Keeyask Generation Project

Terrestrial Effects Monitoring Plan

Construction Monitoring Synthesis Report

TEMP-2024-16

KEEYASK

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

2014 - 2022

KEEYASK GENERATION PROJECT

TERRESTRIAL EFFECTS MONITORING PLAN

REPORT #TEMP-2024-16

CONSTRUCTION PHASE MONITORING: SYNTHESIS REPORT

Prepared for

Manitoba Hydro

By

ECOSTEM Ltd. and
Wildlife Resource Consulting Services MB, Inc.

June 2024

This report should be cited as follows:

ECOSTEM Ltd. and Wildlife Resource Consulting Services MB, Inc. 2024. Keeyask Generation Project Terrestrial Effects Monitoring Plan Report #TEMP-2024-16: Construction Phase Monitoring: Synthesis Report. A report prepared for Manitoba Hydro by ECOSTEM Ltd. and Wildlife Resource Consulting Services MB, Inc., June 2024.

SUMMARY

Background

The Keeyask Generation Project (the Project) is a 695-megawatt hydroelectric generating station (GS) and the associated facilities. The Project is located at the former 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.

Project construction began in July 2014. Most construction activities had been completed by fall 2021. The reservoir was first brought to full supply level in September 2020 and the final generating unit went into service on March 9, 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 (KHLP 2012a). 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; KHLP 2012b). The *Keeyask Generation Project Terrestrial Effects Monitoring Plan* (TEMP; KHLP 2015) was developed as part of the licensing process for the Project. Monitoring activities for various components of the terrestrial environment were described.

This report provides a synthesis of the results for all TEMP monitoring studies over the Project's construction period (2014 – 2021).

Why was the monitoring done?

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 development of the generating station have affected the environment, and whether or not more needs to be done to reduce harmful effects.

What was done?

Between 2014 and 2021, construction-phase monitoring studies for terrestrial plants, habitat and ecosystems, amphibians, birds, and wildlife were carried out, as outlined in the TEMP.

What was found?

Plants, Habitat and Ecosystems

Project effects on terrestrial plants, habitat and ecosystems during Project construction were lower than predicted, and considerably lower for many of the individual VECs, with a few exceptions. Two exceptions included higher than predicted impacts for one land cover type and

three priority habitat types, but in all these cases the impacts were below the benchmark for requiring mitigation. The third exception was higher than assumed linear features, but overall linear feature density was still lower than predicted in the EIS. The lower than predicted effects primarily resulted from the actual Construction Footprint being 28% smaller than assumed in the EIS, as well as implementation of effective mitigation measures. No additional mitigation is recommended.

Terrestrial habitat in the Keeyask region

Amphibians

Overall Project effects on amphibians included the loss and degradation of frog habitat, which were less than predicted in the EIS. Construction monitoring showed that the amphibian habitat enhancement measures provided temporary stop-over habitat for frogs moving throughout the area. The cover provided by vegetation following rehabilitation at the site appeared to provide sufficient habitat for frogs in the area and resulted in limited use of the slash piles. No additional mitigation is recommended.

Birds

Adverse Project effects on birds during Project construction were the same or lower than predicted in the EIS, with one exception. Slightly more common nighthawk breeding habitat was lost than predicted, but the percentage lost was still far from the benchmark value that would raise it to a moderate magnitude adverse effect. In most cases, the lower than predicted effects primarily resulted from the actual Construction Footprint being 28% smaller than assumed in the EIS, as well as the implementation of effective mitigation measures.

There were no unexpected Project effects on birds during construction, other than the higher than expected use of staging and foraging by waterfowl in the newly formed reservoir. These findings contrasted the predictions of the EIS, which suggested Canada goose and mallard use of the reservoir would be minimal until wetland vegetation was re-established in the area. No additional mitigation is recommended.

Pair of bald eagles in the Keeyask area during construction

Mammals

Adverse Project effects on mammals during construction were the same or lower than predicted, with one exception. The use of islands in lakes and peatland complexes by caribou further from the Project was less than predicted in the EIS. Results suggested that sensory disturbance effects may have extended as far as 7 to 9 km from the Project, compared to only 4 km predicted in the EIS. In most cases, the lower than predicted effects primarily resulted from the actual Construction Footprint being 28% smaller than assumed in the EIS, as well as effective mitigation measures.

There were no unexpected Project effects on mammals during construction, with one exception. Some islands that formed in the reservoir by 2021, following impoundment, were immediately used for calving by caribou and moose. These findings contrasted the predictions of the EIS, which suggested new calving island use was expected to take many years. No additional mitigation is recommended.

Trail camera photo of a caribou on an island in Stephens Lake

Mercury in Plants and Wildlife

The EIS did not include predictions regarding Project effects on mercury concentrations in plants. Construction monitoring found that mercury concentrations were either undetectable, or below or near the bottom end of the range for other boreal plant species.

The EIS included predictions regarding Project effects on mercury concentrations in key bird and mammal species. Construction monitoring found that mercury concentrations in three aquatic furbearer species remained low, while river otter mercury concentrations are increasing as anticipated one year after the reservoir was impounded. No country foods tissue sample submissions were received from the partner First Nations under the voluntary sampling program during the construction period.

What does it mean?

There were no major unexpected Project effects on terrestrial VECs during construction, and most effects were lower than predicted in the EIS. No additional mitigation is recommended.

What will be done next?

Monitoring of all terrestrial VECs is continuing during Project operation.

STUDY TEAM

Terrestrial Plants, Habitat and Ecosystems

We would like to thank Sherrie Mason and Rachel Boone of Manitoba Hydro for coordinating the terrestrial monitoring studies and for editorial comments on this report. We also thank the on-site Manitoba Hydro staff for their support and assistance in planning field activities and providing access to the sites. We thank Ron Bretecher of North/South Consultants Inc. for logistical assistance in the field.

Study Design and Project Management

Dr. James Ehnes

Data Analysis and Reporting

James Ehnes	Alex Snitowski	Nathan Ricard
Brock Epp	Jackie Krindle	Anoj Subedi
Alanna Sutton	Meghan Noonan	

Data Collection

Alanna Sutton	Heidi Ahrenholtz	Nathan Ricard
Alex Snitowski	Karine Grotte	Ryan Sheffield
Barry Flett	Kelvin Kitchekeesik	Saul Mayhem
Brock Epp	Kenneth Ouskun	Tyler Kitchekeesik
Fred Wood	Kerry Kirkness	
Gabriel Schmid	Melvin Cook Jr.	

Cartography

Alex Snitowski

Brock Epp

James Ehnes

Nathan Ricard

Wildlife

We would like to thank Sherrie Mason and Rachel Boone of Manitoba Hydro for editorial comments, and Ron Bretecher of North/South Consultants Inc. for logistical assistance in the field. We would also like to thank Dr. James Ehnes of ECOSTEM Ltd. for study designs and multivariate statistical analyses, and Alex Snitowski of ECOSTEM Ltd. for habitat data support and cartography.

Data Analysis and Reporting

Robert Berger	James Ehnes	Nicholas LaPorte
Andrea Ambrose	Brock Epp	Alex McIlraith
Mark Baschuk	Brian Knudsen	

Data Collection

James Aiken	Robert Berger	Robyn Demare
Michael Alperyn	Kristian Bernjak	Kobe Dumas
Andrea Ambrose	Adam Beverstein	Tera Edkins
Brandon Anderson	Charles Bland	Michelle Ewacha
Corbin Anderson	Tanner Booth	Halle Fines
Vincent Anderson	Colin Brightnose	Arlene Flett
Jeremy Baldwin	Graydon Brightnose	Barry Flett
Riley Bartel	Robert Brightnose	Cameron Flett
Mark Baschuk	Jamie Brightnose Jr.	Clayton Flett
August Beardy	Duncan Burnett	Donald Flett
Amery Beardy	Aaron Chornoby	Donovan Flett
Brandon Beardy	Harland Chornoby	Harry Flett
Cory Beardy	James Chornoby	Leslie Flett
Jason Beardy	Jamie Chornoby	Payton Flett
Nathanael Beardy	Leonard Chornoby	Shane Flett
Nicholas Beardy	Grant Connell	Shawn Flett
Payton Beardy	Mike Connellan	Brian Fournier
Marissa Berard	Simone Davidson	Tyler Fourre

Carly Fraser
Maryse Gagné
Michael John Garson
Brendon Gogo
Antonio Greeves
Martina Harvey
Jody Heerema
John Henderson
Peter Hettinga
Anthony Jacobs
Drayden Jobb
Nicole Kaminski
Geoffrey Keeper
Matthew Kerr
Chad Kirkness
Kerry Kirkness
Hunter Kitchekeesik
Jonathan Kitchekeesik
Kelvin Kitchekeesik
Logan Kitchekeesik
Terry Kitchekeesik
Tyler Kitchekeesik
Anna Kramer
Timothy Kroeker
Jeff Laliberty
John Laliberty
Matthew Laliberty
Jessica Lang
Nicholas LaPorte
Samantha Line
Jimmy Lockhart Jr.
Gordon Macdonald
Samantha MacFarlane
Anthony Martin
Hannah Martin
Peter Massan
Saul Mayham
Jordan Mazur
Kaitlin McCormick
Mark McGillvary
Alex McIlraith
Adam McLeod
Kevin McRae
Kevin Methuen
Terian Moriaux
Meghan Murphy
Cameron Neckoway
Keegan Neckoway
Michele Nicholson
Aidan Novalkowski
Kelsey O'Brien
Vincent Ouskan
Benjamin Ouskun
Kenneth Ouskun
Saul Ouskun
Justin Petkau
Hunter Prieston
Erin Prokopanko
Bailey Rankine
Eric Richards
Brittany Rolfe
Owen Romanchuk
Jonathan Sandberg
Delbert Saunders
Jonathan Saunders
Mark Saunders
Kaitlin Sawinsky
Morgan Scharf
Mercede Schindler
Colby Sobchuk
Adam Spence
Calvin Spence
Courtney Spence
Curtis Spence
Eldon Spence
Eugene Spence
Gary Spence
Isaah Spence
Josh Spence
Justin Spence
Riley Spence
Rylan Spence
Vernon Spence
Calvin Spence Jr.
Jillian St. George
Stefano Strapazzon
Taylor Toffan
Jacqueline Verstege
Camryn Vestby
Caroline Walmsley

Levi Warkentine	Wayne Wavey	Jenny Yoo
Darcy Wastesicoot	Ryan West	Morgan Zaretski
Jared Wastesicoot	Thomas Wood	

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF MAPS

LIST OF PHOTOS

1.0 INTRODUCTION

1.1 THE PROJECT

The Keeyask Generation Project (the Project) is a 695-megawatt hydroelectric generating station (GS) and the associated facilities. The Project is located at the former 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.

Project construction began in July 2014. The vast majority of construction activities had been completed by fall 2021. The reservoir was first brought to full supply level in September 2020 and the final generating unit went into service on March 9, 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 (KHLP 2012a). 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; KHLP 2012b). The *Keeyask Generation Project Terrestrial Effects Monitoring Plan* (TEMP; KHLP 2015) was developed as part of the licensing process for the Project. Monitoring activities for various components of the terrestrial environment were described, including the sections of this report.

1.1.1 OVERALL OBJECTIVES

Monitoring is required to verify the short- and long-term effects of the Project's construction and operation on the terrestrial environment, including ecosystems, habitat, plants, amphibians, birds, and mammals. The overall objectives of the terrestrial monitoring are to:

- Determine the accuracy of key effects assessment predictions in the EIS;
- Identify unexpected effects related to the Project;
- Determine the effectiveness of mitigation measures;
- Assess the need for additional mitigation or remedial actions if initial measures are not adequate;
- Determine the effectiveness of any additional/adapted mitigation measure(s); and
- Confirm compliance with any regulatory requirements, including Project approvals and environmental regulations.

1.2 PROJECT AREAS

Four distinct Project areas are used when reporting on where Project clearing or disturbance occurred. This is being done to facilitate comparisons with EIS predictions. See ECOSTEM (2022a) for a detailed description of what is included in each Project area.

The first two Project areas are a subdivision of the footprint licensed for Project use under the Project's *Environment Act* Licence (i.e., licensed Project footprint) into: the planned Project footprint; and the possibly disturbed Project footprint (Map 1-1). The planned Project footprint is largely comprised of permanent Project components. The possibly disturbed Project footprint provided for some of the unknown components of the Project design at the time the Project was being licensed.

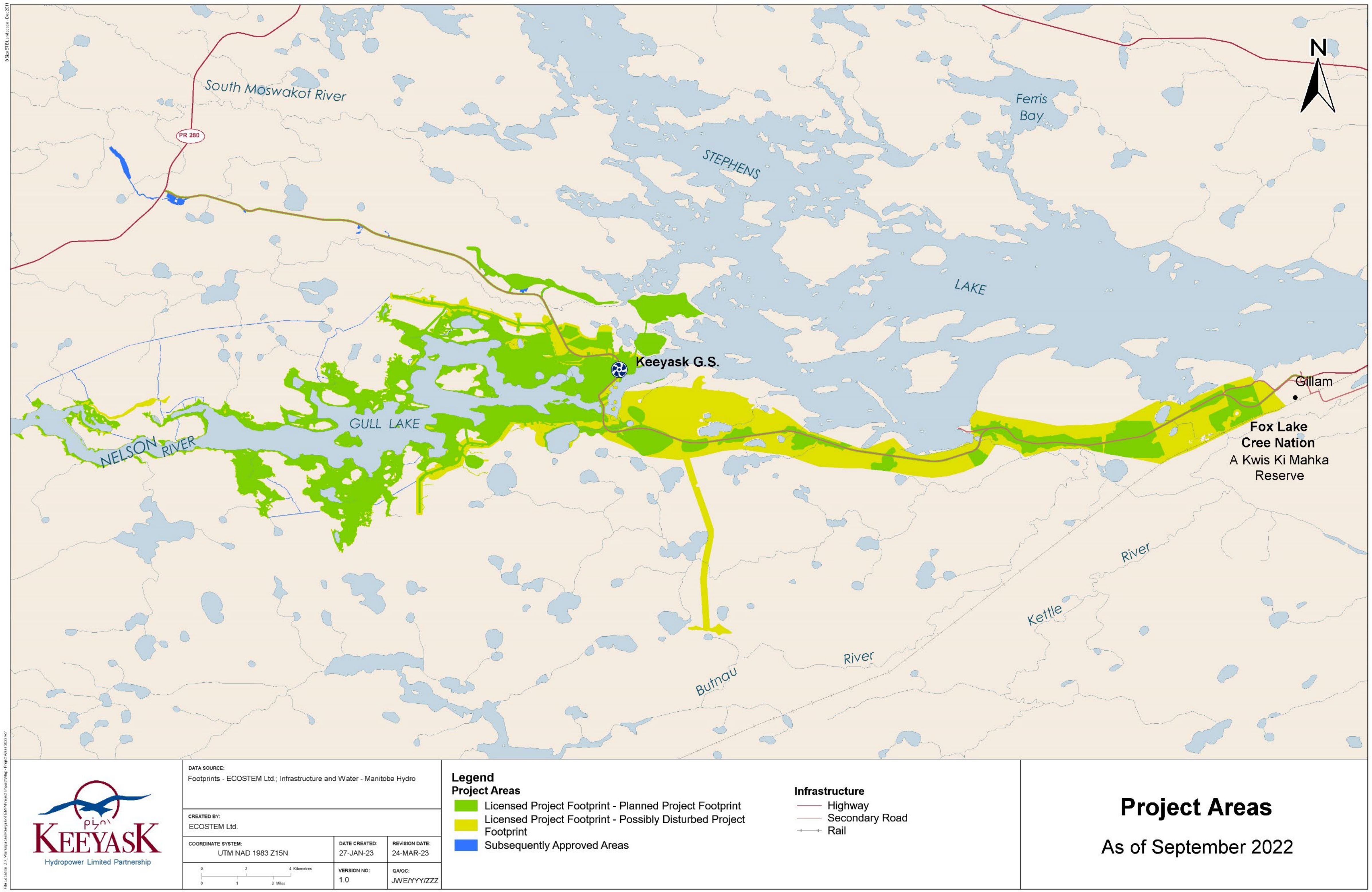
The third Project area includes subsequently approved Project areas, which are areas approved for Project use by the Government of Manitoba after the Project was licensed (Map 1-1).

The preceding three Project areas are collectively referred to as the "approved Project footprint".

The fourth type of Project area includes all cleared or disturbed areas that are outside of the approved Project footprint.

In summary, the Project areas are the:

- Approved Project footprint
    - Planned Project footprint;
    - Possibly disturbed Project footprint;
    - Subsequently approved Project areas; and,
- Areas outside of the approved Project footprint



Map 1-1: Approved Project areas as of September 2022

1.3 TERRESTRIAL STUDY ZONES

Map 1-2 shows the terrestrial study zones and the Keeyask Generation Project area. Study Zone 1 boundaries were determined as the combined potential extent of the Project Footprint during construction and operation, including areas that are unlikely to be used and before considering mitigation, habitat rehabilitation and natural habitat regeneration.

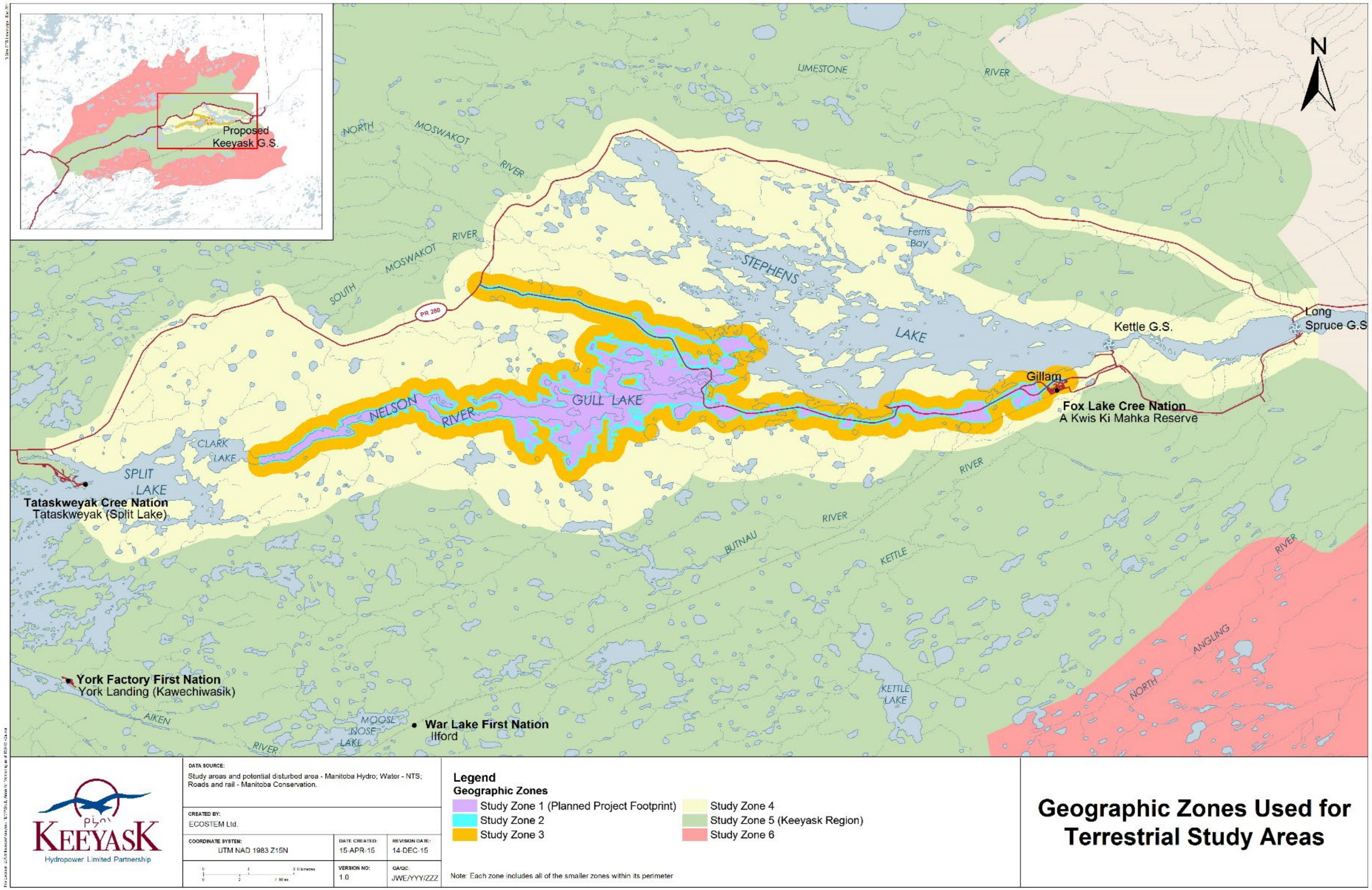
Study Zone 2 boundaries were defined by the Project's maximum potential local zone of influence on terrestrial habitat composition, which were delineated as a 150 m buffer of Study Zone 1. Since Study Zone 2 was the maximum potential extent of altered habitat composition, this zone was used as the Local Study Area for terrestrial habitat and for species with the smallest individual home range sizes (*e.g.*, frogs, mice).

Study Zone 3 boundaries, which reflected the Project's maximum potential local zone of influence on landscape elements, were delineated as a 1,150 m buffer of Study Zone 1. Study Zone 3 was used as the Regional Study Area for species with the smallest population home range sizes (*e.g.*, frogs, mice) and the Local Study Area for species with small to moderate sized population home ranges (*e.g.*, olive-sided flycatcher, beaver).

Study Zone 4 was large enough to capture a repeating sequence of landscape types. Study Zone 4 was used as the Regional Study Area for species with small to moderate sized population home ranges and as the Local Study Area for species with large individual home range sizes.

The spatial limits of Study Zone 5 were determined by the area that was large enough to support the key boreal ecological processes and populations of most resident wildlife species. Consequently, Study Zone 5 was the Regional Study Area for most of the habitat and ecosystems key topics.

