Keeyask Generation Project

Terrestrial Effects Monitoring Plan

Caribou Sensory Disturbance Monitoring Report

TEMP-2023-10

KEEYASK

Manitoba Environment and Climate Client File 5550.00
Manitoba Environment Act Licence No. 3107

2022 - 2023

KEEYASK GENERATION PROJECT

TERRESTRIAL EFFECTS MONITORING PLAN

REPORT #TEMP-2023-10

CARIBOU SENSORY DISTURBANCE MONITORING

YEAR 1 OPERATION

2022

Prepared for

Manitoba Hydro

By

Wildlife Resource Consulting Services MB Inc.

June 2023

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SUMMARY

Background

Construction of the Keeyask Generation Project (the Project) at the former Gull Rapids began in July 2014 and all generating units were in service by March 2022. 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.

In addition to migratory caribou that occasionally reach the Keeyask region in winter, a small group of caribou occupies the Keeyask region in spring and summer, referred to as summer resident caribou. These caribou are known to calve on the islands in Gull and Stephens lakes and in mainland habitat (raised treed patches surrounded by low, wet areas, which essentially act as islands).

Caribou on an Island in Stephens Lake in Summer 2022

Predicted Project effects on summer resident caribou in the Keeyask region included a loss of physical habitat from clearing and development. Caribou were also expected to temporarily avoid or less frequently use otherwise suitable habitat near construction sites due to sensory disturbance (e.g., noise and light from construction activities), resulting in a loss of effective habitat. It was thought that caribou would return to Project-affected calving habitat during operation, but that there may be ongoing avoidance of areas near the generating station and the North and South access roads.

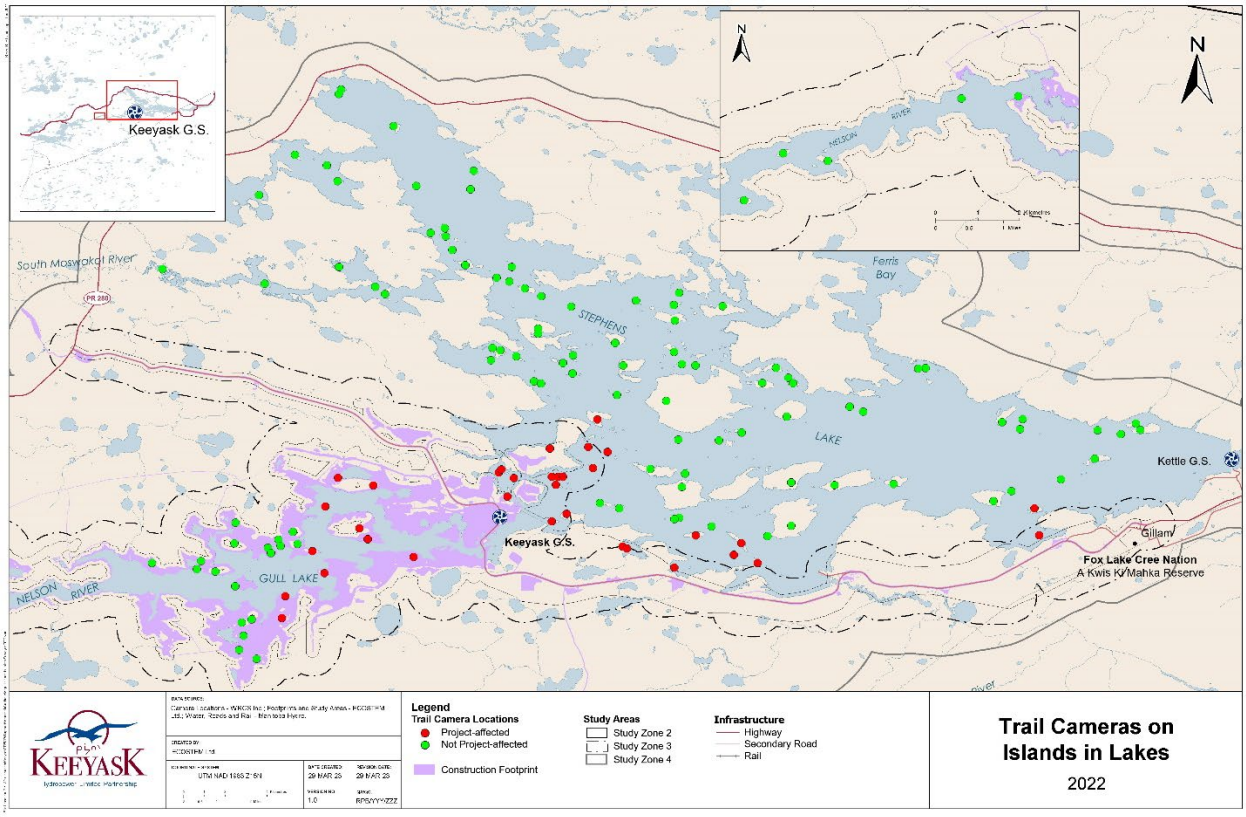
Why is the study being done?

Caribou calving on islands in lakes and in mainland habitat near the Project were expected to be affected by the loss of effective habitat due to noise and light disturbance. The goals of caribou sensory disturbance monitoring during Project operation are to determine the extent to which caribou increase their use of the calving and calf-rearing habitat formerly disturbed by construction activity and to estimate the ongoing loss of effective habitat. At the same time, monitoring 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?

Trail camera surveys were used to gather information on the use of islands in lakes and mainland habitat by caribou and other large mammals in 2022, the first year of Project operation monitoring. Islands in lakes and mainland areas were surveyed because these habitats are known to be used by caribou during the calving and calf-rearing period, when caribou are sensitive to disturbance.

In April 2022, trail cameras were placed on 142 islands in lakes and within 32 mainland habitat areas. Photographs were reviewed following camera removal in September 2022, and the species, number, and age (adult or juvenile) of photographed animals were noted. The timing of ice breakup on Gull and Stephens lakes was monitored using trail cameras placed on islands and along shorelines, to see how it corresponds with the use of islands in the lakes by caribou.



What was found?

Caribou were photographed on 27% of the islands in lakes surveyed in 2022 and calves were photographed on 6%. During the pre-construction period (2010 to 2014), the percentage of islands on which caribou and their calves were detected declined. The trend generally continued on affected islands during Project construction; however, there was also less caribou activity on unaffected islands during construction than during the pre-construction survey years, suggesting a general decline in caribou activity in the broader region. In 2022, caribou were photographed on a similar percentage of islands as in the late construction period. Caribou occupied a small island formed from a larger one after reservoir impoundment. There was no apparent increase in caribou activity on islands affected by the Project during the first year of operation monitoring.

In 2022, ice breakup on Stephens Lake was on June 2 and the lake was ice-free by June 7. Ice breakup was May 28 on Gull Lake, with no ice remaining on May 30.

Caribou were photographed in 19% of all surveyed mainland habitat areas and calves were photographed in 9%. Caribou occupied more unburned than burned habitats. Calves were only found in unburned mainland habitats that were not affected by the Project. There was no apparent increase in caribou activity in mainland habitat affected by the Project during the first year of operation monitoring.

Moose signs were relatively abundant and widely distributed on islands in lakes and in mainland habitats. Signs of black bear and gray wolf presence were sparse in caribou calving habitat in the Keeyask region, and caribou and predators occupied few of the same islands in lakes and mainland habitats in 2022.

What does it mean?

No increase in caribou calving and calf-rearing activity in habitat affected during Project construction was observed in 2022, the first year of operation monitoring. The amount of alternative prey and predator activity in the region in 2022 was generally within the range observed during the construction monitoring period.

What will be done next?

Caribou sensory disturbance monitoring will continue in 2023, when additional studies and further analyses will be conducted to identify potential increases in caribou calving and calf-rearing activity in habitat affected during Project construction, to assess the loss of effective habitat during Project operation, and to identify ongoing avoidance of the access roads or other Project components.

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:

- Robert Berger, Wildlife Resource Consulting Services MB Inc. (WRCS) – Design, analysis, and reporting
- James Ehnes, ECOSTEM Ltd. – Design
- Andrea Ambrose, WRCS – Analysis and reporting
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1.0 INTRODUCTION

The Keeyask Generation Project (the Project) is a 695-megawatt hydroelectric generating station (GS) located at the former Gull Rapids on the lower Nelson River in northern Manitoba where Gull Lake flows into Stephens Lake. Project construction began in July 2014 and all generating units were in service by March 2022.

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 and operation.

In addition to the migratory caribou that occasionally reach the Keeyask region in winter, a small number of caribou occupy the area in spring and summer (herein referred to as caribou or summer resident caribou). These summer resident 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 black bear (*Ursus americanus*) and gray wolf (*Canis lupus*).

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 loss of effective habitat due to sensory disturbance was anticipated during Project construction. Noise generated by construction activity, blasting, and vehicle traffic was expected to result in caribou temporarily avoiding otherwise suitable habitat near these disturbances. This loss of effective habitat for summer resident caribou was predicted to occur within 4 km of the Project construction site and within 2 km of the North and South access roads (Keeyask Hydropower Limited Partnership [KHLP] 2012). Because caribou in the Keeyask region 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 black bears and gray wolves. 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, ground tracking transect and trail camera surveys were conducted during Project construction to monitor changes in the distribution and relative abundance of caribou due to sensory disturbance or to changes in the alternative prey and predator communities. Beginning in 2022, monitoring was continued into operation to determine if caribou calving and calf-rearing activity increased in habitat affected during Project construction, to estimate the loss of effective habitat, and to identify residual avoidance of the access roads or other Project components during operation. 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. The timing of ice breakup on Gull and Stephens lakes was monitored using trail cameras because of its potential to affect the use of islands in lakes by calving caribou.

2.0 METHODS

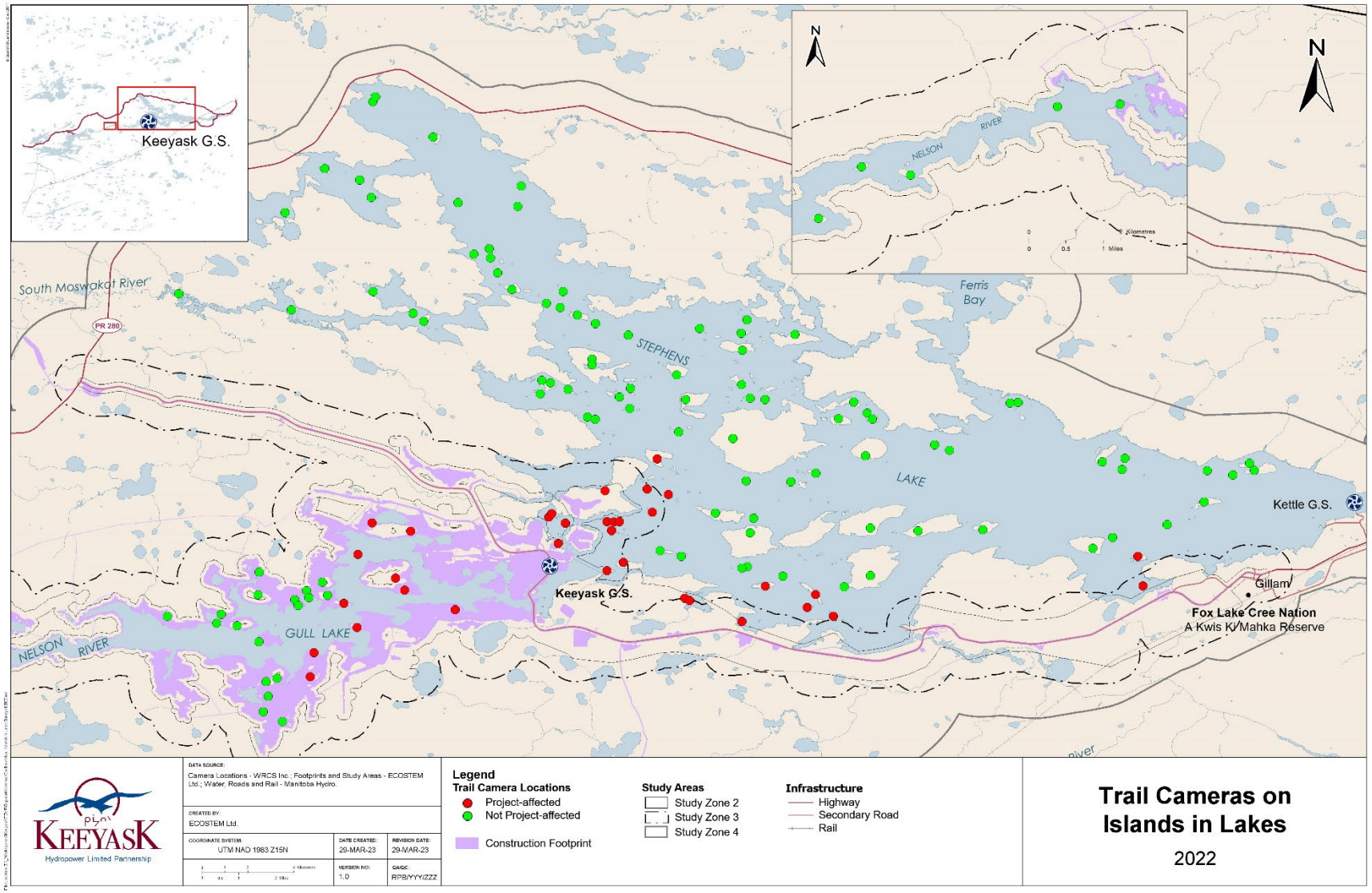
2.1 SURVEY METHODS

The objectives of caribou sensory disturbance monitoring during Project operation are to determine the extent to which caribou increase their use of the calving and calf-rearing habitat disturbed by Project construction activity and to estimate the ongoing loss of effective habitat. Trail camera surveys that were conducted annually from 2015 to 2021 during Project construction monitoring continued in 2022, the first year of Project operation monitoring, 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 because they are common predators of caribou adults and/or calves and can influence their use of habitat. Islands in lakes and peatland complexes were surveyed because these habitats are known to support caribou during the sensitive calving and calf-rearing period.

In 2022, 184 cameras were set up from April 19 to 22, 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 July 16 and 23, and the cameras were removed from September 20 to 26. Photographs were reviewed and the species, number, and age (adult or juvenile) of photographed animals were determined, where possible.

2.1.1 ISLANDS IN LAKES

One hundred and fifty-two Reconyx™ PM35C31 trail cameras were placed on 142 islands in Gull and Stephens lakes and upstream in the Nelson River, most of which had been surveyed at least once during construction monitoring (Map 1; Appendix 1, Table A-1). Islands greater than 0.5 hectares (ha) in size and with more than 5% tree cover were selected and were classified by their distance to Project-related disturbance during construction. Those within 2 kilometres (km) of borrow areas or Project infrastructure (including the North and South access roads) or within 4 km of the generating station construction site were “Project-affected” and those beyond were “unaffected” (KHLP 2012). Thirty-four Project-affected and 108 unaffected islands were surveyed, including eight Project-affected and 18 unaffected islands formed after reservoir impoundment. A single camera was deployed on most islands, and two to six cameras were placed on five larger islands.



