



Keeyask Generation Project Terrestrial Effects Monitoring Plan

Caribou Sensory Disturbance Monitoring Report

TEMP-2020-10



KEEYASK GENERATION PROJECT

TERRESTRIAL EFFECTS MONITORING PLAN

REPORT #TEMP-2020-10

CARIBOU SENSORY DISTURBANCE MONITORING 2019

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 more needs to be done to reduce harmful effects.

The ranges of three migratory caribou herds extend into the Keeyask region: the Qamanirjuaq herd (Barren-ground caribou) and the Southern Hudson Bay (formerly called Pen Islands) and Cape Churchill herds (both Eastern Migratory caribou; formerly called forest-tundra or coastal caribou). Groups from these herds occasionally overwinter in the Keeyask region and leave in spring to calve. The Southern Hudson Bay caribou migrated through the Keeyask region in large numbers in early 2018 and 2019 and in smaller numbers in early 2020.

A small number of caribou occupy the Keeyask region in spring and summer (referred to as summer resident caribou) and are known to calve on the islands in Gull and Stephens lakes and in mainland peatland complexes (raised treed patches surrounded by low, wet areas, which essentially act as islands). Summer resident caribou move within and likely beyond the Keeyask region in the winter months, but the extent of their core range is unknown. These caribou remain in the Keeyask region to calve, but it is unclear whether the same individuals calve in the area in consecutive years.

Predicted Project effects on summer resident caribou in the Keeyask region include the loss of physical habitat from clearing and development (less than 1% of available habitat in the surrounding region) and the effective loss of habitat due to sensory disturbance (e.g., noise and light from construction activities). Caribou may temporarily avoid or less frequently use 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 the operation phase. Caribou movement patterns in and through the Keeyask region could also be affected by the Project.

This report focuses on caribou sensory disturbance monitoring carried out in 2019.

Why is the study being done?

Caribou calving on islands in lakes and in mainland habitat near the Project may be affected by 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 the Project during construction and operation. At the same time, 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.

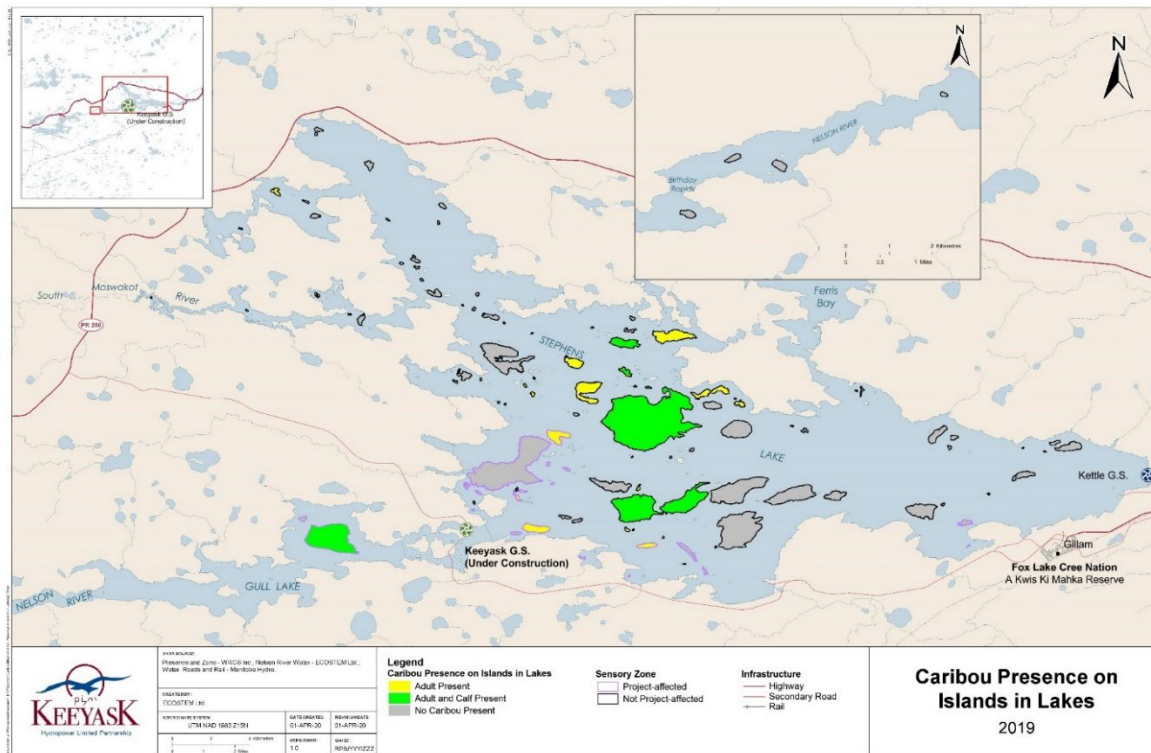
One hundred fifty-eight trail cameras were used to gather information on caribou (and other large mammal) use of islands in lakes and mainland habitat from April to September 2019. These habitats are known to be used by caribou during the calving and calf-rearing period, when caribou are sensitive to disturbance. Camera locations were in both Project-affected areas (close to Project components, including permanent infrastructure, access roads, and the future reservoir area), and in areas not expected to be affected by the Project.

The timing of ice breakup on Gull and Stephens lakes was also monitored using trail cameras deployed along the shorelines, to see how it corresponds with the use of the islands in the lakes by caribou.



Caribou were photographed on 23% of the islands in lakes surveyed in 2019. Five percent of the islands were also occupied by calves. The percentage of islands on which caribou were photographed declined from the pre-construction (2010–2014) to early construction (2015–2016) periods and then increased slightly from 2017 to 2019. Despite the increase during the later

construction period, caribou were observed on a smaller percentage of islands throughout the construction period than during all pre-construction years. As predicted in the EIS, many Project-affected islands (i.e., those near the Project construction areas) appeared to be unoccupied by caribou in 2019. However, there was also typically less caribou activity on these islands than on unaffected islands (i.e., those further away from Project construction areas) during the pre-construction survey years. Moose were also common throughout the region.



Caribou photographed in a mainland habitat area in 2019

Caribou were photographed in 13% of all surveyed mainland habitat areas, none of which were occupied by calves. Caribou activity was found in the smallest percentage of Project-affected mainland habitats. Caribou occupied more unburned than burned habitats.



Moose cow photographed on an island in the Nelson River in June 2019

The percentage of ice cover on Stephens Lake remained consistent from April until mid- to late May and then decreased rapidly. Ice breakup was on May 23 and Stephens Lake was free of ice by May 25. Ice breakup was May 22 on Gull Lake, with no ice remaining on May 25.

What does it mean?

While the spring and summer distribution of caribou in Gull and Stephens lakes can vary from year to year, the potentially unoccupied islands near the Project site may indicate avoidance of habitat by some individuals due to construction-related sensory disturbances. However, some Project-affected islands continued to be occupied by caribou. As caribou can eventually get used to human disturbance, some animals may have been less affected by ongoing construction activity than others.

Caribou activity was found in fewer Project-affected mainland habitats than in unaffected habitats and in more unburned than burned habitats. Caribou tend to avoid forest that is less than 50 years old but may pass through regenerating forest to get from one patch of more suitable habitat to another. Caribou may also use recently burned habitat in summer, when they eat young, green vegetation.

What will be done next?

Monitoring will continue in 2020. Information from this caribou monitoring study will be provided to the Keeyask Caribou Coordination Committee (KCCC) to support the Partnership's monitoring activities and collaborate, if requested, on the development of broader common research goals

and perspectives with Manitoba Hydro, Manitoba Conservation and Climate, and local stakeholders.

A multi-year construction monitoring synthesis report will provide an integrated evaluation of Project effects on caribou distribution and abundance, the availability of suitable habitat, and habitat effectiveness using results from this monitoring study as well as relevant information from other caribou monitoring programs for the Project.

STUDY TEAM

We would like to thank Sherrie Mason and Rachel Boone of Manitoba Hydro and Ron Bretecher of North/South Consultants Inc. for logistical assistance in the field. We would also like to thank James Ehnes of ECOSTEM Ltd. for GIS support and mapping. Biologists and other personnel who designed, participated in, and drafted the survey results included:

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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 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, the use of calving and calf-rearing habitat in the Keeyask region by caribou (*Rangifer tarandus*) during Project construction.

As described in the EIS, 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. Small groups of barren-ground caribou from the Qamanirjuaq herd will occasionally migrate from Nunavut into the Keeyask region in winter, although large numbers (10,000) have been recorded infrequently (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).

Forest-tundra caribou have most recently been referred to as the Eastern Migratory population, and the Pen Islands herd is now called the Southern Hudson Bay subpopulation (Committee on the Status of Endangered Wildlife in Canada [COSEWIC] 2017). In April 2017, the Eastern Migratory population, which includes the Southern Hudson Bay and Cape Churchill subpopulations, was designated as Endangered by COSEWIC, mainly due to the decline in two subpopulations in Quebec and Labrador (COSEWIC 2017). The Barren-ground caribou population was designated as Threatened by COSEWIC in 2016, as many of its subpopulations are in decline, including the Qamanirjuaq (COSEWIC 2016). Neither population is currently protected under the federal *Species at Risk Act* or *The Endangered Species and Ecosystems Act* of Manitoba.

A small number of caribou occupy the Keeyask region in spring and summer (herein referred to as summer resident caribou). These caribou are known to calve on the islands in Gull and Stephens lakes and in peatland complexes composed of treed islands – raised areas of mainland habitat – surrounded by expansive, treeless wetlands. These islands in lakes and in peatland

complexes (collectively referred to as calving habitat hereafter) are provided a physical barrier by the surrounding habitat and offer some protection from predators such as gray wolf (*Canis lupus*) and black bear (*Ursus americanus*). Summer resident caribou move within and likely beyond the Keeyask region, but their herd association and the extent of their core range are uncertain. While these caribou remain in the Keeyask region to calve, it is unclear whether the same individuals calve in the area in consecutive years. Genetic analysis of fecal samples collected in the region during construction monitoring showed that at least one female occupied islands in Stephens Lake over two consecutive summers (Wildlife Resource Consulting Services MB Inc. [WRCS] 2018a); however, it is unknown if she calved.