Study Zone 6 was the area needed to characterize the fire regime. This zone was also used as the Regional Study Area for species with very large population home ranges (i.e., caribou).



Map 1-2: Geographic zones used for Terrestrial Study Areas

1.4 VALUED ECOSYSTEM COMPONENTS AND KEY TOPICS

Key topics were identified during the environmental assessment and in consultation with the partner First Nation communities, resulting in the selection of Valued Environmental Components (VECs). Follow-up monitoring focused on these VECs as particularly valuable indicators of the effectiveness of Project mitigation measures, and also to track the effects on a number of other supporting topics of interest.

The following is a description of each of the Key Topics:

- **Terrestrial Habitat:** Habitat is the place where an organism or a population lives. Because all natural areas are habitat for something, “terrestrial habitat” refers to all land habitat for all species.
- **Ecosystem Diversity:** Ecosystem diversity refers to the number of different ecosystem types, as well as their size and distribution, within a defined geographic area.
- **Intactness:** Intactness is the degree to which an ecosystem remains unaltered by human development and other activities that remove habitat and increase fragmentation.
- **Wetland Function:** Wetland functions are the natural properties or processes that are associated with wetlands, stated in ways that describe what they do for the ecosystem.
- **Fire Regime Changes:** A fire regime is the pattern, type, intensity, frequency and seasonality of fires that prevails in an area. It plays a critical role in producing the vegetation mosaic that exists in the Regional Study Area and maintaining regional ecosystem health.
- **Priority Plants:** Priority plants are defined as those plants that are particularly important for ecological and/or social reasons.
- **Invasive Plants:** Non-native plants are those plants that are growing outside of their country or region of origin. Invasive plants are non-native plants that can out-compete or even replace native plants.
- **Amphibians:** Frogs are used to assess the effectiveness of Project mitigation measures. The loss and degradation of frog habitat is compared to Project effects predictions.
- **Birds:** Bird VECs include Canada goose, mallard, olive-sided flycatcher, rusty blackbird and common nighthawk. Other priority bird species addresses concerns for species-at-risk, species at the edge of breeding range, those that depend on rare environmental features (e.g., rocky islands), and species valued by partner First Nations.
- **Mammals:** Mammal VECs include caribou, moose and beaver. Other priority mammal species addresses concerns for species-at-risk, species at the edge of breeding range, furbearers, predators, and species valued by partner First Nations.

- **Mercury in Plants and Wildlife:** This study addresses concerns that members of the partner First Nations expressed about mercury levels in traditionally used terrestrial plants and animals and addresses scientific concerns for riparian wildlife species.

1.5 MONITORING APPROACH

1.5.1 TRADITIONAL KNOWLEDGE MONITORING

Tataskweyak Cree Nation, War Lake First Nation, Fox Lake Cree Nation, and York Factory First Nation (known collectively as the partner First Nations), together with Manitoba Hydro formed the Keeyask Hydropower Limited Partnership (KHLP) to develop the Keeyask Project in an environmentally and socially responsible manner.

Similar to the two-track approach used by the Keeyask Hydropower Limited Partnership (KHLP) to identify and assess the anticipated effects of the Project, the KHLP is also using a two-track approach to determine the usefulness, accuracy and efficacy of monitoring and mitigation measures. One track consists of Aboriginal Traditional Knowledge (ATK) monitoring and the other track of western science monitoring. It is important to note that during the environmental assessment of Keeyask, the KHLP determined that ATK and western science would be given equal weight and that the intent of this principle is carried forward into Keeyask monitoring activities.

The partner First Nations are involved in the Environmental Protection Program through a number of avenues including participating on Project committees, providing field workers for the technical monitoring studies; and implementing community specific ATK monitoring programs. Monitoring determines if the predictions about environmental effects in the Keeyask Environmental Impact Statement (EIS) are correct and if mitigation measures are working as expected. There is a Monitoring Advisory Committee (MAC), made up of partner First Nation members and Manitoba Hydro staff. Members are responsible for reviewing and discussing the implementation and outcomes of the Environmental Protection Program, including social and economic monitoring activities. The MAC meets every two months and advises the KHLP Board on environmental mitigation, monitoring and management issues.

1.5.2 TECHNICAL SCIENCE MONITORING

The *Keeyask Generation Project Terrestrial Effects Monitoring Plan* (TEMP; KHLP 2015) was developed as part of the licensing process for the Project. Monitoring activities for various components of the terrestrial environment are described, which include the studies summarized in this synthesis report.

Monitoring and follow-up address areas where uncertainty exists in the EIS predictions (EIS Section 8.1.1; TEMP Section 1.2). The Project approach to monitoring is adaptive. There is provision to review results and modify monitoring programs and mitigation measures, if and as required, including reducing the scope of work if effects are lower than anticipated (TEMP Section 1.2).

For wildlife species, the question of ultimate concern for the Project effects assessments was how the Project would affect long-term population viability (TE SV Section 1.3.5). Because suitable population data are either very difficult or extremely costly to obtain for many species, Project effects predictions used a combination of changes in habitat availability, resource harvesting and other key influences as a proxy for potential Project effects on population size (TE SV Appendix 1A). As such, the effects predictions implicitly relied on the EIS habitat quality models being accurate. As a precautionary measure, the wildlife monitoring described in TEMP contemplated verifying and refining the EIS habitat quality models for a number of species using construction monitoring data. However, construction monitoring has shown that the effort needed to verify and refine the EIS models is not justified for several reasons:

- Predicted Project effects were well below the benchmark values for all species where model verification and refinement was contemplated;
- Total terrestrial habitat loss during construction was 28% lower than assumed for the effects assessment. With one minor exception, every native land cover type had lower direct effects than assumed for the EIS. This means that effects on all wildlife habitats combined were substantially lower than assumed;
- With one minor exception, physical habitat loss during construction was lower than assumed for the EIS. Loss of habitat effectiveness was higher than assumed for caribou;
- Monitoring has shown that the actual values for the non-habitat Project effects metrics (e.g., vehicle mortality) were lower than predicted for all relevant species;
- Based on the preceding bullets, the EIS habitat models would have to be very inaccurate before a better model could increase the amount of affected habitat to be close to the benchmark values; and,
- For some species, construction monitoring has provided reliable population data (e.g., beaver), which eliminates the need for habitat to serve as a proxy for population effects.

Nevertheless, multivariate statistical effects modeling, which incorporated habitat variables, was still completed for key species including caribou, moose, olive-sided flycatcher and rusty blackbird. Those results are presented in this construction phase synthesis report.

2.0 TERRESTRIAL HABITAT AND ECOSYSTEM MONITORING

2.1 TERRESTRIAL HABITAT

2.1.1 BACKGROUND

Habitat is the place where an organism or a population lives (Photo 2-1). Because all natural areas are habitat for something, “terrestrial habitat” refers to all land habitat for all species. Habitat for a particular species is identified with the species name of interest, such as moose habitat, rusty blackbird nesting habitat or jack pine (*Pinus banksiana*) habitat. Terrestrial habitat is a keystone driver for ecosystems and, for many reasons, provides the best single indicator for Project effects on terrestrial ecosystems.

Photo 2-1: Several peatland habitat types in the Keeyask Study Area

Prior to the Project, terrestrial habitat accounted for approximately 87% of the Regional Study Area (i.e., Study Zone 5 in Map 1-2). For the assessment, terrestrial habitat included lowlands, uplands, and areas submerged under water that were less than 2m deep.

Two common broad habitat types covered approximately 53% of the land area in the Regional Study Area: black spruce (*Picea mariana*) dominant treed vegetation on thin peatland; and black spruce dominant treed vegetation on shallow peatland (Photo 2-2). The remaining terrestrial area included 51 broad habitat types. The common broad habitat types were less abundant in the Local Study Area due to the higher abundance of uncommon and rare habitat types that occur on mineral soils.

Photo 2-2: Black spruce treed vegetation on shallow peatland habitat in the Keeyask Study Area

The Project was expected to cause loss, alteration and physical disturbance of habitat and ecosystems (i.e., direct effects) in the actual Project Footprint. These direct effects were expected to create indirect effects, both within the Project Footprint (e.g., soil warming, altered hydrology) and in some surrounding areas (e.g., edge effects).

For terrestrial habitat as a whole, the EIS considered a 10% cumulative loss of historical terrestrial habitat area in the Regional Study Area as the benchmark that led to the need for mitigation. Mitigation implemented for the Project that helped to reduce habitat effects below this benchmark included selecting a low-head option to reduce the amount of Project-related flooding, reducing the total size of the borrow area and excavated material placement area (EMPA) footprints, avoiding sensitive sites, minimizing clearing and disturbance within and adjacent to the Project Footprint and blocking cutlines and trails where they intersected the Project Footprint.

The EIS predicted that, after mitigation, Project construction could directly affect up to 6,872 ha of terrestrial habitat, but this could increase to 6,952 ha if Borrow Area E-1 (the Ellis Esker) was used. A conservative estimate (i.e., erring on the side of overestimating potential effects) of the area that could be indirectly affected by the Project increased the potentially affected area to 8,927 ha if Borrow Area E-1 was not used, or 9,070 ha if it was used.

2.1.2 MONITORING

Construction monitoring focused on Project-related effects on terrestrial habitat due to habitat loss and disturbance. The reporting of where Project clearing or disturbance occurred was based on the four distinct Project areas (defined in Section 1.2).

Remote sensing identified the spatial extent and the nature of Project clearing or disturbance. Remote sensing data included digital orthorectified images (DOIs) created from high-resolution satellite imagery or stereo photographs, and photos and notes taken during aerial surveys. Aerial surveys were conducted by helicopter in September of each construction year (Photo 2-3).

Photo 2-3: Identifying an area with sedimentation from a Project borrow area into the surrounding native habitat during an aerial survey

Ground surveys collected more detailed data at sites where either the remote sensing data were ambiguous or had been identified as having impacts of special concern (e.g., erosion of a magnitude to merit installation of containment measures; Photo 2-4). Additionally, impacts of concern that had been identified in previous years were surveyed again by foot to monitor for change or assess the effectiveness of mitigation measures (Photo 2-5).

Photo 2-4: Sediment fence deployed after terrestrial habitat survey

Photo 2-5: Ground survey of an area with sedimentation into the surrounding habitat

Project clearing and disturbance were mapped regardless of whether they occurred in terrestrial or in aquatic areas. Aquatic areas dewatered during construction were included under the "Project clearing" umbrella. The extent of permanently dewatered areas will be mapped once the temporary footprint components are decommissioned and the extent of the created wetlands are finalized. Initial flooding was mapped using the terrestrial habitat shoreline position in September, 2021 (the terrestrial habitat shoreline is defined as the visible current and historical limit of water and ice regime effects).

Project clearing and disturbance for each year of construction were mapped as of September of that year.

2.1.3 RESULTS

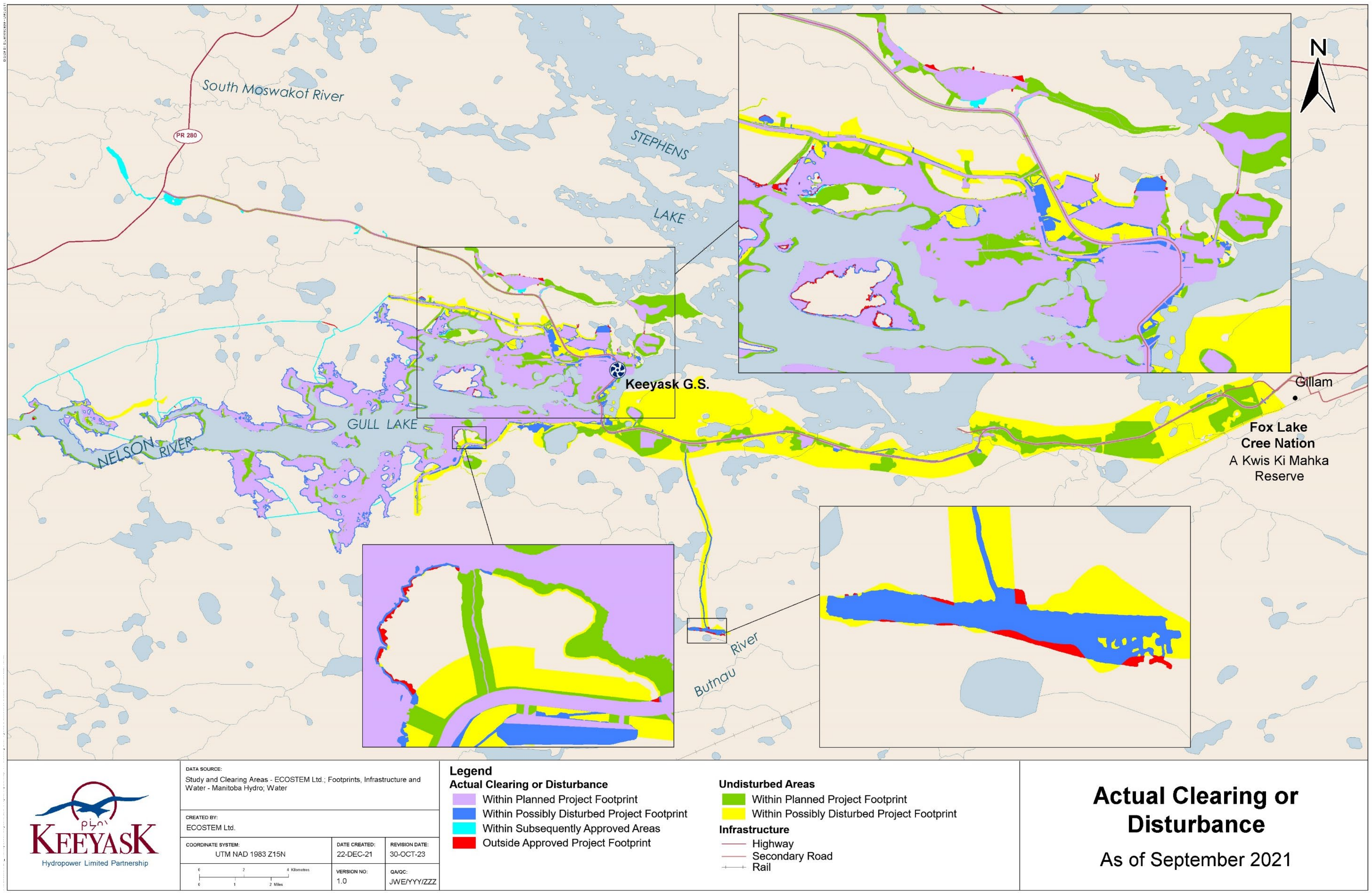
As of September 2021, the size of the Construction Footprint (i.e., overall actual Project clearing or disturbance) was 5,724 ha (Map 2-1). The vast majority (91%) of the area had been impacted by construction as of September, 2017 (Table 2-1).

Most construction activities had been completed by fall 2021. Remaining activities generally included much of the decommissioning of temporary features (e.g., borrow areas and EMPAs) and revegetation of areas not needed for Project operation. As the construction phase was considered to have ended in September 2021, Project clearing and disturbance as of this date is referred to as the Construction Footprint (Map 2-1).

Table 2-1: Cumulative actual Project clearing or disturbance area as of September 2021, by year and Project area

Project Area[2]	Total Approved Area (ha)	Total Area (ha)[1]							
		2014 (from KIP)	2015	2016	2017	2018	2019	2020	2021
Planned Project Footprint	7,616	420	1,246	3,294	4,971	5,279	5,299	5,301	5,302
Possibly Disturbed Project Footprint	5,123	10	63	191	242	306	313	314	314
Subsequently Approved Project Areas	n/a	29	29	56	63	63	63	100	100
Outside the Approved Project Footprint	n/a	-	2	5	6	8	8	9	9
All	**12,738**	**459**	**1,340**	**3,546**	**5,281**	**5,656**	**5,684**	**5,723**	**5,724**

Notes:[1] Areas for some Project areas differ slightly from those presented in the 2016 through 2020 annual reports because some infrastructure downstream of the spillway was removed. [2] See Section 1.2 for definitions of the Project areas.



Map 2-1: Construction Footprint: Actual Project clearing or disturbance as of September 2021

Although it had not been anticipated that Borrow Area E-1 (the Ellis esker) would be used during construction, insufficient suitable material in the other borrow areas along the South Access Road led to the addition of this borrow area and the winter road to access it.

Project clearing accounted for the vast majority (98.7%) of the 5,724 ha Construction Footprint (Table 2-2).

Table 2-2: Cumulative actual Project clearing or disturbance area (ha) as of September 2021, by year and Project area

Impact type		2014 (from KIP)	2015	2016	2017	2018	2019	2020	2021
Clearing	Terrestrial habitat clearing	456.5	1223.4	3398.9	5126.7	5481.4	5505.4	5506.0	5506.4
	Dewatered	-	15.5	17.5	17.7	19.3	22.0	22.0	22.0
	Re-inundated	0.5	89.4	92.3	94.6	112.2	112.7	112.7	112.7
	Flooding[1]	-	1.2	1.2	1.2	1.2	1.4	1.4	1.4
Disturbance		1.7	9.9	35.6	41.1	41.7	42.2	81.1	81.6
All (ha)		**458.7**	**1339.5**	**3545.5**	**5281.3**	**5655.9**	**5683.7**	**5723.2**	**5724.1**

Notes: [1] Flooding that is not related to reservoir impoundment.

Approximately 97% of the Construction Footprint was in areas that had been mapped as terrestrial habitat for the EIS. The remainder of the Construction Footprint was: aquatic habitat that had been converted to terrestrial habitat by either dewatering or displacement by Project infrastructure; and, previously dewatered aquatic habitat that was re-inundated.

Approximately 93% of the Construction Footprint was within the planned Project footprint (Table 2-1; Map 2-1; Figure 2-1). Impacts in the possibly disturbed Project footprint and in the subsequently approved Project areas, totaled approximately 314 ha and 100 ha, respectively. Areas impacted outside of the approved Project footprint totalled 8.6 ha, or 0.15% of the Construction Footprint.

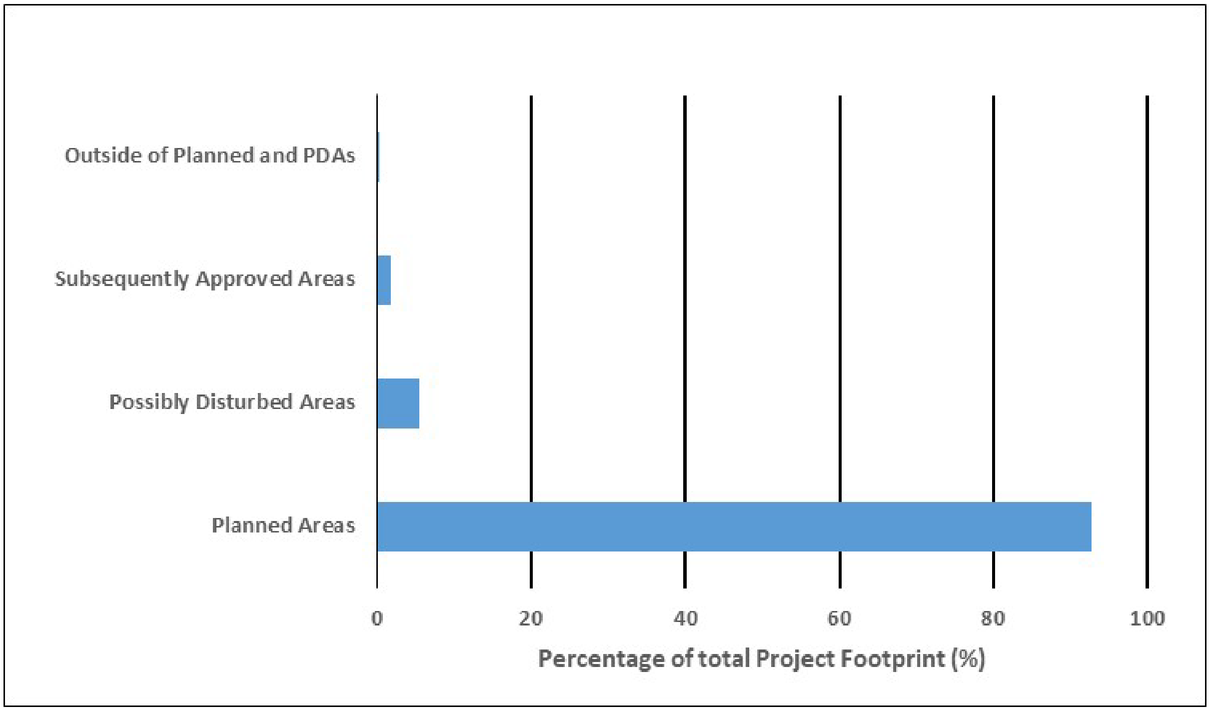


Figure 2-1: Cleared or disturbed areas as a percentage of the total Project Footprint

Of the major Project components (e.g., access roads, dikes, generating station), the highest impacts to terrestrial habitat loss were from reservoir clearing (which includes access trails to get to the clearing areas), followed by borrow area clearing and development (Figure 2-2).