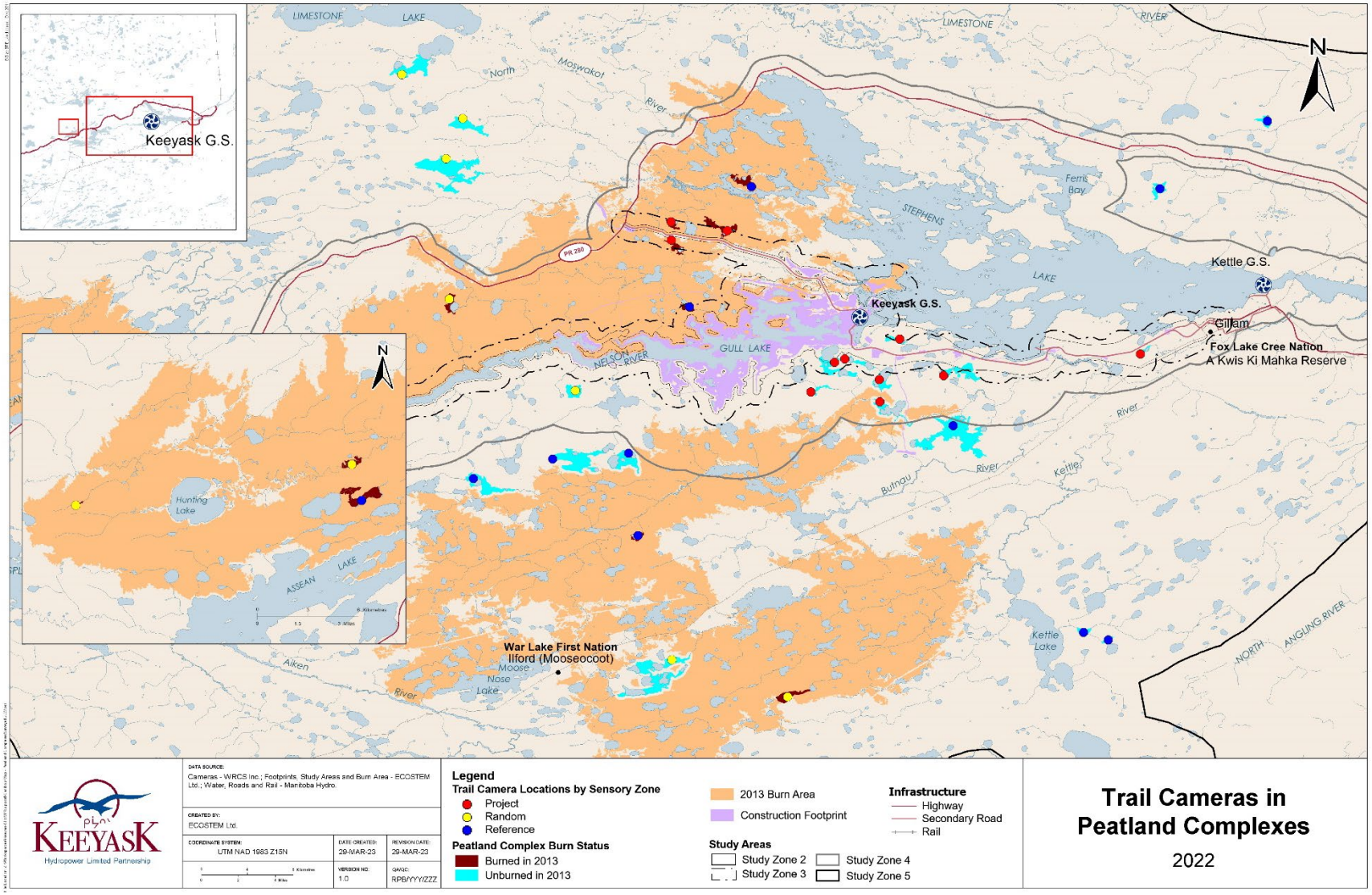
Map 1: Trail Cameras on Islands in Lakes, 2022

2.1.2 PEATLAND COMPLEXES

Reconyx™ PM35C31 trail cameras were placed on raised mainland habitat "islands" within a wet bog matrix, collectively called peatland complexes. Thirty-two complexes were selected and categorized by their distance to a disturbance source during Project construction. Project-affected peatland complexes were within 4 km of the Project construction site or within 2 km of the North or South access road, 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 forest fires in 2013 (burned or unburned) was also identified. A camera was placed on one habitat island within each of 32 peatland complexes, all at locations surveyed in previous years (Map 2; Appendix 1, Table A-2).

Table 1: Trail Cameras in Peatland Complexes, 2022

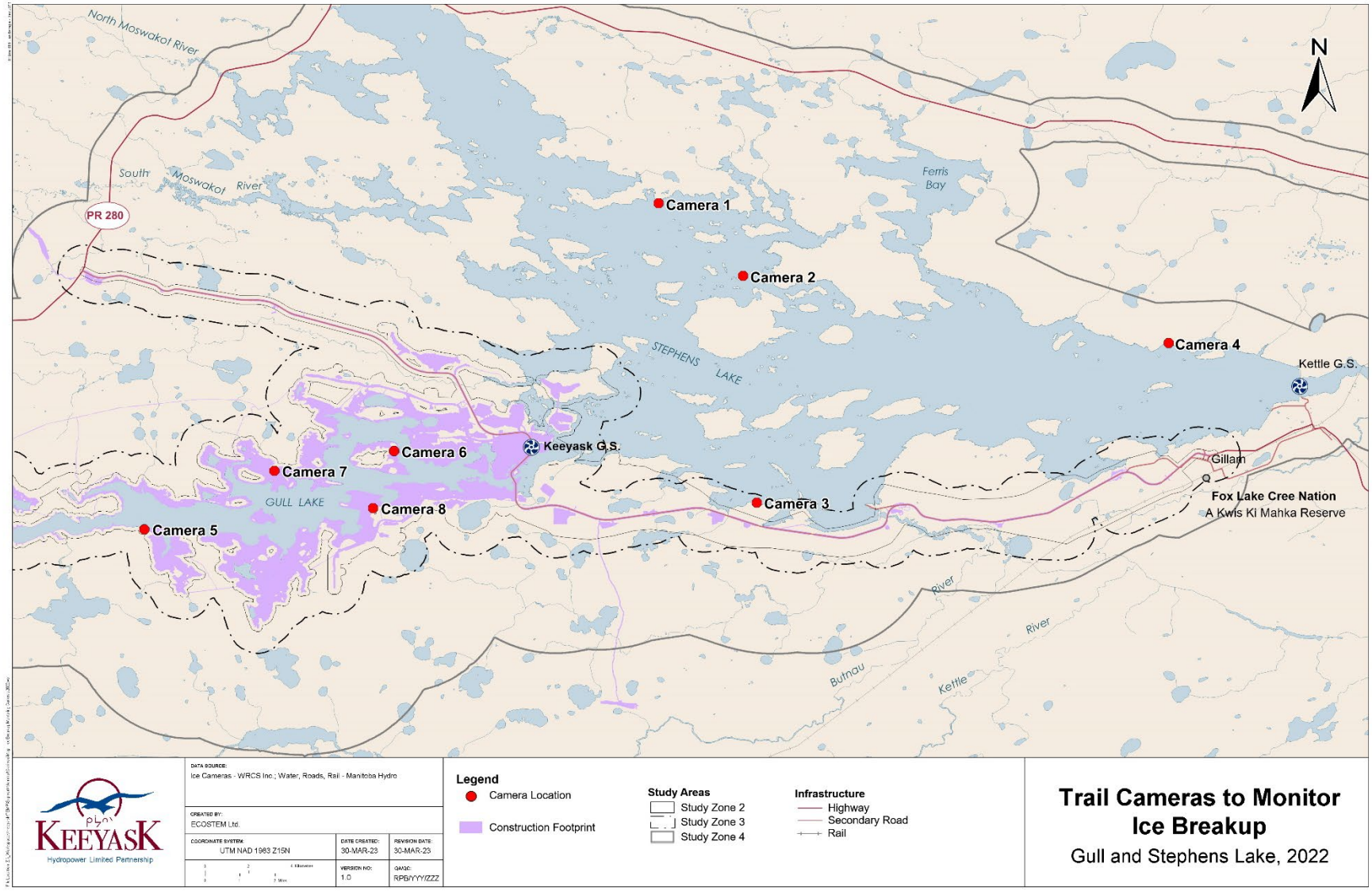
Complex Type	Number of Complexes
Project-affected, burned in 2013	3
Project-affected, not burned in 2013	8
Reference, burned in 2013	4
Reference, not burned in 2013	8
Random, burned in 2013	4
Random, not burned in 2013	5
Total	32



Map 2: Trail Cameras in Peatland Complexes, 2022

2.1.3 TIMING OF ICE BREAKUP

Four trail cameras were placed on the shores of or on islands in Stephens Lake and four were placed on the shores of or on islands in Gull Lake from April 19 to 22, 2022 to monitor the timing of ice breakup (Map 3). The trail cameras, which were set to take a picture of the lake every four hours during daylight hours, were removed in mid-July 2022. Ice coverage was estimated at 25% increments in each photograph from each camera. Ice breakup was defined as the date when all cameras on a lake indicated 25% or less ice coverage in view.



Map 3: Trail Cameras to Monitor Ice Breakup on Gull and Stephens Lakes, 2022

2.2 DATA ANALYSIS

The presence and general distribution of caribou on islands in lakes and in peatland complexes was examined in 2022 and from 2015 to 2021, during Project construction. Trail camera data for 116 islands in lakes and 32 peatland complexes that were surveyed for at least six years from 2015 to 2022 and 28 newly formed islands in the reservoir that were surveyed in 2021 and/or 2022 were analyzed by averaging the percentage of camera days (total number of days each camera was deployed and functional) during which caribou were photographed each year for an indication of the relative amount of caribou activity. A Mann-Whitney test was used to compare the percentage of camera days caribou were photographed on Project-affected and unaffected islands in lakes each year and a Kruskal-Wallis test was performed to compare the percentage of camera days caribou were photographed in Project-affected, reference, and random peatland complexes each year (McDonald 2014), with significance determined at the $\alpha = 0.05$ level. A Kruskal-Wallis test was also performed to compare the percentage of camera days caribou were photographed on Project-affected islands and Project-affected peatland complexes among survey years, to identify potential increases in caribou activity in affected calving and calf-rearing habitat during the first year of Project operation. Where a significant difference was found, a Dwass-Steel-Critchlow-Fligner test for pairwise comparisons (Systat Software Inc. 2009) was performed, also with significance determined at the $\alpha = 0.05$ level. Statistical tests were performed with SYSTAT 13.2.

3.0 RESULTS

3.1 ISLANDS IN LAKES

3.1.1 2022

In 2022, caribou were photographed on 39 of the 142 (27%) islands surveyed in 2022, including one of the newly formed islands in the reservoir (Map 4). Caribou calves (Photo 1) were photographed on eight (6%) of these islands, including one large island in the reservoir. Caribou were first photographed on the islands on May 8 and the first female was identified on June 7. From 2015 to 2021, the first adult was photographed between April 9 and June 28 and the first female was photographed between May 14 and June 7. The first caribou calf was photographed on June 4, 2022 (a cow and calf were photographed incidentally on an island in Stephens Lake by an ice breakup camera on May 23, 2022; see Section 3.4). In previous years caribou calves were first photographed on May 25, 2015; June 19, 2016; June 6, 2017; May 21, 2018; June 20, 2019, June 18, 2020, and June 20, 2021.

Moose were photographed on 38 islands in 2022, including five newly formed islands in the reservoir (Map 5). Moose calves (Photo 2) were photographed on 20 islands, three of which were formed after reservoir impoundment. The first moose calf was photographed on May 25, 2022. In previous survey years, moose calves were first photographed on June 3, 2015; May 29, 2016; May 31, 2017; June 12, 2018; June 9, 2019, June 13, 2020, and June 13, 2021.

The number of islands occupied by caribou and moose in 2022 appeared to peak in June and July, and then declined in August and September (Table 2). Few predators (black bear; Photo 3 and gray wolf; Photo 4) were captured on trail cameras (Map 6). Gray wolves were photographed on two islands and black bears were photographed on 11. Caribou and black bear were photographed on one common island (Table 3; Map 7). Forty-eight days separated the observations of each species. Moose and black bear were photographed on three of the same islands. A minimum of 14 and a maximum of 44 days separated the observations. No gray wolves were photographed on the same island as caribou or moose. Caribou and moose were photographed on 12 (8%) of the same islands in 2022 (Map 7); 31% of the 39 islands occupied by caribou were also occupied by moose. No wolverines (*Gulo gulo*), uncommon predators in the Keeyask region, were photographed on islands in lakes during the sensory disturbance study in 2022. A wolverine was photographed incidentally by an ice breakup camera on the same island in Stephens Lake as a caribou cow and calf (see Section 3.4), with 14 days separating the observations.

