were not triggered by the presence of animals. No large mammals were documented on these islands, which were also excluded from the analysis because the likelihood of photographing an animal was less than for the cameras that functioned with the correct settings. A total of seven cameras/islands was removed from the analysis of results.

Additionally, seven cameras malfunctioned before or after batteries and memory cards were exchanged in June; there were no photos on two cameras before the switch and none for five cameras after. The nine cameras that only functioned for part of the survey were included in the results, which were summarized for 123 cameras on 111 islands. It should be noted, however, that these cameras were less likely to photograph large mammals than cameras that functioned throughout the survey period.

Caribou were photographed on 17 islands over the survey period (Map 4). Caribou were only photographed on one island in May and September, but more frequently in June, July and August (Table 1). Caribou calves (Photo 1) were documented on six islands in lakes. The first calf was photographed June 19, and the last on September 10. Calving islands were all located and clustered near the north-central portion of Stephens Lake.

Moose were documented on 53 islands (Map 5). Moose were photographed throughout the survey period, with the most islands occupied in June and July. Moose calves (Photo 2) were photographed on 25 islands beginning May 29. A moose calf was last photographed on September 9. Calving islands were widely distributed on Stephens and Gull lakes.

Black bear were documented on seven islands over the survey period (Map 6). Black bears were photographed from May to August on relatively few islands each month. No gray wolves were documented on islands in lakes in 2016. No caribou calves were photographed on islands on which black bear (Photo 3) were also documented. Moose calves were photographed on four islands also occupied by black bear, with five to 62 days separating the nearest observations of the two species.



Species	April	Мау	June	July	August	September
Caribou	0	1	12	7	10	1
Caribou calves	0	0	3	2	3	1
Moose	1	7	39	29	10	4
Moose calves	0	1	11	11	3	1
Black Bear	0	3	1	2	3	0

Table 1:	lumber of Islands in Lakes on Which Large Mammals Were Photographe	d
	Nonthly, 2016	

The percentage of islands on which caribou were photographed more than doubled from 2015 to 2016 (Table 2). Caribou calves were documented on the same percentage of islands in 2015 and 2016. Moose, moose calves, and black bear were photographed on a greater percentage islands in 2016 than in the previous year. Gray wolves were photographed on a single island in 2015.

Table 2:	Percentage of Islands in Lakes on Which Large Mammals Were Photographed,
	2015 and 2016

Species	2015	2016	Percent Change
Caribou	7	15	+114
Caribou calves	5	5	0
Moose	42	50	+14
Moose calves	16	23	+44
Black bear	5	6	+20
Gray wolf	1	0	-100

Caribou, moose, and black bear were photographed on the same island only once (Map 7) over the survey period. On this island, moose was photographed in June, July, and September, while caribou and black bear were photographed in August, five days apart. Black bear and ungulates (either moose or caribou) occupied four of the same islands over the survey period, in one case on the same day (Table 3).

Table 3:Nearest Dates on Which Black Bear and Moose or Caribou Were Photographed
on the Same Islands in Lakes, 2016

Location	Black Bear	Moose	Caribou
KI124115	July 20	July 25	-
KI124193	July 25	July 26	-
KI122003	August 14	August 14	-
KI124210	August 19	September 1	August 14





Photo 1: Adult Female Caribou and Calf on an Island in Stephens Lake: August 8, 2016



Photo 2: Adult Female Moose and Calf on an Island in Stephens Lake: July 8, 2016



TERRESTRIAL EFFECTS MONITORING PLAN CARIBOU SENSORY DISTURBANCE MONITORING



Photo 3: Black Bear on an Island in the Nelson River: August 20, 2016











Map 5: Moose Photographed on Islands in Lakes: 2016











Map 7: Large Mammals Photographed on the Same Island in Lakes: 2016



3.1.2 PEATLAND COMPLEXES

Large mammals were photographed on 12 of the 34 habitat islands surveyed in peatland complexes (Appendix A, Table A-3) in 2016. Caribou were documented on four habitat islands, moose on five, and black bear on four (Map 8, Photo 4 to Photo 6). No gray wolves were photographed. No caribou were photographed until June (Table 4). Trail cameras documented more than one species on a single habitat island. Black bear was photographed May 29 and moose was photographed June 28 on the same island, with 29 days separating the observations. A caribou calf was photographed with a radio-collared adult female on one island in peatland complexes (Photo 7, see Map 8), on June 6, while no moose calves were photographed. It should be noted that five cameras malfunctioned after batteries and memory cards were exchanged; the photos from spring and early summer were included in the survey results above, and that the likelihood of large mammals being photographed on these habitat islands was reduced.