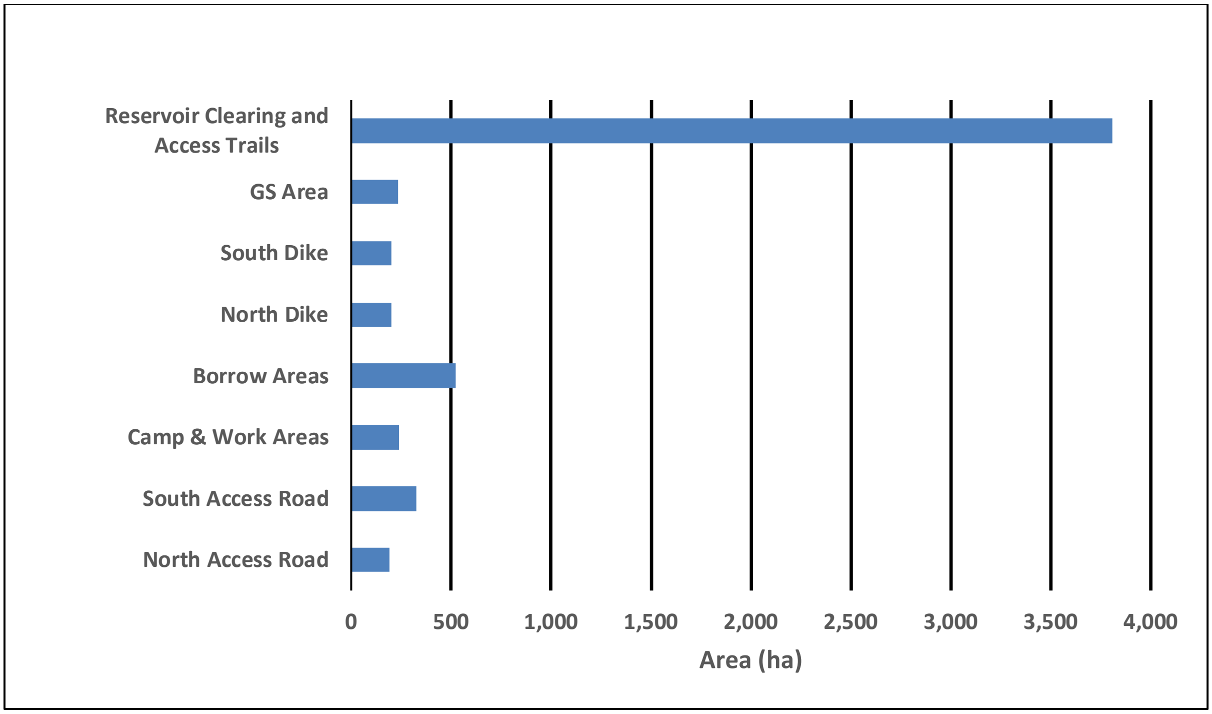


Figure 2-2: Area cleared or disturbed for construction, by Project component

Monitoring results led to recommendations for site-specific mitigation measures. These measures were implemented to address identified sources of additional disturbance within and outside the Construction Footprint. Examples of these measures are sediment fences (Photo 2-6), and erosion channels and rock barriers along portions of some of the borrow areas and EMPAs.

Photo 2-6: Rock berm around EMPA D16(1)-E in 2019

Reservoir clearing (and the related access trails; Photo 2-7) was the Project component that created the largest amount of clearing and disturbance within the possibly disturbed Project Footprint (Figure 2-3), followed by borrow areas, mainly the E-1 Borrow Area (Ellis Esker) and its winter access road. The largest amount of disturbance outside the Approved Project Footprint was from borrow areas (5.55 ha; Figure 2-4; See Photo 2-8), followed by reservoir clearing and access trails (2.32 ha).

Photo 2-7: New winter trail to access reservoir clearing areas

Photo 2-8: Sediment deposition in marsh adjacent to Borrow Area G-3

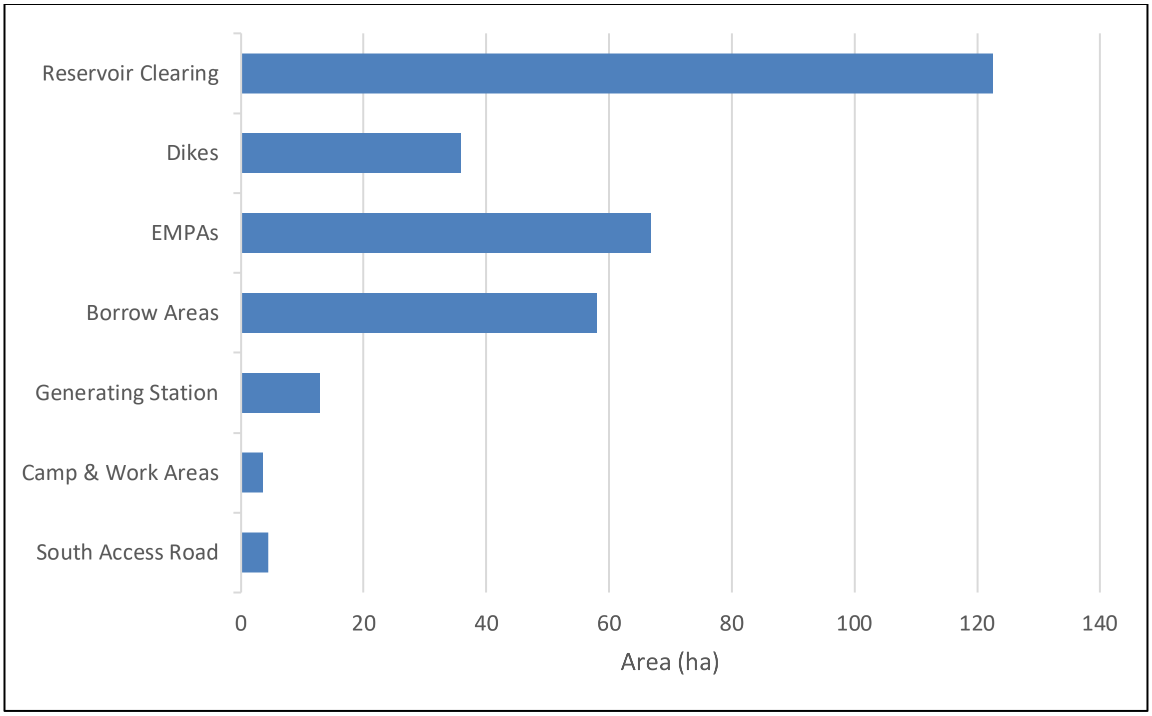


Figure 2-3: Area cleared or disturbed by Footprint component within the Possibly Disturbed Areas

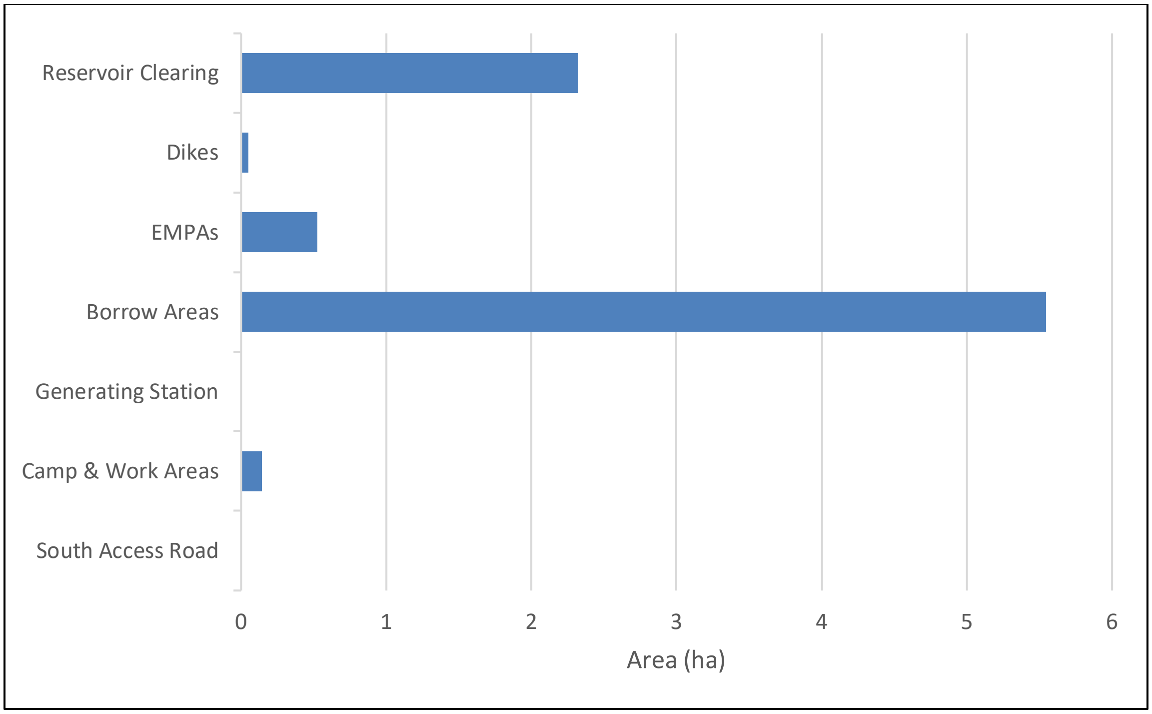


Figure 2-4: Area cleared or disturbed by Footprint component outside of the combined Planned and Possibly Disturbed Areas

2.1.4 DISCUSSION

2.1.4.1 COMPARISON WITH PREDICTED PROJECT EFFECTS

The size of the Construction Footprint impacts within terrestrial habitat was 28% smaller than the 6,952 ha (planned Project footprint plus Borrow Area E-1) assumed in the EIS (Figure 2-5). This was not surprising as it was expected that much of the possibly disturbed area would not be used during Project construction (KHLP 2012b, Section 2.3.6.2.1), and the EIS predictions erred on the side of overestimating expected effects.

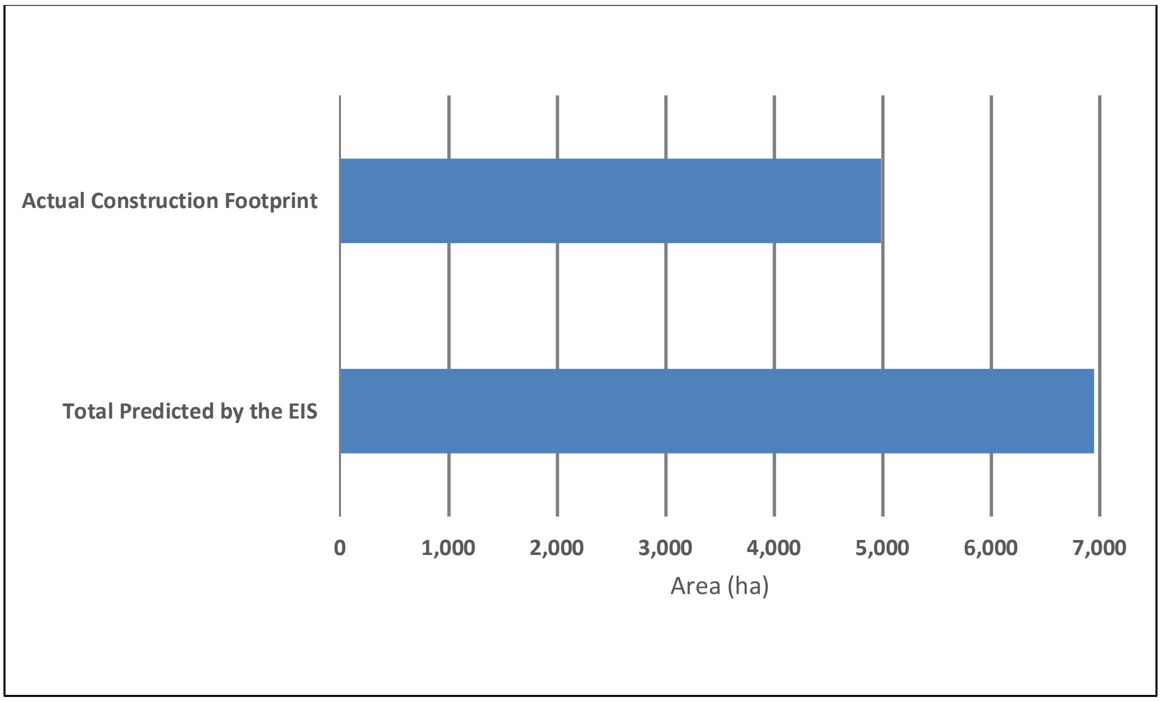


Figure 2-5: Predicted and actual Construction Footprint area (ha)

Approximately 45% of the originally licensed Project footprint (i.e., the Planned plus Possibly Disturbed Project footprint) was cleared or disturbed during construction. Just under 70% of the Planned Areas were cleared or disturbed and only 6.1% of the Possibly Disturbed Areas were cleared or disturbed (Figure 2-6).

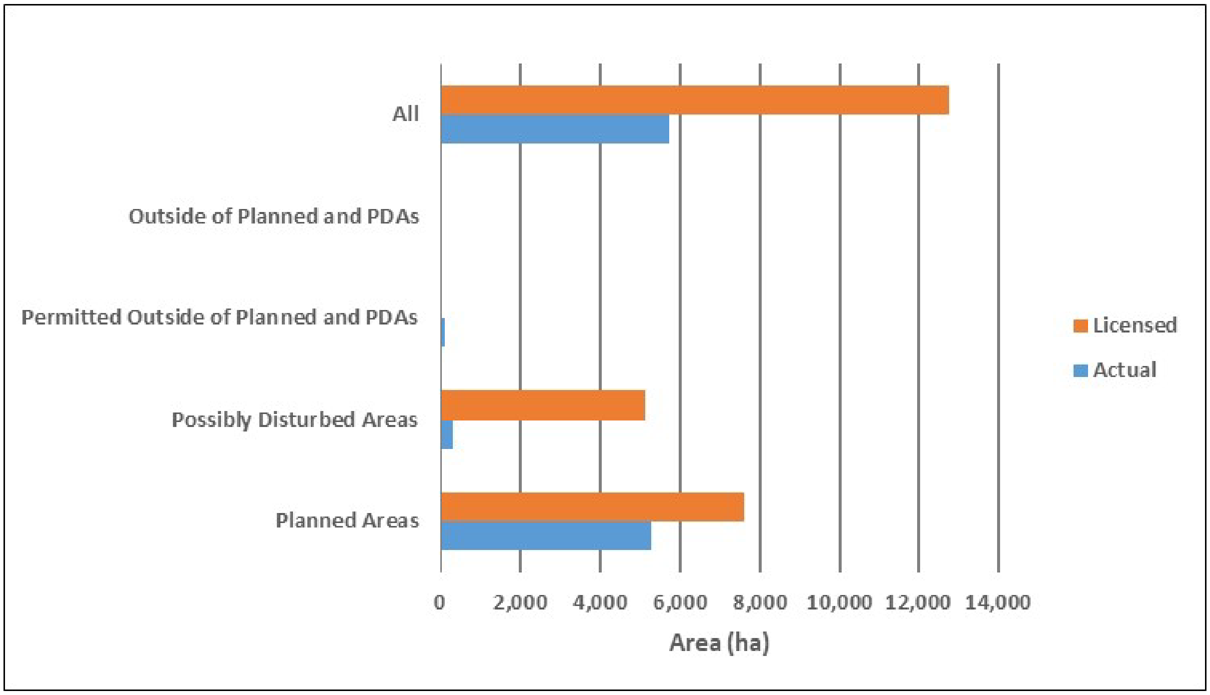


Figure 2-6: Project clearing or disturbance (actual) vs predicted (licensed)

As illustrated in Map 2-1, the 8.6 ha of the clearing or disturbance outside the approved Project Footprint was very small (0.15%) relative to the 7,123 ha of remaining undisturbed area within the licensed Project footprint. Additionally, virtually all of the still undisturbed area within the licensed Project footprint in 2021 is expected to remain undisturbed by the Project now that construction is largely complete.

With one exception, every native land cover type had lower direct effects than assumed for the EIS (Table 2-3; Figure 2-5). The exception was for the Shrub or low vegetation on riparian peatland type, where actual direct effects were 3% (6.5 ha) larger than assumed for the EIS. The majority of this land cover type occurred within the reservoir area, where a large proportion of the Project impacts in the possibly disturbed Project Footprint occurred.

In descending order, the highest reductions between predicted and actual effects were for Needleleaf treed vegetation on mineral or thin peatland, Needleleaf treed vegetation on other peatlands and Low vegetation on mineral or thin peatland types.

Table 2-3. Predicted and actual area (ha) of terrestrial habitat in the Construction Footprint, by land cover type

Land Cover	Total Predicted by the EIS	Actual Construction Footprint	Difference	
			ha	%
Needleleaf treed on mineral or thin peatland	3,129.2	2,162.8	-966.4	-31
Needleleaf treed on other peatlands	2,079.7	1,780.5	-299.2	-14
Low vegetation on mineral or thin peatland	426.6	160.6	-266.0	-62
Nelson River shore zone	282.8	72.7	-210.1	-74
Tall shrub on other peatlands	40.7	35.3	-5.3	-13
Broadleaf treed on all ecosites	189.2	71.5	-117.8	-62
Low vegetation on other peatlands	532.3	445.4	-86.9	-16
Tall shrub on mineral or thin peatland	49.4	33.3	-16.1	-33
Off-system shore zone	8.4	4.3	-4.1	-49
Shrub/ low vegetation on riparian peatland	214.0	220.5	6.5	3
All	**6,952.3**	**4,987.0**	**-1,965.3**	**-28**

2.1.4.2 CONCLUSIONS

Monitoring has shown that the EIS predictions for the total size of the Construction Footprint were cautious, as expected. With one minor exception, all of the direct Project effects on overall terrestrial habitat during construction were less than predicted (the exception was Shrub/low vegetation on riparian peatland, where actual direct effects were 3% higher than assumed for the EIS). EIS mitigation measures were generally implemented, and have been effective. The Project has not created any major unanticipated removal or alteration of terrestrial habitat.

2.1.4.3 FUTURE MONITORING

Terrestrial Habitat Loss and Disturbance monitoring will continue during the Project's operation phase.

The construction phase monitoring did not identify the need to alter any of the methods for the operation phase.

A new study, the Long-term Effects on Terrestrial Habitat study (KHLP 2015, Section 2.1.3), will monitor long-term indirect Project effects on terrestrial habitat. This monitoring begins during operation because it can take several years for such effects to become notable, and because some areas were still being impacted in the first year of operation. This study will also monitor recovery to native habitat in Project-affected areas and in areas where trails intersect the Project footprint.

2.2 HABITAT REHABILITATION

2.2.1 BACKGROUND

Terrestrial habitat rehabilitation mitigates adverse Project effects on terrestrial habitat and plants (e.g., habitat loss, erosion, invasive plant spread), restores wildlife habitat and improves aesthetics, among other benefits (Photo 2-9). Terrestrial habitat will be rehabilitated in areas not required for Project operation, and in some areas that are required for Project operation (e.g., along access roads; Photo 2-10). Some of the planned rehabilitation addresses potential adverse Project effects on intactness by blocking or hindering access from Project areas to surrounding areas.

Photo 2-9: Borrow area off the North Access Road with planted jack pine seedlings

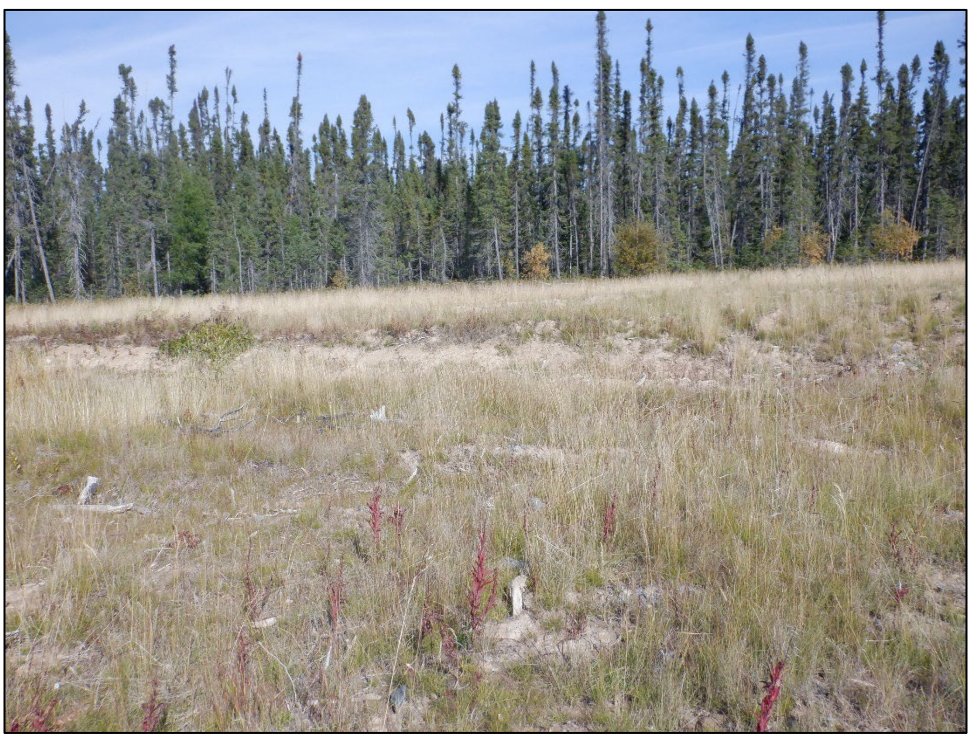


Photo 2-10: Roadside seeded with native grasses along the South Access Road

Prior to the Project, predictions for all of the key topics were directly or indirectly based on assumptions regarding the effectiveness of habitat rehabilitation efforts and natural regeneration processes.

The Keeyask Hydropower Limited Partnership (KHLP) was required to prepare a plan for rehabilitating terrestrial habitat. The *Keeyask Generation Project Vegetation Rehabilitation Plan* (the VRP; KHLP 2015b), which is part of the overall Environmental Protection Program, provides the framework for rehabilitating terrestrial habitat in areas impacted by Keeyask Infrastructure Project (KIP) and the Project.

2.2.2 MONITORING

Construction monitoring focussed on verifying adequate implementation of the first several years rehabilitation efforts. Rehabilitation is ongoing during Project operation.

The reporting of habitat rehabilitation implementation during construction was based on four distinct areas:

1. The vegetation regeneration in temporary portions of the Construction Footprint
2. Grass seeding rehabilitation in locations along the South Access Road
3. Trails selected for blocking and rehabilitation
4. Tree planting in various borrow, camp or work areas along the North Access Road

The spatial extent and degree of habitat regeneration success were mapped through high resolution remote sensing. Remote sensing data included DOIs, digital stereo photography and photographs from aerial surveys collected during terrestrial habitat surveys (Section 2.1).