The Project may affect the distribution of caribou and their use of calving habitat due to habitat loss and alteration, sensory disturbance, and changes in the predator community. Predicted Project effects on caribou included the loss or alteration of winter and calving habitat and a reduction in habitat intactness (i.e., 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 Project-related loss of effective habitat due to sensory disturbance was anticipated. Caribou are particularly vulnerable to sensory disturbance during the calving period. Reproduction could be reduced if calving habitat, which comprises a relatively small proportion of the Keeyask region, becomes limited. Noise generated by construction activity, blasting, and vehicle traffic may result in caribou temporarily avoiding otherwise suitable habitat near these disturbances. This loss of effective habitat for summer resident caribou is predicted to occur within 4 km of the Project construction site and within 2 km of the north and south access roads (KHLP 2012). Because caribou tend 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 cows and calves to gray wolves and black bears. Habitat alteration, including land clearing for trails and roads, may change or facilitate predator movements and can increase predation risk (James and Stuart-Smith 2000). Habitat alteration may also result in increased populations of alternative prey such as moose (*Alces alces*), which could increase the predator population, potentially affecting caribou mortality and reproduction (James et al. 2004; Peters et al. 2012).

As part of the TEMP, trail camera surveys were conducted to monitor changes in the distribution and relative abundance of caribou near the Project due to sensory disturbance or to changes in the predator community. The distribution and relative abundance of moose, black bear, and gray wolf were also documented to estimate the amount of alternative prey and predator activity in the region.

2.0 METHODS

Trail camera surveys that have been conducted annually since 2015 continued in 2019 to gather information on the use of islands in lakes and peatland complexes by caribou and three other large mammal species. Moose were included in the surveys as they are a potential attractant for wolves, which could opportunistically prey on caribou. Black bears and gray wolves were included as they are common predators of adult caribou and calves and can influence their use of habitat. Islands in lakes and peatland complexes were surveyed as these habitats are known to support caribou during the sensitive calving and calf-rearing period.

One hundred fifty-eight cameras were set up from April 2 to 8, 2019, in areas where caribou activity would most likely be detected (e.g., heavily used game trails, large openings). Batteries and memory cards were exchanged between June 27 and July 18, and the cameras were removed from September 18 to 22. 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 ISLANDS IN LAKES

One hundred and twenty-six Reconyx™ PM35C31 trail cameras were placed on 115 islands in Gull and Stephens lakes and upstream in the Nelson River (Map 1; Appendix A, Table A-1). Islands greater than 5 hectares (ha) in size and with more than 5% tree cover were selected and were classified by their distance to Project-related disturbance. Those within 2 kilometres (km) of borrow areas or Project infrastructure or within 4 km of the generating station construction site were “Project-affected” and those beyond were “unaffected” (KHLP 2015). Twenty-five Project-affected and 90 unaffected islands were surveyed. A single camera was deployed on most islands, and two to six cameras were placed on seven larger islands. No cameras were placed on islands that had been cleared of vegetation during the Project’s reservoir clearing program.

2.2 PEATLAND COMPLEXES

Trail cameras were placed on raised mainland habitat “islands” within a wet bog matrix. Peatland complexes were selected and categorized by their distance to a disturbance source. Project-affected peatland complexes were within 4 km of the Project construction site or within 2 km of the north or south access roads, and where disturbance was caused only by these features (KHLP 2015). For each Project-affected peatland complex, a reference peatland complex similar in size and with similar habitat characteristics but not affected by sensory disturbance (i.e., more than 4 km from the Project construction site and more than 2 km from an access road) was selected. Random peatland complexes were selected randomly from undisturbed areas to act as a

reference for natural variability. The state of Project-affected, reference, and random peatland complexes relative to the forest fires in 2013 (burned or unburned) was also identified.

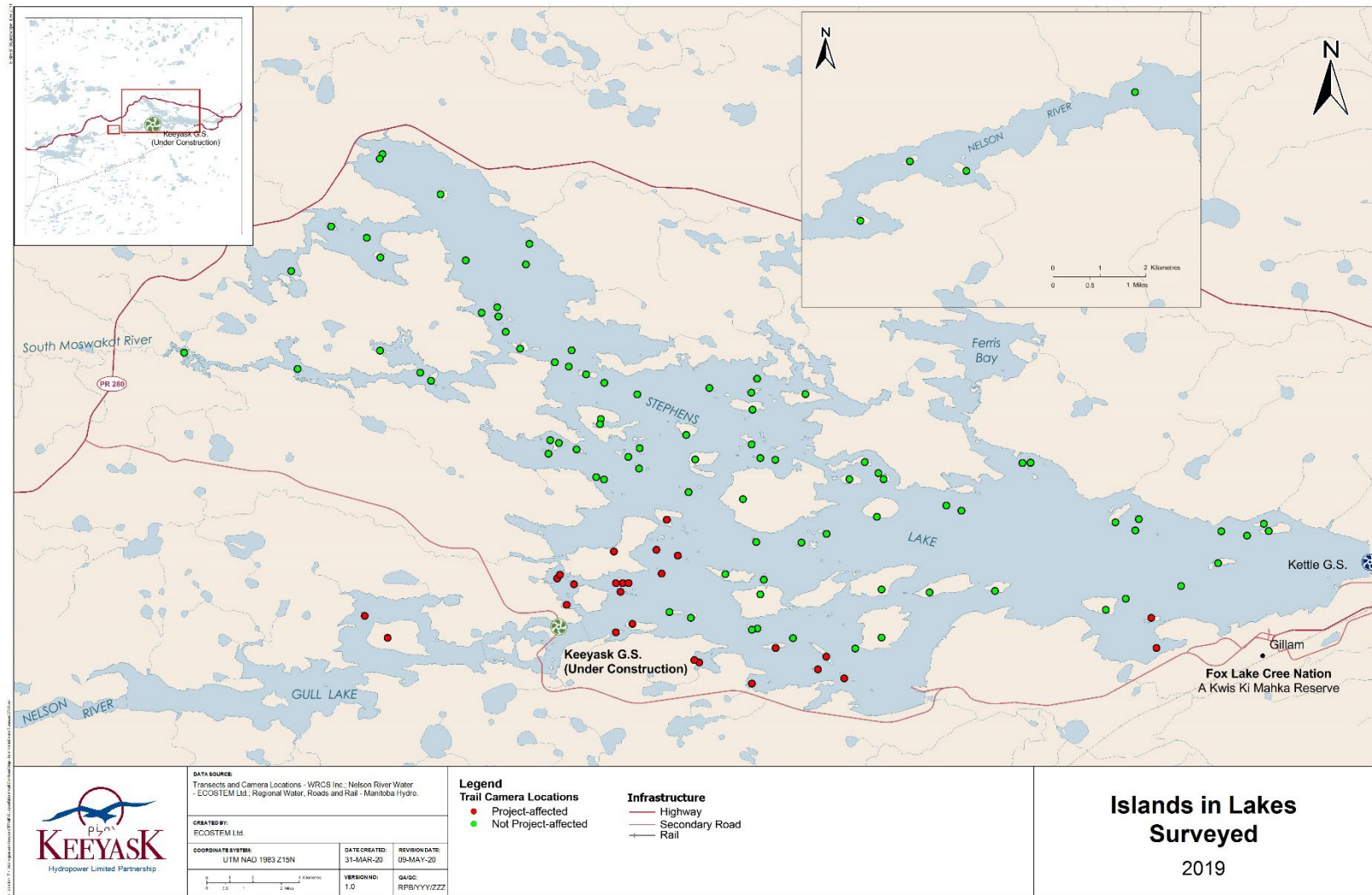
A Reconyx™ PM35C31 trail camera was placed on one habitat island in each of 32 peatland complexes (Map 2; Appendix A, Table A-2). Eleven cameras were placed in Project-affected complexes, 12 in reference complexes, and 9 in random complexes (Table 1).

Table 1: Trail Cameras in Peatland Complexes, 2019

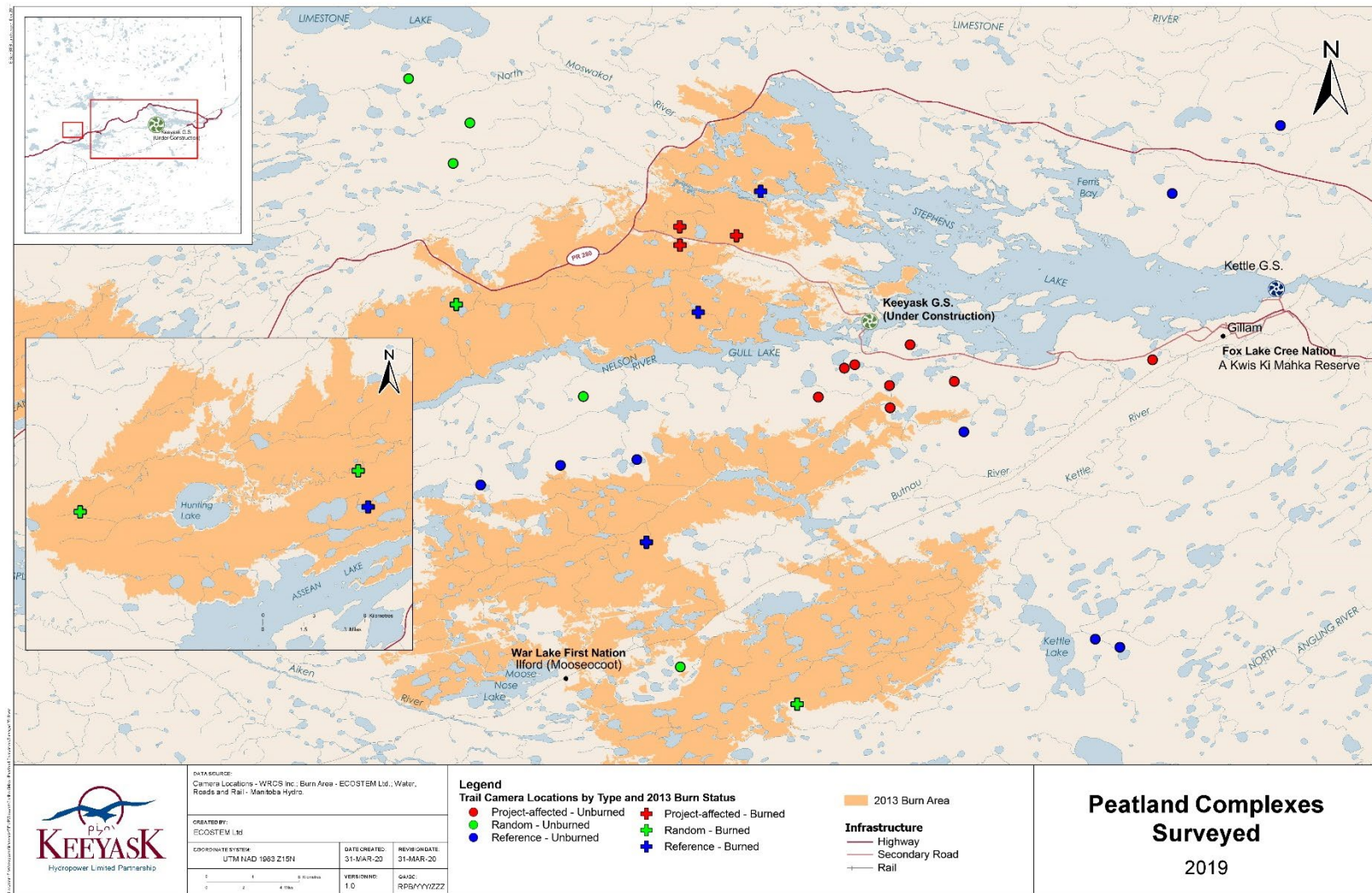
Complex Type	Burned in 2013	Number of Cameras
Project-affected	Yes	3
	No	8
	<i>Total</i>	<i>11</i>
Reference	Yes	4
	No	8
	<i>Total</i>	<i>12</i>
Random	Yes	4
	No	5
	<i>Total</i>	<i>9</i>
All		32