Species	April	Мау	June	July	August	September
Caribou	0	0	2	1	2	1
Caribou calves	0	0	1	0	0	0
Moose	0	3	3	0	2	1
Moose calves	0	0	0	0	0	0
Black bear	0	2	1	1	0	0

Table 4:	Number of Habitat Islands in Peatland Complexes on Which Large Mammals
	Were Photographed by Month, 2016

The percentage of habitat islands on which caribou, moose, and moose calves were photographed decreased from 2015 to 2016 (Table 5). Caribou calves were documented on the same percentage of habitat islands. Black bear were documented on a greater percentage of habitat islands in 2016 than the previous year. No gray wolves were photographed either year.

Table 5:Percentage of Habitat Islands in Peatland Complexes on Which LargeMammals Were Photographed, 2015 and 2016

Species	2015	2016	Percent Change
Caribou	13	12	-8
Caribou calves	3	3	0
Moose	25	15	-40
Moose calves	6	0	-100
Black bear	9	12	+33
Gray wolf	0	0	0





Photo 4: Adult Male Caribou in a Peatland Complex: September 8, 2016



Photo 5: Adult Male Moose in a Peatland Complex: June 1, 2016





Photo 6: Black Bear in a Peatland Complex: June 28, 2016



Note that the female at left is wearing a radio collar.

Photo 7: Adult Female Caribou and Calf in a Peatland Complex: June 6, 2016



TERRESTRIAL EFFECTS MONITORING PLAN CARIBOU SENSORY DISTURBANCE MONITORING



Map 8: Large Mammals Photographed on Habitat Islands in Peatland Complexes: 2016



3.2 TIMING OF ICE BREAKUP

The percentage of ice cover on Stephens Lake remained consistent from the time of camera installation, in late April, to early May (Table 6). From approximately mid-May on, the ice cover appeared to decrease rapidly. Ice breakup was May 20, and Stephens Lake was free of ice by May 22 (Photo 8 to Photo 12).

% Ice Cover	Camera 1	Camera 2	Camera 3	Camera 4
100	April 29	April 29	April 27	April 28
75	May 17	May 7	May 8	May 8
50	May 19	May 17	May 10	May 10
25	May 20	May 18	May 14	May 15
0	May 22	May 19	May 18	May 18

 Table 6:
 Timing of Ice Breakup on Stephens Lake, 2016



Photo 8: 100% Ice Cover on Stephens Lake: April 29, 2016





Photo 9: 75% Ice Cover on Stephens Lake: May 17, 2016



Photo 10: 50% Ice Cover on Stephens Lake: May 19, 2016



TERRESTRIAL EFFECTS MONITORING PLAN CARIBOU SENSORY DISTURBANCE MONITORING



Photo 11: 25% Ice Cover on Stephens Lake: May 20, 2016



Photo 12: No Ice Cover on Stephens Lake: May 22, 2016



% Ice Cover	Camera 1	Camera 2	Camera 3	Camera 4
100	May 11	May 11	May 12	May 9
75	May 25	May 27	May 20	May 24
50	June 1	May 31	May 23	May 25
25	June 2	June 2	June 1	May 25
0	June 3	June 3	June 2	May 26

Table 7:Timing of Ice Breakup on Stephens Lake, 2015



4.0 SUMMARY AND CONCLUSIONS

Caribou, moose, and their calves were relatively common on islands throughout Gull and Stephens lakes in 2016. Black bears were less common on these islands, and no gray wolves were photographed.

The specific timing of summer resident caribou calving in the area is uncertain, but likely occurs from May 1 to June 30, based on data collected on calving caribou in Stephens Lake from 2010 to 2014 and from studies on boreal woodland caribou (*R. t. caribou*) at roughly the same latitude (Rettie and Messier 2001; Ferguson and Elkie 2004). Caribou cows may avoid islands if there is ice on the lakes during the calving period. In 2016, ice breakup on Stephens Lake was in late May, overlapping the general calving period and earlier than the time of the first caribou calf photograph (June 19). It is also interesting to note that caribou detections in 2016 more than doubled on islands in lakes when ice breakup was 12 days earlier, as compared to 2015, while caribou detections in peatland complexes remained nearly the same. The occupancy of only one island by both caribou and black bear was documented, and no gray wolves were detected by trail cameras. Islands in lakes likely provided caribou and their calves with some protection from predators during the calving and calf-rearing period.