Ground surveys were conducted within the rehabilitation areas. Each tree planting area was divided into treatment areas based on a combination of surface substrate material, topography and the species planted. Planting implementation and tree regeneration surveys (Figure 2-7) were conducted along 1 m wide belt transects within the treatment areas. Target tree species (jack pine and black spruce) stems were tallied along with stem health and other information along the belt transects.

Flagged sampling transect at the Main Camp entrance

Sampling a transect in Borrow Area KM-1

Figure 2-7: Tree regeneration sampling in 2017

2.2.3 RESULTS

As of September 2021, the rehabilitation monitoring area encompassed 1,138 ha. This area included the cleared portion of the North and South Access Road rights-of-way (but not including the roadbed), borrow areas, EMPAs, and camp and work areas not required for Project operation.

2.2.3.1 VEGETATION REGENERATION

Just over half (52%) of the monitored area was vegetated as of September 2021 (Figure 2-8). Map 2-2 and Map 2-3 show vegetation cover by class.

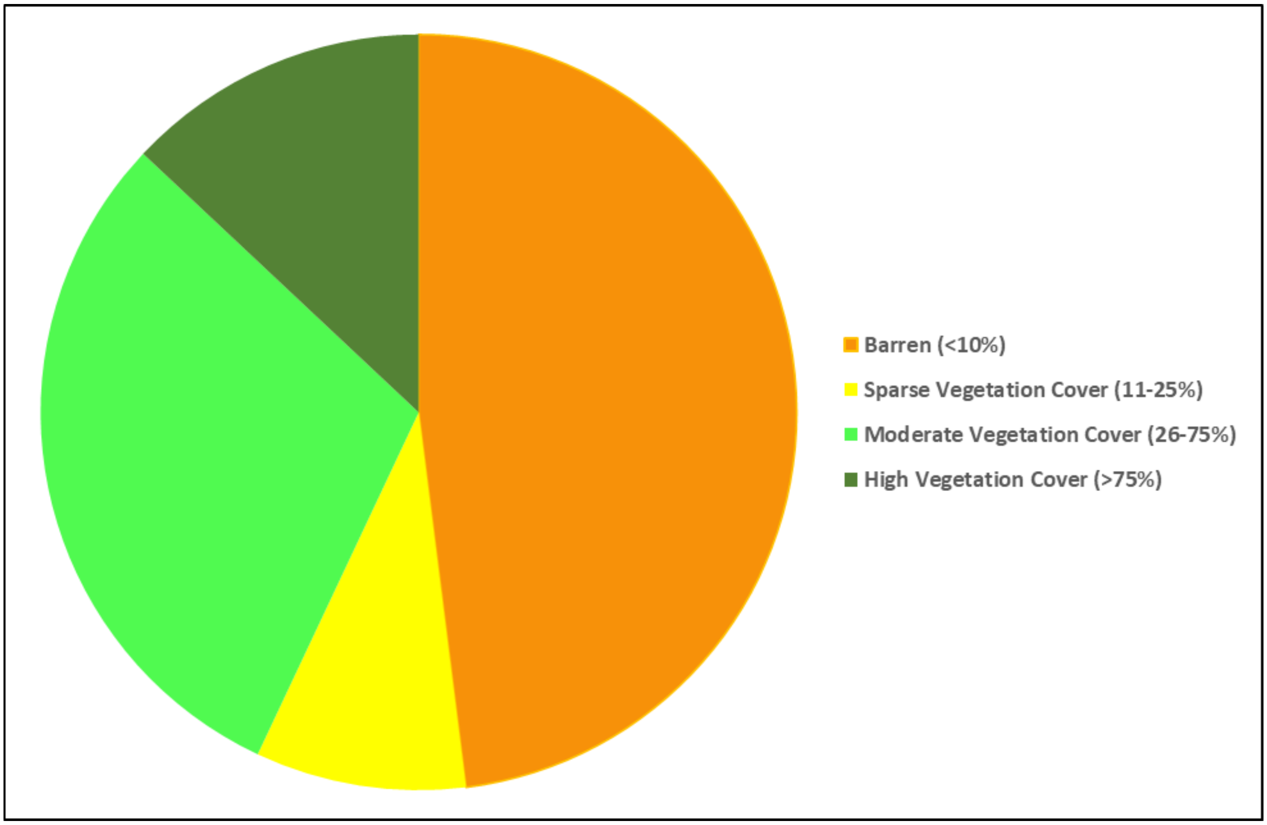
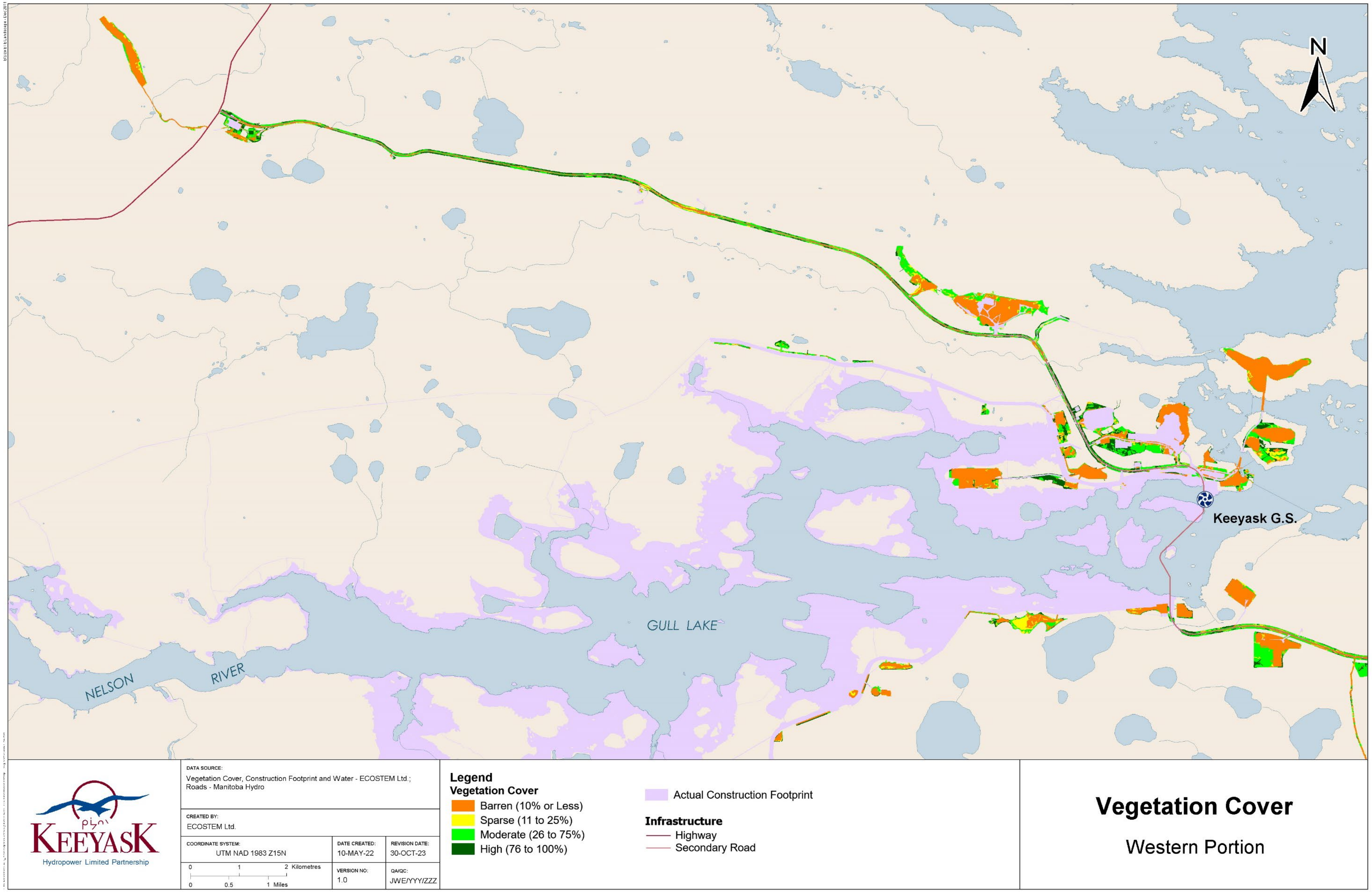
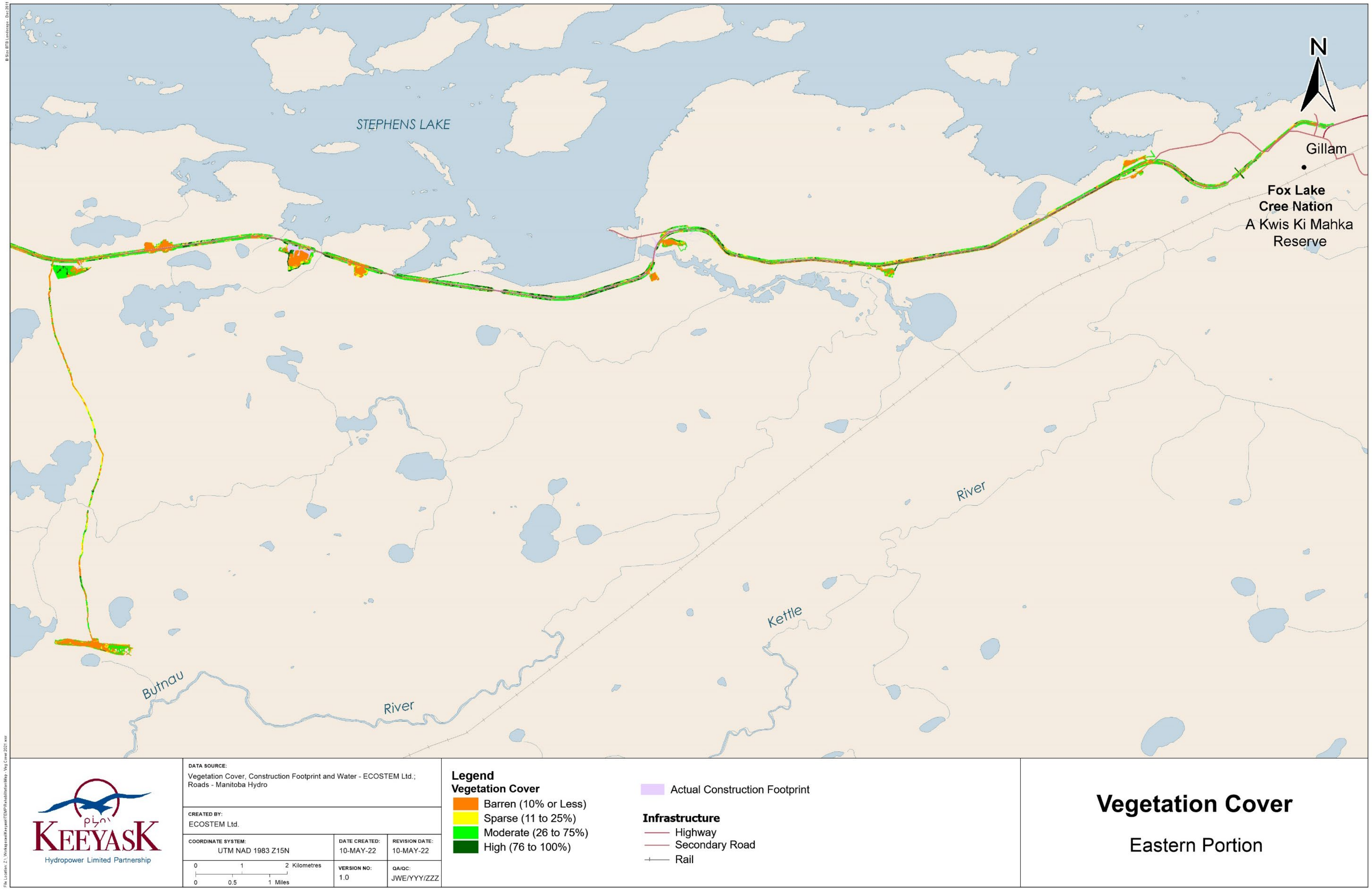


Figure 2-8: Vegetation cover by cover class as of 2021



Map 2-2: Vegetation cover in the western portions of the Construction Footprint as of 2021



Map 2-3: **Vegetation cover in the eastern portions of the Construction Footprint as of 2021**

Nineteen percent of the North and South Access Roads footprint (i.e., rights-of-way) was determined to be barren (Figure 2-9; Photo 2-11). In the remaining areas, 39% was vegetated (i.e., not barren, had some vegetative cover).

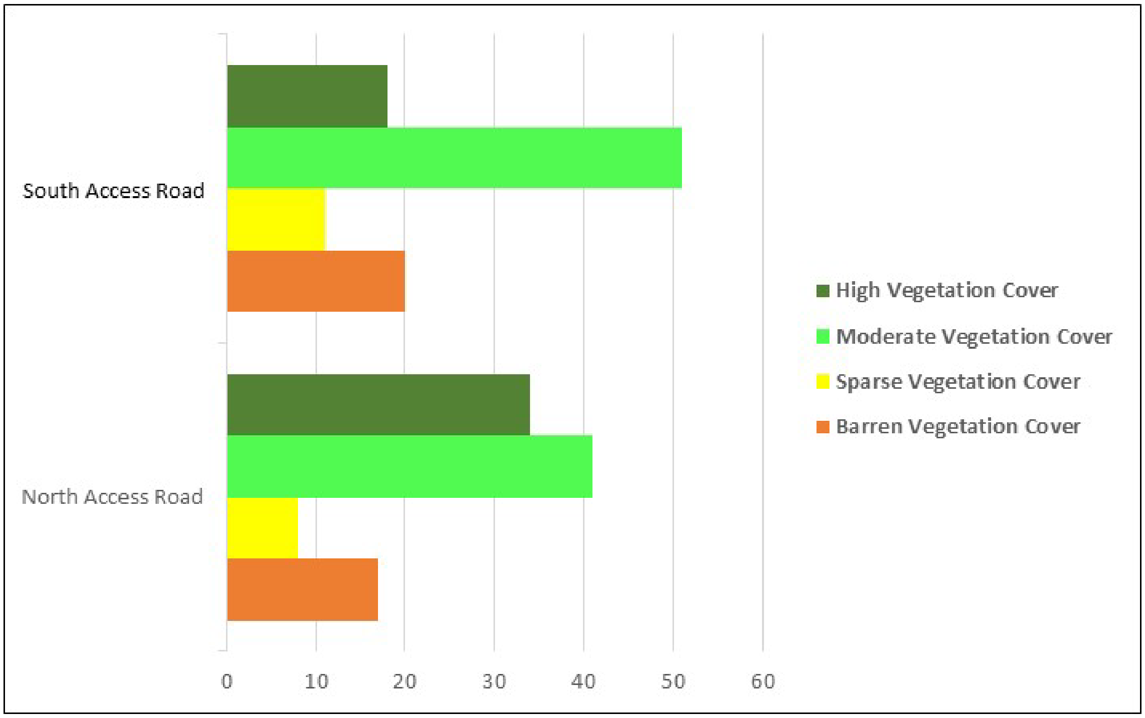


Figure 2-9: North Access Road vegetation cover by class as of 2021

Photo 2-11: Barren, sparse, moderate and high vegetation cover on the old Butnau road along the South Access Road

Barren areas comprised a large proportion of the borrow areas, EMPAs and work areas, and particularly so for areas that were recently used for construction. The most common vegetation structure in the vegetated areas was low shrub/graminoid/bryoid (Table 2-4).

Table 2-4: Construction Footprint vegetation structure and cover by class as of 2021

Vegetation Structure	Vegetation Cover Class (ha)				Total Area (ha)
	Barren	Sparse	Moderate	High	
Barren	472.6	0.0	0.0	0.0	472.6
Woodland	0.0	0.0	3.8	3.4	7.2
Woodland/ Tall Shrub	0.0	0.0	0.0	0.4	0.4
Emergent	0.0	0.1	0.2	0.3	0.5
Low Shrub and/or Graminoid and/ or Bryoid	0.0	66.4	129.6	38.1	234.2
Sparsely Treed	0.0	0.3	1.6	5.9	7.7
Sparsely Treed/ Tall Shrub	0.0	0.1	5.6	3.0	8.8
Tall Shrub	0.0	0.1	17.2	13.4	30.8
Unclassified Young Regeneration	0.0	0.6	10.0	0.4	10.9
Forest	0.0	0.0	0.0	0.8	0.8
Total	**472.6**	**67.7**	**168.0**	**65.6**	**773.8**

Notes: Totals may not equal sum of values due to rounding.

It was estimated that approximately 11 ha was seeded with native grasses in Borrow Area B-3 and Q-9 (Table 2-5; ; Photo 2-12). Approximately 58% of the seeded area had at least sparse vegetation cover and 35% had moderate to high cover as of September 2021.

Table 2-5: Vegetation cover as a percentage of total area in the seeded portions of the rehabilitation locations

Location	Seeding Area	Area Seeded (ha)	Percent in Vegetation Cover Class			
			High	Moderate	Sparse	Barren
Borrow Area B-3	1	0.38	-	9.1	34.2	56.8
	2	0.99	-	36.8	18.3	44.9
	3	1.22	-	24.3	17.1	58.6
	4	4.54	-	39.8	18.9	41.3
	Total	**7.12**	**-**	**35.1**	**19.3**	**45.6**
Borrow Area Q-9	1	0.21	-	18.1	24.5	57.4
	2	3.66	4.4	29.8	30.6	35.1
	Total	**3.86**	**4.2**	**29.2**	**30.3**	**36.3**
All areas		**10.99**	**1.5**	**33.0**	**23.2**	**42.3**

Notes: Totals may not equal sum of values due to rounding.

Photo 2-12: Seeded area regeneration in Borrow Area B-3 as of 2021

Monitoring of the 47 trails that intersect the Construction Footprint found no change in vegetation regeneration status or trail blocking measures since 2017 (Table 2-6; ; Photo 2-13). Signs of recent ATV activity were present along a trail connected to the clearing at the south side of the Start-up Camp (SUC) and one at the northwest corner of Borrow Area G-5.

Table 2-6: Condition of surveyed trails in 2021

Trail Condition	Number of Trails	Percent of Trails
Blocked	2	4
Signs of recent activity[1]	2	4
Tree planting	0	0
Natural tree or shrub regeneration:		
Trees only	8	17
Shrubs only	8	17
Both trees and shrubs	20	43
Sub-Total for natural tree or shrub regeneration	36	77
Dense natural regeneration following 2013 burn	26	55
Total trails surveyed	**47**	**-**

Notes: [1] Recent activity that did not appear to be from the Project.

Photo 2-13: Trail with advanced natural regeneration leading off the North Access Road

2.2.3.2 TREE PLANTING AREAS

2016 Planting Areas

One year after tree planting, in 2017, the estimated mean planted stem density was at or above the target density of 2,500 stems/ha for a woodland habitat in all 2016 rehabilitation locations except for Borrow Area KM-9.

As of September 2021, stem density averaged 11,441 stems/ha in areas that were planted with jack pine (Photo 2-14) in 2016. In areas where black spruce (Photo 2-15) or a mixture of black spruce and jack pine were planted, average stem density was 2,898 stems/ha (Table 2-7).

Photo 2-14: Jack pine seedling planted in 2016

Photo 2-15: Black spruce seedling planted in 2016

Table 2-7: Jack pine and black spruce live stem average density and standard deviation (in brackets), percent of stems from natural regeneration and average percent mortality as of September 2021 for areas planted in 2016, by treatment area

Location	Treatment Area	Number of Transects	Black Spruce			Jack Pine		
			Average Density (stems/ha) [1]	Percent of Stems from Natural Regeneration	Average Percent Mortality[2]	Average Density (stems/ha) [1]	Percent of Stems from Natural Regeneration	Average Percent Mortality[2]
Borrow Area KM-1	1	2	**2,034 (305)**	5.6 (7.9)	-	-	-	-
	2	10	20 (64)	-	-	**15,037 (3,668)**	0.8 (2.7)	0.1
	3	3	**2,916 (36)**	0.0	-	-	-	-
Borrow Area KM-4	4	2	**2,030 (2,817)**	13.0	-	**11,722 (3,179)**	0.0	0.0
	5	3	**2,240 (1,631)**	33.3 (57.7)	-	**10,739 (2,736)**	0.0	0.0
	6	12	524 (1,673)	100.0	-	**12,430 (1,728)**	0.0	0.7
Borrow Area KM-9	7	5	**5,920 (7,044)**	24.3 (39.3)	-	**1,923 (2,570)**	0.0	0.0
	8	3	23 (40)	-	-	**12,414 (1,040)**	0.0	0.0
	9	3	**3,212 (999)**	0.0	-	430 (391)	100.0	-
	10	2	**1,936 (111)**	0.0	-	-	-	-
Main Camp Entrance	16	2	-	-	-	**11,242 (1,198)**	0.0	2.4
	17	2	-	-	-	**9,966 (1,671)**	0.0	2.2
Near the Start-up Camp	12	2	581 (667)	100.0	-	**14,872 (489)**	0.0	0.0
	13	4	418 (552)	100.0	-	**14,126 (1,539)**	0.0	0.7
	15	2	8,203 (8,742)	100.0	-	**11,377 (170)**	54.4 (62.6)	0.3

Notes: [1]Bolded species indicate a planned species for the given planting area. Corresponding densities occur through natural regeneration. [2] Percent mortality of each transect averaged over the total number of transects in the planting area with planted species

Naturally regenerating black spruce were present in most of the treatment areas and ranged from 5.6% to 100% of stems. Jack pine natural regeneration was present in three planting areas, including an area near the start up camp.

Recorded mortality for planted jack pine stems was low and nil for black spruce.