2.3 TIMING OF ICE BREAKUP

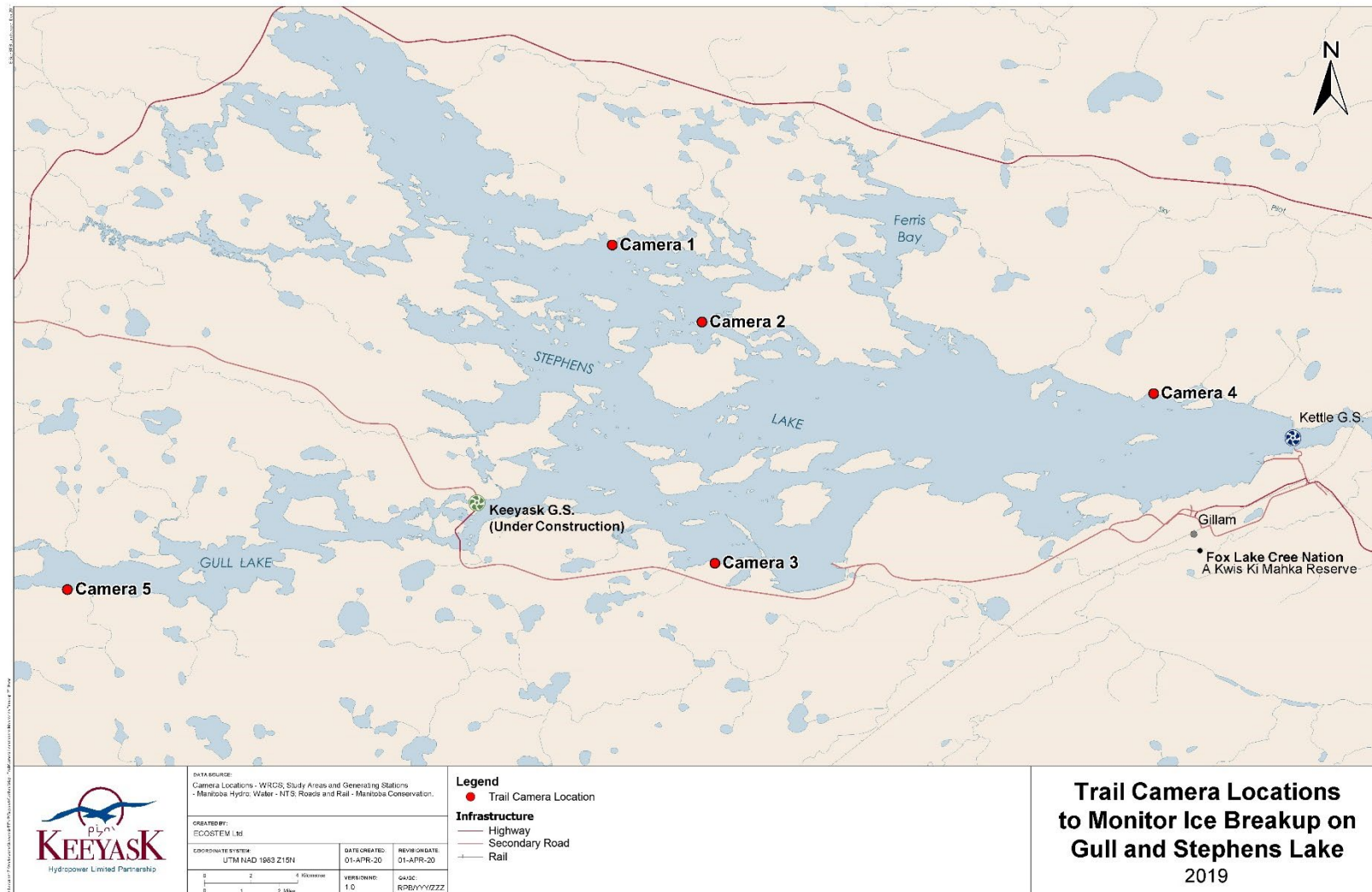
Four Reconyx™ PM35C31 trail cameras were placed on the shores of Stephens Lake and one was placed on the shore of Gull Lake on April 4 and 6, 2019 to monitor the timing of ice breakup (Map 3). The trail cameras were set to take a picture of the lake every four hours during daylight hours. Ice coverage was estimated at 25% increments in each photograph from each camera. Ice breakup was defined as the date when all cameras indicated less than 25% ice coverage in view.



Map 1: Islands in Lakes Surveyed in 2019



Map 2: Peatland Complexes Surveyed in 2019



Map 3: Trail Camera Locations to Monitor Ice Breakup on Gull and Stephens Lakes, 2019

3.0 RESULTS

3.1 ISLANDS IN LAKES

Caribou were photographed on islands in lakes from May to September in 2019 (Table 2). The first caribou was photographed on May 24 and the first calf was photographed on June 20 (see Photo 1 for a caribou and calf). In previous survey years caribou calves were first photographed on May 25, 2015; June 19, 2016; June 6, 2017; and May 21, 2018. Moose were photographed throughout the 2019 survey period. The first moose calf (see Photo 2 for a moose cow and calf) was photographed on June 9, 2019. In previous survey years moose calves were first photographed on June 3, 2015; May 29, 2016; May 31, 2017; and June 12, 2018. The number of islands occupied by caribou and moose appeared to peak in July and then declined in August and September. Black bear and gray wolf were photographed sporadically throughout the survey period (see Photo 3 for a black bear and cubs).

Caribou, moose, and black bear were all photographed on the same island (Table 3; Map 4). Black bear was observed approximately two months earlier than the other two species. Caribou and moose were both photographed on five other islands, in one instance on the same day. Moose were photographed on one other island with black bear and on one island with gray wolf, on the same day.

Table 2: Number of Islands in Lakes Occupied by Large Mammals Monthly from Trail Camera Data, 2019

Species	April	May	June	July	August	September	All
Caribou	0	3	13	14	10	4	26
Caribou calf	0	0	1	4	4	1	6
Moose	2	4	16	18	12	2	36
Moose calf	0	0	7	5	1	0	12
Black bear	0	2	1	0	2	0	4
Gray wolf	1	0	0	1	0	0	2

Table 3: Nearest Dates on Which Large Mammals Were Photographed on the Same Islands in Lakes, 2019

Island	Caribou	Moose	Black Bear	Gray Wolf
KI124029	July 29	July 27	May 31	–
KI124030	July 12	July 12	–	–
KI124035	June 12	Aug. 4	–	–
KI124047	–	Aug. 2	Aug. 11	–
KI124092	–	July 4	–	July 4
KI224145	May 29	July 2	–	–
KI124182	Aug. 2	July 30	–	–
KI124193	Aug. 1	Aug. 27	–	–

**Photo 1: Caribou Cow and Calf on an Island in Gull Lake on July 7, 2019**



Photo 2: Moose Cow on an Island in the Nelson River on June 22, 2019



Photo 3: Black Bear and Cubs on an Island in Stephens Lake on May 31, 2019

Caribou were photographed on 26 (23%) of the islands surveyed in 2019 (Table 4; Map 5). Caribou and calves occupied similar percentages of Project-affected and unaffected islands. Moose were the most widely distributed large mammal, photographed on 36 (31%) of the islands surveyed (Map 6). Moose and calves were observed on similar percentages of Project-affected and unaffected islands. Little black bear and gray wolf activity was photographed on islands in lakes (see Map 4). Each species was observed on Project-affected and unaffected islands.