Table 2: Number of Islands in Lakes Occupied by Large Mammals Monthly, 2022

Species	April	May	June	July	August	September	All
Caribou	0	3	20	21	16	6	39
Caribou calf	0	0	3	5	3	0	8
Moose	0	6	23	20	6	6	38
Moose calf	0	1	13	12	4	1	20
Black bear	0	4	1	1	7	0	11
Gray wolf	1	0	0	1	1	0	2

Table 3: Nearest Dates on Which Caribou or Moose and Predators Were Photographed on the Same Islands in Lakes, 2022

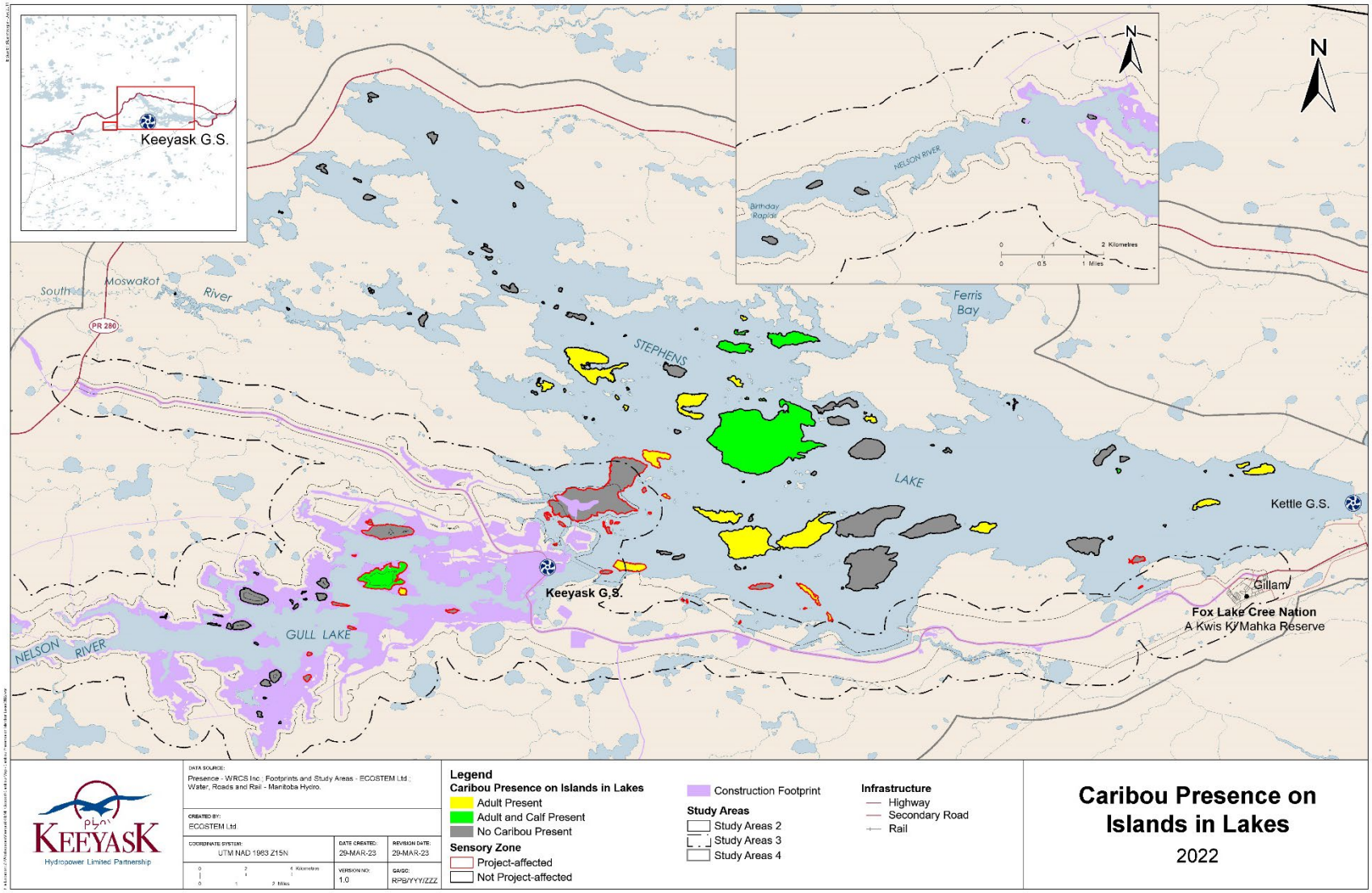
Island	Caribou	Moose	Black Bear	Gray Wolf
KI124080	June 13	–	July 31	–
KI124083	–	May 21	May 7	–
KI124092	–	June 5	May 17	–
KI124142	–	May 3	June 16	–

Photo 1: Caribou Calf on an Island in Stephens Lake on June 4, 2022

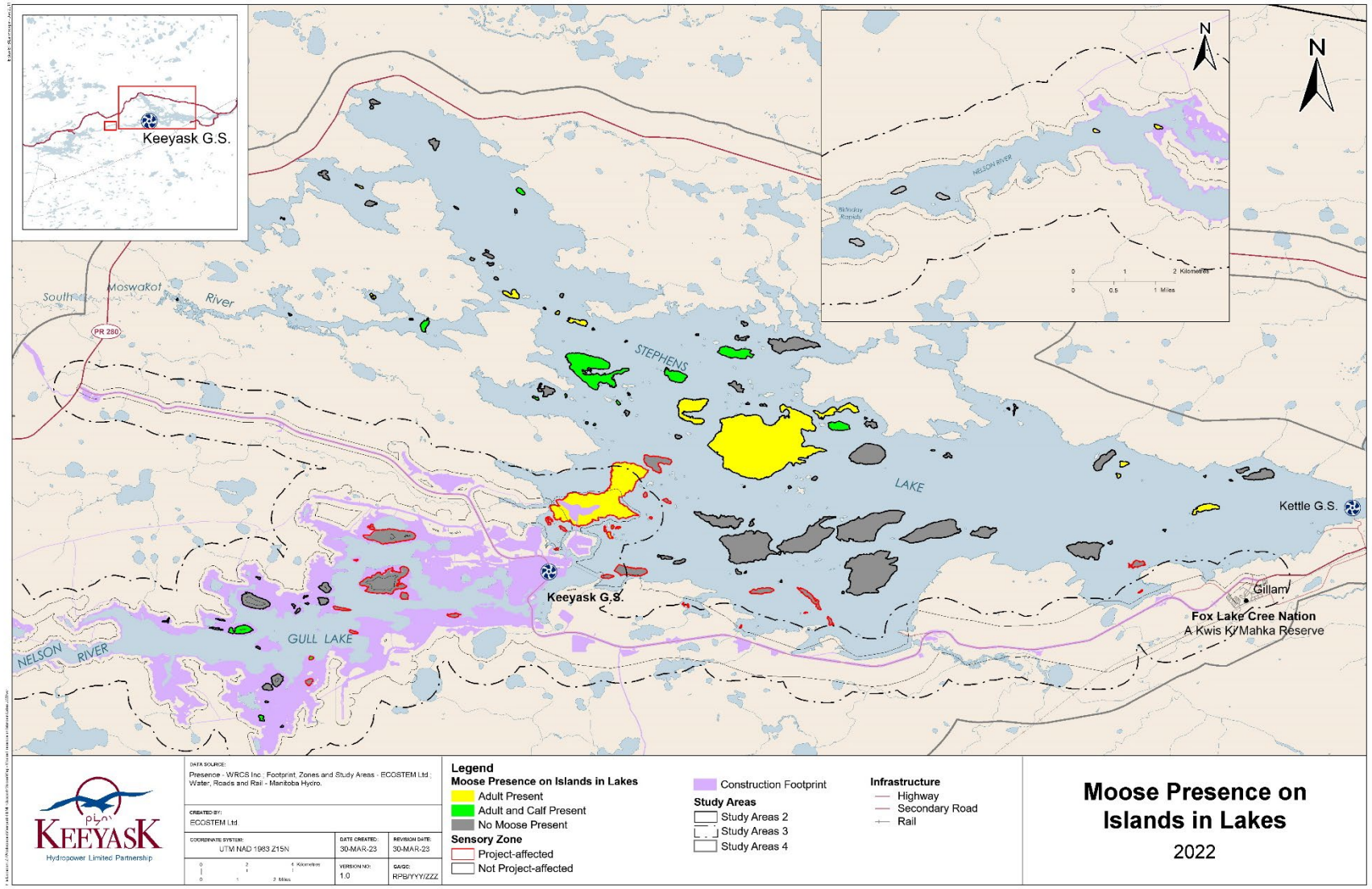
Photo 2: Moose Cow and Calves on a Newly Formed Island in Gull Lake on June 30, 2022

Photo 3: Black Bear on a Newly Formed Island in Gull Lake on August 27, 2022

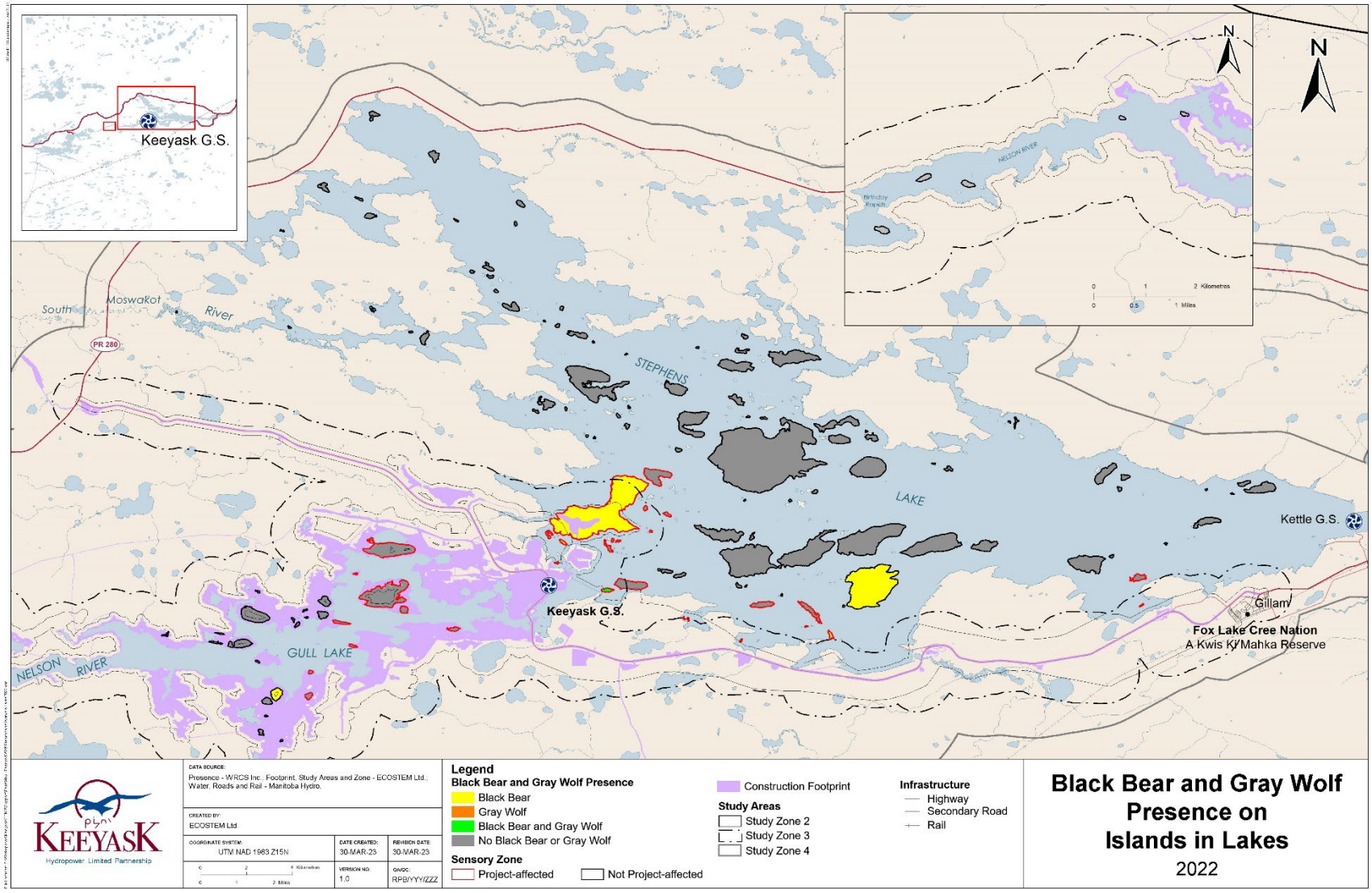
Photo 4: Gray Wolf on an Island in Stephens Lake on August 31, 2022



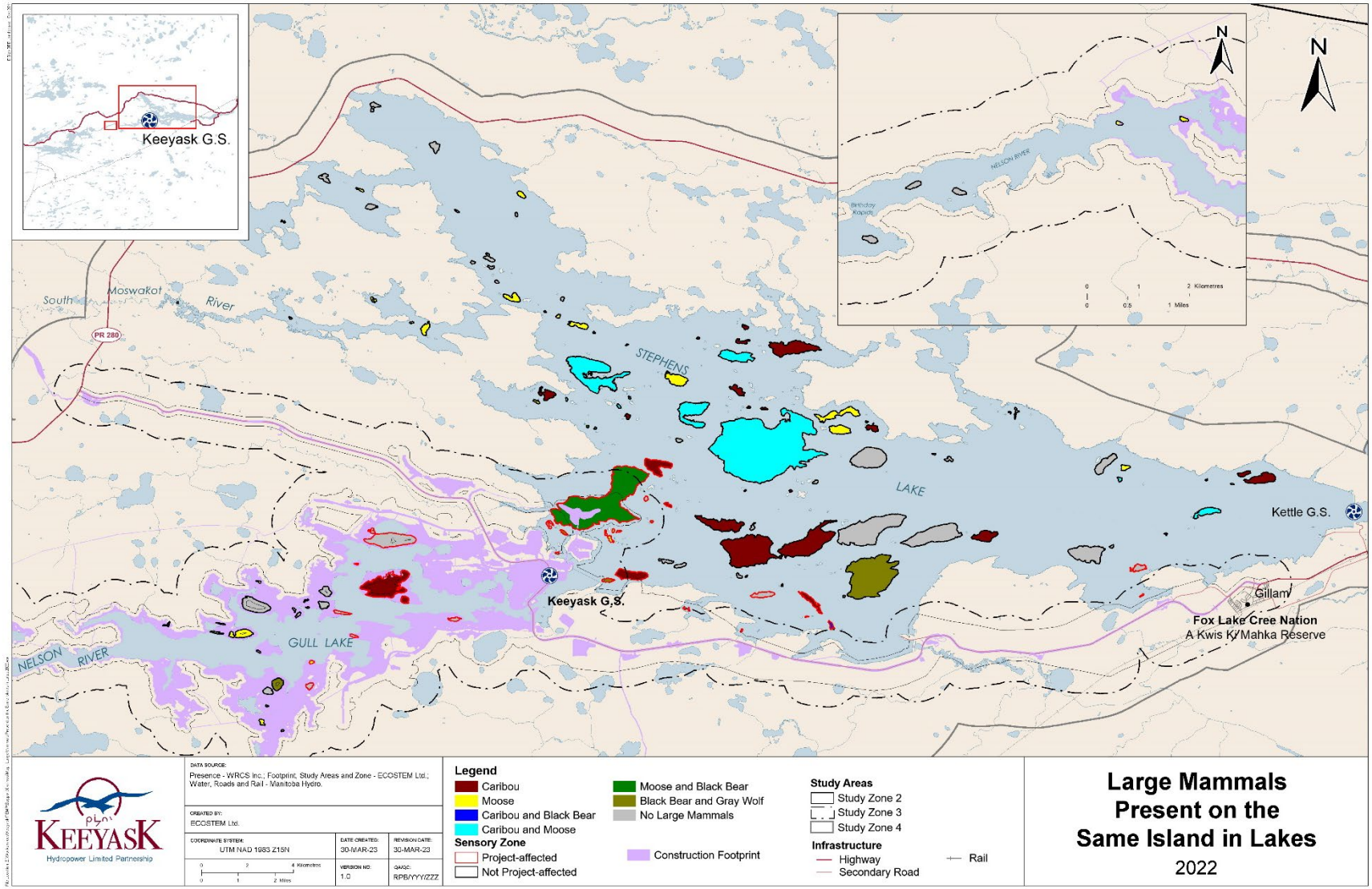
Map 4: Caribou Presence on Islands in Lakes, 2022



Map 5: Moose Presence on Islands in Lakes, 2022



Map 6: Black Bear and Gray Wolf Presence on Islands in Lakes, 2022



Map 7: Large Mammals Present on the Same Island in Lakes, 2022

3.1.2 CARIBOU 2015 TO 2022

Trail cameras were set up on 25 to 28 Project-affected islands in lakes and on 88 or 89 unaffected islands from 2015 to 2020. After reservoir impoundment, trail cameras were placed on 31 or 34 Project-affected islands and 107 or 108 unaffected islands in 2021 and 2022. No caribou were photographed on Project-affected islands in 2018 (Table 4). Caribou were photographed on 4 to 21% of Project-affected islands in other survey years. No caribou calves were photographed on Project-affected islands from 2016 to 2018 or in 2020. Calves were photographed on the same large Project-affected island in 2015, 2019, and 2022, and on a smaller island formed from it in 2021. Caribou and calves were photographed on unaffected islands in lakes each year, on 16 to 33% and 6 to 10% respectively, over the survey period. No caribou were photographed on newly formed unaffected islands in the reservoir in 2022, after having been photographed on two in 2021.