2020 Planting Areas

As of September 2021, stem densities for the areas planted in 2020 were below the woodland density targets. The average live stem density for planted and naturally regenerating jack pine ranged from 314 to 3,928 stems/ha (Table 2-8) across the planting areas. Stem densities for black spruce ranged from 64 to 15,509 stems/ha.

Table 2-8: Jack pine and black spruce live stem average density and standard deviation (in brackets) as of September 2021 for areas planted in 2020, by treatment area

Location	Treatment Area	Number of Transects	Black Spruce			Jack Pine		
			Average Density (stems/ha) [1]	Percent of Stems from Natural Regeneration	Average Percent Mortality[2]	Average Density (stems/ha) [1]	Percent of Stems from Natural Regeneration	Average Percent Mortality[2]
Borrow Area G-3	1	3	-	-	-	1,066 (1,285)	22.2 (38.5)	0.0
	2	3	-	-	-	3,583 (942)	0.0	7.4
	4	14	193 (264)	37.2 (47.0)	10.7	2,998 (884)	0.8 (2.3)	11.5
	5	11	64 (212)	100		3,267 (1,582)	0.0	4.8
	6	11	15,509 (20,468)	100	--	2,765 (2,861)	60.4 (45.2)	0.0
	7	10	-	-	-	1,368 (1,706)	0.0	30.5
	8	9	7,487 (9,183)	85.5 (37.7)	0.0	3,928 (2,824)	68.8 (42.2)	0.0
EMPA D27(4)-E	1	15	1,134 (1,146)	0.5 (1.7)	4.6	2,658 (1,413)	0.0	4.7
	2	4	83 (167)	0.0	5.1	1,581 (763)	0.0	9.4
	3	8	1,522 (1,689)	0.0	0.0	1,643 (1,227)	0.0	5.5
	4	6	-	-	-	577	0.0	-
	7	6	1,006 (291)	0.9 (2.3)	4.8	656 (286)	0.0	8.8
	8	5	556 (471)	0.0	0.0	314 (559)	0.0	23.6
	9	1	1250	0.0	-	769	0.0	-
	10	5	1,913 (1,019)	0.0	-	415 (337)	0.0	-

Notes: [1]Bolded species indicate a planned species for the given planting area. Corresponding densities occur through natural regeneration. [2] Percent mortality of each transect averaged over the total number of transects in the planting area with planted species

Naturally regenerating black spruce and jack pine occurred in 7 of the 13 treatment areas. Jack pine made up a smaller portion of the naturally regenerating stems than black spruce, occurring in only 4 treatment areas in Borrow Area G-3.

Jack pine stem mortality ranged from 0% to 30.5% and black spruce mortality was low, from 0% to 6.5%.

2.2.4 DISCUSSION

2.2.4.1 COMPARISON WITH PRESCRIPTIONS AND TARGETS

Preliminary evaluation of habitat regeneration in the temporary portions of the Construction Footprint and North and South Access Road rights-of-way showed that just over half of the mapped area was found to have vegetation cover of 10% or higher. This evaluation was preliminary because it used approximate boundaries for the temporary Project areas as well as provisional determinations of the target habitat types. Boundaries for the temporary Project areas were approximate since some of these areas had not yet been, or were in the process of being, decommissioned.

Overall, vegetation cover along the access roads was higher than for the remaining area monitored. This was expected as construction was still active or had only recently ended in several areas, while most of the road construction had been completed for some time (and portions were seeded) and remained undisturbed since earlier in construction. More than half of the grass seeded area had at least sparse vegetation cover.

Monitoring found no substantive change to the status of trails selected for blocking and regeneration. Natural vegetation regeneration after the 2013 wildfire has obscured most of the monitored trails, and eliminated the need to implement other blocking measures.

In total, approximately 357,180 seedlings were planted in 2016 and 2020. Tree regeneration surveys conducted the year after the seedlings were planted found that the implementation of the tree planting prescriptions likely occurred as planned.

Stem density comparison from monitoring conducted in 2016 and 2021 indicated that planted black spruce seedlings were struggling to thrive in several of the 2016 planting areas. However, planted seedling mortality was being partially offset by natural black spruce regeneration, and stem densities were above the targets for a woodland in 13 of the 15 areas planted in 2016. Tree seedlings generally appeared healthy in the 2020 planting areas. This suggested that most of the stems still living in 2021 will continue to survive, barring unusual circumstances.

It is unclear at this time if additional tree planting will be required to achieve the stem density targets in the areas already planted. It is not feasible to determine which areas may require additional tree planting until the boundaries of the temporary Project areas are finalized, followed by mapping of substrate conditions and planting limitations.

2.2.4.2 CONCLUSIONS

The rehabilitation monitoring has found that vegetation cover was above 10% in the majority of portions of the Construction Footprint selected for rehabilitation.

Monitoring of trail blocking and habitat regeneration in 2021 found that the status of the trails that were physically blocked was unchanged. For the remaining trails, natural regeneration following the 2013 wildfire (which was not caused by the Project) has obscured the trails and removed the need for these trails to be blocked by other means.

For tree regeneration, monitoring indicates that the tree planting prescriptions were likely implemented as planned. It also found that many of the areas planted in 2016 met the live stem density target of 2,500 stems/ha. While the results suggested that many of the areas planted in 2020 did not meet the density target, this was a tentative finding as the boundaries for the areas to become woodland or forest habitat were still to be confirmed.

2.2.4.3 FUTURE MONITORING

Habitat rehabilitation implementation monitoring will continue during the Project operation phase.

Once the areas not needed for Project operation are determined, site-specific target habitat types and rehabilitation prescriptions will be developed. This information will be used to determine if any areas require additional tree planting.

A new study, terrestrial habitat recovery success, will begin during operation. This study starts later because it begins no sooner than three years after rehabilitation of a broad area is complete (e.g., a borrow area).

2.3 ECOSYSTEM DIVERSITY

2.3.1 BACKGROUND

Ecosystem diversity refers to the number of different ecosystem types, as well as their size and distribution, within a defined geographic area. Priority habitat types (Photo 2-16) are those native habitat types that are particularly important for ecological and/or social reasons.

Photo 2-16: Priority habitat (rare): Trembling aspen treed vegetation on all ecosites

The Regional Study Area for ecosystem diversity (i.e., Study Zone 5 in Map 1-2) included 53 native inland broad habitat types. The distribution of area amongst these habitat types was very uneven.

Forty-three native inland broad habitat types met at least one of the priority habitat criteria. Of the 43 priority habitats, 7 were regionally uncommon and 36 were regionally rare (Photo 2-17). Many of the regionally rare and uncommon habitat types were more abundant within the Local Study Area (i.e., Study Zone 2 in Map 1-2) than the rest of the Regional Study Area.

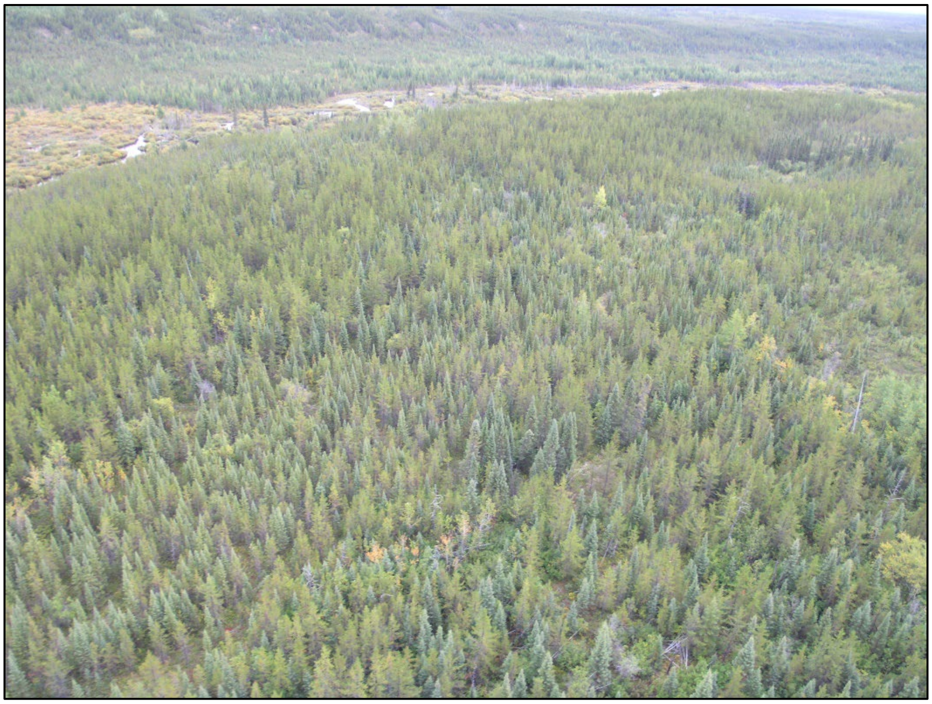


Photo 2-17: Priority habitat (rare): Jack pine mixture treed vegetation on thin peatland

The EIS predicted that, without mitigation, Project construction would affect 39 of the priority habitat types, and effects could be as high as 3.8% of their total area. For some types, this would increase cumulative effects above the 10% benchmark used for the assessment.

Mitigation implemented to reduce effects on ecosystem diversity included avoiding the N-6 sensitive site (Photo 2-18) and giving preference to rehabilitating the most affected priority habitat types using approaches that “go with nature”. This mitigation built on the mitigation implemented for terrestrial habitat as a whole (Section 2.1).

Photo 2-18: White birch mixedwood treed vegetation priority habitat in N-6 prior to the 2013 fire

The EIS predicted that, after mitigation, Project construction would not change the total number of native stand level habitat types or substantially change the proportions of any of the regionally common or uncommon native habitat types.

2.3.2 MONITORING

In addition to priority habitats, the ecosystem diversity monitoring included three other types of sensitive terrestrial sites included in the Environmental Protection Plans (EnvPPs), which were off-system marsh, mammal riparian habitat, and caribou calving and rearing habitat.

Monitoring during Project construction occurred annually.

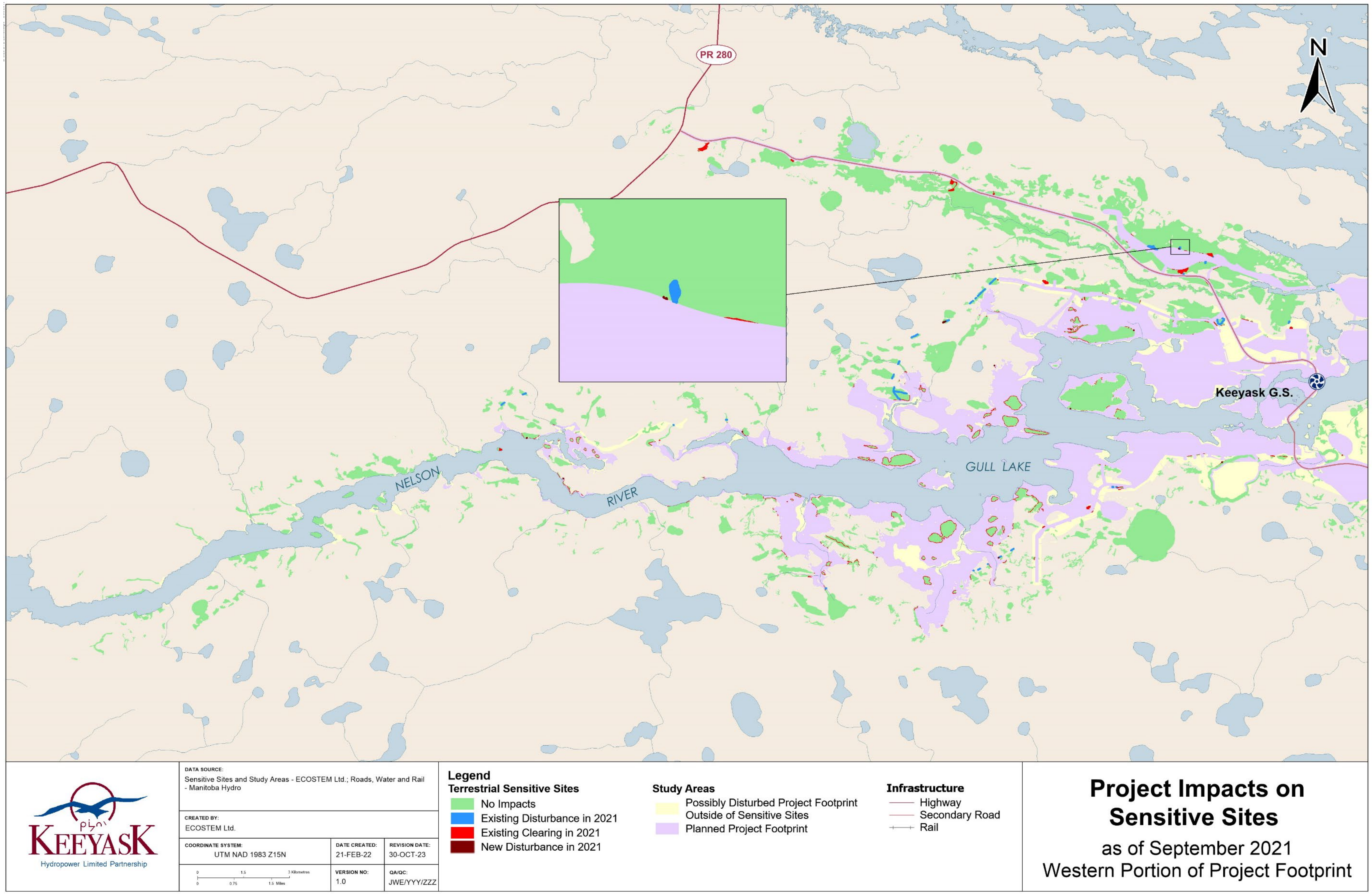
Aerial and ground surveys of sensitive site areas were done in conjunction with the terrestrial habitat surveys (Section 2.1), as well as the Wetland Function surveys (Section 2.5). Ground surveys included the "N-6 priority habitat to avoid" area (Photo 2-19).

Photo 2-19: Ground survey in sensitive site N-6 in 2015

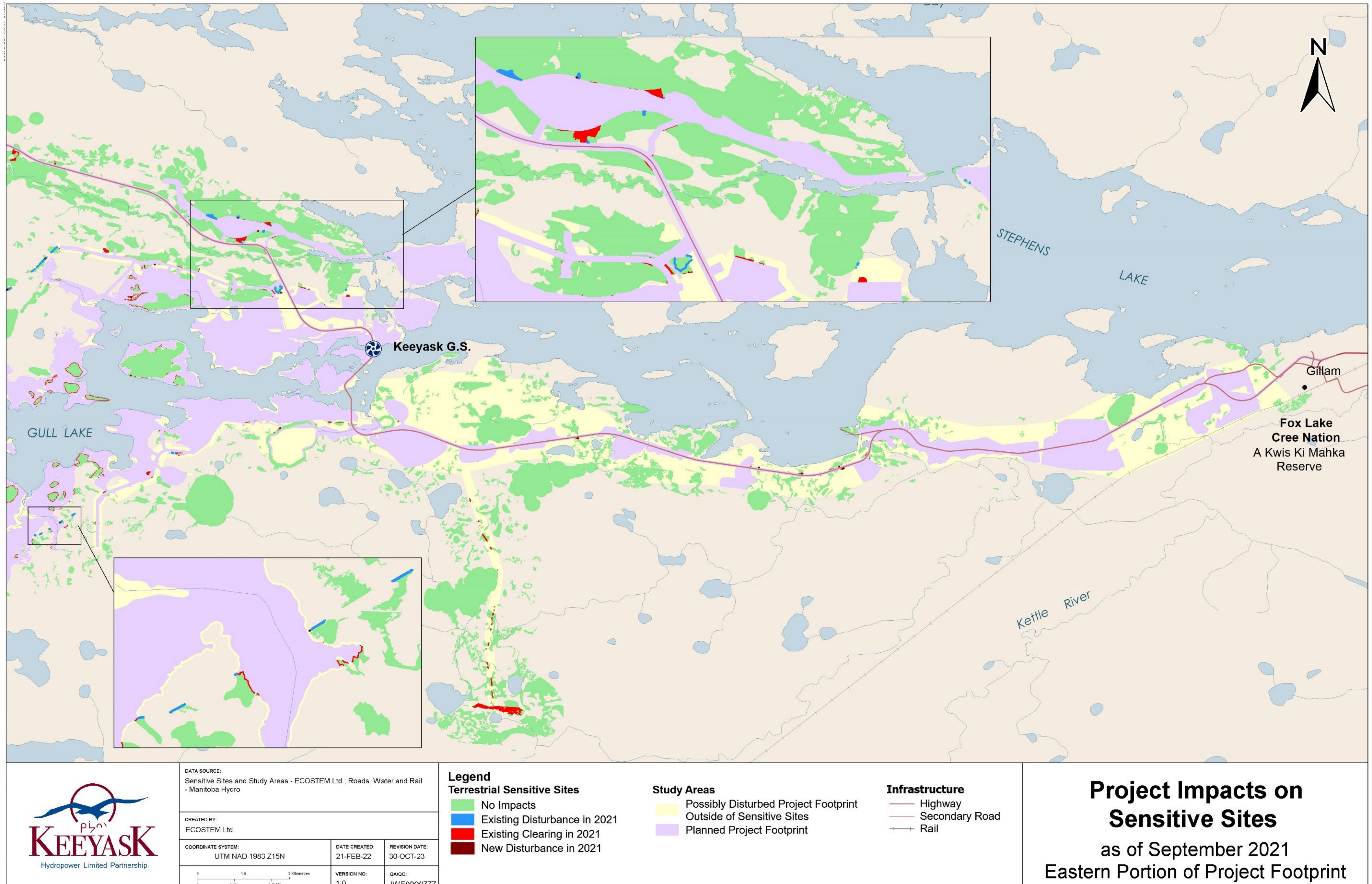
The Construction Footprint map produced by the Habitat Loss and Disturbance study (Section 2.1.2) was used to quantify and locate direct impacts on the sensitive sites as of September 2021. The Construction Footprint was overlaid on the sensitive sites map in a Geographic Information System (GIS), and then the boundaries were used to subdivide each sensitive site into cleared, disturbed or undisturbed.

2.3.3 RESULTS

As of September 2021, the 2,878 sensitive sites being monitored covered 6,684 ha. Map 2-4 and Map 2-5 shows the sensitive sites that were cleared or disturbed by the Project. Project impacts in the form of clearing (Photo 2-20) or disturbance (Photo 2-21) had impacted 220.2 ha, or 3.3% of total sensitive site area (Figure 2-10).



Map 2-4: Project impacts on terrestrial sensitive sites outside of the planned Project footprint as of September 2021 – western portion of Project footprint



Map 2-5: **Project impacts on terrestrial sensitive sites outside of the planned Project footprint as of September 2021 – eastern portion of Project footprint**

Photo 2-20: Example of 2021 Project clearing in a priority habitat type (black spruce mixture treed vegetation on shallow peatland)

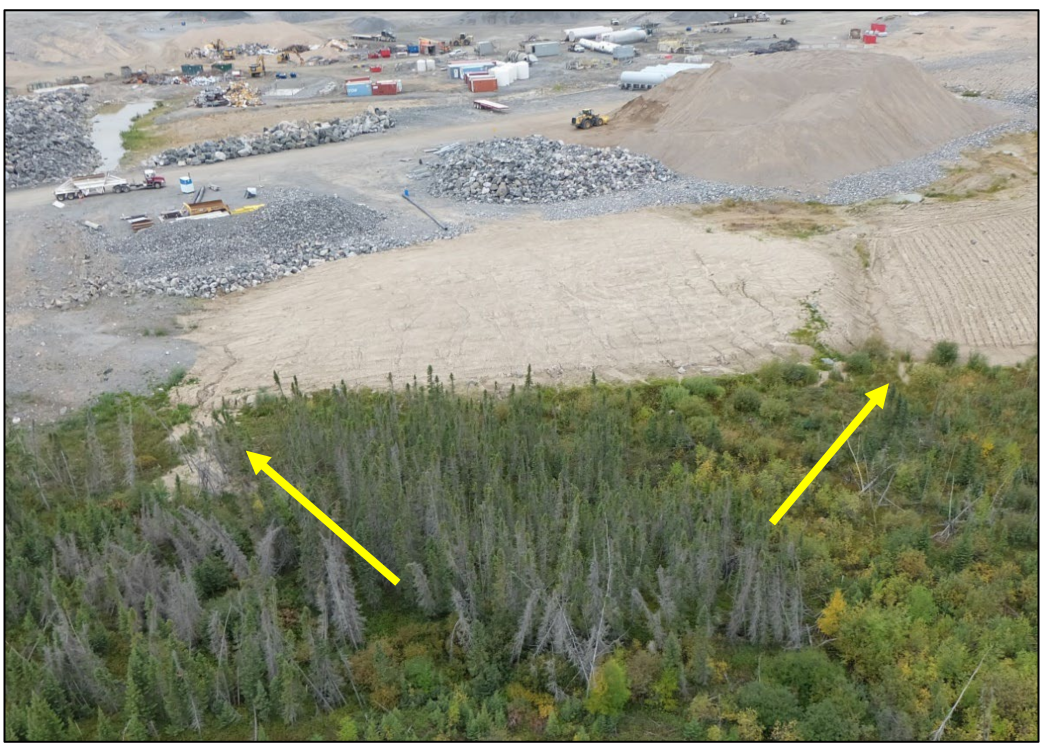


Photo 2-21: Example of an area with sediment deposition into priority habitat (Tall shrub vegetation on thin peatland site) in September, 2021