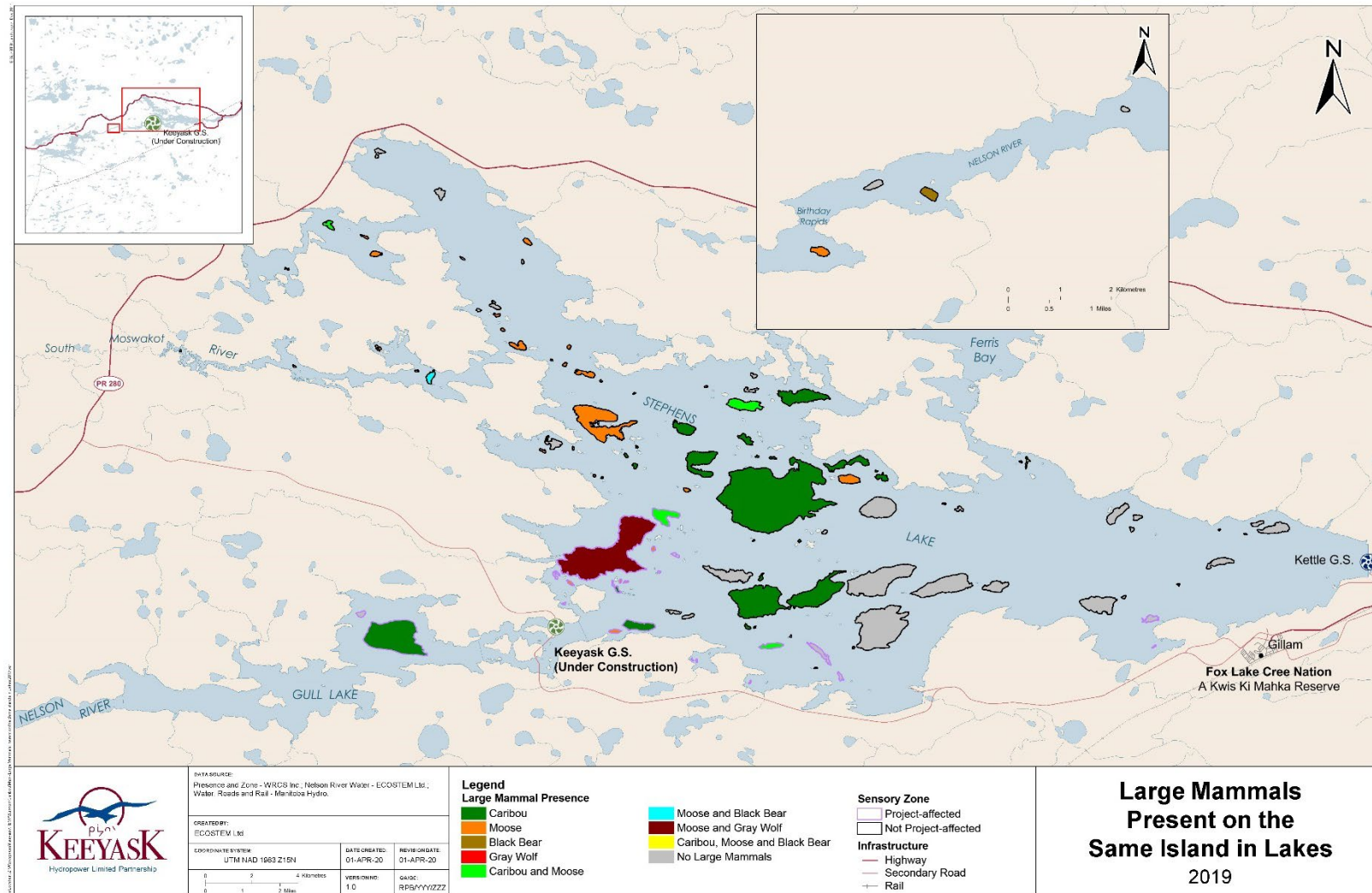
Table 4: Project-affected and Unaffected Islands in Lakes Occupied by Large Mammals, 2019

Species	Project-affected Islands		Unaffected Islands		All Islands	
	Number Occupied	Percentage Occupied	Number Occupied	Percentage Occupied	Number Occupied	Percentage Occupied
Caribou	5	20	21	23	26	23
Caribou calf	1	4	5	6	6	5
Moose	8	32	28	31	36	31
Moose calf	3	12	9	10	12	10
Black bear	1	4	3	3	4	3
Gray wolf	1	4	1	1	2	2

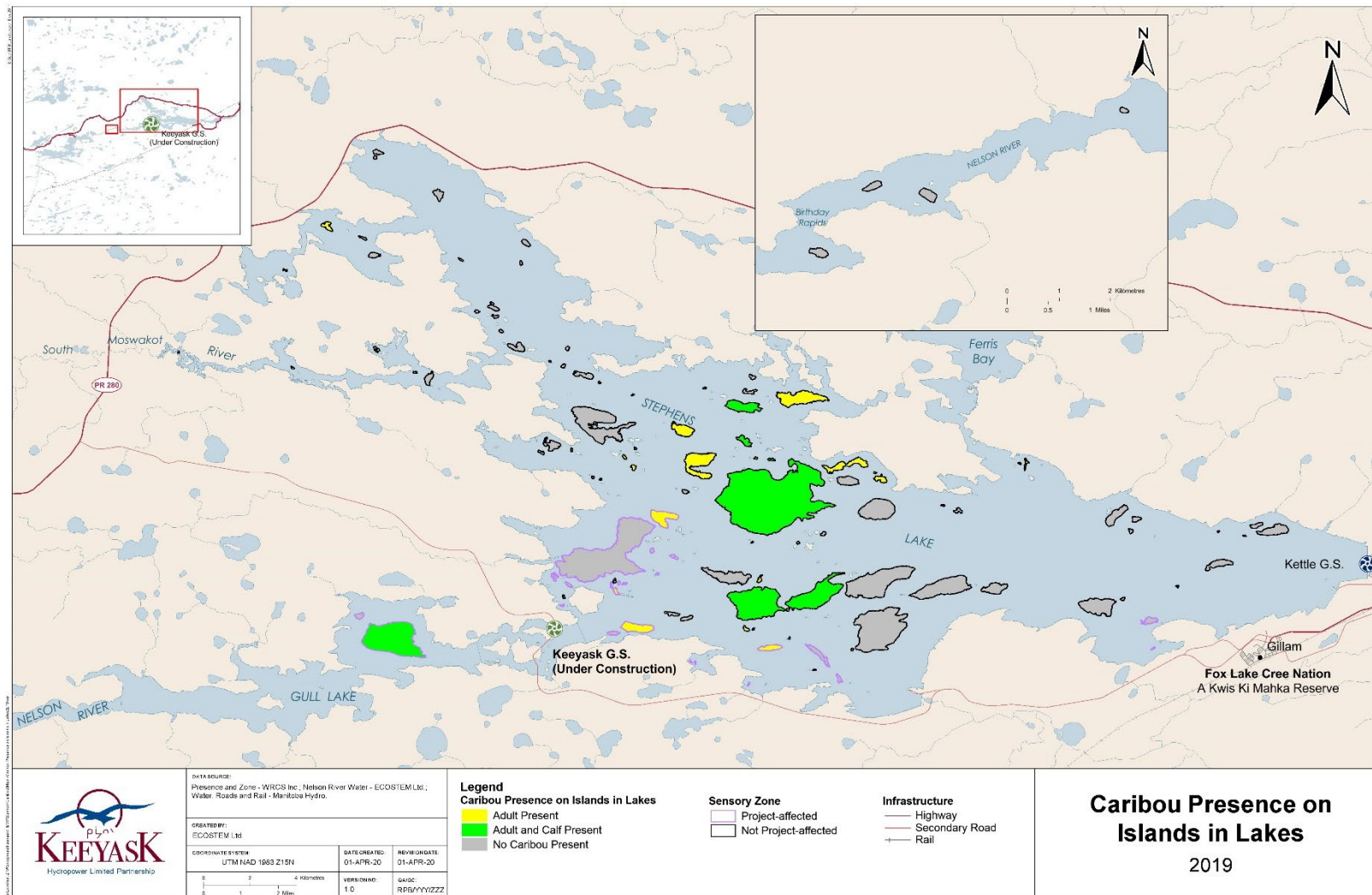
Caribou were photographed on a greater percentage of unaffected islands than Project-affected islands each year from 2015 to 2019 (Table 5). No caribou were photographed on Project-affected islands in 2018 and no calves were photographed on Project-affected islands from 2016 to 2018. Caribou occupied the greatest percentage of Project-affected islands in 2019. The percentage of Project-affected islands on which moose were observed was similar from 2015 to 2019 (Table 5). Moose calves occupied a smaller percentage of Project-affected and unaffected islands in 2019 than the previous year.

Table 5: Percentage of Project-affected and Unaffected Islands in Lakes on Which Caribou and Moose Were Photographed, 2015–2019

Species	Project-affected Islands					Unaffected Islands				
	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019
Caribou	4	11	8	0	20	17	14	19	26	23
Caribou calf	4	0	0	0	4	6	7	10	8	6
Moose	41	33	48	36	32	36	35	33	28	31
Moose calf	11	7	16	16	12	16	19	10	11	10



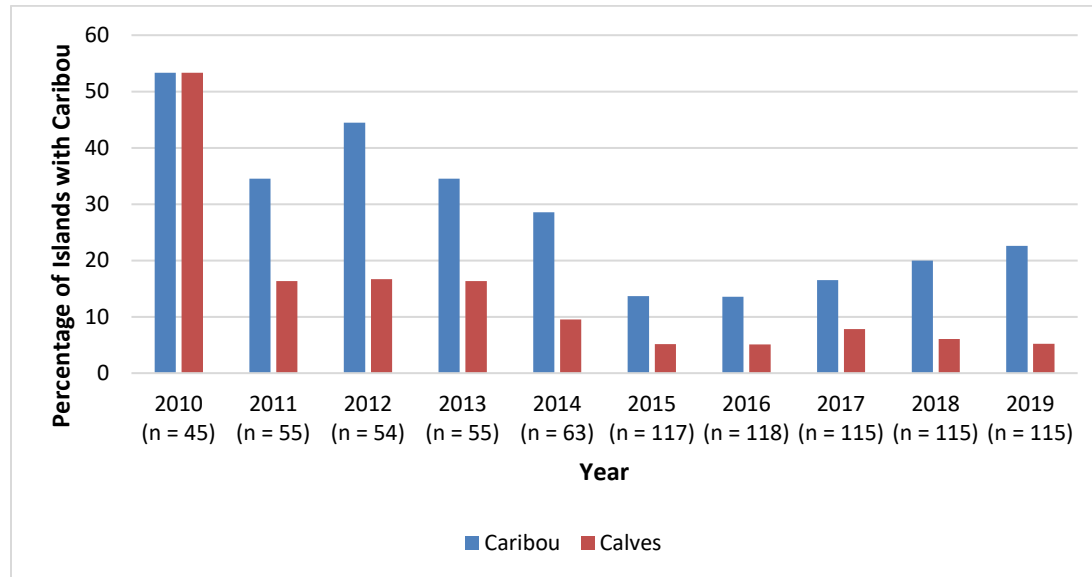
Map 4: Large Mammals Present on the Same Island in Lakes, 2019