Table 4: Number and Percentage of Project-affected and Unaffected Islands in Lakes on Which Caribou and Calves Were Photographed, 2015–2022

Year	Project-affected				Unaffected			
	Number with Caribou	Percentage with Caribou	Number with Calves	Percentage with Calves	Number with Caribou	Percentage with Caribou	Number with Calves	Percentage with Calves
2015	1	4	1	4	15	17	5	6
2016	3	11	0	0	14	16	6	7
2017	2	8	0	0	17	19	9	10
2018	0	0	0	0	23	26	7	8
2019	5	19	1	4	21	24	5	6
2020	4	16	0	0	29	33	5	6
2021	5	16	1	3	30	28	7	7
2022	7	21	1	3	32	30	7	6

A total of 45 to 63 islands were surveyed from 2010 to 2014, before Project construction; 117 to 138 islands were surveyed from 2015 to 2021, during Project construction; and 142 islands were surveyed in 2022, the first year of Project operation monitoring. When the pre-construction, construction, and first-year operation periods were compared, the percentage of islands in lakes on which caribou were photographed declined from the pre-construction (Wildlife Resource Consulting Services MB Inc. [WRCS] unpublished data) to early construction (2015–2016) periods and then increased from 2017 to 2022 (Figure 1). The percentage of islands on which caribou were photographed from 2020 to 2022 was similar to 2014, before Project construction began. The percentage of islands on which calf activity was photographed was lower during the Project construction and early operation periods than before construction began.

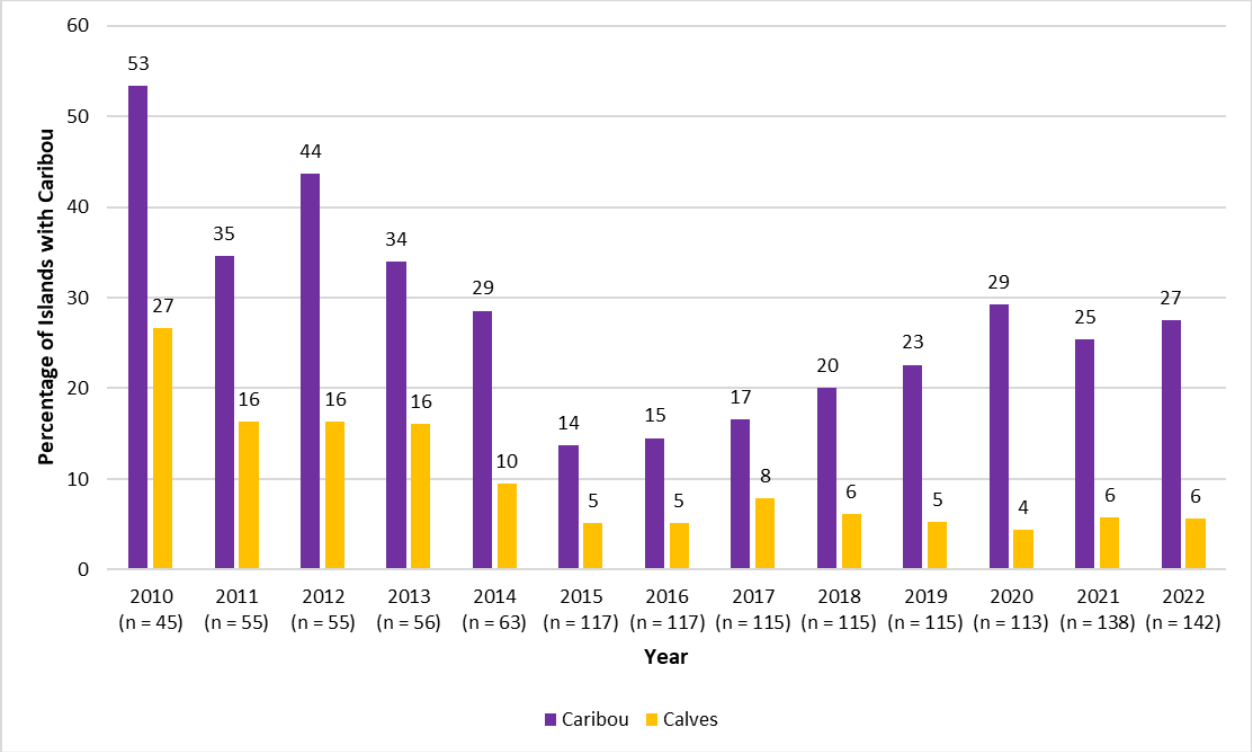


Figure 1: Percentage of Islands in Lakes on Which Caribou Were Photographed before (2010–2014), during (2015–2021), and after (2022) Project Construction

Between three and six Project-affected and 30 and 40 unaffected islands were surveyed from 2010 to 2014, before Project construction; between 25 and 31 Project-affected and 88 and 107 unaffected islands were surveyed from 2015 to 2021, during Project construction; and 34 Project-affected and 108 unaffected islands were surveyed in 2022, the first year of Project operation monitoring. The percentage of Project-affected islands on which caribou were detected varied during the pre-construction period (Figure 2). They were photographed on relatively few Project-affected islands during the early construction monitoring period (2015–2018) and on a slightly increasing percentage of the islands from 2019 to 2022. A similar trend was observed on unaffected islands, where caribou were photographed on the greatest percentage during the pre-construction period, followed by a decline in the early construction period (2015–2017), and an increase thereafter.

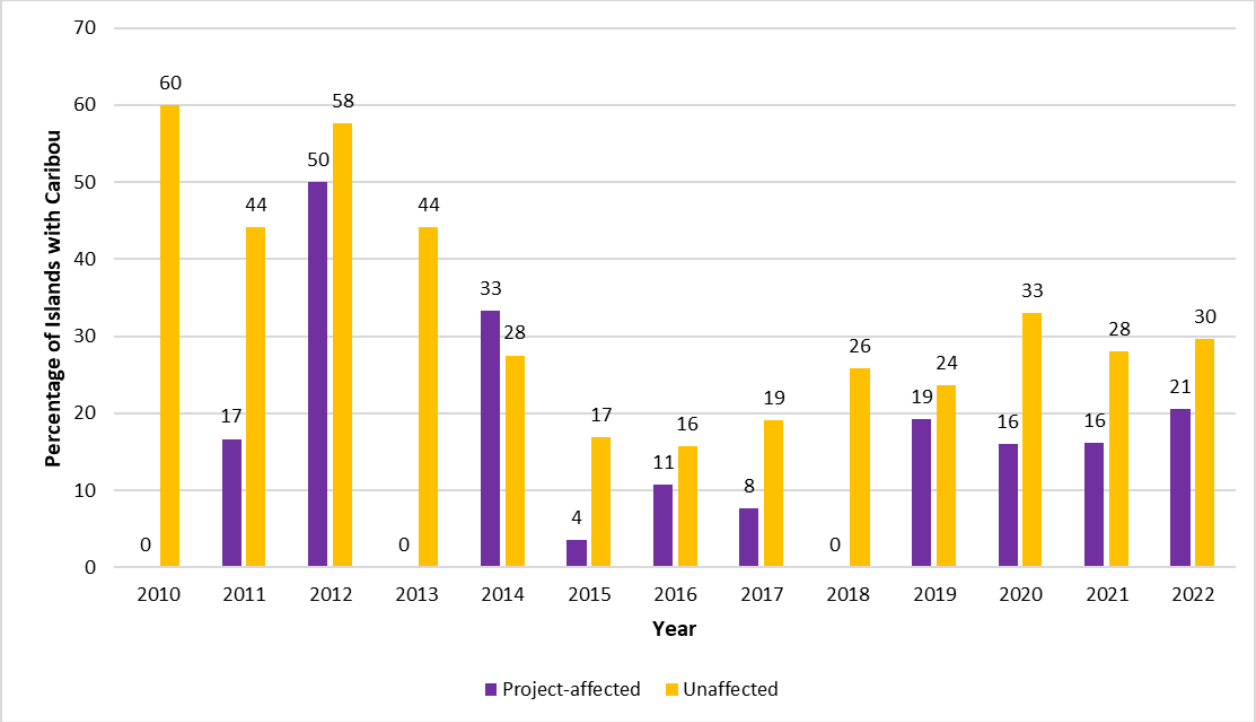


Figure 2: Percentage of Project-affected and Unaffected Islands in Lakes on Which Caribou Were Photographed before (2010–2014), during (2015–2021), and after (2022) Project Construction

Relatively little caribou calf activity was photographed on islands in lakes from 2010 to 2022 (Figure 3). Where they were observed, calves were photographed on the greatest percentage of Project-affected and unaffected islands from 2010 to 2013, before Project construction. No calves were photographed on Project-affected islands in 2010, 2013, or 2014. During and after construction, calves were only photographed on Project-affected islands in 2015, 2019, 2021, and 2022. Calves were photographed on 6 to 10% of unaffected islands during the construction (2015–2021) and early operation (2022) monitoring periods.

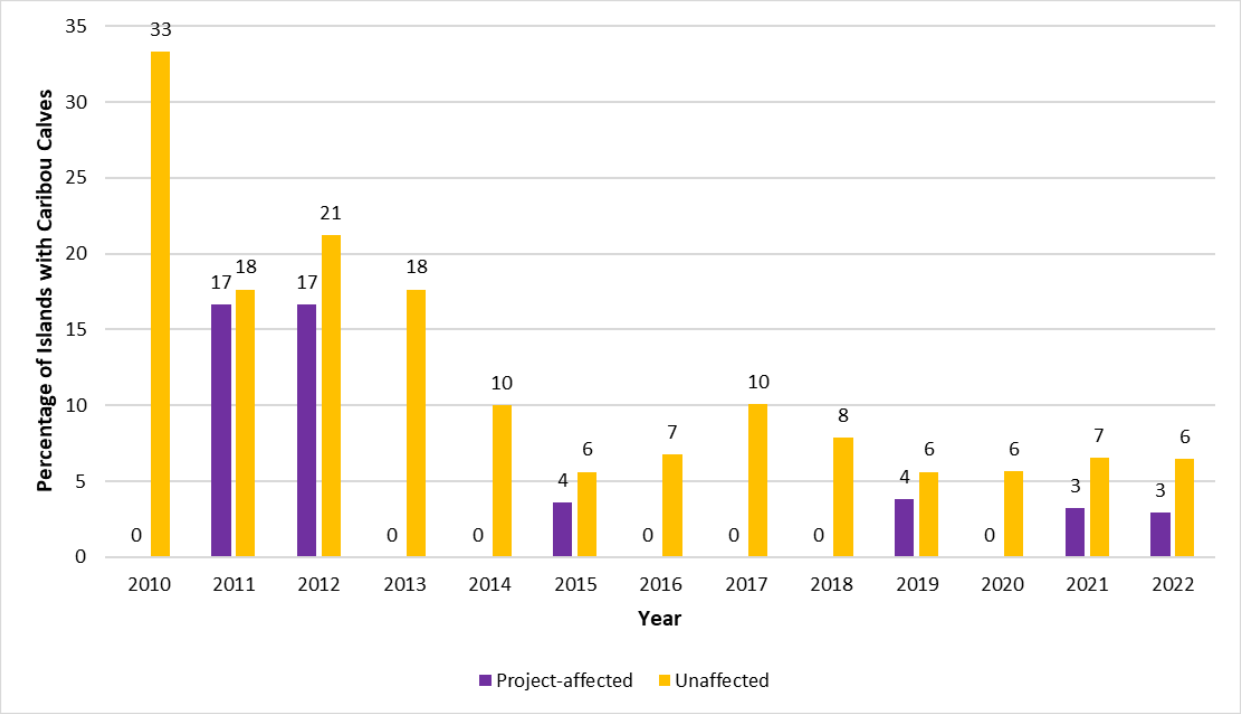


Figure 3: Percentage of Project-affected and Unaffected Islands in Lakes on Which Caribou Calves Were Photographed before (2010–2014), during (2015–2021), and after (2022) Project Construction

Trail cameras were deployed relatively continuously on 116 islands in lakes over the 2015 to 2022 monitoring period, 26 Project-affected and 90 unaffected. Of these, caribou were photographed on 68 (59%) during at least one year. Caribou were photographed every year on five unaffected islands in Stephens Lake. No caribou were ever photographed on 48 of the 116 islands (41%). Cameras were placed on six or eight Project-affected and 18 unaffected islands formed in the reservoir after impoundment in 2021 and 2022 (Appendix 1, Table A-3), for a total of 34 Project-affected and 110 unaffected islands surveyed those two years. There was no significant difference in the percentage of camera days caribou were photographed on Project-affected versus unaffected islands every year except one (Table 5). In 2018, caribou were photographed on a significantly greater percentage of camera days on unaffected islands because no caribou were photographed on Project-affected islands that year. There was no significant difference in the percentage of camera days caribou were photographed on Project-affected islands among the eight survey years (Kruskal-Wallis $H = 9.87$, $p = 0.20$).