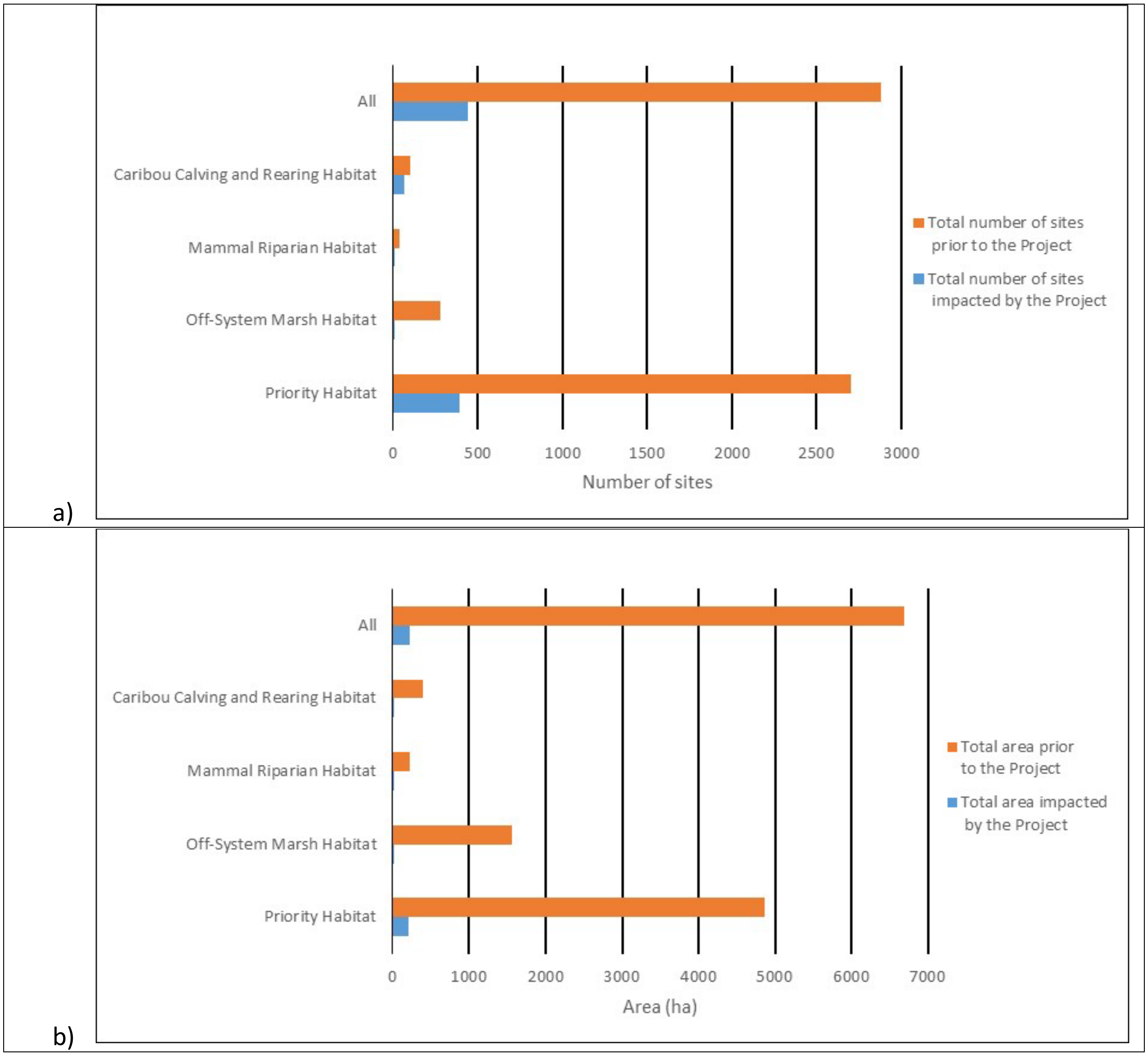


Figure 2-10: Project impacts on sensitive sites, by type, vs Pre-Project in terms of a) the number of sites and b) total area

While clearing or disturbance affected 67% of the caribou calving and rearing sites being monitored, the total area impacted was only 4% of the pre-Project area. All these impacts were in the future reservoir area (Figure 2-10).

Similarly, while 14% of the priority habitat sites were impacted, the total area impacted was only 4% of its pre-Project area impacted. The priority habitat types with the highest Project impacts in absolute terms, were black spruce mixture treed vegetation on mineral ecosites (67.9 ha) and jack pine dominant treed vegetation on mineral ecosites (35.7 ha). This represents only 28% and 31% of the area predicted to be impacted for these two habitat types.

Two percent of the pre-Project off-system marsh sites (0.1% of pre-Project area) and 3% of the mammal riparian habitat sites (0.2% of the total area) had clearing or disturbance as of 2021 (Photo 2-22).

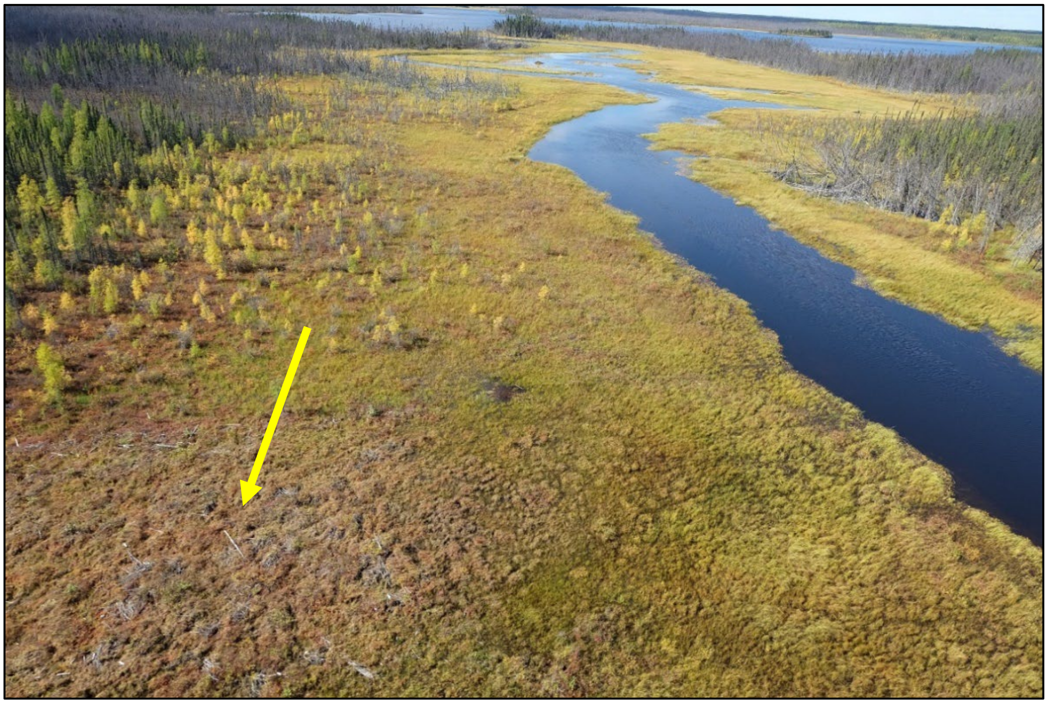


Photo 2-22: Mammal riparian habitat sensitive site in Ellis Esker access corridor in 2018. Yellow arrow points to clearing visible at lower left of photo

Of the total sensitive site area cleared or disturbed, 68% was within the planned Project Footprint (Figure 2-11), 24% was in the possibly disturbed Project footprint, 7% was in the subsequently approved Project areas and 2% were outside the approved Project Footprint. A majority of the priority habit and off-system marsh impacts were in the planned Project Footprint, while the caribou calving and rearing habitat and the mammal riparian habitat impacts were predominantly in the possibly disturbed Project Footprint.

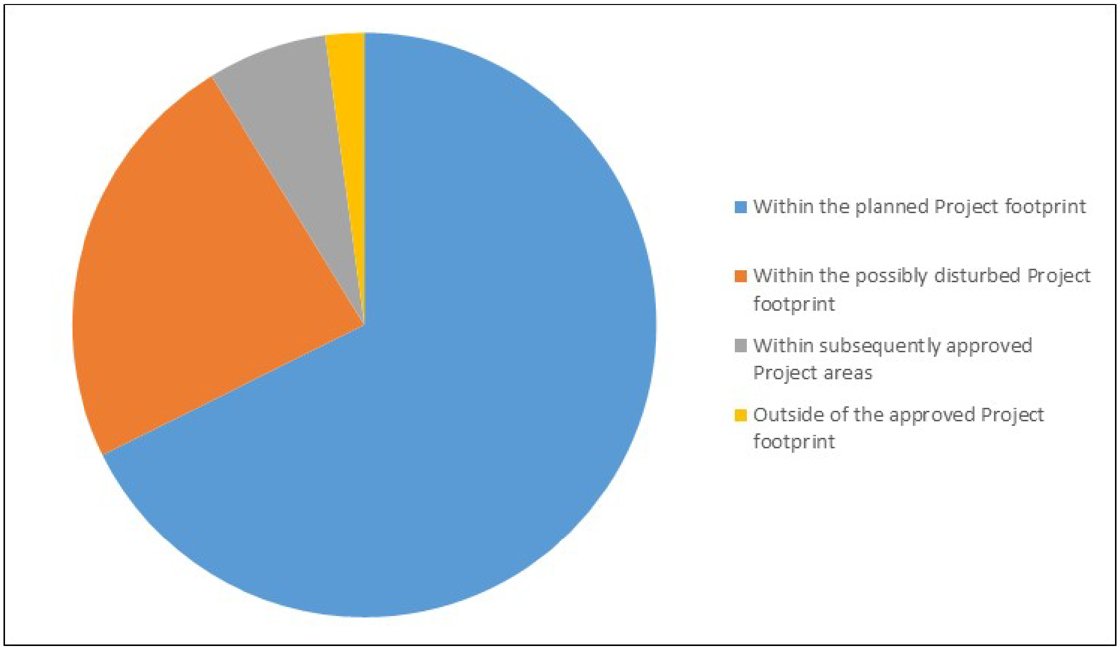


Figure 2-11: Project impacts in sensitive sites, by Project area

The N-6 priority habitat site to avoid had some adjacent priority habitat impacted by reservoir clearing and geotechnical explorations (Photo 2-23). However, no impacts were found within the N-6 site. It is noted that the 2013 wildfire, which was unrelated to the Project, affected a portion of this site.

Photo 2-23: Trails and reservoir clearing area (now inundated) adjacent to the western boundary of the "N-6 priority habitat site to avoid" in 2021

2.3.4 DISCUSSION

2.3.4.1 COMPARISON WITH PREDICTED PROJECT EFFECTS

The Construction Footprint (Map 2-1) clearing and disturbance included 220.2 ha of area identified as sensitive sites by the EIS. The actual impacted sensitive site area was only 14% of the total sensitive site area that the EIS assumed could be affected by the Project (i.e., if all of the possibly disturbed area was used, which was highly unlikely). The large decrease in sensitive site areas impacted was largely due to the Construction Footprint being much smaller than assumed for the EIS predictions. Effective implementation of mitigation measures also contributed to lower than predicted effects.

Of the impacted area, only 2% of the impacted sensitive site area was outside of approved Project areas. This area was not a major ecological concern given that the total impacted area within the Planned or Possibly Disturbed areas was considerably lower than cautiously assumed for the EIS.

During construction, there was no Project clearing or disturbance in the “N-6 priority habitat site to avoid”. The only clearing or disturbance within 300m of this site was the removal of trees in areas that would be inundated by the reservoir.

Of the four types of sensitive sites monitored, Project impacts were highest on priority habitat. This was expected because a larger proportion of priority habitat occurs on mineral substrates and these substrates were preferentially used by the Project. Even so, the Project affected less than 7% of the maximum area that the EIS assumed would be affected by the Project. As predicted by the EIS, the total number of native broad habitat types in the Regional Study Area did not decline, the total number of stands affected for each of the native broad habitat types was less or the same, and the proportional area of each of the common and uncommon native habitat types in the Regional Study Area did not change substantially.

With respect to area, caribou calving and rearing habitat had the second highest degree of Project impacts, followed by off-system marsh sites and mammal riparian areas.

As noted above, total area impacted was relatively low for all four types of sensitive sites.

2.3.4.2 CONCLUSIONS

Monitoring has shown that actual Project effects on ecosystem diversity during construction were predominantly lower than predicted in the EIS, and considerably lower for some measures (e.g., total area of affected priority habitat was 39% lower). For three of 41 priority habitat types for which effects were higher than predicted, the higher area was very small in all cases (ranging from 0.05 to 0.2 ha).

Monitoring has shown that EnvPP measures were effective for all four types of sensitive sites.

2.3.4.3 FUTURE MONITORING

Ecosystem diversity monitoring will continue during the Project operation phase.

The construction phase monitoring did not identify the need to alter any of the methods for the operation phase.

2.4 INTACTNESS

2.4.1 BACKGROUND

Intactness is the degree to which an ecosystem remains unaltered by human development and other activities that remove habitat and increase fragmentation. Fragmentation is a landscape-level process in which human features (i.e., linear features such as cutlines and roads) progressively subdivide habitat blocks into smaller and more isolated fragments. Among other things, fragmentation reduces the size of large natural areas (i.e., core areas), creates edges, isolates habitat and reduces connectivity. Very large core areas make relatively large contributions to intactness. Some wildlife species that are sensitive to human disturbance require large core areas.

Intactness in the Regional Study Area (i.e., Study Zone 5 in Map 1-2) is relatively high. Prior to the Project, total linear feature (Photo 2-24) density was 0.45 km/km^2. Cutlines, which have lower fragmentation effects than other types of human linear features, accounted for 0.2 km/km^2 of the total linear feature density. Additionally, core areas larger than 200 ha comprised 84% of regional land area. Over half of the total core area was in a few very large core areas.

Photo 2-24: Cutlines and a road in the Keeyask Study Area

The magnitude of regional cumulative effects on intactness was in the low range for most indicators. The exception was total linear feature density (0.45 km/km^2), which was at the low end of the moderate magnitude effects range (between 0.40 km/km^2 and 0.60 km/km^2) for the entire Regional Study Area. However, this indicator dropped to well within the small magnitude range when the Thompson area (a small, highly impacted area relative to the rest of the region) was excluded.

The Project was expected to cause slight reductions in total linear feature density, total core area, average core area size and the sizes of some of the largest core areas. Total linear feature density would decline since Project features such as reservoir flooding would cover some existing cutlines and trails.

2.4.2 MONITORING

The intactness monitoring program included a single study, Linear Density and Core Area. This study occasionally evaluates changes to intactness using information produced by other TEMP studies. The first evaluation occurred at the end of Project construction.

Several data sources were used to quantify actual Project effects on intactness. The primary source was the Construction Footprint map (Section 2.1;Map 2-1). Additionally, new linear features created by the Project were mapped from digital stereo photos acquired in the fall of 2021 (see Photo 2-25).

Core areas as of the end of construction (i.e., September, 2021) were mapped as the residual areas left after buffering linear features and other human created features that existed as of September 2021.

Photo 2-25: Example stereo photo of new cutlines and dike north of Gull Lake used for the Project features mapping

2.4.3 RESULTS

The net total length of linear features created by the Project during construction was 91.7 km (Table 2-9), which was 22.8 km higher than assumed for the EIS. The predominant reason for this increase was a need for additional temporary winter trails to access the reservoir clearing areas (Figure 2-12; Photo 2-26) and the Ellis Esker borrow area (Photo 2-27; Map 2-6).

Table 2-9. Planned versus actual length of new linear features created by the Project during construction

Type	Planned	Actual	Difference
Dike	25.4	25.4	0.0
Highway	32.3	34.3	2.0
Road (all weather)	3.9	2.2	-1.7
Access Trail	7.3	29.8	22.6
All	**68.9**	**91.7**	**22.8**

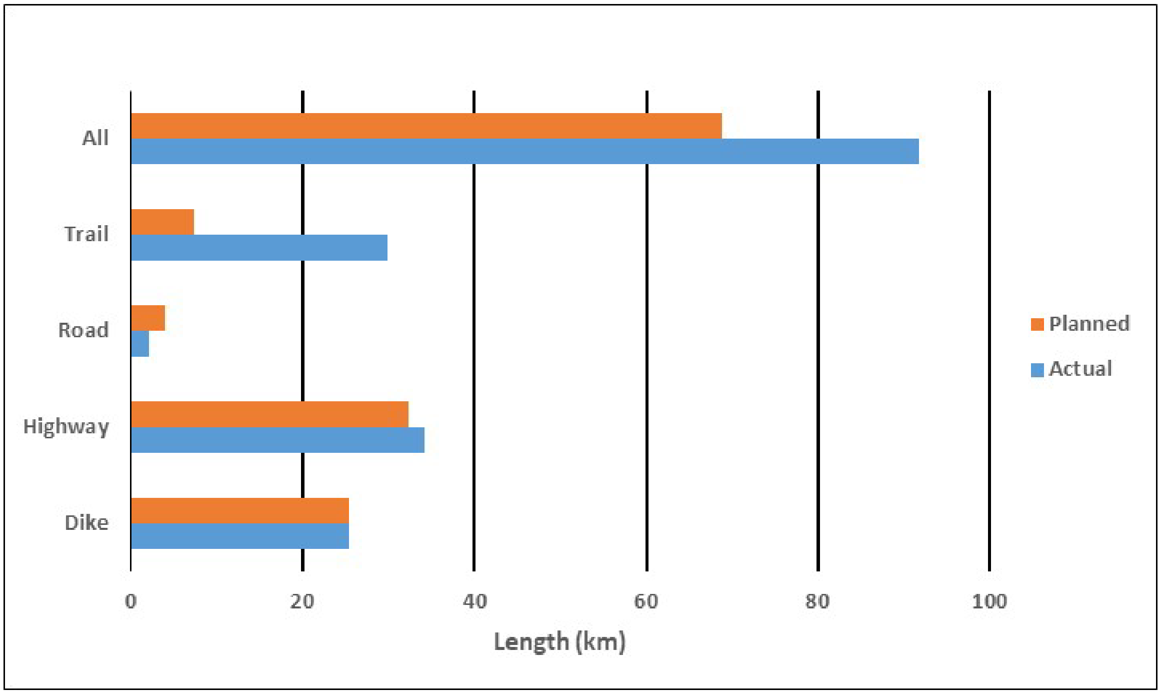
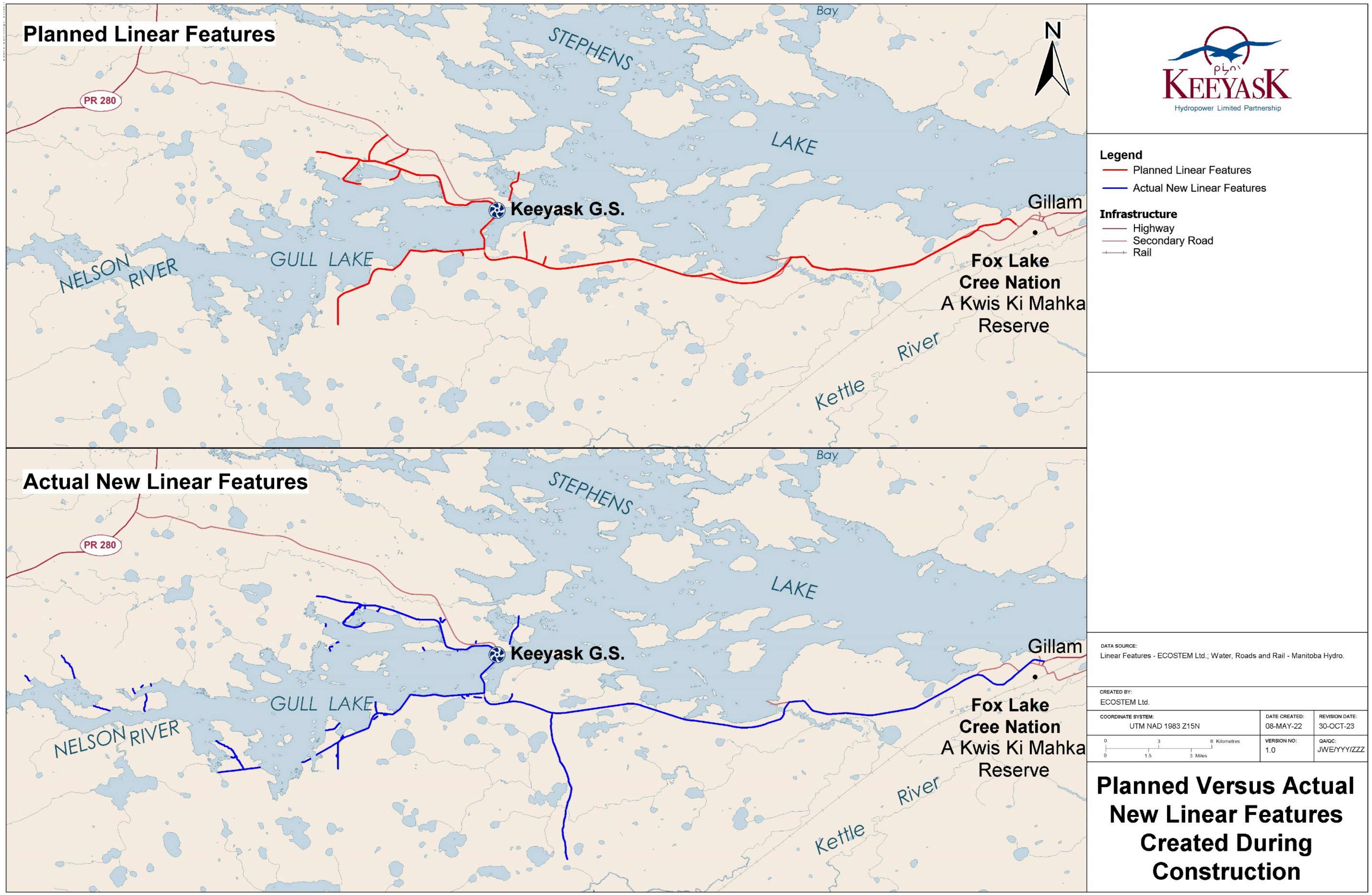


Figure 2-12: Total length of linear features planned and actually created by the Project (Actual) by feature type

Photo 2-26: New trail added to access reservoir clearing areas on the south side of the Nelson River