The percentage of islands in lakes on which caribou and their calves were photographed declined during the pre-construction period (2010 to 2014), ranging from 64% in 2010 to 29% in 2014 for caribou, and from 64% in 2010 to 8% in 2014 for calves (Keeyask Generation Project Terrestrial Environment Supporting Volume; WRCS unpubl. data). The percentage of islands in lakes where caribou were photographed in 2015 followed this declining trend (with 7% for caribou and 5% for calves). In 2016, the percentage of islands on which caribou were photographed from 2015. There was no change in the percentage of islands on which calves were photographed from 2015 to 2016.

As predicted in the EIS, no caribou or calves were documented on the islands nearest the areas under construction in 2016, including some islands on which their presence was observed in 2015. Caribou were mainly distributed on islands in the north-central portion of Stephens Lake in 2016. While the spring and summer distribution of caribou in Gull and Stephens lakes can vary from year to year, the potentially unoccupied islands nearest the Project site may indicate an avoidance of construction-related sensory disturbances. It should be noted, however, that trail cameras can document animals' presence in a limited area but not their absence; as such, it cannot be known for certain that there were no caribou on the islands.

Moose were somewhat more widely distributed on islands in lakes than caribou in 2016 and occupied islands nearer to the construction areas. Moose occupied more islands in 2016 than in the previous year. The percentage of surveyed islands on which moose were photographed varied during the pre-construction and construction periods, ranging from 68% in 2010 to 21% in 2013, before construction began. Similarly, the percentage of surveyed islands on which moose calves were observed ranged from 39% in 2010 to 13% in 2013, before construction began. It



should be noted that trail cameras cannot document animals' absence, so it cannot be known for certain that there were no moose on the islands.

Black bears occupied more islands in lakes in 2016 than in the previous year. The extent of predator influence on the caribou population is unknown in the Keeyask region; however, the relatively small number of islands with both predators and caribou or moose documented suggests that it is likely minor.

Black bears were photographed in relatively few peatland complexes, with very little spatial overlap with moose and none with caribou. The percentage of habitat islands on which caribou and moose were photographed decreased from 2015 to 2016. Black bears occupied a slightly greater percentage of habitat islands in 2016 than the previous year. No gray wolves were photographed in either year.

Overall, caribou and moose were relatively common on islands in lakes and in peatland complexes in 2016. Moose and caribou calves were less abundant than adults, and caribou calves in particular were less widely distributed. Future monitoring will continue to explore the influence of predators on calving caribou and moose in the Keeyask region. Ground tracking surveys, which cover a larger area, will be combined with trail camera surveys for a broader indication of the presence of large mammals in the Keeyask region from the pre-construction to construction period. Future surveys will provide a more robust dataset, which can be analysed using multiple variables and provide a more thorough understanding of the factors affecting habitat use by caribou and other large mammals.



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APPENDIX A: TABLES



	Islands in Lak	es	Islands in Peatland Complexes			
Location	Number of Cameras 2016	Number of Cameras 2015	Location	Number of Cameras 2016	Number of Cameras 2015	
KI122001	1	1	KV005814	1	0	
KI122003	1	1	KV006602	1	0	
KI122005	1	1	KV022002	1	1	
KI122006	1	1	KV023001	1	1	
KI123005	1	1	KV036016	1	1	
KI123008	1	1	KV037003	1	1	
KI123010	1	1	KV038008	1	1	
KI123012	2	2	KV039001	1	1	
KI124003	1	1	KV044001	1	1	
KI124004	1	1	KV047001	1	1	
KI124005	1	1	KV050006	1	1	
KI124007	1	1	KV058014	1	1	
KI124009	1	1	KV061003	1	1	
KI124010	1	1	KV062001	1	1	
KI124013	1	1	KV063005	1	1	
KI124015	1	1	KV066002	1	1	
KI124016	1	1	KV069005	1	1	
KI124017	1	1	KV071001	1	1	
KI124018	1	1	KV094002	1	1	
KI124019	1	1	KV097002	1	1	
KI124020	1	1	KV098001	1	1	
KI124022	1	1	KV101005	1	1	
KI124024	1	1	KV102002	1	1	
KI124026	1	1	KV103001	1	1	
KI124029	1	1	KV107007	1	1	
KI124030	1	1	KV113005	1	1	
KI124035	1	1	KV116001	1	1	
KI124037	1	1	KV119005	1	1	
KI124038	1	1	KV120001	1	1	
KI124040	1	1	KV121001	1	1	
KI124041	1	1	KV122001	1	1	
KI124042	1	1	KV123001	1	1	
KI124043	1	1	KV124001	1	1	
KI124044	1	1	KV597000	1	1	
KI124045	1	1	-			
KI124046	1	1				
KI124047	1	1				
KI124050	1	1				