Table 5: Mean Percentage of Camera Days That Caribou Were Photographed on Project-affected and Unaffected Islands in Lakes, 2015–2022

	Project-affected			Unaffected				
Year	Mean	SD	Rank Sum	Mean	SD	Rank Sum	*U*	*p*
2015	0.05	0.23	1,329.50	0.31	0.94	5,111.50	978.50	0.09
2016	0.10	0.30	1,392.00	0.35	0.98	4,824.00	1,041.00	0.48
2017	0.09	0.38	1,354.50	0.47	1.30	5,200.50	1,003.50	0.14
2018	0	0	1,209.00	0.49	1.17	5,461.00	858.00	0.00
2019	0.13	0.30	1,430.50	0.42	0.99	5,239.50	1,079.50	0.48
2020	0.15	0.42	1,283.00	0.56	1.14	5,272.00	932.00	0.07
2021	0.15	0.40	1,938.50	0.53	1.20	7,652.50	1,442.50	0.15
2022	0.30	0.82	2,249.50	0.45	0.86	7,903.50	1,654.50	0.27

3.1.3 OTHER LARGE MAMMALS 2015 TO 2022

Trail cameras were set up on 25 to 28 Project-affected islands in lakes and on 88 or 89 unaffected islands from 2015 to 2020. After reservoir impoundment, trail cameras were placed on 31 or 34 Project-affected islands and 107 or 108 unaffected islands in 2021 and 2022. In 2022, moose were photographed on 27% of the 142 islands surveyed and moose calves were photographed on 14%. Moose and calves were photographed on Project-affected and unaffected islands in lakes each year. Moose were photographed on 8 to 46% of Project-affected islands from 2015 to 2022 (Table 6). Moose calves were photographed on 3 to 18% of Project-affected islands over the same period. Moose were photographed on 18 to 45% and calves were photographed on 9 to 22% of unaffected islands over the survey period. Moose were detected on one newly formed, Project-affected island in the reservoir and on four new unaffected islands in 2022, after having been photographed on two Project-affected and four unaffected newly formed islands in 2021.

Table 6: Number and Percentage of Project-affected and Unaffected Islands in Lakes on Which Moose and Calves Were Photographed, 2015–2022

	Project-affected				Unaffected			
Year	Number with Moose	Percentage with Moose	Number with Calves	Percentage with Calves	Number with Moose	Percentage with Moose	Number with Calves	Percentage with Calves
2015	11	39	3	11	38	43	16	18
2016	13	46	5	18	40	45	20	22
2017	12	46	4	15	30	34	9	10
2018	11	42	4	15	25	28	10	11
2019	8	31	3	12	28	31	9	10
2020	2	8	1	4	16	18	8	9
2021	7	23	1	3	38	36	19	18
2022	5	15	3	9	33	31	17	16

In 2022, black bears were photographed on 11 of the 142 (8%) islands surveyed and gray wolves were photographed on two (1%). Predators were relatively uncommon on the islands from 2015 to 2022. Black bears were photographed on 4 to 19% of Project affected islands and on 2 to 7% of unaffected islands over the eight-year survey period (Table 7). No gray wolves were photographed on Project-affected islands from 2016 to 2018. Wolves were photographed on 4 to 10% of Project-affected islands in the years they were observed. Gray wolves were only photographed on unaffected islands in 2017 and 2019.

Table 7: Number and Percentage of Project-affected and Unaffected Islands in Lakes on Which Black Bear and Gray Wolf Were Photographed, 2015–2022

	Project-affected				Unaffected			
Year	Number with Bears	Percentage with Bears	Number with Wolves	Percentage with Wolves	Number with Bears	Percentage with Bears	Number with Wolves	Percentage with Wolves
2015	4	14	1	4	2	2	0	0
2016	3	11	0	0	4	4	0	0
2017	2	8	0	0	3	3	2	2
2018	2	8	0	0	3	3	0	0
2019	1	4	1	4	3	3	1	1
2020	3	12	1	4	2	2	0	0
2021	6	19	3	10	7	7	0	0
2022	5	15	2	6	6	6	0	0

3.2 PEATLAND COMPLEXES

3.2.1 2022

In 2022, caribou were photographed in six of the 32 (19%) peatland complexes surveyed (Map 8). Caribou calves (Photo 5) were photographed in three peatland complexes. Caribou were first photographed in peatland complexes on April 27 and the first female was identified on April 29. From 2015 to 2021, the first adult was photographed between April 21 and June 13. The first caribou calf was photographed on July 18, 2022. In previous years caribou calves were first photographed on June 13, 2015; June 6, 2016; September 1, 2017; June 30, 2018; and June 20, 2020. No caribou calves were photographed in peatland complexes in 2019 or 2021.

In 2022, no caribou or calves were photographed in burned peatland complexes (Table 8). No caribou were photographed in Project-affected complexes. Caribou were photographed in 38% of unburned reference complexes and in 60% of unburned reference complexes. Caribou calves were also photographed in unburned reference and random complexes.

Table 8: Peatland Complexes in Which Caribou Were Photographed by Disturbance Source and Forest Fire Influence, 2022

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
Reference	Yes	0	0	0	0
	No	3	38	2	25
Random	Yes	0	0	0	0
	No	3	60	1	20

Moose (Photo 6) were photographed in five peatland complexes in 2022 (Map 9). No moose calves were photographed. The first adult was observed on April 27, 2022. From 2015 to 2021, adults were first photographed between April 6 and May 16. In previous years moose calves were first photographed on June 17, 2015; July 29, 2019; May 11, 2020; and June 24, 2021. No moose calves were photographed in peatland complexes from 2016 to 2018.

In 2022, moose were photographed in burned and unburned peatland complexes (Table 9). They were photographed in the greatest percentage of burned Project-affected complexes (33%) and were not photographed in unburned reference complexes. No moose calves were photographed in peatland complexes in 2022. Black bears were photographed in the greatest percentage of burned Project-affected complexes and were not photographed in burned random complexes. No gray wolves or wolverines were photographed in peatland complexes in 2022.

Table 9: Peatland Complexes in Which Moose and Black Bear Were Photographed by Disturbance Source and Forest Fire Influence, 2022

Complex Type	Burned in 2013	Moose		Moose Calf		Black Bear	
		Number Occupied	Percentage Occupied	Percentage Occupied	Percentage Occupied	Number Occupied	Percentage Occupied
Project-affected	Yes	1	33	0	0	2	67
	No	1	13	0	0	2	25
Reference	Yes	1	25	0	0	2	50
	No	0	0	0	0	3	38
Random	Yes	1	25	0	0	0	0
	No	1	20	0	0	1	20

In 2022, the number of peatland complexes occupied by caribou and moose appeared to peak in July, and then declined in August and September (Table 10). Black bears (Photo 7) were photographed in more peatland complexes (Map 10) than caribou or moose. Caribou and black bear were photographed in two of the same complexes (Table 11; Map 11). Forty-five days and one day separated the observations of each species. Moose and black bear were photographed in one common complex. Twenty-three days separated the observations. Caribou and moose

were photographed in one (3%) common complex in 2022; 17% of the six complexes occupied by caribou were also occupied by moose.

Table 10: Number of Peatland Complexes Occupied Monthly by Large Mammals, 2022

Species	April	May	June	July	August	September	All
Caribou	2	2	1	4	3	1	6
Caribou calf	0	0	0	3	0	0	3
Moose	1	2	3	4	1	2	5
Moose calf	0	0	0	0	0	0	0
Black bear	0	1	6	0	2	2	10
Gray wolf	0	0	0	0	0	0	0

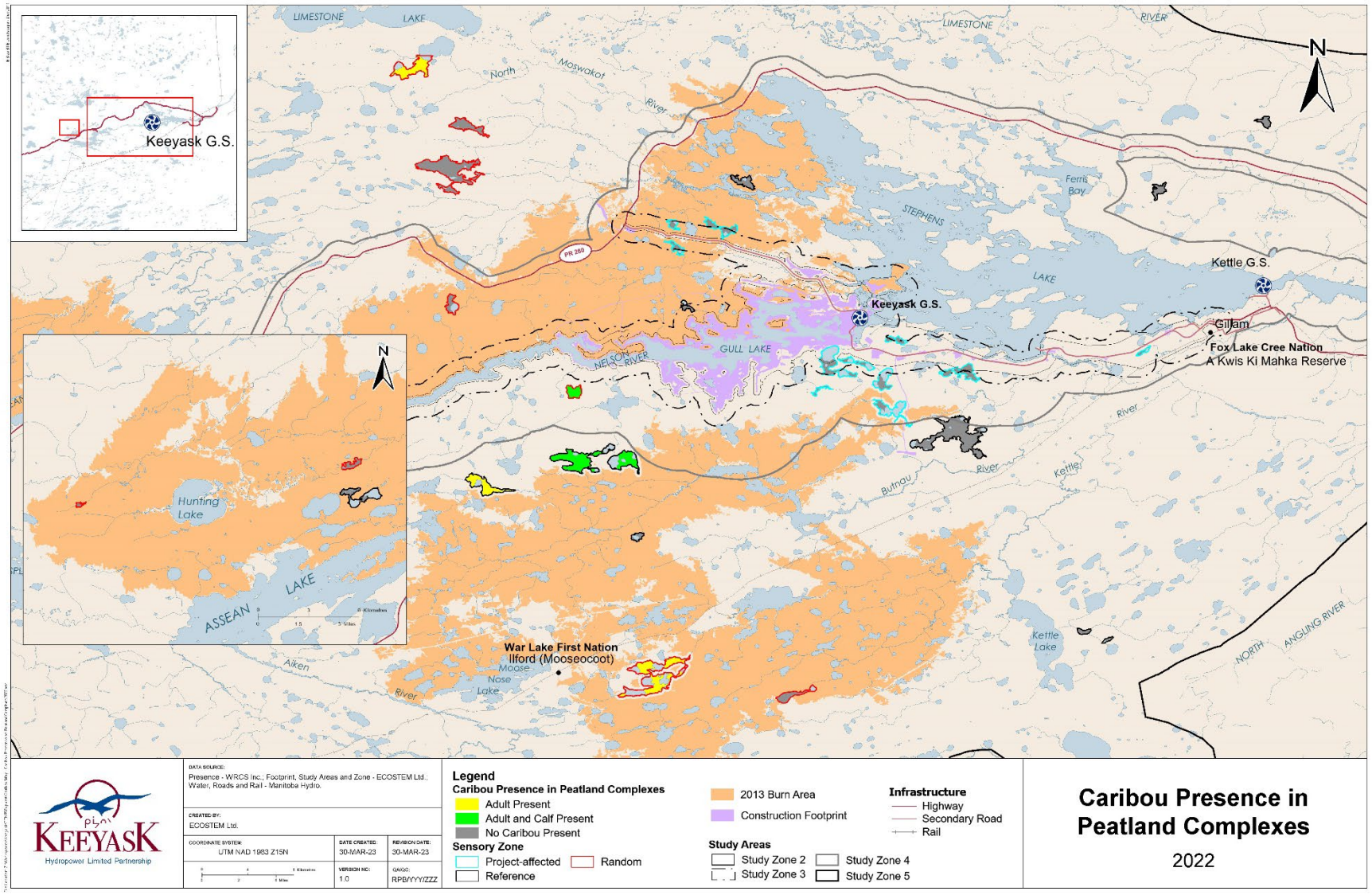
Table 11: Nearest Dates on Which Caribou or Moose and Predators Were Photographed in the Same Peatland Complexes, 2022

Complex	Caribou	Moose	Black Bear	Gray Wolf
KV097000	July 24	–	September 7	–
KV103000	–	May 30	June 22	–
KV107000	August 6	–	August 7	–

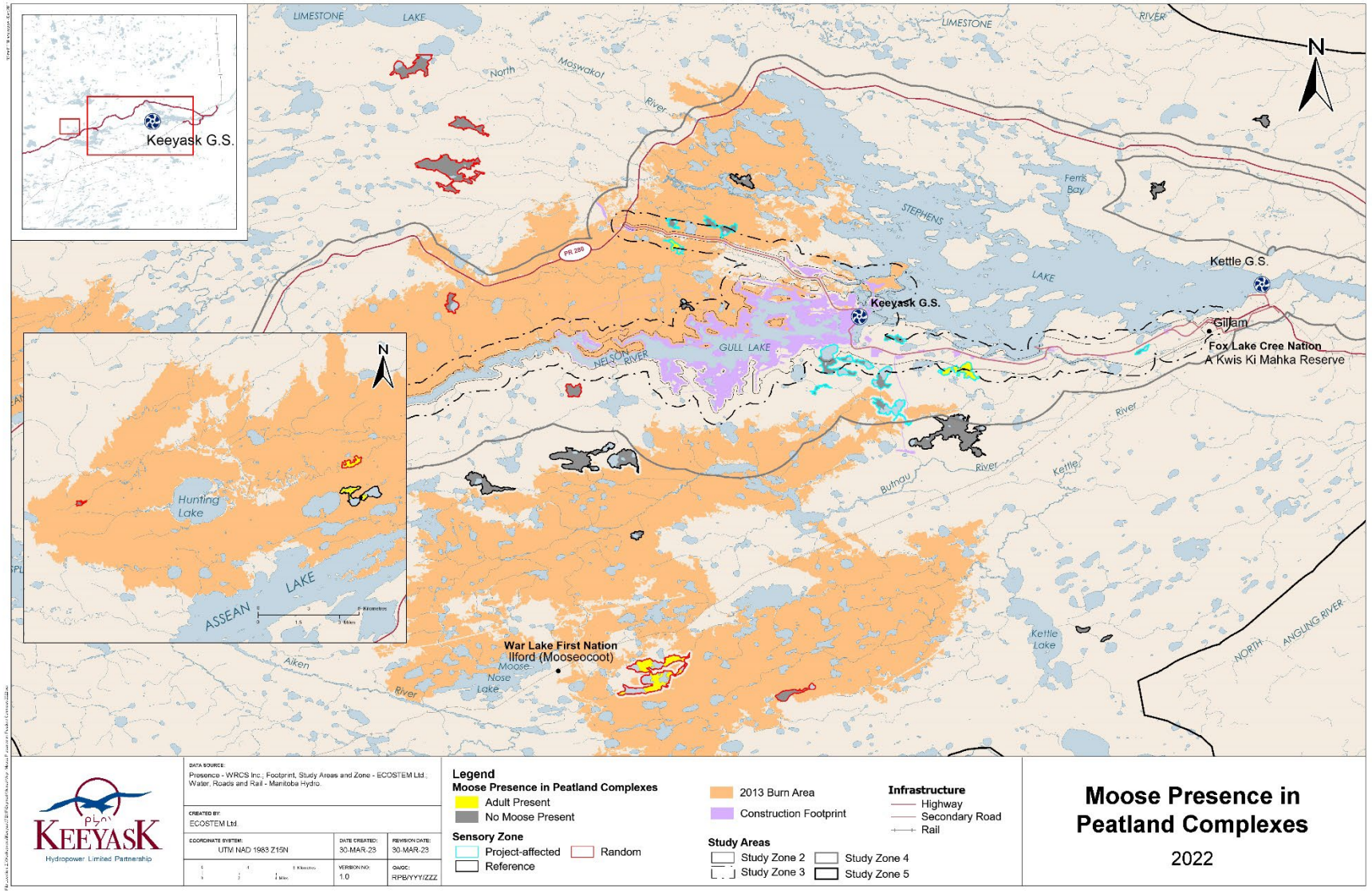
Photo 5: Caribou and Calf in a Peatland Complex on July 24, 2022