Photo 2-27: Regeneration along the trail cleared to access the Ellis Esker borrow area



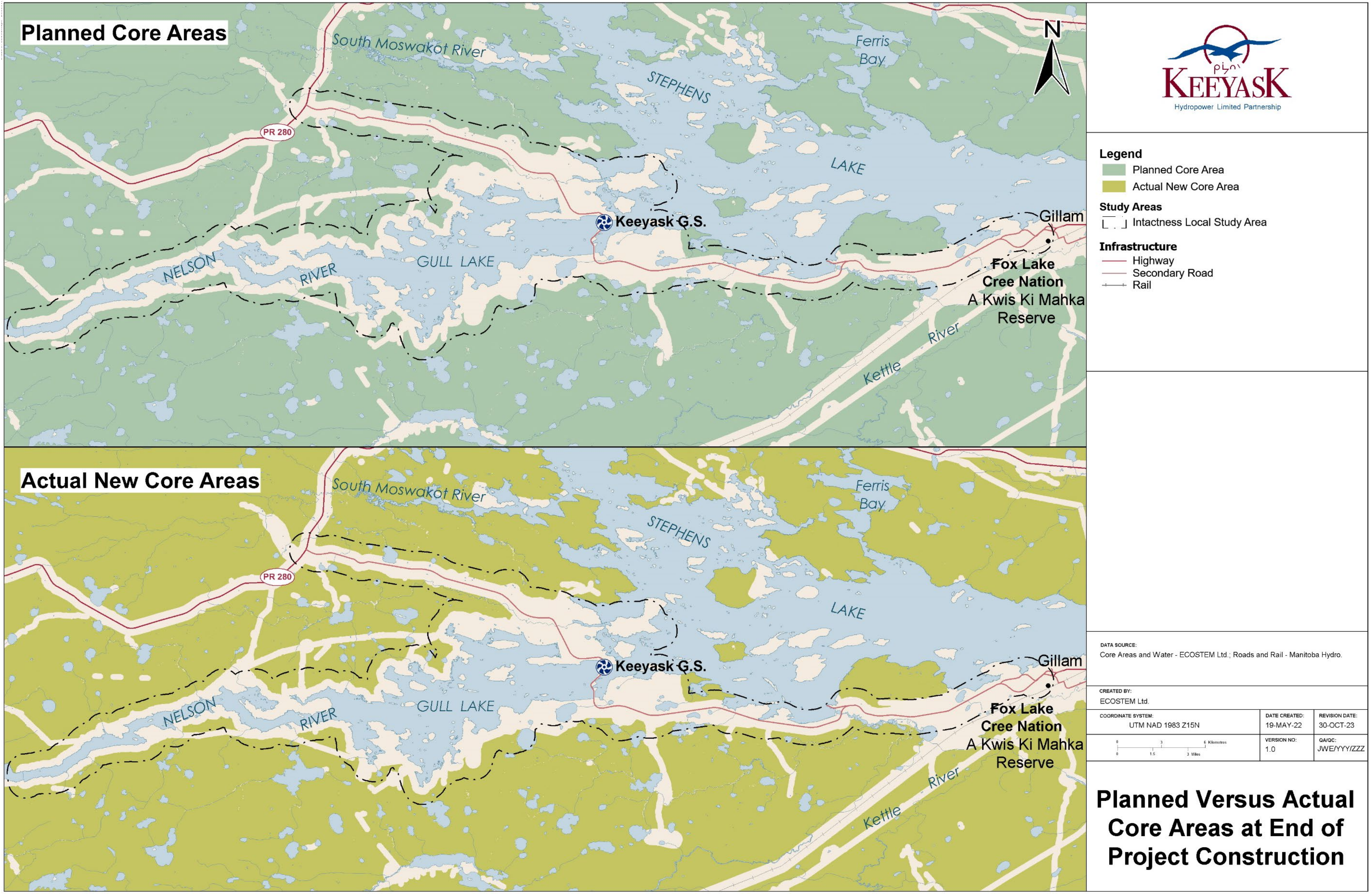
Map 2-6: Planned versus actual new linear features created by the Project during construction

As predicted, Project construction removed one core area that was slightly larger than 1,000 ha and two core areas that were between 200 ha and 1,000 ha in size (Table 2-10). Additionally, several larger core areas on the north and south sides of the Nelson River became smaller (Map 2-7).

Table 2-10. Number and size (ha) of core areas in the Regional Study Area before, and at the end of Project construction, by minimum size, and core area as a percentage of land area

Core Area Minimum Size	Before or After Project Construction	Number	Total Area (ha)	Core Area Percentage of RSA
1,000 ha	Before	57	1,022,169	83
	After	56	1,011,655	82
	Difference	-1	-10,514	-1
200 ha[1]	Before	111	1,046,097	84
	After	111	1,036,044	84
	Difference	0	-10,053	-1

[1]Notes: The values for “200 ha” show the increases that result from reducing the minimum core area size from 1,000 ha to 200 ha.



Map 2-7: Planned versus actual core areas at the end of Project construction

2.4.4 DISCUSSION

2.4.4.1 COMPARISON WITH PREDICTED PROJECT EFFECTS

Project construction created 91.7 km of linear features. This total length was 22.8 km higher than assumed for the EIS. Even so, total linear feature density in the Local Study Area declined from 1.49 km/km^2 to 1.00 km/km^2, as expected. This occurred because: existing cutlines were replaced by Project features such as borrow areas and reservoir clearing; and, most of the Project roads were either already existing or were built on existing cutlines.

Project construction removed one core area that was slightly larger than 1,000 ha, as expected. While a few core areas larger than 200 ha were completely removed, the total number of core areas in the Regional Study Area remained at 111 because several other core areas were fragmented into smaller blocks.

Construction monitoring did not identify any unanticipated Project effects.

2.4.4.2 CONCLUSIONS

Monitoring has shown that actual Project effects on intactness during construction were quite consistent with what was predicted. The actual effects were either lower or the same as was predicted with one minor exception. The exception was that the actual percentage of land area included in core areas larger than 1,000 ha was 1% lower than predicted. Nevertheless, the percentage was still far from the benchmark value that would raise it to a moderate magnitude adverse effect.

2.4.4.3 FUTURE MONITORING

Intactness monitoring will continue during the Project operation phase.

The construction monitoring did not identify the need to alter any of the methods for subsequent monitoring.

2.5 WETLAND FUNCTION

2.5.1 BACKGROUND

A wetland is a land ecosystem where periodic or prolonged water saturation at or near the soil surface is the dominant factor shaping soil attributes and vegetation distribution and composition. Wetland functions are the natural properties or processes that are associated with wetlands, stated in ways that describe what they do for the ecosystem.

Wetlands typically make relatively high contributions to ecosystem function. In the Keeyask region, off-system marsh is a particularly important wetland type based on the contributions it makes to the range of wetland functions (Photo 2-28).

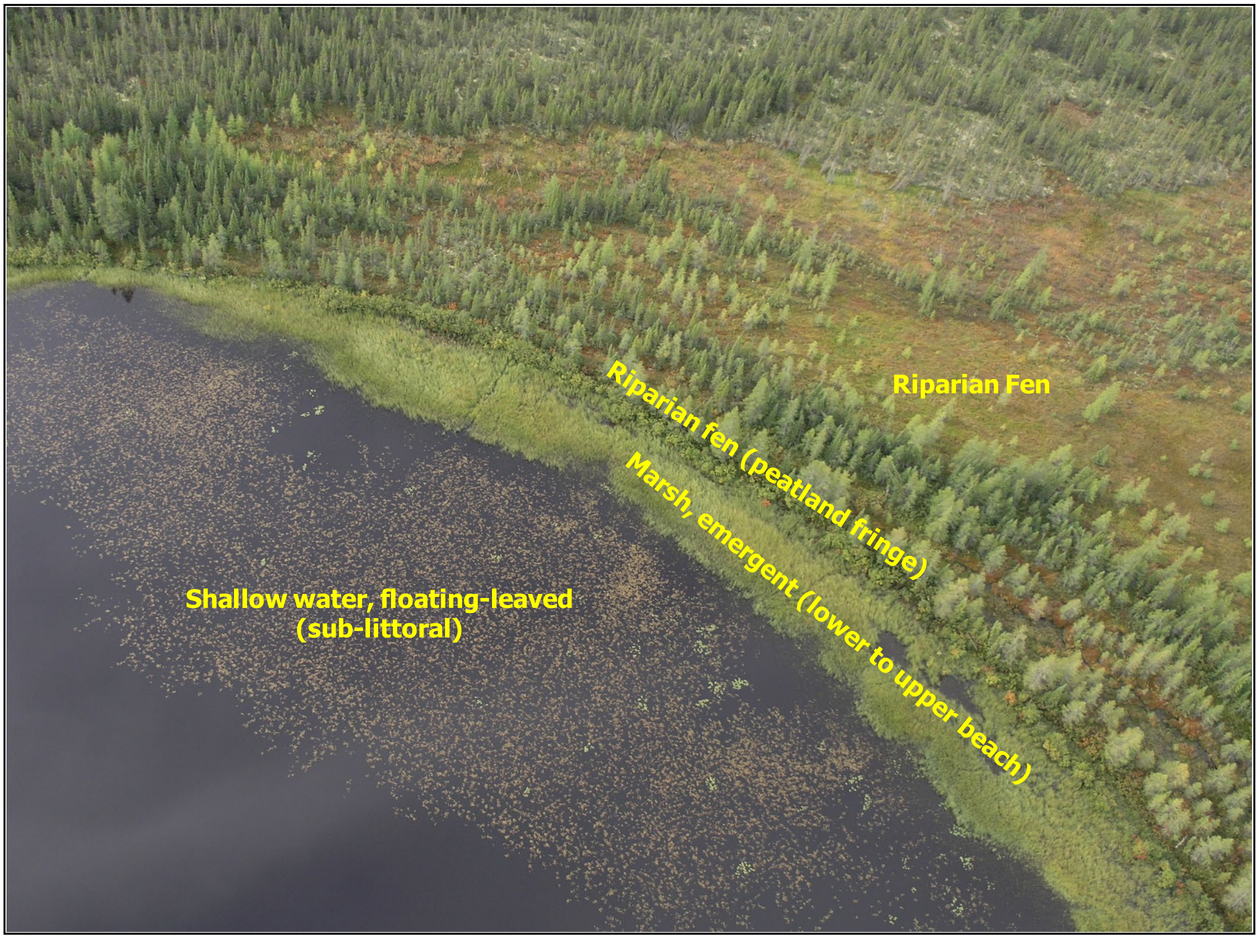


Photo 2-28: Off-system marsh wetland in the Keeyask region

Prior to the Project, wetlands accounted for approximately 90% of the land area in the Regional Study Area (i.e., Study Zone 5 in Map 1-2). The Regional Study Area was essentially one large wetland complex dotted with mineral-capped ridges and hills. Bog, fen and marsh accounted for the majority of the wetland area. Swamp was virtually absent, with none occurring in the Local Study Area.

The vast majority of wetlands in the Keeyask region were in a relatively natural condition. The largest exception was wetlands along the Nelson River. These wetlands had been dramatically altered by past hydroelectric development. All of the pre-development Nelson River shoreline wetlands were either lost to flooding or were modified by the new water and ice regimes. In the Gull Lake reach of the Nelson River, marsh and riparian peatlands were virtually confined to inlets and sheltered bays.

The Project was expected to increase historical effects on five wetland types to between 1.7% and 6.5% of their estimated historical area. Based on the benchmarks used for the assessment, these percentage values were moderate magnitude cumulative effects.

The Project was not expected to increase historical effects on five of the remaining wetland types, Nelson River wetlands, or off-system marsh.

2.5.2 MONITORING

Wetland function monitoring during construction included one study, the Wetland Loss and Disturbance study (KHLP 2015, Section 2.5.2). This study focused on direct impacts on wetlands due to Project related clearing and disturbance.

During Project construction, wetland function monitoring focused on verifying the implementation and effectiveness of off-system marsh protection measures. Project effects to date on wetland function were evaluated at the end of the construction phase.

All wetlands that were within approximately 1 km of Project clearing or disturbance were included in the monitoring. Wetlands to be surveyed in a particular year were selected using the most recent Project Footprint map (Section 2.1), recent DOIs, and aerial surveys to identify new areas of Project clearing or physical disturbance.

Aerial surveys of the selected off-system marshes occurred in conjunction with the terrestrial habitat surveys (Section 2.1), as well as the ecosystem diversity surveys (Section 2.3). Ground surveys were conducted at a subset of the wetlands (Photo 2-29).

Photo 2-29: Ground survey of an off-system marsh in 2015

Each year, mitigation recommendations were provided to address any impacts to off-system marsh, where appropriate.

Construction effects on wetland function were evaluated by revising the wetland map for Study Zone 4 (TE SV; Section 2.8.2 and Map 2-21) to identify which wetlands areas were within the Construction Footprint (Map 2-1). The resulting map was then used to locate and quantify actual direct Project effects on wetland function.

2.5.3 RESULTS

The Construction Footprint impacted 4.2 ha of off-system marsh and its habitat (Table 2-11), which was 0.5% of its total area. The vast majority (97%) of construction impacts were in areas adjacent to the marshes, and not in the marsh or its habitat. Of the 4.2 ha of impacts, 0.1 ha was in marsh habitat and 4.1 ha was within the 100 m buffer of this habitat (Table 2-11).

Table 2-11: Impacts and potential future effects in the off-system marsh wetlands within 100 m of Project clearing or disturbance, as of September, 2021

Wetland ID[1]	Total Wetland Area (ha)			Area (ha) Impacted[2] by Project Clearing and Disturbance			Other Project Impacts up to 2021	2013 Burn in Buffer (%)[3]	Potential Additional Future Effects or Effects Outside of the Monitored Wetlands
	Total	Marsh Habitat	Buffer	Total	Marsh Habitat	Buffer			
3	5.0	1.0	4.0	0.364	0.105	0.260	None	90	None
17	135.1	97.4	37.7	-	-	-	None	85	Water flow from a road culvert
37	17.0	4.1	12.9	0.006	-	0.006	None	5	Likely none[4]
40	7.9	1.2	6.7	1.754	-	1.754	None	10	Likely none[4]
42	15.7	2.9	12.8	-	-	-	None	50	Likely none[4]
45	7.3	0.8	6.5	0.236	-	0.236	None	50	Likely none[4]
47	189.7	140.7	49.0	1.033	-	1.033	None	0	Runoff from dike through drainage channels into marsh
51	25.7	10.5	15.2	0.023	-	0.023	Sediment from EMPA D16(1)-E into the buffer zone	20	Deposition of sediment or other materials into the marsh habitat buffer from EMPA. Increase in water levels due to runoff from culvert at Main Camp
52	28.4	9.1	19.4	-	-	-	None	0	Hydrological effects from a road culvert
53	5.5	0.3	5.2	-	-	-	None	0	None
54	113.1	70.1	43.0	-	-	-	None	0	None
57	64.6	37.6	27.0	0.793	-	0.793	None	0	Hydrological effects from a road culvert
60	232.4	150.0	82.5	-	-	-	None	0	Additional vegetation clearing and disturbance from adjacent ATV usage
All	847.6	525.7	322.0	4.208	0.105	4.104			

Notes:
[1] Bold font identifies wetlands that were ground sampled in 2021.
[2] All mapped Project clearing or physical disturbance in monitored wetlands. See ECOSTEM (2022a) for the mapping.
[3] Percentage of total buffer area that burned in the 2013 wildfire (which was unrelated to the Project).
[4] The potential runoff from EMPA or dike slope is declining. Evidence of runoff has not been recorded for past few years and colonizing vegetation may eventually prevent it.

All recorded impacts in off-system marsh were within the licensed Project footprint, and the vast majority were within the planned Project footprint (3.9 ha; Figure 2-13).

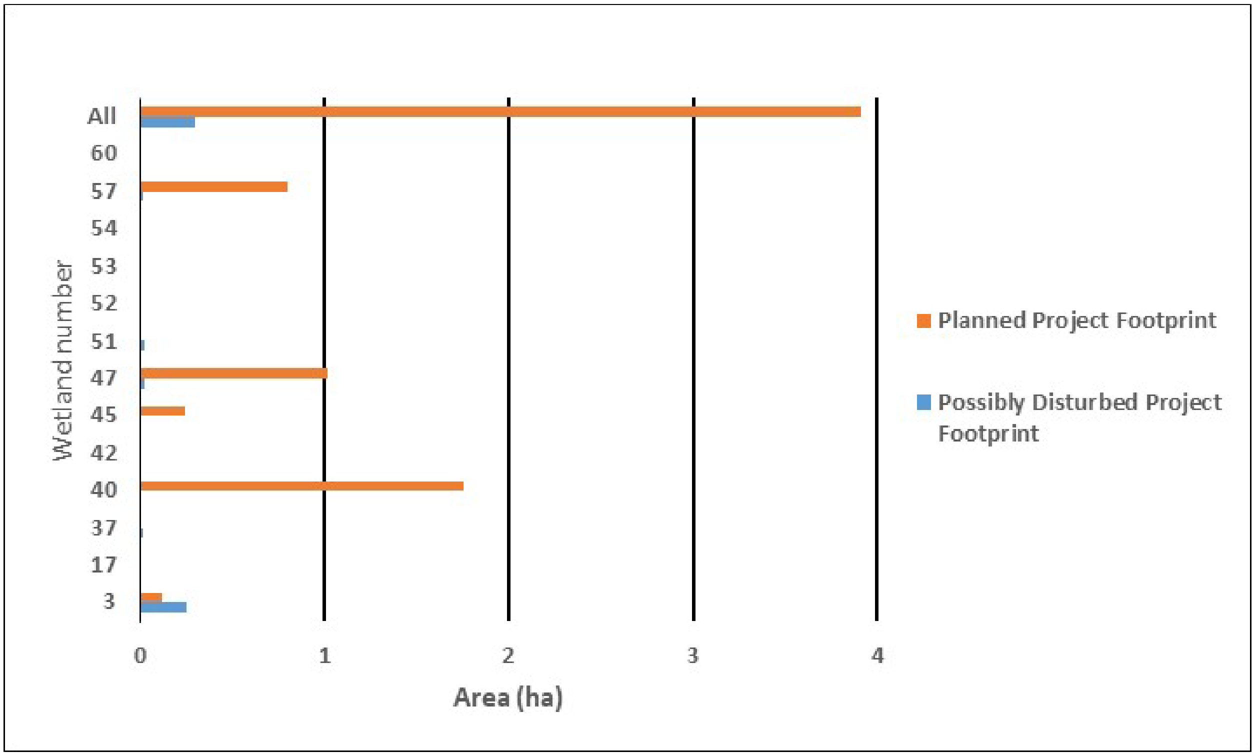


Figure 2-13: Impacted wetland area by footprint type

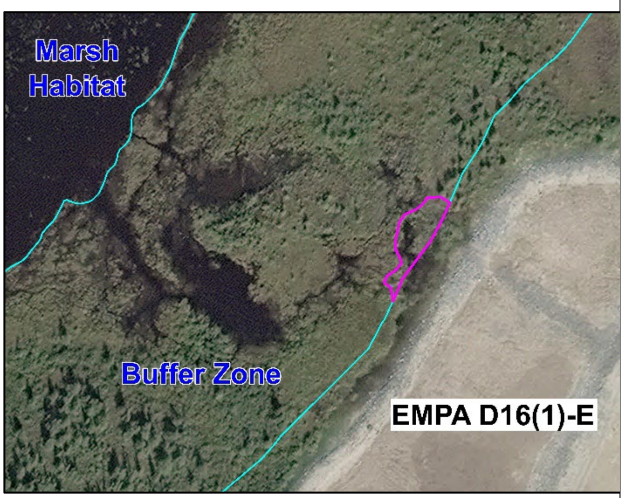
The Project had no direct impacts on five of the monitored wetlands (including 17, 42, 52, 53 and 60), either within the marsh habitat or its 100 m buffer (Photo 2-30; Table 2-11). Wetland 3, 37, 40, 45, 47, 53 and 57 experienced some clearing or disturbance within the marsh buffer (Photo 2-31).

At Wetland 51, clearing and sedimentation from EMPA D16(1)-E (Figure 2-14) extended into the marsh buffer. Additionally, water flow and sedimentation from the Main Camp was flowing through previously undisturbed forest towards a low area directly adjacent to Wetland 51. A number of mitigation measures were recommended and implemented for this wetland.

Because hydrological effects could extend for considerable distances, surveys were conducted at wetlands located more than 100 m from the Construction Footprint. Possible hydrological effects were not observed in any of these wetlands.

Photo 2-30: Aerial view of southern portion of Wetland 17 on September 12, 2021

Photo 2-31: Aerial view of Wetland 40 on September 12, 2021

<table>
<tr>
<td>
Aerial view of Wetland 51 and location of sediment deposition in the wetland buffer zone (yellow arrow)</td>
<td>
Gap in rock barrier surrounding EMPA D16(1)-E (yellow arrow) and adjacent sediment deposition in flooded portion of Wetland 51 buffer (background)</td>
</tr>
<tr>
<td>

Extent of sediment deposition in the buffer zone of Wetland 51 (in blue) to 2021 (in pink)</td>
<td></td>
</tr>
</table>

Figure 2-14: Sediment deposition in buffer zone of Wetland 51 in 2021

2.5.4 DISCUSSION

2.5.4.1 COMPARISON WITH PREDICTED PROJECT EFFECTS

The Construction Footprint included approximately 4,609 ha of wetland area, which was 21% less than assumed for the EIS predictions. This was not surprising, as a cautious approach was used to define the licensed Project footprint and predict Project effects. Additionally, mitigation measures were implemented as prescribed, and were highly effective.

Direct effects on all wetland types were lower than assumed for the EIS predictions, except for stream riparian marsh where the actual and predicted effect areas were the same. Of the wetland types where effects were lower than assumed for the EIS predictions, strongly sloped veneer bog and blanket bog had the largest difference.