Map 5: Caribou Presence on Islands in Lakes, 2019



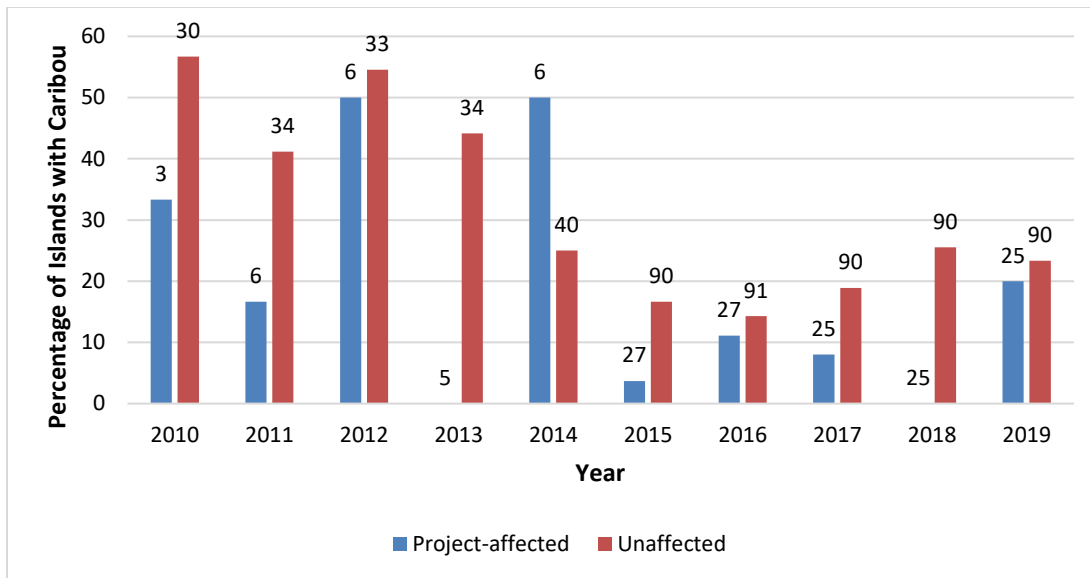
The percentage of islands in lakes on which caribou were photographed declined from the pre-construction (2010–2014; WRCS unpubl. data) to early construction (2015–2016) periods and then increased slightly from 2017 to 2019 (Figure 1). Despite the increase during the later construction period, caribou were observed on a smaller percentage of islands throughout the construction period than during all pre-construction years. Calf activity also declined during the pre-construction period and was lower throughout the construction period (2015–2019).



NOTE: “n” indicates the number of islands with cameras each study year.

Figure 1: Percentage of Islands in Lakes on Which Caribou Activity Was Photographed before (2010–2014) and during (2015–2019) Construction

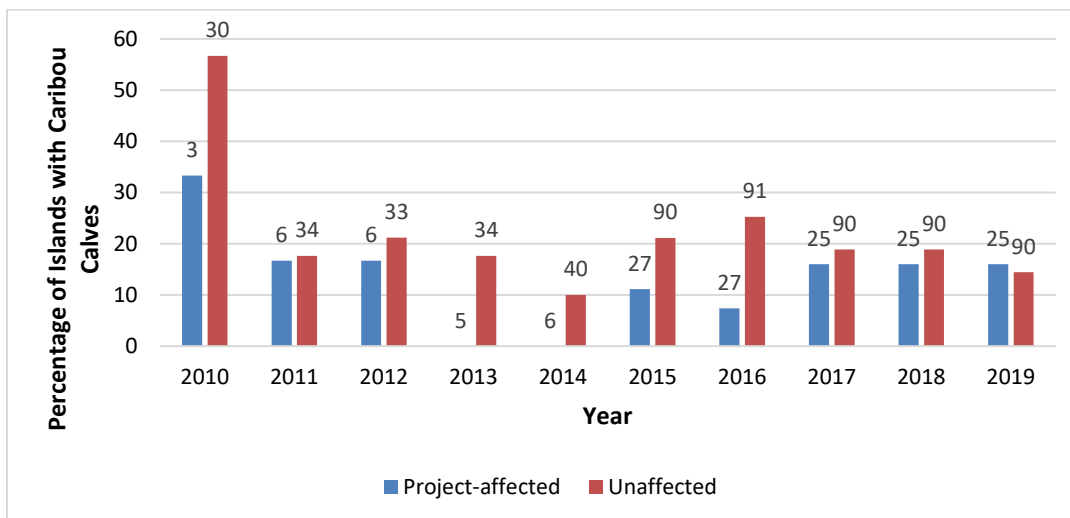
During the 2010–2014 pre-construction period, trail cameras were set up on 3 to 6 Project-affected and 30 to 34 unaffected islands, most of which were also surveyed from 2015 to 2019. Caribou were photographed on a lower percentage of Project-affected islands than unaffected islands all years except 2014 (Figure 2), which was before construction began. No caribou were observed on the five Project-affected islands surveyed in 2013, before construction, or on the 25 Project-affected islands surveyed in 2018, during construction.



NOTE: Data labels indicate the number of Project-affected and unaffected islands with cameras each study year.

Figure 2: Percentage of Project-affected and Unaffected Islands on Which Caribou Activity Was Photographed before (2010–2014) and during (2015–2019) Construction

Caribou calves were photographed on a lower percentage of Project-affected than unaffected islands in all years before and during construction (Figure 3). No calves were observed on Project-affected islands in 2013 and 2014, before construction, or from 2016 to 2018 during construction.



NOTE: Data labels indicate the number of Project-affected and unaffected islands surveyed each study year.

Figure 3: Percentage of Project-affected and Unaffected Islands on Which Caribou Calf Activity Was Photographed before (2010–2014) and during (2015–2019) Construction

3.2 PEATLAND COMPLEXES

Caribou (Photo 4) were photographed in peatland complexes from May to August in 2019 (Table 6). The first caribou was photographed on May 3. No caribou calves were observed. In earlier survey years caribou calves were first photographed on June 15, 2015; June 6, 2016; September 1, 2017; and June 30, 2018. Moose (Photo 5) were photographed throughout the 2019 survey period. The first moose calf was photographed on July 29. In previous survey years moose calves were first observed on June 17, 2015; none were photographed from 2016 to 2018. Black bear was photographed throughout the 2019 survey period and gray wolf was only observed in April.

Table 6: Number of Peatland Complexes Occupied Monthly by Large Mammals from Trail Camera Data, 2019

Species	April	May	June	July	August	September	All
Caribou	0	3	2	3	3	0	4
Caribou calf	0	0	0	0	0	0	0
Moose	1	2	3	2	1	1	7
Moose calf	0	0	0	2	0	1	3
Black bear	1	2	2	1	3	1	6
Gray wolf	1	0	0	0	0	0	1

Caribou were not photographed in any of the same peatland complexes as predators (Table 7). Caribou and moose were photographed in one complex (Map 7), separated by 26 days. Moose were observed in three complexes with black bear and in one complex with gray wolf.

Table 7: Nearest Dates on Which Large Mammals Were Photographed in the Same Peatland Complex, 2019

Complex	Caribou	Moose	Black Bear	Gray Wolf
KV062001	–	April 23	Sept. 10	–
KV116001	–	May 11	May 5	–
KV123001	–	July 14	–	April 24
KV124001	May 9	June 4	–	–
KV597000	–	May 11	May 22	–



Photo 4: Caribou Cow in a Peatland Complex on August 24, 2019



Photo 5: Bull Moose in a Peatland Complex on July 2, 2018

Caribou were photographed in four (13%) of the peatland complexes surveyed in 2019 (Table 8; Map 8). No caribou were observed in Project-affected complexes or in burned reference complexes. Overall, there was a 43% difference in the total percentage of burned and unburned peatland complexes occupied by caribou, where they were detected in 9% and 14% of complexes, respectively. No caribou calves were photographed in peatland complexes.

Table 8: Peatland Complexes Occupied by Caribou by Disturbance Source and Forest Fire Influence, 2019

Complex Type	Burned in 2013	Caribou		Caribou Calf	
		Number Occupied	Percentage Occupied	Number Occupied	Percentage Occupied
Project-affected	Yes	0	0	0	0
	No	0	0	0	0
	<i>Total</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>
Reference	Yes	0	0	0	0
	No	1	13	0	0
	<i>Total</i>	<i>1</i>	<i>8</i>	<i>0</i>	<i>0</i>
Random	Yes	1	25	0	0
	No	2	40	0	0
	<i>Total</i>	<i>3</i>	<i>33</i>	<i>0</i>	<i>0</i>
All		4	13	0	0

1. Visits 2 and 3 only.

Moose were photographed in seven (22%) of the peatland complexes surveyed in 2019 (Table 9; Map 9). They were relatively evenly distributed, having been observed in 18% of Project-affected complexes and 25% of reference complexes. Overall, moose were detected in 45% of burned complexes and in 10% of unburned complexes, a difference of 127%. Moose calves were photographed in 9% of peatland complexes and were also relatively evenly distributed. Calves were observed in the greatest percentage of random complexes and in the smallest percentage of reference complexes. A greater percentage of burned complexes (18%) than unburned complexes (5%) was occupied by moose calves.

Table 9: Peatland Complexes Occupied by Moose by Disturbance Source and Forest Fire Influence, 2019

Complex Type	Burned in 2013	Moose		Moose Calf	
		Number Occupied	Percentage Occupied	Number Occupied	Percentage Occupied
Project-affected	Yes	0	0	0	0
	No	2	25	1	13
	<i>Total</i>	<i>2</i>	<i>18</i>	<i>1</i>	<i>9</i>
Reference	Yes	3	75	1	25
	No	0	0	0	0
	<i>Total</i>	<i>3</i>	<i>25</i>	<i>1</i>	<i>8</i>
Random	Yes	2	50	1	25
	No	0	0	0	0
	<i>Total</i>	<i>2</i>	<i>22</i>	<i>1</i>	<i>11</i>
All		7	22	3	9

Black bear and gray wolf activity was observed in peatland complexes in 2019 (see Map 7). Black bears were photographed in six (19%) of the peatland complexes surveyed (Table 10). None were observed in random complexes. Overall, black bears were detected in 18% of burned complexes and in 19% of unburned complexes. Gray wolf was photographed in a single random complex that was burned in 2013.