Photo 6: Bull Moose in a Peatland Complex on September 10, 2022

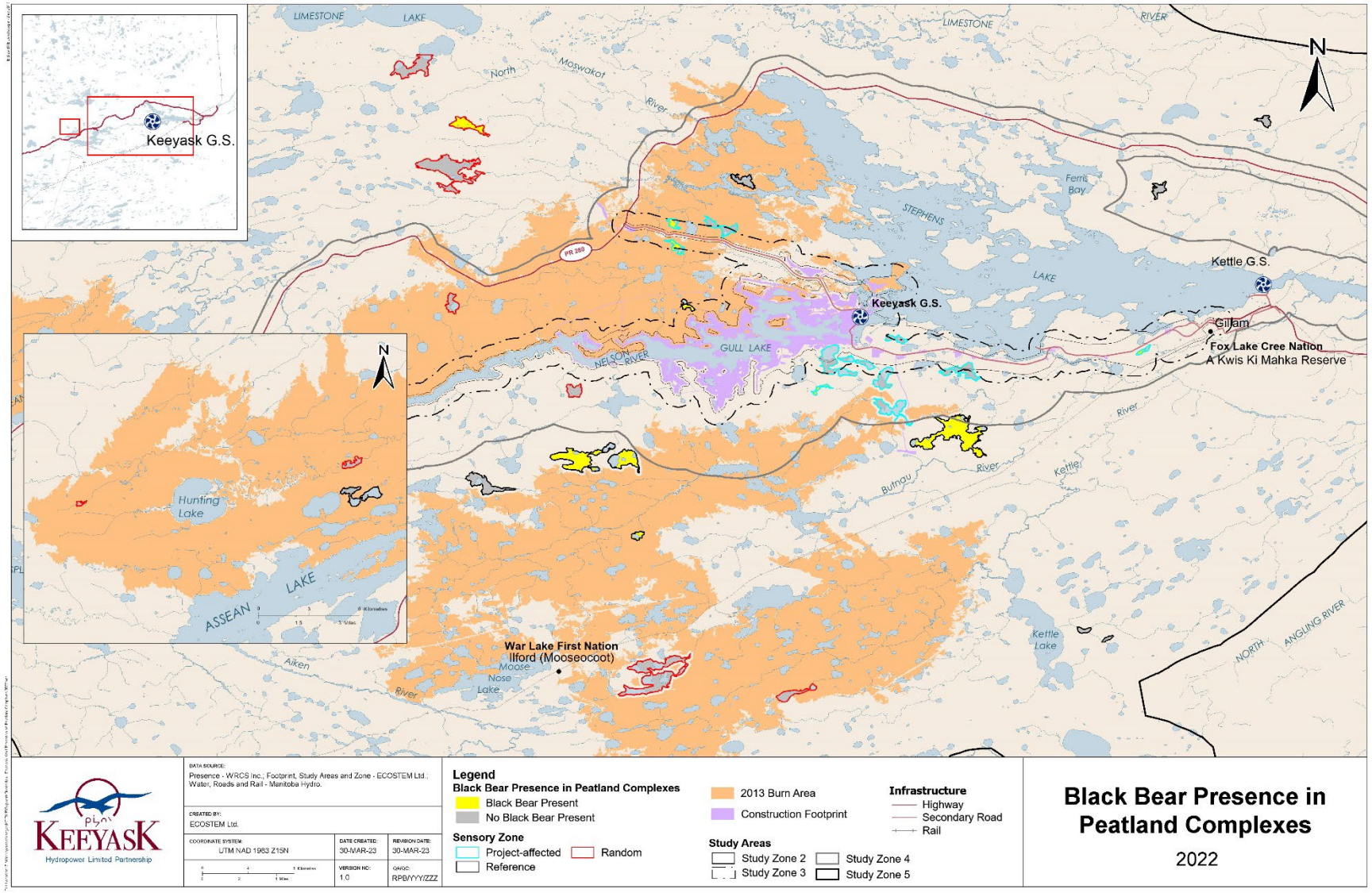
Photo 7: Black Bear in a Peatland Complex on June 1, 2022



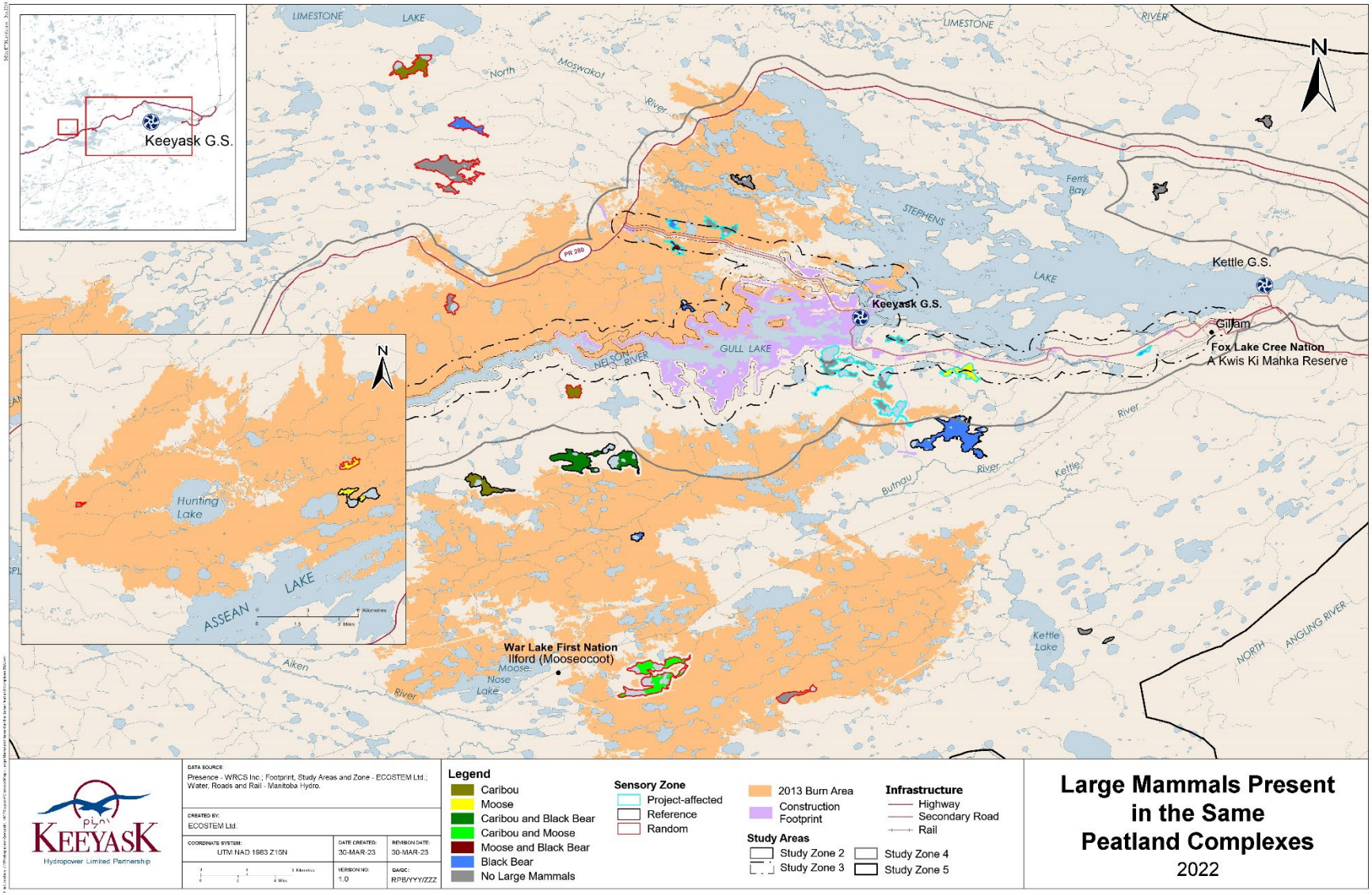
Map 8: Caribou Presence in Peatland Complexes, 2022



Map 9: Moose Presence in Peatland Complexes, 2022



Map 10: Black Bear Presence in Peatland Complexes, 2022



Map 11: Large Mammals Present in the Same Peatland Complexes, 2022

3.2.2 CARIBOU 2015 TO 2022

Trail cameras were placed in 32 peatland complexes from 2015 to 2020 and in 2022 and were placed in 31 complexes in 2021. Caribou were photographed in 0 to 18% of Project-affected peatland complexes over the survey period (Table 12). They were photographed in 8 to 33% of reference complexes and 0 to 33% of random complexes from 2015 to 2022.

Table 12: Number and Percentage of Peatland Complexes in Which Caribou Were Photographed, 2015–2022

	Project-affected		Reference		Random	
Year	Number	Percentage	Number	Percentage	Number	Percentage
2015	1	9	1	8	2	22
2016	2	18	1	8	1	11
2017	2	18	1	8	0	0
2018	0	0	4	33	2	22
2019	0	0	1	8	3	33
2020	2	18	3	25	2	22
2021	0	0	2	17	3	33
2022	0	0	3	25	3	33

No caribou calves were photographed in Project-affected peatland complexes from 2015 to 2022 (Table 13). They were photographed in relatively few reference complexes over the same period. Calves were generally photographed in the greatest percentage of random complexes, ranging from 0 to 22%. No calves were photographed in any complex in 2019 and 2021.

Table 13: Number and Percentage of Peatland Complexes in Which Caribou Calves Were Photographed, 2015–2022

	Project-affected		Reference		Random	
Year	Number	Percentage	Number	Percentage	Number	Percentage
2015	0	0	0	0	1	11
2016	0	0	0	0	1	11
2017	0	0	1	8	0	0
2018	0	0	1	8	2	22
2019	0	0	0	0	0	0
2020	0	0	0	0	1	11
2021	0	0	0	0	0	0
2022	0	0	2	17	1	11

Trail cameras were placed in 11 Project-affected, 12 reference, and nine random peatland complexes most years from 2015 to 2022 (Appendix 1, Table A-4). Caribou were photographed in four (36%) Project-affected, five (42%) reference, and six (67%) random complexes at least one year over the survey period. No caribou were ever photographed in 17 (53%) of the

complexes. There was no significant difference in the number of camera days caribou were photographed among Project-affected, reference, and random peatland complexes in any year (Table 14). Caribou were not photographed consistently in any peatland complex from 2015 to 2022. They were photographed in one random complex every year except 2017. There was no significant difference in the percentage of camera days caribou were photographed in Project-affected complexes among the eight survey years (Kruskal-Wallis $H = 8.20$, $p = 0.32$).

Table 14: Mean Percentage of Camera Days That Caribou Were Photographed in Project-affected, Reference, and Random Peatland Complexes, 2015–2022

	Project-affected			Reference			Random				
Year	Mean	SD	Rank Sum	Mean	SD	Rank Sum	Mean	SD	Rank Sum	*H*	*p*
2015	0.19	0.63	175.00	0.27	0.94	190.50	0.50	1.29	162.50	1.04	0.59
2016	0.49	1.43	192.50	0.05	0.19	188.50	0.22	0.65	147.00	0.65	0.72
2017	0.48	1.21	198.00	0.05	0.18	195.00	0	0	135.00	2.03	0.36
2018	0	0	148.50	0.34	0.60	226.00	0.22	0.47	153.50	4.09	0.13
2019	0	0	159.50	0.25	0.86	191.00	0.80	1.23	177.50	4.87	0.09
2020	0.16	0.37	173.00	0.43	1.16	204.50	0.26	0.59	150.50	0.23	0.89
2021	0	0	135.00	0.22	0.51	192.00	0.50	0.84	169.00	3.89	0.14
2022	0	0	148.50	0.48	1.03	210.50	0.86	1.90	169.00	3.89	0.14

3.2.3 OTHER LARGE MAMMALS 2015 TO 2022

Trail cameras were placed in 32 peatland complexes from 2015 to 2020 and in 2022 and were placed in 31 complexes in 2021. Moose were photographed in 9 to 20% of Project-affected complexes, 8 to 42% of reference complexes, and 11 to 33% of random complexes from 2015 to 2022 (Table 15). Moose calves were photographed in 0 to 10% of Project-affected complexes, 0 to 8% of reference complexes, and 0 to 11% of random complexes over the same period (Table 16).

Table 15: Number and Percentage of Peatland Complexes in Which Moose Were Photographed, 2015–2022

	Project-affected		Reference		Random	
Year	Number	Percentage	Number	Percentage	Number	Percentage
2015	2	18	5	42	1	11
2016	2	18	2	17	1	11
2017	1	9	1	8	2	22
2018	2	18	2	17	2	22
2019	2	18	3	25	2	22
2020	2	18	1	8	3	33
2021	2	20	2	17	1	11
2022	2	18	1	8	2	22

Table 16: Number and Percentage of Peatland Complexes in Which Moose Calves Were Photographed, 2015–2022

	Project-affected		Reference		Random	
Year	Number	Percentage	Number	Percentage	Number	Percentage
2015	1	9	0	0	1	11
2016	0	0	0	0	1	11
2017	0	0	0	0	0	0
2018	0	0	0	0	0	0
2019	1	9	1	8	1	11
2020	1	9	0	0	0	0
2021	1	10	0	0	0	0
2022	0	0	0	0	0	0

From 2015 to 2022, black bears were photographed in 9 to 36% of Project-affected peatland complexes, 0 to 42% of reference complexes, and 0 to 33% of random complexes (Table 17). Gray wolves were photographed in 0 to 27% of Project-affected complexes over the same period (Table 18). Wolves were only photographed in reference complexes in 2021 and in random complexes in 2019.

Table 17: Number and Percentage of Peatland Complexes in Which Black Bears Were Photographed, 2015–2022

	Project-affected		Reference		Random	
Year	Number	Percentage	Number	Percentage	Number	Percentage
2015	1	9	1	8	1	11
2016	2	18	1	8	1	11
2017	0	0	0	0	2	22
2018	2	18	4	33	0	0
2019	2	18	4	33	0	0
2020	1	9	2	17	3	33
2021	3	30	2	17	0	0
2022	4	36	5	42	1	11

Table 18: Number and Percentage of Peatland Complexes in Which Gray Wolves Were Photographed, 2015–2022

	Project-affected		Reference		Random	
Year	Number	Percentage	Number	Percentage	Number	Percentage
2015	0	0	0	0	0	0
2016	0	0	0	0	0	0
2017	3	27	0	0	0	0
2018	1	9	0	0	0	0
2019	0	0	0	0	1	11
2020	0	0	0	0	0	0
2021	1	10	1	8	0	0
2022	0	0	0	0	0	0

3.3 INCIDENTAL OBSERVATIONS 2022

In 2022, mammal and bird species incidentally photographed on islands in lakes and in peatland complexes included: American crow, American marten, American robin, bald eagle (Photo 8), Canada goose, Canada jay, common raven, long-eared owl, Canada lynx (Photo 9), merlin, mink, northern flicker (Photo 10), red fox, red squirrel, North American river otter (Photo 11), rusty blackbird, ruffed grouse, sandhill crane, snowshoe hare, spruce grouse, sharp-tailed grouse, and yellow warbler.