Table A-1: Trail Cameras on Islands in Lakes and in Peatland Complexes, 2016 and 2015



Islands in Lakes			Islands in Peatland Complexes			
Location	Number of Cameras 2016	Number of Cameras 2015	Location	Number of Cameras 2016	Number of Cameras 2015	
KI124051	1	0				
KI124052	1	1				
KI124053	1	1				
KI124055	1	1				
KI124056	1	1				
KI124057	1	1				
KI124058	1	1				
KI124060	1	1				
KI124063	1	1				
KI124065	1	1				
KI124066	2	2				
KI124069	1	1				
KI124070	1	1				
KI124072	1	1				
KI124075	1	1				
KI124077	1	0				
KI124079	1	1				
KI124080	1	0				
KI124082	1	1				
KI124083	0	1				
KI124086	1	1				
KI124088	1	1				
KI124089	1	1				
KI124090	1	1				
KI124091	1	1				
KI124092	2	2				
KI124094	1	1				
KI124096	1	1				
KI124097	1	1				
KI124102	1	1				
KI124103	1	1				
KI124105	1	1				
KI124111	1	1				
KI124113	1	0				
KI124115	2	1				
KI124117	1	1				
KI124120	1	1				
KI124124	1	1				
KI124125	1	1				



Islands in Lakes			Islands in Peatland Complexes			
Location	Number of Cameras 2016	Number of Cameras 2015	Location	Number of Cameras 2016	Number of Cameras 2015	
KI124128	1	1				
KI124129	1	1				
KI124131	1	0				
KI124133	1	1				
KI124136	1	1				
KI124141	1	1				
KI124145	1	1				
KI124146	1	1				
KI124147	1	1				
KI124151	1	1				
KI124152	1	1				
KI124153	1	1				
KI124155	1	1				
KI124156	1	1				
KI124158	1	1				
KI124162	1	1				
KI124164	1	1				
KI124165	1	1				
KI124166	1	1				
KI124167	1	1				
KI124170	1	1				
KI124173	1	1				
KI124176	1	1				
KI124178	1	1				
KI124180	3	2				
KI124182	1	1				
KI124186	6	4				
KI124192	1	1				
KI124193	1	1				
KI124194	1	1				
KI124196	1	1				
KI124197	1	1				
KI124202	1	1				
KI124205	2	1				
KI124206	1	1				
KI124209	1	1				
KI124210	1	1				
KI124212	1	1				
KI124214	1	1				



	Islands in Lake	es	Islands in Peatland Complexes			
Location	Number of Cameras 2016	Number of Cameras 2015	Location	Number of Cameras 2016	Number of Cameras 2015	
KI124217	1	1				
KI124227	0	1				
KI126017	0	1				
KI126016	1	1				
KI126020	1	1				



	Cari	ibou1	Мо	ose	Black	Bear	Gray	Wolf
Location	2016	2015	2016	2015	2016	2015	2016	2015
KI122001								
KI122003			✓	✓	✓	✓		
KI122005		\checkmark						
KI122006			\checkmark					
KI123005	Х		Х		Х		Х	
KI123008	Х		Х		Х		Х	
KI123010			\checkmark	\checkmark				
KI123012	\checkmark	\checkmark	\checkmark	\checkmark				
KI124003								
KI124004	Х		Х		Х		Х	
KI124005								
KI124007								
KI124009								
KI124010								
KI124013			\checkmark					
KI124015								
KI124016					\checkmark			
KI124017		\checkmark	\checkmark	\checkmark				
KI124018		\checkmark	✓	\checkmark				
KI124019			\checkmark					
KI124020								
KI124022			✓					
KI124024								
KI124026			\checkmark					
KI124029					\checkmark	\checkmark		
KI124030			\checkmark	\checkmark				
KI124035 ²				\checkmark				
KI124037								
KI124038			✓	\checkmark				
KI124040			✓	\checkmark				
KI124041								
KI124042								
KI124043		\checkmark						
KI124044				\checkmark				
KI124045		\checkmark						
KI124046		\checkmark						
KI124047			\checkmark	\checkmark				
KI124050			\checkmark					
KI124051		_	✓	_		_		_