Table 10: Peatland Complexes Occupied by Black Bear and Gray Wolf by Disturbance Source and Forest Fire Influence, 2019

Complex Type	Burned in 2013	Black Bear		Gray Wolf	
		Number Occupied	Percentage Occupied	Number Occupied	Percentage Occupied
Project-affected	Yes	0	0	0	0
	No	2	25	0	0
	<i>Total</i>	<i>2</i>	<i>18</i>	<i>0</i>	<i>0</i>
Reference	Yes	2	50	0	0
	No	2	25	0	0
	<i>Total</i>	<i>4</i>	<i>33</i>	<i>0</i>	<i>0</i>
Random	Yes	0	0	1	< 1
	No	0	0	0	0
	<i>Total</i>	<i>0</i>	<i>0</i>	<i>1</i>	<i><1</i>
All		6	19	1	< 1

No caribou activity was photographed in Project-affected burned peatland complexes from 2015 to 2019 (Table 11). Caribou were observed in 13% to 25% of unburned complexes from 2015 to 2017 and were not observed in 2018 or 2019. No caribou calves were photographed in Project-affected complexes throughout the five-year survey period. Moose were photographed in a single burned complex in 2018 and were observed in 13% to 25% of unburned complexes from 2015 to 2019. Moose calves were photographed in one unburned complex in 2015 and 2019.

Table 11: Percentage of Burned and Unburned Project-affected Peatland Complexes in Which Caribou and Moose Were Photographed, 2015–2019

Species	Burned					Unburned				
	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019
Caribou	0	0	0	0	0	13	13	25	0	0
Caribou calf	0	0	0	0	0	0	0	0	0	0
Moose	0	0	0	33	0	25	13	13	13	25
Moose calf	0	0	0	0	0	13	0	0	0	13

No caribou were observed in burned reference peatland complexes from 2015 to 2019 (Table 12). Caribou were photographed in 13% ($n = 1$) of unburned complexes all years but 2018, when activity was observed in four of the eight complexes surveyed. Caribou calves were photographed in unburned reference complexes in 2017 and 2018. Moose were more widely distributed in burned reference complexes, having been observed in at least 25% ($n = 1$) and up to 100% ($n = 4$) of complexes each survey year. Moose calves were only photographed in 2019, in a burned reference complex.

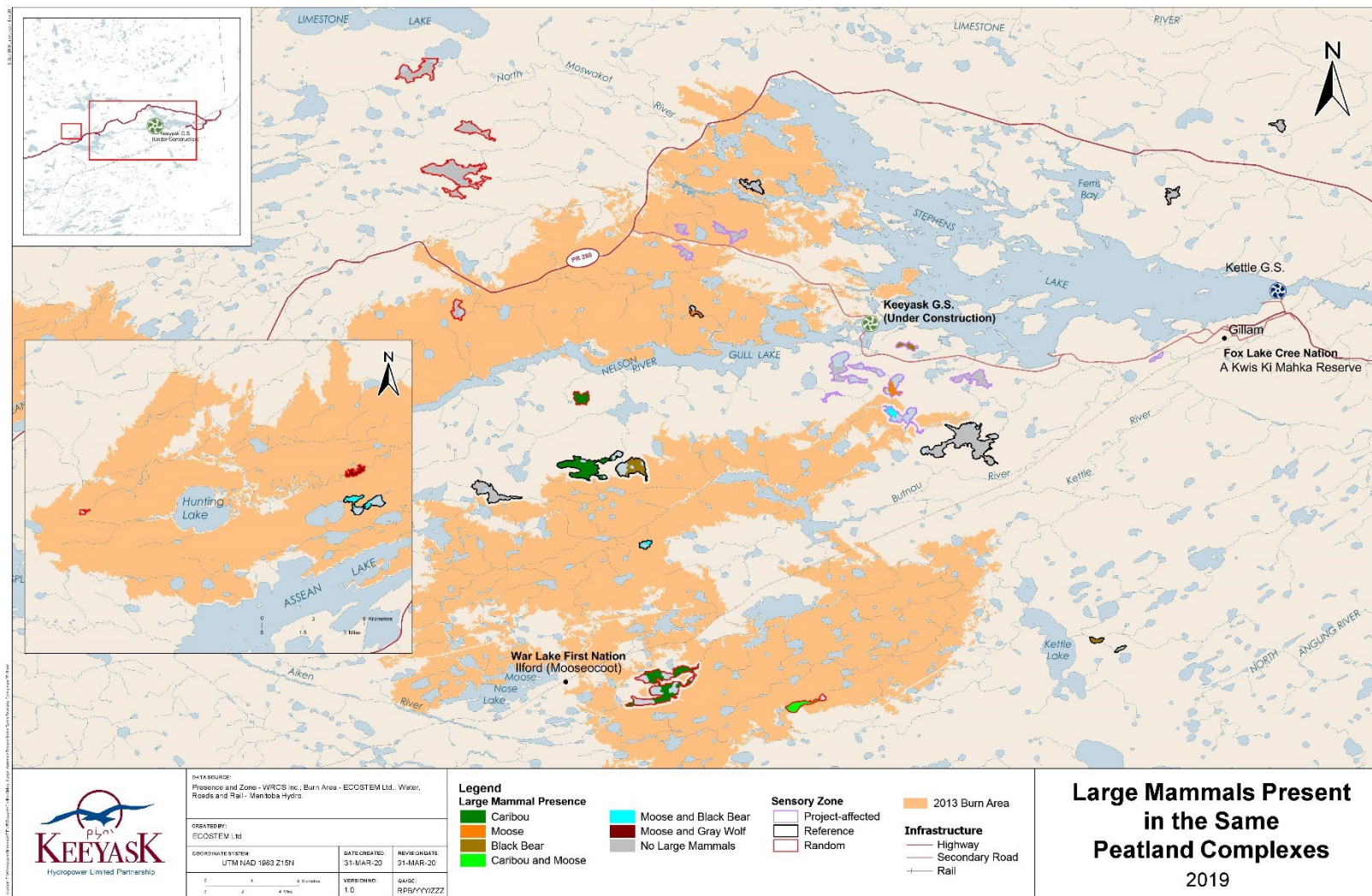
Table 12: Percentage of Reference Peatland Complexes in Which Caribou and Moose Were Photographed, 2015–2019

Species	Burned					Unburned				
	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019
Caribou	0	0	0	0	0	13	13	13	50	13
Caribou calf	0	0	0	0	0	0	0	13	13	0
Moose	25	50	25	25	100	50	0	0	13	0
Moose calf	0	0	0	0	33	0	0	0	0	0

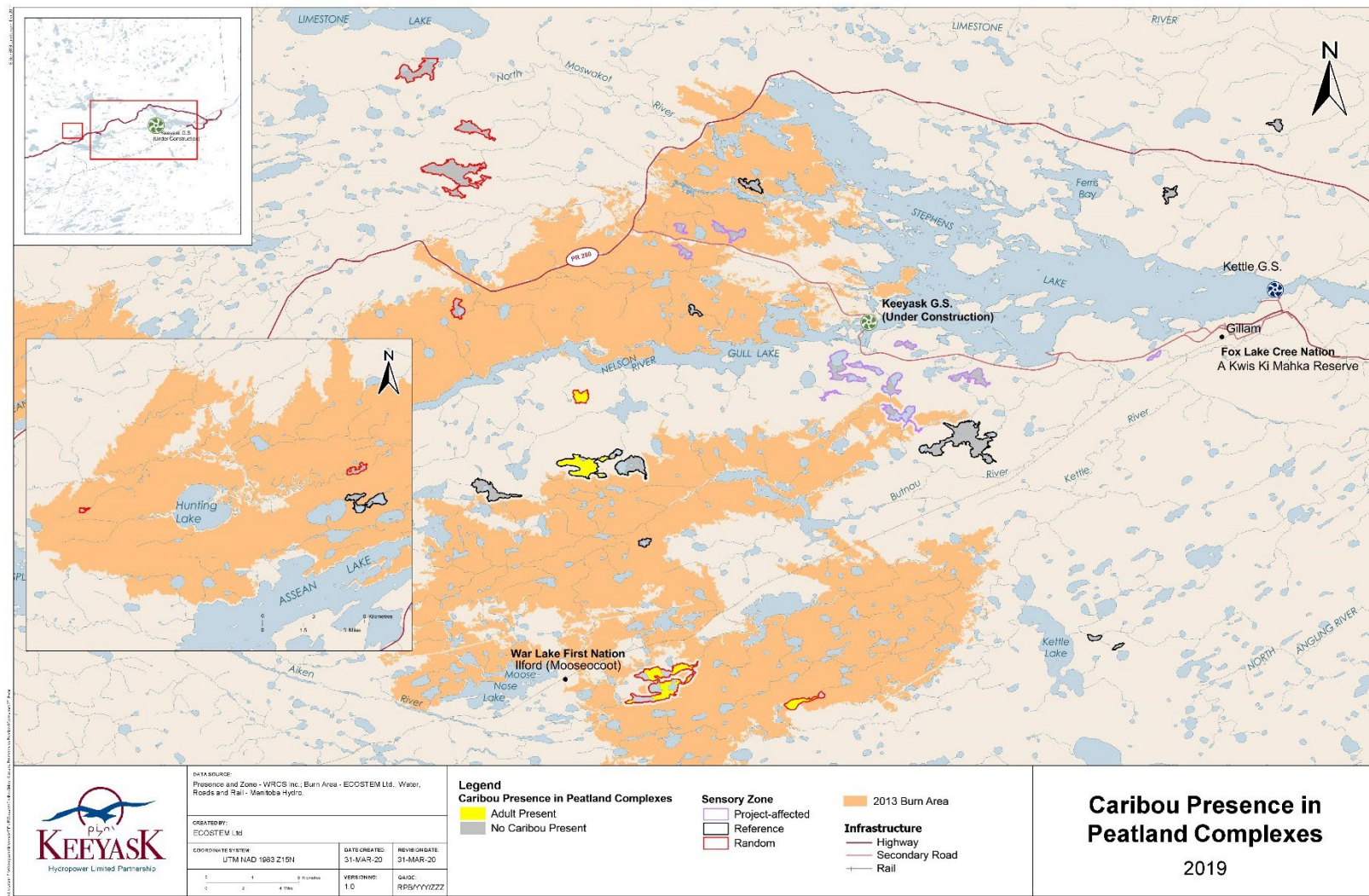
No caribou were photographed in burned random peatland complexes from 2015 to 2017 and calves were only observed in 2018 (Table 13). Caribou were generally more widely distributed in unburned random complexes over the survey period. Moose were more commonly photographed in burned than unburned complexes from 2015 to 2019, having only been photographed in unburned complexes in 2018. No moose calves were observed in unburned complexes.