Photo 8: Juvenile Bald Eagle on May 27, 2022

Photo 9: Canada Lynx on April 23, 2022

Photo 10: Northern Flicker on May 7, 2022

Photo 11: North American River Otter on April 28, 2022

3.4 TIMING OF ICE BREAKUP

Four cameras were placed at Stephens Lake and four cameras were placed at Gull Lake to monitor the timing of ice breakup in 2022. Two of the cameras at Stephens Lake malfunctioned. Ice breakup on Stephens Lake was on June 2 and the lake was ice-free by June 7 (Table 19; Photo 12 to Photo 16). Ice breakup was May 28 on Gull Lake, with no ice remaining on May 30. A wolverine (Photo 17) and a caribou cow and calf (Photo 18) were photographed incidentally on the same island in Stephens Lake in May.

From 2015 to 2021, four cameras were placed at Stephens Lake to monitor the timing of ice breakup. One camera was placed at Gull Lake from 2017 to 2020 and three more were added in 2021. In previous survey years ice breakup on Stephens Lake was observed by June 2, 2015; May 20, 2016; June 2, 2017; May 27, 2018; May 23, 2019; May 26, 2020; and June 6, 2021. Stephens Lake was free of ice by June 3, 2015; May 22, 2016; June 3, 2017; June 4, 2018; May 25, 2019; June 1, 2020; and June 12, 2021 (Table 20). In 2021, ice breakup on Gull Lake was May 28, with no ice remaining on May 30.

Table 19: Timing of Ice Breakup on Stephens and Gull Lakes, 2022

Percent Ice Cover	Stephens Lake Cameras				Gull Lake Cameras			
	1	2	3	4	5	6	7	8
100	April 21	–	–	April 20	April 19	April 22	April 19	April 22
75	May 8	–	–	May 9	May 7	May 7	May 9	May 7
50	May 29	–	–	May 22	May 18	May 26	May 21	May 16
25	June 2	–	–	May 23	May 21	May 28	May 23	May 20
0	June 7	–	–	May 28	May 27	May 29	May 29	May 24

Table 20: Timing of Ice Breakup on Stephens Lake, 2015–2021

Percent Ice Cover	2015	2016	2017	2018	2019	2020	2021
100	May 9–12	April 27–29	April 11–16	April 7–11	April 6–7	March 25–28	April 12–17
75	May 20–27	May 8–17	May 20–31	May 20–24	April 20–28	April 29–30	May 16–30
50	May 23–June 1	May 10–19	May27–June 1	May 22–24	May 18–20	May 20–26	May 26–June 3
25	May 25–June 2	May 14–20	May 27–June 2	May 23–27	May 19–23	May 25–26	May 27—June 6
0	May 26–June 3	May 18–22	May 28–June 3	May 28–June 4	May 21–25	May 28–June 1	May 31—June 12

Photo 12: Ice Cover at 100% on Gull Lake on April 19, 2022

Photo 13: Ice Cover at 75% on Gull Lake on May 7, 2022

Photo 14: Ice Cover at 50% on Gull Lake on May 18, 2022

Photo 15: Ice Cover at 25% on Gull Lake on May 21, 2022

Photo 16: Ice Cover at 0% on Gull Lake on May 27, 2022

Photo 17: Wolverine on an Island in Stephens Lake on May 9, 2022

Photo 18: Caribou and Calf on an Island in Stephens Lake on May 23, 2022

4.0 DISCUSSION

4.1 CARIBOU

It was predicted in the EIS that primary calving and calf-rearing habitat for caribou within 2 km of the GS would be less suitable for calving and would be more likely to be used by adults without calves during Project operation. Primary calving habitat was defined as islands more than 10 hectares (ha) in size in lakes and peatland complexes greater than 200 ha in area. Caribou were expected to re-occupy most habitats avoided during Project construction, with a long-term loss of effective habitat up to 500 m from the North and South access roads.

During the first year of operation monitoring in 2022, caribou were observed on a similar percentage of Project-affected islands in lakes as in later construction monitoring years (2019 to 2021). During the pre-construction period from 2010 to 2014, no caribou were photographed on Project-affected islands in 2010 or 2013, but they were photographed on 17 to 50% of Project-affected islands surveyed in 2011, 2012, and 2014. The number of Project-affected islands on which caribou were photographed decreased during the first four years of construction monitoring (2015–2018), when disturbance levels were high, as predicted in the EIS. Caribou were also photographed on a smaller percentage of unaffected islands over the same period, and there was no significant difference in the number of camera-days caribou were photographed on Project-affected versus unaffected islands most years from 2015 to 2021, possibly indicating that the changes were not entirely Project-related. The apparent absence of caribou on most Project-affected islands from 2015 to 2021 suggested that caribou were generally avoiding construction-related sensory disturbance. However, there was adult caribou activity on several Project-affected islands, and a cow and calf were observed on a large Project-affected island during pre-impoundment monitoring surveys (WRCS 2021). As caribou can habituate to human disturbance, some individuals may have been 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 Project construction site) may have been less than predicted in the EIS. It should be noted that these field studies 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 surveyed islands.

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, from construction monitoring studies from 2015 to 2022, 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 early calving period. In 2022, ice breakup on Gull and Stephens lakes was in late May/early June, in the middle of the general calving period and approximately a week earlier than the first caribou calf was photographed for sensory disturbance surveys (June 4). A calf was photographed incidentally by a camera on an island in Stephens Lake on May 23, just over a week before ice breakup.

Caribou were photographed in relatively few (0–18%) Project-affected peatland complexes during the 2015 to 2021 construction monitoring period and none were photographed in these complexes in 2022, the first year of operation monitoring. No calves were photographed in Project-affected complexes from 2015 to 2022, possibly indicating avoidance of construction-related sensory disturbances by calving females. There was no significant difference in the number of camera-days caribou were photographed on Project-affected versus random and reference complexes each year from 2015 to 2022, possibly indicating that the changes were not entirely Project-related. The percentage of Project-affected and random peatland complexes in which caribou were photographed varied over the eight-year survey period and was greater than in Project-affected complexes most years. The percentage of each type of complex occupied by caribou in 2022 was within the range of previous survey years, suggesting that there was relatively little change during the first year of Project operation monitoring.

4.2 OTHER LARGE MAMMALS

Moose appeared to be somewhat less widely distributed on islands in lakes and in peatland complexes in 2022 than during the 2015 to 2021 Project construction monitoring period. The abundance and distribution of moose signs in the Keeyask region suggest that enough habitat is available to sustain a moose population, which is likely an adequate source of primary prey for gray wolves. Moose occupied 12 (8%) of the same islands in lakes and one (3%) of the same peatland complexes as caribou, suggesting that the selection of calving habitat by caribou reduced the risk of predation by spatially separating from moose (James et al. 2004). Signs of black bear and gray wolf presence were sparse in caribou calving habitat in the Keeyask region, and caribou and predators occupied relatively few of the same islands in lakes and peatland complexes in 2022. These areas appeared to provide calving caribou with protection from predators, as expected.

5.0 SUMMARY AND CONCLUSIONS

No significant increase in caribou calving and calf-rearing activity in habitat affected during Project construction was observed in 2022, the first year of Project operation monitoring. The amount of alternative prey and predator activity in the region in 2022 was generally within the range observed during the construction monitoring period. Caribou sensory disturbance monitoring will continue in 2023, when additional studies and further analyses will be conducted to identify potential increases in caribou calving and calf-rearing activity in habitat affected during Project construction, to assess the loss of effective habitat during Project operation, and to identify residual avoidance of the access roads or other Project components.

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APPENDIX A: TABLES

Table A-1: Number of Trail Cameras on Islands in Lakes, 2015–2022

Island	2022	2021	2020	2019	2018	2017	2016	2015
KI122001	1	1	1	1	1	1	1	1
KI122003	1	1	1	1	1	1	1	1
KI122005	1	1	1	1	1	1	1	1
KI122006	1	1	1	1	1	1	1	1
KI122200[1]	1	1	–	–	–	–	–	–
KI122202[1]	0	1	–	–	–	–	–	–
KI123005	1	1	0	0	0	0	1	1
KI123008	0	0	0	0	0	0	0	1
KI123010	1	1	1	1	1	1	1	1
KI123012	1	1	1	2	2	2	2	2
KI123201[1]	1	0	–	–	–	–	–	–
KI123205[1]	1	1	–	–	–	–	–	–
KI123206[1]	1	1	–	–	–	–	–	–
KI123207[1]	1	1	–	–	–	–	–	–
KI123209[1]	1	1	–	–	–	–	–	–
KI123210[1]	1	1	–	–	–	–	–	–
KI123212[1]	1	0	–	–	–	–	–	–
KI123214[1]	1	1	–	–	–	–	–	–
KI123215[1]	1	1	–	–	–	–	–	–
KI123216[1]	1	1	–	–	–	–	–	–
KI123217[1]	1	1	–	–	–	–	–	–
KI123218[1]	1	1	–	–	–	–	–	–
KI123219[1]	1	1	–	–	–	–	–	–
KI123220[1]	1	1	–	–	–	–	–	–
KI123221[1]	1	1	–	–	–	–	–	–
KI123225[1]	1	0						
KI123226[1]	1	1	–	–	–	–	–	–
KI123229[1]	1	1	–	–	–	–	–	–
KI123230[1]	1	1	–	–	–	–	–	–
KI123231[1]	1	1	–	–	–	–	–	–
KI123233[1]	1	1	–	–	–	–	–	–
KI123237[1]	1	1	–	–	–	–	–	–
KI123238[1]	1	1	–	–	–	–	–	–
KI123240[1]	1	0	–	–	–	–	–	–
KI123252[1]	0	1	–	–	–	–	–	–
KI123253[1]	1	1	–	–	–	–	–	–

Island	2022	2021	2020	2019	2018	2017	2016	2015
KI124003	1	1	1	1	1	1	1	1
KI124004	1	1	1	1	1	1	1	1
KI124005	1	1	1	1	1	1	1	1
KI124007	1	1	1	1	1	1	1	1
KI124009	1	1	1	1	1	1	1	1
KI124010	1	1	1	1	1	1	1	1
KI124013	1	0	0	1	1	1	1	1
KI124015	1	1	1	1	1	1	1	1
KI124016	1	1	1	1	1	1	1	1
KI124017	1	1	1	1	1	1	1	1
KI124018	1	1	1	1	1	1	1	1
KI124019	1	1	1	1	1	1	1	1
KI124020	1	1	1	1	1	1	1	1
KI124022	1	1	1	1	1	1	1	1
KI124024	1	1	1	1	1	1	1	1
KI124026	1	1	1	1	1	1	1	1
KI124029	1	1	1	1	1	1	1	1
KI124030	1	1	1	1	1	1	1	1
KI124035	1	1	1	1	1	1	1	1
KI124037	1	1	1	1	1	1	1	1
KI124038	1	1	1	1	1	1	1	1
KI124040	1	1	1	1	1	1	1	1
KI124041	1	1	1	1	1	1	1	1
KI124042	1	1	1	1	1	1	1	1
KI124043	1	1	1	1	1	1	1	1
KI124044	1	1	1	1	1	1	1	1
KI124045	1	1	1	1	1	1	1	1
KI124046	1	1	1	1	1	1	1	1
KI124047	1	1	1	1	1	1	1	1
KI124050	1	1	1	1	1	1	1	1
KI124051	0	0	0	0	0	0	1	0
KI124052	1	1	1	1	1	1	1	1
KI124053	1	1	1	1	1	1	1	1
KI124055	1	1	1	1	1	1	1	1
KI124056	1	1	1	1	1	1	1	1
KI124057	1	1	1	1	1	1	1	1
KI124058	1	1	1	1	1	1	1	1

Island	2022	2021	2020	2019	2018	2017	2016	2015
KI124060	1	1	1	1	1	1	1	1
KI124063	1	1	1	1	1	1	1	1
KI124065	1	1	1	1	1	1	1	1
KI124066	2	2	1	2	2	2	2	2
KI124069	1	1	1	1	1	1	1	1
KI124070	1	1	1	1	1	1	1	1
KI124072	1	1	1	1	1	1	1	1
KI124075	1	1	1	1	1	1	1	1
KI124077	1	1	1	1	1	1	1	0
KI124079	1	1	1	1	1	1	1	1
KI124080	1	1	1	1	1	1	1	0
KI124082	1	1	1	1	1	1	1	1
KI124083	1	1	1	1	1	1	0	1
KI124086	1	1	1	1	1	1	1	1
KI124088	1	1	0	1	1	1	1	1
KI124089	1	1	1	1	1	1	1	1
KI124090	1	1	1	1	1	1	1	1
KI124091	1	1	1	1	1	1	1	1
KI124092	2	2	1	2	2	2	2	2
KI124094	1	1	1	1	1	1	1	1
KI124096	1	1	1	1	1	1	1	1
KI124097	1	0	1	1	1	1	1	1
KI124102	1	1	1	1	1	1	1	1
KI124103	1	1	1	1	1	1	1	1
KI124105	1	1	1	1	1	1	1	1
KI124111	0	0	0	0	0	0	1	1
KI124113	1	1	1	1	1	1	1	0
KI124115	1	1	1	1	1	1	2	1
KI124117	1	1	1	1	1	1	1	1
KI124120	1	1	1	1	1	1	1	1
KI124124	1	1	1	1	1	1	1	1
KI124125	1	1	1	1	1	1	1	1
KI124128	1	1	1	1	1	1	1	1
KI124129	1	1	1	1	1	1	1	1
KI124131	1	1	1	1	1	1	1	0
KI124133	1	1	1	1	1	1	1	1
KI124136	1	1	1	1	1	1	1	1