Table A-2:Large Mammals Photographed on Islands in Lakes, 2016 and 2015



	Cari	ibou1	Мо	ose	Black	Bear	Gray	Wolf
Location	2016	2015	2016	2015	2016	2015	2016	2015
KI124052				✓				
KI124053								
KI124055			\checkmark	✓				
KI124056			✓	✓				
KI124057			\checkmark	✓				
KI124058			✓	✓				
KI124060			✓	✓				
KI124063			✓					
KI124065			✓	✓				
KI124066								
KI124069								
KI124070								
KI124072			√	✓				
KI124075 ²								
KI124077		_	\checkmark	_		_		_
KI124079			\checkmark					
KI124080		_		_		_		_
KI124082				\checkmark				
KI124083	_		_	\checkmark	_		_	
KI124086			\checkmark	\checkmark				
KI124088			\checkmark	\checkmark				
KI124089 ²								
KI124090 ²				\checkmark				
KI124091	\checkmark		\checkmark	\checkmark				
KI124092 ³			\checkmark	\checkmark				
KI124094			✓					
KI124096			✓	✓				
KI124097								
KI124102								
KI124103						✓		
KI124105				✓				
KI124111			✓					
KI124113	✓	_	✓	_		_		_
KI124115 ³			✓	✓	✓			
KI124117			✓	✓				
KI124120	✓		✓	✓				
KI124124			✓	✓				
KI124125	Х		Х		Х		Х	
KI124128	√	✓						
KI124129	~		✓	✓				



	Car	ibou1	Mo	ose	Black	Bear	Gray	Wolf
Location	2016	2015	2016	2015	2016	2015	2016	2015
KI124131		_		_		_		_
KI124133			\checkmark					
KI124136	\checkmark	\checkmark						
KI124141								
KI124145				\checkmark				
KI124146			\checkmark	\checkmark				
KI124147	\checkmark							
KI124151	\checkmark	\checkmark		✓				
KI124152	х		х	\checkmark	х		х	
KI124153								
KI124155			\checkmark					
KI124156 ²								
KI124158			\checkmark	✓				
KI124162	\checkmark		\checkmark			\checkmark		
KI124164						\checkmark		
KI124165			\checkmark					
KI124166			\checkmark	✓				
KI124167								
KI124170			\checkmark					
KI124173	\checkmark	\checkmark		\checkmark				
KI124176	\checkmark							
KI124178				✓				
KI124180 ³				\checkmark				
KI124182	\checkmark	\checkmark	\checkmark					
KI124186	\checkmark	\checkmark	\checkmark					
KI124192	\checkmark		\checkmark	\checkmark				
KI124193			\checkmark	\checkmark	\checkmark			
KI124194	х	\checkmark	х	\checkmark	х		х	
KI124196	\checkmark	\checkmark						
KI124197						\checkmark		
KI124202				\checkmark				
KI124205								
KI124206					✓			
KI124209			\checkmark					
KI124210	\checkmark		\checkmark		\checkmark			
KI124212 ⁴		\checkmark		\checkmark				
KI124214			\checkmark	✓				
KI124217								
KI124227	_		_		_		_	
KI126017	_		_		_		_	



	Cari	ibou1	Мо	ose	Black	Bear	Gray	Wolf
Location	2016	2015	2016	2015	2016	2015	2016	2015
KI126016	Х		Х		Х		Х	\checkmark
KI126020								

1. ✓ Species documented; – No camera set up; X Camera missing/malfunctioned in 2016; x Camera malfunctioned, replaced with incorrectly set camera in 2016.

2. Single camera on island functioned normally during part of the 2016 survey.

3. One camera on island functioned normally during part of the 2016 survey; other camera(s)on same island functioned normally.



	Cari	bou ¹	Мо	ose	Black	Bear
Location	2016	2015	2016	2015	2016	2015
KV005814		_		_		_
KV006602	✓	_		_		_
KV022002					✓	
KV023001				\checkmark		
KV036016						
KV037003						
KV038008						
KV039001						
KV044001						
KV047001 ²			\checkmark	\checkmark	\checkmark	
KV050006	\checkmark			\checkmark		
KV058014				\checkmark		
KV061003					✓	
KV062001 ²						✓
KV063005			\checkmark	\checkmark		
KV066002		\checkmark				
KV069005	\checkmark					
KV071001						
KV094002						
KV097002		✓				
KV098001						
KV101005		\checkmark				
KV102002 ²						
KV103001 ²						
KV107007						
KV113005		\checkmark				
KV116001			\checkmark	\checkmark		
KV119005			\checkmark			
KV120001 ²					\checkmark	\checkmark
KV121001				\checkmark		
KV122001						
KV123001			\checkmark	✓		
KV124001						\checkmark
KV597000						
1 √ Specie	s documented – N	lo camera set un				

Table A-3:	Large Mammals	Photographed in	Peatland Complexes	, 2016 and 2015
1401071.01	Eargo marman	i notogi apnoa n	i i outiuna oompiokoe	

1. ✓ Species documented – No camera set up

2. Camera malfunctioned during part of the 2016 survey.