Table 13: Percentage of Random Peatland Complexes in Which Caribou and Moose Were Photographed, 2015–2019

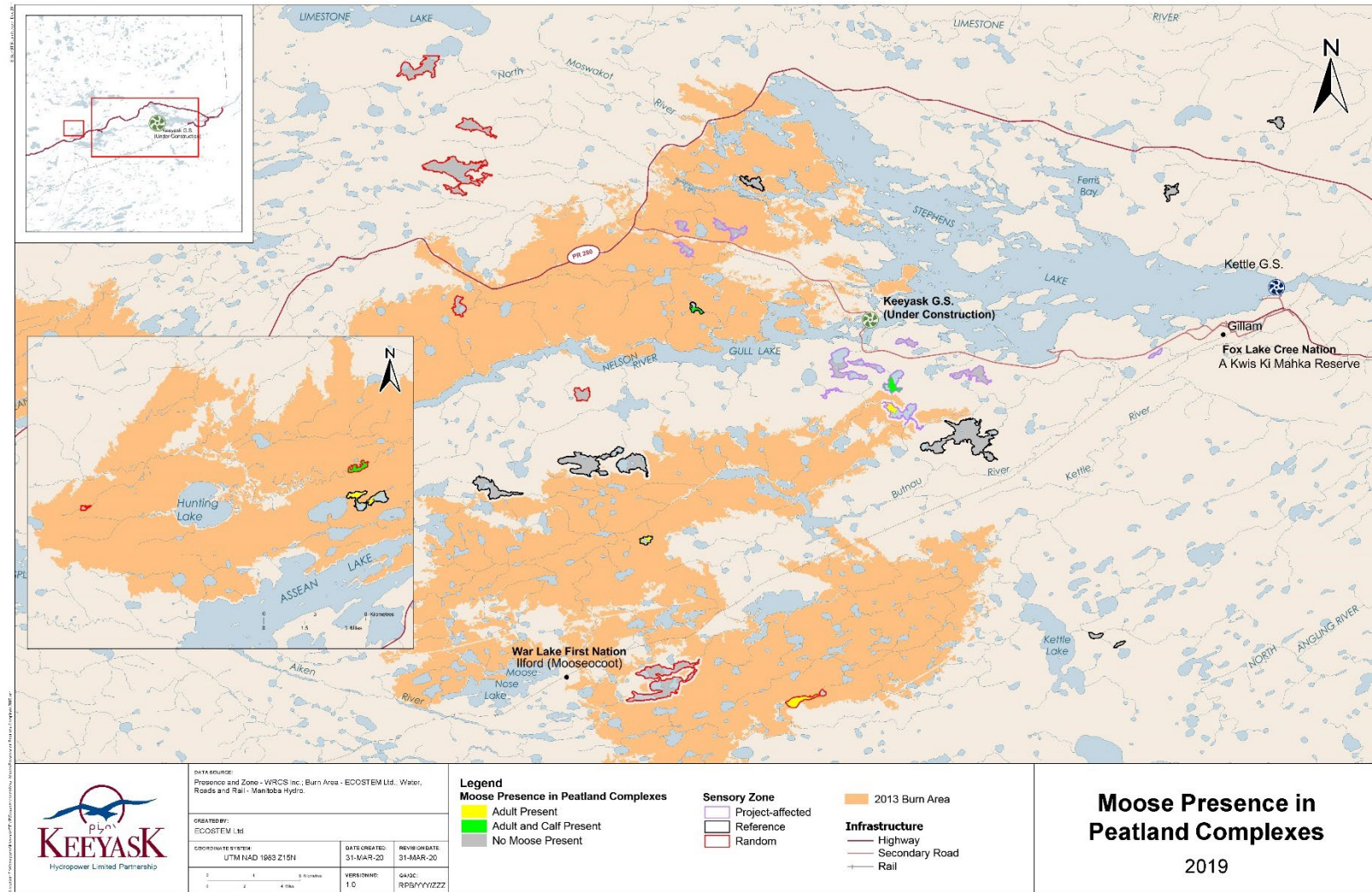
Species	Burned					Unburned				
	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019
Caribou	0	0	0	25	33	40	20	0	20	25
Caribou calf	0	0	0	25	0	0	0	0	20	0
Moose	25	25	50	25	67	0	0	0	20	0
Moose calf	25	0	0	0	33	0	0	0	0	0



Map 7: Large Mammals Present in the Same Peatland Complexes, 2019



Map 8: Caribou Presence in Peatland Complexes, 2019



Map 9: Moose Presence in Peatland Complexes, 2019

3.3 INCIDENTAL OBSERVATIONS

In 2019, mammal and bird species incidentally photographed on islands in lakes and peatland complexes were: American crow, American marten (Photo 6), American robin, American three-toed woodpecker, bald eagle (Photo 7), Canada goose, Canada jay, Canada lynx (Photo 8), common nighthawk, common raven, great gray owl, mink, northern flicker, red fox (Photo 9, Photo 10), red squirrel, North American river otter, sandhill crane, snowshoe hare, spruce grouse, sharp-tailed grouse, and wolverine (Photo 11).



Photo 6: American Marten



Photo 7: Bald Eagle



Photo 8: Canada Lynx



Photo 9: Red Fox



Photo 10: Red Fox



Photo 11: Wolverine

3.4 TIMING OF ICE BREAKUP

Four cameras were placed at Stephens Lake and one camera was placed at Gull Lake to monitor the timing of ice breakup. On Stephens Lake, the percentage of ice cover remained consistent from installation in April until mid- to late May, and then decreased rapidly (Table 14). Ice breakup was on May 23 and Stephens Lake was free of ice by May 25 (Photo 12 to Photo 16). Ice breakup was May 22 on Gull Lake, with no ice remaining on May 25.

In previous survey years ice breakup on Stephens Lake was observed by June 2, 2015; May 20, 2016; June 2, 2017; and May 27, 2018. Stephens Lake was free of ice by June 3, 2015; May 22, 2016; June 3, 2017; and June 3, 2018 (Table 15). In 2018, ice breakup on Gull Lake was May 22 and no ice remained on June 2.

Table 14: Timing of Ice Breakup on Stephens and Gull Lakes, 2019

Percent Ice Cover	Stephens Lake				Gull Lake
	Camera 1	Camera 2	Camera 3	Camera 4	Camera 5
100	April 6	April 7	April 7	April 7	April 4
75	April 24	April 20	April 28	April 21	April 24
50	May 19	May 20	May 20	May 18	May 11
25	May 21	May 23	May 21	May 19	May 12
0	May 23	May 25	May 22	May 21	May 25

Table 15: Timing of Ice Breakup on Stephens Lake, 2015–2018

Percent Ice Cover	2015 Cameras 1–4	2016 Cameras 1–4	2017 Cameras 2–4	2018 Cameras 1–4
100	May 9–12	April 27–29	April 11–16	April 7–11
75	May 20–27	May 8–17	May 20–31	May 20–24
50	May 23–Jun. 1	May 10–19	May 27–Jun.1	May 22–25
25	May 25–June 2	May 14–20	May 27–Jun. 2	May 23–27
0	May 26–Jun. 3	May 18–22	May 28–Jun. 3	May 28–June 3

**Photo 12: Ice Cover at 100% on Stephens Lake on April 7, 2019**

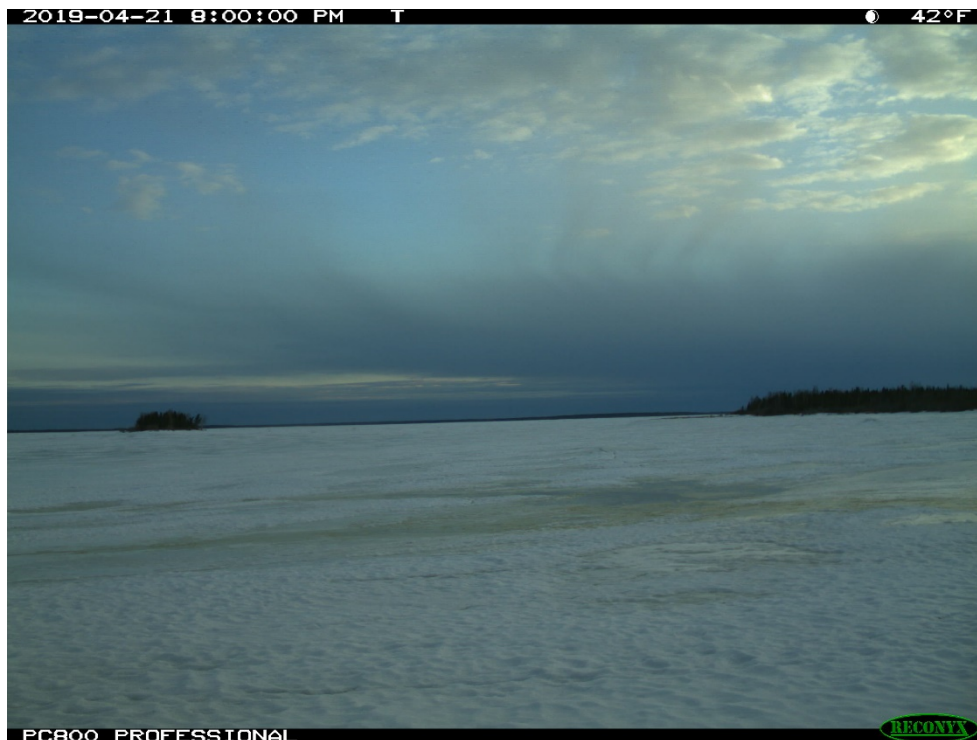


Photo 13: Ice Cover at 75% on Stephens Lake on April 21, 2019



Photo 14: Ice Cover at 50% on Stephens Lake on May 18, 2019



Photo 15: Ice Cover at 25% on Stephens Lake on May 19, 2019



Photo 16: Ice Cover at 0% on Stephens Lake on May 21, 2019

4.0 DISCUSSION

As predicted in the EIS, several Project-affected islands appeared to be unoccupied by caribou in 2019. No caribou calves were photographed on Project-affected islands from 2016 to 2018. The apparent absence of caribou activity on most Project-affected islands could indicate that caribou were generally avoiding construction-related sensory disturbance. However, there was adult caribou activity on several Project-affected islands most survey years. As caribou can habituate to human disturbance, some individuals may be less affected by ongoing construction activity than others (Haskell et al. 2006), or the extent of the disturbance effect (i.e., 4 km from the GS site) may be less than predicted in the EIS. It should be noted that trail cameras can document animals' presence in an area but cannot confirm their absence; as such, it cannot be known for certain that there were no caribou on some of the islands. Additionally, no ground tracking surveys, which increase the amount of caribou activity detected, were conducted in 2019. As such, there was likely more caribou activity in the study area than indicated by trail cameras alone.