Island	2022	2021	2020	2019	2018	2017	2016	2015
KI124141	1	1	1	1	1	1	1	1
KI124145	1	1	1	1	1	1	1	1
KI124146	1	1	1	1	1	1	1	1
KI124147	1	1	1	1	1	1	1	1
KI124151	1	1	1	1	1	1	1	1
KI124152	1	1	0	1	1	1	1	1
KI124153	1	1	1	1	1	1	1	1
KI124155	1	1	1	1	1	1	1	1
KI124156	1	1	1	1	1	1	1	1
KI124158	1	1	1	1	1	1	1	1
KI124162	1	1	1	1	1	1	1	1
KI124164	1	1	1	1	1	1	1	1
KI124165	1	1	1	1	1	1	1	1
KI124166	1	1	1	1	1	1	1	1
KI124167	1	1	1	1	1	1	1	1
KI124170	1	1	1	1	1	1	1	1
KI124173	1	1	1	1	1	1	1	1
KI124176	1	1	1	1	1	1	1	1
KI124178	1	1	1	1	1	1	1	1
KI124180	3	3	2	3	3	2	3	2
KI124181	1	1	1	1	1	1	0	1
KI124182	1	1	1	1	1	1	1	1
KI124186	6	6	5	6	6	5	6	4
KI124192	1	1	1	1	1	1	1	1
KI124193	1	1	1	1	1	1	1	1
KI124194	1	1	1	1	1	1	1	1
KI124196	1	1	1	1	1	1	1	1
KI124197	1	1	1	1	1	1	1	1
KI124202	1	1	1	1	1	1	1	1
KI124205	2	2	1	2	2	2	2	1
KI124206	1	1	1	1	1	1	1	1
KI124209	1	1	1	1	1	1	1	1
KI124210	1	1	1	1	1	1	1	1
KI124212	1	1	1	1	1	1	1	1
KI124214	1	1	1	1	1	1	1	1
KI124217	1	1	1	1	1	1	1	1
KI124227	1	1	1	1	1	1	0	1

Island	2022	2021	2020	2019	2018	2017	2016	2015
KI126016	0	0	0	0	0	0	1	1
KI126017	0	0	0	0	0	0	0	1
KI126020	0	0	0	0	0	0	1	1

1. Formed after reservoir impoundment.

Table A-2: Number of Trail Cameras in Peatland Complexes, 2015–2022

Complex	2022	2021	2020	2019	2018	2017	2016	2015
KV022000	1	1	1	1	1	1	1	1
KV023000	1	1	1	1	1	1	1	1
KV036000	1	1	1	1	1	1	1	1
KV037000	1	1	1	1	1	1	1	1
KV038000	1	1	1	1	1	1	1	1
KV039000	1	1	1	1	1	1	1	1
KV044000	1	1	1	1	1	1	1	1
KV047000	1	1	1	1	1	1	1	1
KV050000	1	1	1	1	1	1	1	1
KV580000	1	1	1	1	1	1	1	1
KV061000	1	1	1	1	1	1	1	1
KV062000	1	1	1	1	1	1	1	1
KV063000	1	1	1	1	1	1	1	1
KV066000	1	1	1	1	1	1	1	1
KV069000	1	1	1	1	1	1	1	1
KV071000	1	1	1	1	1	1	1	1
KV094000	1	0	1	1	1	1	1	1
KV097000	1	1	1	1	1	1	1	1
KV098000	1	1	1	1	1	1	1	1
KV101000	1	1	1	1	1	1	1	1
KV102000	1	1	1	1	1	1	1	1
KV103000	1	1	1	1	1	1	1	1
KV107000	1	1	1	1	1	1	1	1
KV113000	1	1	1	1	1	1	1	1
KV116000	1	1	1	1	1	1	1	1
KV119000	1	1	1	1	1	1	1	1
KV1224000	1	1	1	1	1	1	1	1
KV1260000	1	1	1	1	1	1	1	1
KV1261000	1	1	1	1	1	1	1	1
KV273000	1	1	1	1	1	1	1	1
KV597000	1	1	1	1	1	1	1	1
KV622000	1	1	1	1	1	1	1	1

Table A-3: Number of Camera-days on Islands in Lakes, 2015–2022

Island Type	Island	2022	2021	2020	2019	2018	2017	2016	2015
Project-affected	KI123010	152	153	175	167	150	161	154	172
	KI123012	155	153	350	334	304	322	308	344
	KI124015	156	161	171	165	153	151	157	173
	KI124016	156	160	171	166	151	147	151	173
	KI124080	158	146	170	165	154	146	160	163
	KI124088	156	149	167	166	154	157	159	168
	KI124090	155	149	167	163	154	157	107	168
	KI124092	310	300	334	327	300	309	320	340
	KI124094	156	149	167	163	154	157	160	168
	KI124097	159	0	170	165	154	147	160	163
	KI124102	158	150	170	165	157	149	160	163
	KI124103	155	149	167	163	147	153	159	150
	KI124141	155	148	168	167	160	157	160	161
	KI124145	158	148	171	165	157	145	58	164
	KI124146	154	148	171	167	160	153	159	144
	KI124152	154	149	175	163	157	153	159	160
	KI124155	154	148	171	163	154	155	159	160
	KI124162	159	148	171	165	154	147	159	117
	KI124164	155	149	168	167	160	154	159	166
	KI124165	154	147	172	163	154	153	159	165
	KI124192	154	149	171	163	146	155	161	168
	KI124193	154	150	167	164	157	155	159	170
	KI124197	159	152	168	165	160	157	160	164
	KI124202	154	149	171	163	163	153	160	161
	KI124206	159	148	168	165	160	157	160	164
	KI124209	154	149	171	163	153	153	160	170
	Total	4,203	3,901	4,762	4,612	4,327	4,303	4,287	4,579
Project-affected new	KI123225	155	0	–	–	–	–	–	–
	KI123226	155	153	–	–	–	–	–	–
	KI123231	152	153	–	–	–	–	–	–
	KI123233	152	153	–	–	–	–	–	–
	KI123237	155	153	–	–	–	–	–	–
	KI123238	152	153	–	–	–	–	–	–
	KI123240	155	0	–	–	–	–	–	–
	KI123253	155	153	–	–	–	–	–	–
	Total	1,231	918	–	–	–	–	–	–
Project-affected total		5,434	4,819	4,762	4,612	4,327	4,303	4,287	4,579
Unaffected	KI122001	155	158	174	168	161	165	154	172
	KI122003	155	158	174	168	161	165	154	172
	KI122005	155	158	174	168	161	165	154	172
	KI122006	155	158	174	168	161	163	155	172
	KI123005	155	153	0	0	0	0	0	172

Island Type	Island	2022	2021	2020	2019	2018	2017	2016	2015
Unaffected	KI124003	155	160	171	166	150	147	152	173
	KI124004	155	152	168	168	176	157	0	171
	KI124005	156	160	171	166	151	147	151	173
	KI124007	156	160	171	166	151	151	152	173
	KI124009	156	160	171	166	150	151	181	173
	KI124010	156	153	171	166	150	151	181	173
	KI124013	156	0	0	166	150	151	151	173
	KI124017	156	160	173	166	154	142	158	173
	KI124018	156	153	174	165	154	143	181	173
	KI124019	156	158	172	167	148	150	184	171
	KI124020	156	160	171	166	151	147	151	173
	KI124022	156	153	173	166	153	143	152	173
	KI124024	156	160	171	166	154	147	151	173
	KI124026	156	152	172	183	148	155	161	171
	KI124029	156	154	175	166	153	143	158	173
	KI124030	156	154	175	166	153	143	158	165
	KI124035	156	158	172	167	146	150	184	172
	KI124037	155	154	168	167	155	146	152	167
	KI124038	156	154	172	167	148	150	184	171
	KI124040	156	154	172	167	148	150	184	172
	KI124041	156	158	172	167	148	150	184	172
	KI124042	156	158	172	167	148	150	155	172
	KI124043	156	160	175	167	157	153	158	168
	KI124044	156	157	172	167	147	154	184	171
	KI124045	156	160	175	166	157	153	158	168
	KI124046	155	150	167	168	155	147	158	166
	KI124047	156	157	176	167	146	154	184	173
	KI124050	156	158	172	167	148	150	184	172
	KI124052	155	154	172	167	156	150	184	171
	KI124053	156	150	172	167	148	150	184	171
	KI124055	156	152	175	168	157	156	158	168
	KI124056	156	158	172	167	148	150	184	104
	KI124057	156	158	172	167	148	150	184	171
	KI124058	156	152	175	168	157	156	158	168
	KI124060	156	150	176	167	148	150	184	171
	KI124063	156	150	175	168	157	153	158	169
	KI124065	156	154	176	167	148	157	184	170
	KI124066	314	302	340	330	314	296	318	325
	KI124069	157	152	170	165	154	148	159	163
	KI124070	155	150	172	167	156	148	155	171
	KI124072	155	150	172	167	156	150	184	171
	KI124075	157	152	167	165	157	147	101	164
	KI124077	156	153	175	166	156	0	157	0

Island Type	Island	2022	2021	2020	2019	2018	2017	2016	2015
Unaffected	KI124079	156	152	175	168	156	154	158	166
	KI124082	156	153	175	168	161	155	159	168
	KI124083	156	153	174	167	161	155	0	282
	KI124086	155	154	176	167	151	154	183	170
	KI124089	156	152	175	168	157	156	158	167
	KI124091	157	154	176	168	157	158	159	165
	KI124096	155	154	176	167	151	154	183	170
	KI124105	155	154	176	166	145	154	183	172
	KI124113	156	153	175	166	167	150	159	0
	KI124115	156	157	171	166	161	154	107	171
	KI124117	155	154	176	167	151	154	183	169
	KI124120	156	154	176	168	157	158	158	165
	KI124124	156	153	175	164	161	157	159	167
	KI124125	158	146	171	166	157	147	106	163
	KI124128	155	155	173	167	161	153	157	175
	KI124129	156	157	171	167	161	154	161	171
	KI124131	155	154	176	166	161	149	154	0
	KI124133	156	153	175	164	161	157	159	167
	KI124136	155	158	176	167	157	155	159	170
	KI124147	156	150	171	166	160	148	159	166
	KI124151	155	152	176	167	157	155	159	170
	KI124153	159	149	172	164	160	147	159	164
	KI124156	156	154	176	167	157	156	103	166
	KI124158	155	151	173	166	161	153	158	175
	KI124166	156	157	176	164	161	155	161	167
	KI124167	159	149	172	164	165	147	160	162
	KI124170	155	155	173	166	161	153	158	183
	KI124173	155	158	176	167	157	153	159	170
	KI124176	156	154	175	164	161	152	161	168
	KI124178	155	153	174	167	161	154	183	169
	KI124180	474	450	512	493	311	440	475	332
	KI124181	156	157	176	164	156	155	0	285
	KI124182	155	155	173	166	161	153	157	170
	KI124186	930	929	1030	1000	940	935	945	845
	KI124194	155	155	174	166	161	155	183	172
	KI124196	156	155	171	166	160	99	158	166
	KI124205	310	298	336	328	320	304	318	161
	KI124210	157	156	174	164	161	154	183	170
	KI124212	157	152	174	164	159	154	183	170
	KI124214	155	154	172	164	159	153	154	169
	KI124217	155	149	168	164	160	152	160	161
	KI124227	156	157	172	168	147	146	0	287
	Total	15,429	15,118	16,765	16,313	15,103	14,695	15,241	16,041

Island Type	Island	2022	2021	2020	2019	2018	2017	2016	2015
Unaffected new	KI122200	155	158	–	–	–	–	–	–
	KI122202	0	158	–	–	–	–	–	–
	KI123201	155	0	–	–	–	–	–	–
	KI123205	155	153	–	–	–	–	–	–
	KI123206	155	153	–	–	–	–	–	–
	KI123207	155	157	–	–	–	–	–	–
	KI123209	155	153	–	–	–	–	–	–
	KI123210	155	158	–	–	–	–	–	–
	KI123212	152	0	–	–	–	–	–	–
	KI123214	155	157	–	–	–	–	–	–
	KI123215	155	157	–	–	–	–	–	–
	KI123216	155	157	–	–	–	–	–	–
	KI123217	158	157	–	–	–	–	–	–
	KI123218	155	153	–	–	–	–	–	–
	KI123219	155	153	–	–	–	–	–	–
	KI123220	155	153	–	–	–	–	–	–
	KI123221	155	153	–	–	–	–	–	–
	KI123229	155	157	–	–	–	–	–	–
	KI123230	155	157	–	–	–	–	–	–
	KI123252	0	158	–	–	–	–	–	–
	Total	2,790	2,802	–	–	–	–	–	–
Unaffected total		18,219	17,920	16,765	16,313	15,103	14,695	15,241	16,041

Table A-4: Number of Camera-days in Peatland Complexes, 2015–2022

Complex Type	Burned in 2013	Complex	2022	2021	2020	2019	2018	2017	2016	2015
Project-affected	Yes	KV094000	154	0	169	166	150	146	153	155
		KV102000	154	154	164	166	149	145	106	155
		KV103000	154	161	164	166	128	51	154	164
		Total	462	315	497	498	427	447	413	474
	No	KV039000	154	147	176	166	152	149	81	149
		KV047000	155	153	165	166	153	146	104	152
		KV061000	155	146	165	166	148	149	153	152
		KV062000	155	154	176	166	148	64	105	108
		KV063000	155	154	176	166	148	152	153	151
		KV066000	155	149	168	166	148	154	153	144
		KV069000	155	149	168	166	148	153	147	144
		KV071000	89	149	172	166	148	145	152	144
		Total	1,173	1,201	1,366	1,328	1,193	1,112	1,048	1,144
	Total		1,635	1,516	1,863	1,826	1,620	1,642	1,557	1,618
Reference	Yes	KV098000	158	155	174	167	153	154	154	155
		KV116000	155	153	172	168	152	157	155	155
		KV119000	155	158	173	167	153	151	154	159
		KV597000	155	156	176	170	163	152	155	157
		Total	623	622	695	672	621	614	618	626
	No	KV023000	154	160	171	163	144	156	151	154
		KV037000	155	158	177	163	147	156	48	154
		KV050000	154	151	173	168	149	165	155	148
		KV058000	155	155	166	166	148	146	48	143
		KV097000	156	154	173	168	152	164	155	154
		KV107000	155	153	172	168	143	164	155	158
		KV1260000	155	154	165	167	148	146	107	162
		KV1261000	155	154	165	167	148	146	155	162

Complex Type	Burned in 2013	Complex	2022	2021	2020	2019	2018	2017	2016	2015
Reference	No	Total	1,239	1,239	1,362	1,330	1,179	1,243	974	1,235
	Total		1,862	1,861	2,057	2,002	1,800	1,857	1,592	1,861
Random	Yes	KV036000	155	152	173	166	151	161	154	149
		KV1224000	155	154	112	167	145	158	155	169
		KV273000	155	149	173	169	528	152	155	157
		KV622000	155	146	173	169	528	148	143	156
		Total	620	601	631	671	1352	619	607	631
Random	No	KV022000	155	153	185	166	149	161	154	153
		KV038000	155	157	175	166	150	162	154	150
		KV044000	155	156	175	168	149	160	154	151
		KV101000	156	153	173	168	151	156	155	154
		KV113000	155	154	172	168	144	157	155	156
		Total	776	773	880	836	743	796	772	764
	Total		1,396	1,374	1,511	1,507	2,095	1,415	1,379	1,395