There was less caribou activity on Project-affected islands in lakes during construction than during the pre-construction period, as predicted in the EIS. However, there was also a decline in caribou activity on islands unaffected by the Project, suggesting that caribou were not re-locating to the undisturbed islands in Stephens Lake as may be expected. There may have been an overall decrease in the amount of caribou and calf activity in the Keeyask region from 2010 to 2019. Additional construction phase monitoring and a multi-year analysis of results may identify trends in the occupancy of Project-affected and unaffected islands in lakes by caribou.

The specific timing of 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 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 2019, ice breakup on Stephens Lake was in late May, within the general calving period and a month earlier than the first caribou calf was photographed (June 20).

Moose were somewhat more widely distributed on islands in lakes than caribou in 2019. Fewer than a quarter of the islands occupied by caribou were also occupied by moose. Predators were more likely to occupy islands on which only moose were found than those on which only caribou were found. The abundance and distribution of moose signs in the Keeyask region suggests that enough habitat is available to sustain a moose population, which is likely an adequate source of primary prey for gray wolves.

No caribou or calves were photographed in Project-affected peatland complexes in 2019, possibly indicating avoidance of construction-related sensory disturbances during the calving period. Caribou occupied a greater percentage of unburned than burned complexes. Caribou tend to avoid forest that is less than 50 years old (Schaefer and Pruitt 1991) but may pass through regenerating forest to get from one patch of more suitable habitat to another. Caribou may also

use recently burned (within five years) habitat in summer, when they eat regenerating herbs and deciduous browse (Schaefer and Pruitt 1991).

Moose and moose calves occupied more peatland complexes than caribou. Calves were detected in burned and unburned complexes, possibly indicating that moose select a wider range of habitats for calving than caribou.

5.0 SUMMARY AND CONCLUSIONS

In 2019, caribou were photographed on 23% of the islands in lakes and in approximately 13% of the peatland complexes surveyed in the Keeyask region. Caribou did not avoid all islands but appeared to avoid all peatland complexes within 4 km of the Project construction site. As predicted in the EIS, sensory disturbance from construction may have caused some individuals to avoid areas nearer the Project construction site, but some areas within the predicted disturbance zones were occupied by caribou and calves. These caribou may have habituated to the construction disturbance, or the zone of disturbance may be smaller than predicted in the EIS. Sensory disturbance monitoring will continue in 2020. Additional construction phase monitoring and a multi-year analysis of results may identify trends in caribou activity nearer or farther from disturbance at the Project construction site and near the access roads.

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APPENDIX A: TABLES

Table A-1: Number of Trail Cameras on Islands in Lakes, 2015 to 2019

Island	2019	2018	2017	2016	2015
KI122001	1	1	1	1	1
KI122003	1	1	1	1	1
KI122005	1	1	1	1	1
KI122006	1	1	1	1	1
KI123005	0	0	0	1	1
KI123008	0	0	0	1	1
KI123010	1	1	1	1	1
KI123012	2	2	2	2	2
KI124003	1	1	1	1	1
KI124004	1	1	0	1	1
KI124005	1	1	1	1	1
KI124007	1	1	1	1	1
KI124009	1	1	1	1	1
KI124010	1	1	1	1	1
KI124013	1	1	1	1	1
KI124015	1	1	1	1	1
KI124016	1	1	1	1	1
KI124017	1	1	1	1	1
KI124018	1	1	1	1	1
KI124019	1	1	1	1	1
KI124020	1	1	1	1	1
KI124022	1	1	1	1	1
KI124024	1	1	1	1	1
KI124026	1	1	1	1	1
KI124029	1	1	1	1	1
KI124030	1	1	1	1	1
KI124035	1	1	1	1	1
KI124037	1	1	1	1	1
KI124038	1	1	1	1	1
KI124040	1	1	1	1	1
KI124041	1	1	1	1	1
KI124042	1	1	1	1	1
KI124043	1	1	1	1	1
KI124044	1	1	1	1	1
KI124045	1	1	1	1	1
KI124046	1	1	1	1	1

Island	2019	2018	2017	2016	2015
KI124047	1	1	1	1	1
KI124050	1	1	1	1	1
KI124051	0	0	0	1	0
KI124052	1	1	1	1	1
KI124053	1	1	1	1	1
KI124055	1	1	1	1	1
KI124056	1	1	1	1	1
KI124057	1	1	1	1	1
KI124058	1	1	1	1	1
KI124060	1	1	1	1	1
KI124063	1	1	1	1	1
KI124065	1	1	1	1	1
KI124066	2	2	2	2	2
KI124069	1	1	1	1	1
KI124070	1	1	1	1	1
KI124072	1	1	1	1	1
KI124075	1	1	1	1	1
KI124077	1	1	0	1	0
KI124079	1	1	1	1	1
KI124080	1	1	1	1	0
KI124082	1	1	1	1	1
KI124083	1	1	1	0	1
KI124086	1	1	1	1	1
KI124088	1	1	1	1	1
KI124089	1	1	1	1	1
KI124090	1	1	1	1	1
KI124091	1	1	1	1	1
KI124092	2	2	2	2	2
KI124094	1	1	1	1	1
KI124096	1	1	1	1	1
KI124097	1	1	1	1	1
KI124102	1	1	1	1	1
KI124103	1	1	0	1	1
KI124105	1	1	1	1	1
KI124111	0	0	1	1	1
KI124113	1	1	0	1	0
KI124115	1	1	1	2	1

Island	2019	2018	2017	2016	2015
KI124117	1	1	1	1	1
KI124120	1	1	1	1	1
KI124124	1	1	1	1	1
KI124125	1	1	1	1	1
KI124128	1	1	1	1	1
KI124129	1	1	1	1	1
KI124131	1	1	0	1	0
KI124133	1	1	1	1	1
KI124136	1	1	1	1	1
KI124141	1	1	1	1	1
KI124145	1	1	1	1	1
KI124146	1	1	0	1	1
KI124147	1	1	1	1	1
KI124150	0	0	1	0	0
KI124151	1	1	1	1	1
KI124152	1	1	0	1	1
KI124153	1	1	1	1	1
KI124155	1	1	1	1	1
KI124156	1	1	1	1	1
KI124158	1	1	1	1	1
KI124162	1	1	1	1	1
KI124164	1	1	1	1	1
KI124165	1	1	0	1	1
KI124166	1	1	1	1	1
KI124167	1	1	1	1	1
KI124170	1	1	1	1	1
KI124173	1	1	1	1	1
KI124176	1	1	1	1	1
KI124178	1	1	1	1	1
KI124180	3	3	2	3	2
KI124181	1	1	1	0	0
KI124182	1	1	1	1	1
KI124186	6	6	5	6	4
KI124192	1	1	1	1	1
KI124193	1	1	1	1	1
KI124194	1	1	1	1	1
KI124196	1	1	1	1	1

Island	2019	2018	2017	2016	2015
KI124197	1	1	1	1	1
KI124202	1	1	1	1	1
KI124205	2	2	2	2	1
KI124206	1	1	1	1	1
KI124209	1	1	1	1	1
KI124210	1	1	1	1	1
KI124212	1	1	1	1	1
KI124214	1	1	1	1	1
KI124217	1	1	1	1	1
KI124227	1	1	1	0	1
KI126016	0	0	0	1	1
KI126017	0	0	0	0	1
KI126020	0	0	0	1	1

Table A-2: Number of Trail Cameras in Peatland Complexes, 2015 to 2019

Complex	2019	2018	2017	2016	2015
KV005000	0	0	0	1	0
KV006600	0	0	0	1	0
KV022000	1	1	1	1	1
KV023000	1	1	1	1	1
KV036000	1	1	1	1	1
KV037000	1	1	1	1	1
KV038000	1	1	1	1	1
KV039000	1	1	1	1	1
KV044000	1	1	1	1	1
KV047000	1	1	1	1	1
KV050000	1	1	1	1	1
KV580000	1	1	1	1	1
KV061000	1	1	1	1	1
KV062000	1	1	1	1	1
KV063000	1	1	1	1	1
KV066000	1	1	1	1	1
KV069000	1	1	1	1	1
KV071000	1	1	1	1	1
KV094000	1	1	1	1	1
KV097000	1	1	1	1	1
KV098000	1	1	1	1	1
KV101000	1	1	1	1	1
KV102000	1	1	1	1	1
KV103000	1	1	1	1	1
KV107000	1	1	1	1	1
KV113000	1	1	1	1	1
KV116000	1	1	1	1	1
KV119000	1	1	1	1	1
KV120000	1	1	1	1	1
KV121000	1	1	1	1	1
KV122000	1	1	1	1	1
KV123000	1	1	0	1	1
KV124000	1	1	1	1	1
KV597000	1	1	0	1	1