As in the case of the wetland types, Project effects on wetland quality were lower than predicted for all of the wetland types quality classes.

The planned development of the 12 ha of off-system marsh (KHLP 2015, Section 2.5.1.2) has been delayed as the proposed work is still under review. As of the date of this report, it is still expected that there will be no net area loss for off-system marsh.

2.5.4.2 CONCLUSIONS

Monitoring has shown that there have been no unexpected effects on the off-system marsh wetlands being monitored by this study, or on wetland function. While there has been some clearing or disturbance within seven of the monitored wetlands, these impacts were expected as the wetlands overlapped the licensed Project footprint. The magnitude of actual construction effects on the indicators of wetland function were lower than predicted.

2.5.4.3 FUTURE MONITORING

Monitoring for the off-system marsh wetlands and wetland function will continue during Project operation. Additionally, the Long-Term Effects on Wetlands study (KHLP 2015, Section 2.5.3) will monitor long-term indirect Project effects on wetland function. The efficacy of measures implemented to create 12 ha of off-system marsh will be evaluated by the Created Wetlands study once the wetland is constructed.

The construction monitoring did not identify the need to alter any of the methods for subsequent monitoring.

2.6 FIRE REGIME CHANGES

2.6.1 BACKGROUND

Wildfire is the keystone driver for terrestrial ecosystems in the boreal biome. A fire regime is the overall pattern, type, intensity, frequency and seasonality of fires that prevails in an area. Many boreal plant and animal species are adapted to a particular fire regime.

Available fire history data indicated that fires burned approximately 1,045,000 ha in the Regional Study Area between 1979 and 2008. The annual burn rate was crudely estimated to be nearly 35,000 ha/year, or 1.3% of the Regional Study Area. Using this burn rate, the recent fire cycle was crudely estimated to be nearly 78 years. Approximately 34% of the Regional Study Area burned at least once between 1979 and 2008. Large burns were distributed throughout the Regional Study Area, with the most recent burns occurring near the Nelson River (Photo 2-32).

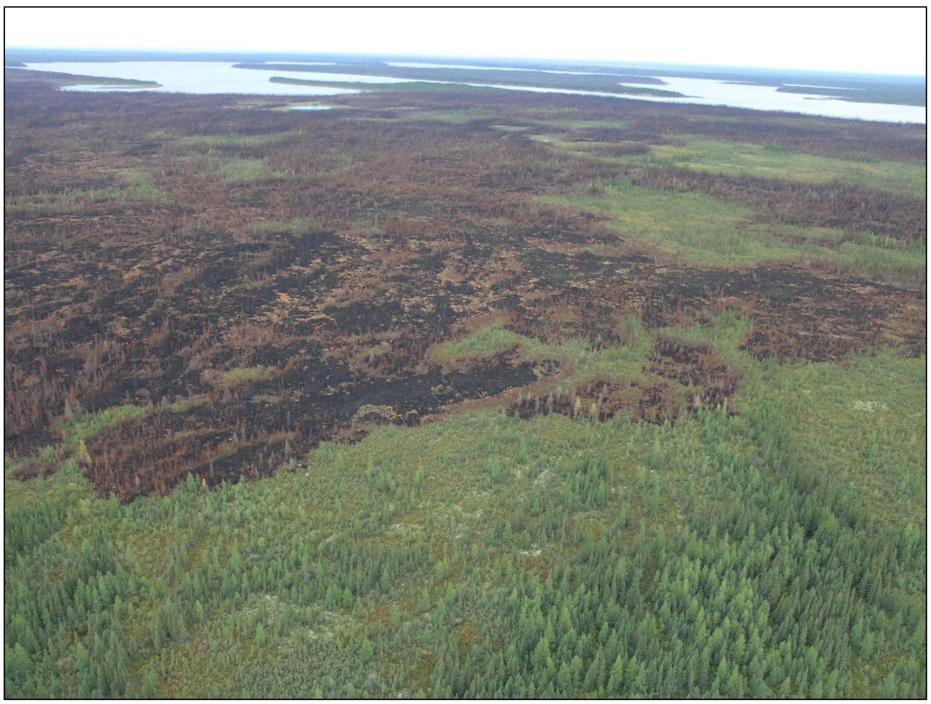


Photo 2-32: Area burned during the 2005 fire south of the South Dike area

Overall, the likely residual Project effects on the fire regime were expected to be adverse but negligible. It was expected that any accidental Project-related fires would be extinguished before they become large.

During construction, a study monitored the occurrence and nature of Project-related fire regime effects.

2.6.2 MONITORING

Construction monitoring for fire regime changes was only triggered if it was determined that the Project had caused a fire or had altered the behavior of fires started by other sources.

2.6.3 RESULTS

Fire regime monitoring did not identify any Project-related fires or effects on fire behavior.

2.6.4 DISCUSSION

2.6.4.1 COMPARISON WITH PREDICTED PROJECT EFFECTS

Project construction was not expected to affect the fire regime given the mitigation and EnvPP measures in place.

2.6.4.2 CONCLUSIONS

Fire regime monitoring has shown that effects were consistent with EIS predictions, and that there have been no unexpected effects.

2.6.4.3 FUTURE MONITORING

Fire regime monitoring will continue during operation. Activities will be triggered if the Project creates an accidental wildfire or peat fire, or if a non-Project fire spreads into the Project Footprint area.

2.7 SYNTHESIS

Adverse Project effects on terrestrial habitat and ecosystems during Project construction were lower than predicted, and considerably lower for many of the individual VECs, with a few exceptions. Two exceptions included higher than predicted impacts for one land cover type and three priority habitat types, but in all these cases the impacts were below the benchmark for management concern. The third exception was higher than assumed linear features, but overall linear feature density still declined as predicted in the EIS.

The lower than predicted effects primarily resulted from the actual Construction Footprint being 28% smaller than assumed in the EIS, as well as effective mitigation measures.

There were no unexpected Project effects on terrestrial habitat and ecosystems during construction. No additional mitigation is recommended.

Monitoring of all terrestrial habitat and ecosystem VECs will continue during Project operation.

3.0 TERRESTRIAL PLANT MONITORING

3.1 PRIORITY PLANTS

3.1.1 BACKGROUND

Priority plants are defined as those plants that are particularly important for ecological and/or social reasons. Specifically, priority plants are the native plant species that are highly sensitive to Project impacts, make high contributions to ecosystem function and/or are of particular interest to the partner First Nations. A plant species is classified as being highly sensitive to Project impacts if it is globally, nationally, provincially or regionally rare, near a range limit, has low reproductive capacity, depends on rare environmental conditions and/or depends on the natural disturbance regime (wildlife studies monitor plant species that are critical for the survival and/or reproduction of an animal species). The partner First Nations have noted a variety of plants of traditional importance that are present in the Project area, such as *wihkis* (sweet flag; *Acorus americanus*) and dwarf Labrador tea (tea leaves; *Rhododendron tomentosum*; Photo 3-1).

Photo 3-1: Dwarf Labrador tea (plant with narrow leaves) and Labrador tea

The EIS studies recorded 101 priority plant species in the priority plant Regional Study Area (i.e., Study Zone 5 in Map 1-2) prior to Project construction. The EIS also considered endangered, threatened or globally rare species that could potentially occur in the Regional Study Area.

The priority plant species list included 27 provincially critically imperilled to vulnerable species (rankings from the Manitoba Conservation Data Centre (MBCDC)), 10 range limit species, 29 regionally rare species and 10 species considered to be of particular interest to the partner First Nations. Most of the species of particular interest to the partner First Nations are common or relatively common in the regional study area.

None of the priority plant species were considered to be a keystone species. No endangered, threatened or globally rare species had been documented in the Regional Study Area.

The Project was expected to cause loss, alteration and physical disturbance of some individual plants, plant populations and their habitats.

Project effects on priority plants and their anticipated habitats were expected to be either none or low, depending on the species.

The EIS included mitigation for provincially critically imperilled to imperiled species. Mitigation would be recommended in the event that such species were discovered during pre-clearing surveys, and if the species was not present in at least 20 healthy patches outside of the Project's zone of influence on plants. Other mitigation implemented to reduce effects on priority plants included modifying the south access road route, refining the boundaries of the potential borrow areas and locating the excavated material placement areas away from areas of concern. All this mitigation built on that included for terrestrial habitat as a whole (Section 2.1).

The EIS predicted that, after mitigation, Project-related effects on priority plants were expected to be small to moderate in magnitude. This was based on the known locations of priority plants and Project effects on the various terrestrial habitat types.

3.1.2 MONITORING

Construction monitoring included pre-clearing rare plant surveys and a desktop review of the known priority plant locations that were being affected by construction.

Pre-clearing ground surveys (Photo 3-2) were conducted since rare plants are by their nature difficult to detect. Pre-clearing surveys were conducted in areas that had not been previously surveyed for rare plants prior to construction, could be directly or indirectly affected by the Project, and had a high potential for supporting provincially very rare to rare species.

The evaluation of construction phase effects on priority plants and their habitat was completed by using the terrestrial habitat map and Construction Footprint (Section 2.1) to identify the directly affected priority plant habitat areas and the known priority plant locations. This desktop review confirmed which of the known locations were within the Construction Footprint, and then compared the number of predicted versus actual locations impacted. Also, the amounts of terrestrial habitats affected by the Project were compared with the EIS predictions.

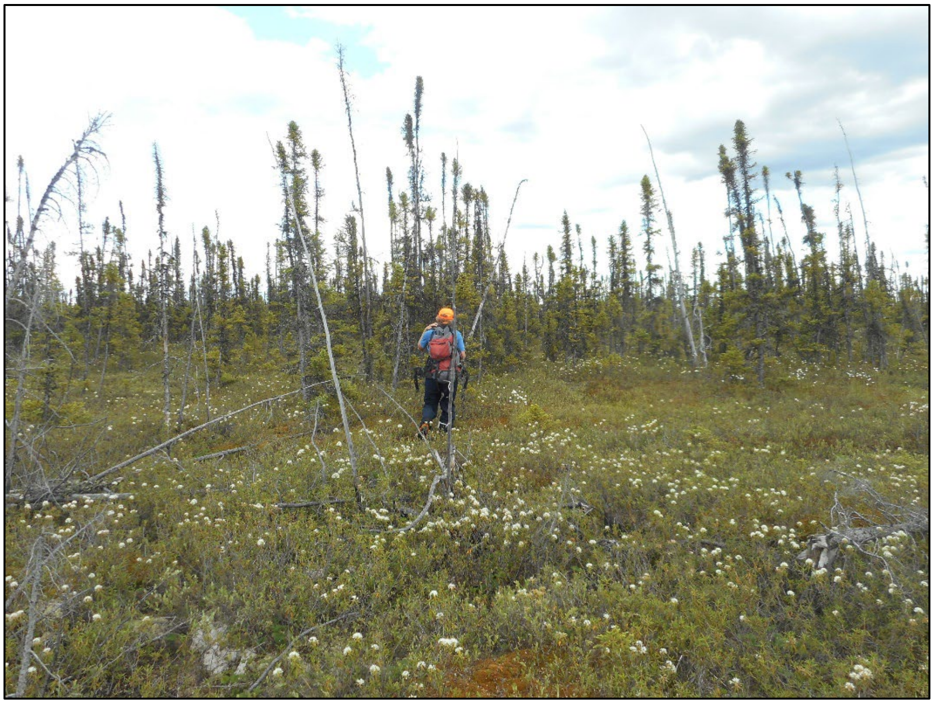


Photo 3-2: Pre-clearing ground survey in rare plant habitat

3.1.3 RESULTS

The Construction Footprint affected the known locations of 29 priority plant species. This included locations found by the EIS studies (pre-construction) and during the construction monitoring (Figure 3-1). See Map 3-1 for these plant locations.

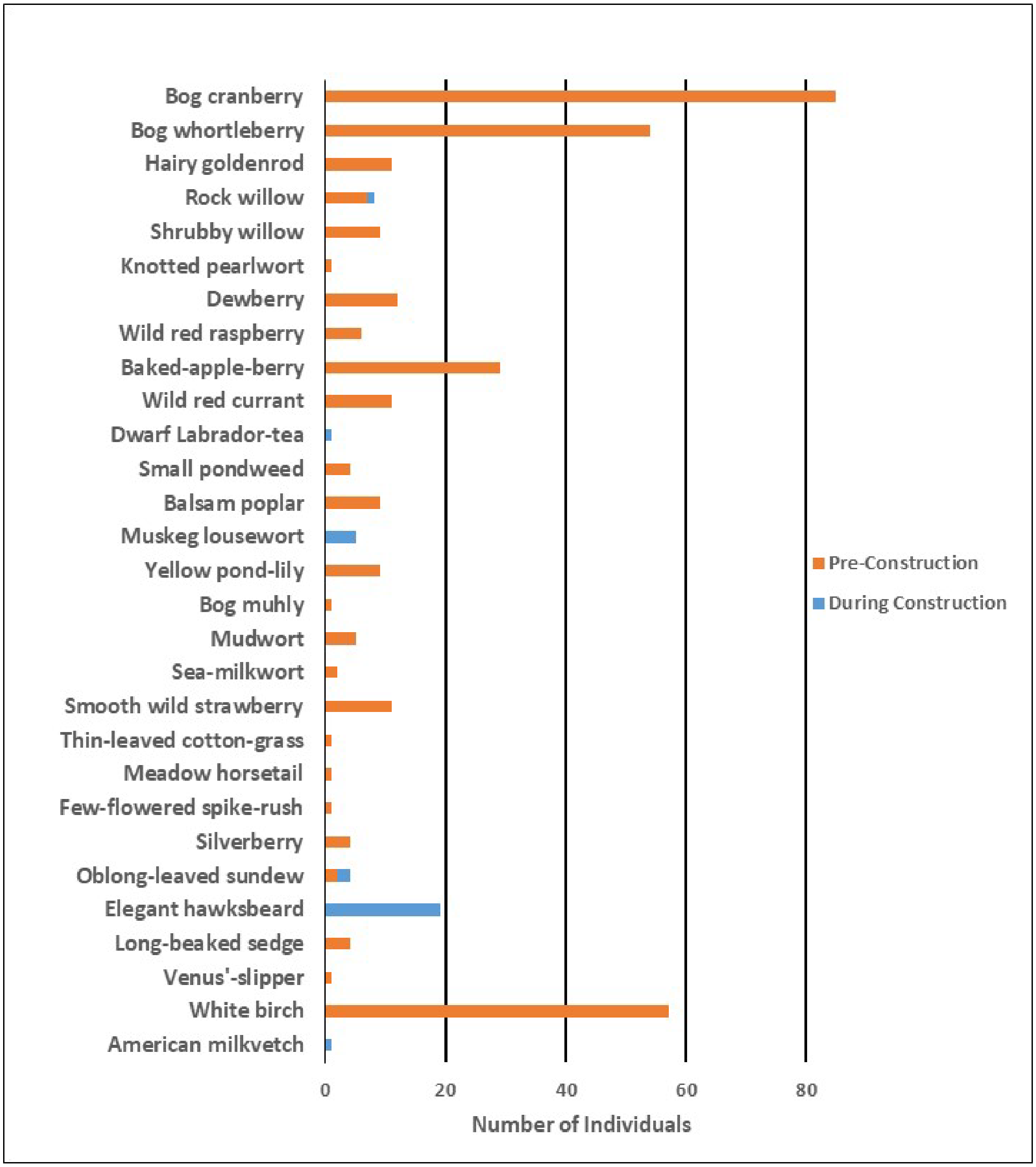
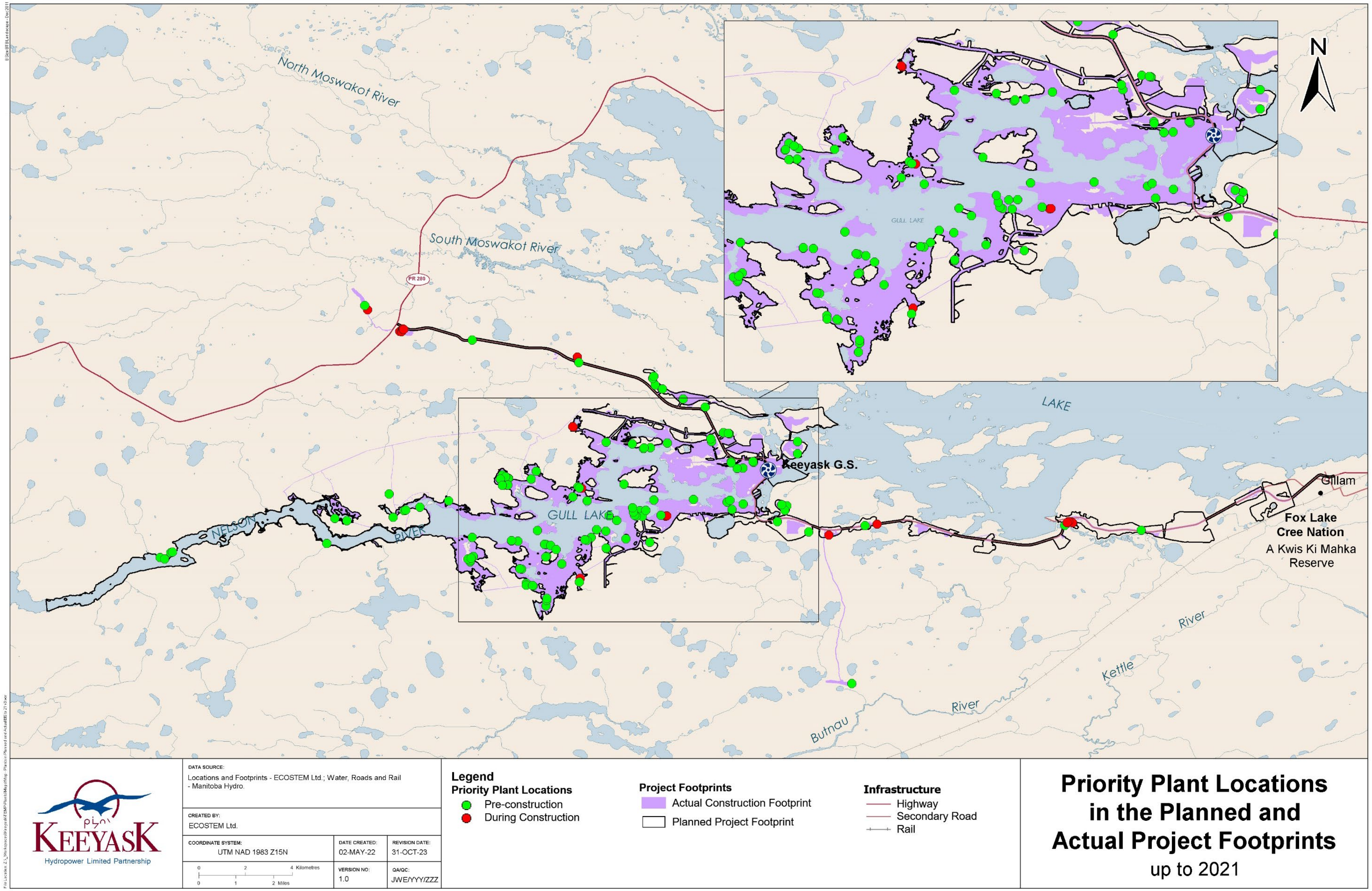


Figure 3-1: Number of individuals of priority plant species found pre-construction and during construction in the Study Area



Map 3-1: Known priority plant locations in the planned (pre-construction) and during (construction) Project footprint up to 2021

No endangered or threatened plant species were found during construction monitoring.

For the provincially critically imperiled to vulnerable species, oblong-leaved sundew (Photo 3-3) was found in two more locations in the Construction Footprint than those known for the EIS. The Construction Footprint included three species not recorded during EIS studies. These species were elegant hawksbeard (*Crepis elegans*; Photo 3-4), muskeg lousewort (*Pedicularis macrodonta*; Photo 3-5) and American milkvetch (*Astragalus americanus*; Photo 3-6).

Photo 3-3: Oblong-leaved sundew

Photo 3-4: Elegant hawksbeard growing in the Start-up Camp in 2021

Photo 3-5: Muskeg lousewort location in the planned reservoir area in 2015

Photo 3-6: American milkvetch location in the planned reservoir area in 2016

As expected, the majority of the known locations of critically imperilled to vulnerable plant species within the planned Project footprint were impacted during construction. The exception was several shrubby willow and rock willow sites.

Mitigation was implemented for the two species of highest concern, which were elegant hawksbeard (Photo 3-7) and muskeg lousewort (Photo 3-8). Elegant hawksbeard was discovered within the Project footprint, and was either marked for avoidance, or transplanted to new locations (Figure 3-2). Additional surveys identified muskeg lousewort in 14 new locations outside the Project zone of influence on plants, increasing the total number of known locations outside of the zone of influence to 22.

Photo 3-7: Elegant hawksbeard flowering in the Start-up Camp

Photo 3-8: Muskeg lousewort (purple flowers) found growing outside of the terrestrial plant zone of influence during additional surveys

Figure 3-2: Marking a patch of elegant hawksbeard, preparing and transporting the plants and then planting them in new, marked locations

As expected, the Construction Footprint included a high proportion of the previously known locations of regionally rare and range limit species (Photo 3-9).

Photo 3-9: Yellow pond-lily (left foreground), a species at it's northern range limit in the Keeyask region

Six of the eight (Photo 3-10) species of particular interest to the partner First Nations had a lower number of impacted locations that assumed for the planned Project footprint. Dwarf Labrador tea was only found in one new location which was affected by the Project.

Photo 3-10: Velvet-leaf blueberry, a wild food species in the Project area

The total amount of priority habitat in the Construction Footprint was 39% lower than predicted in the EIS (see Section 2.3).

3.1.4 DISCUSSION

3.1.4.1 COMPARISON WITH PREDICTED PROJECT EFFECTS

The Construction Footprint included 74% of the 337 known priority plant locations that the EIS predicted could be affected by the Project (Figure 3-3).

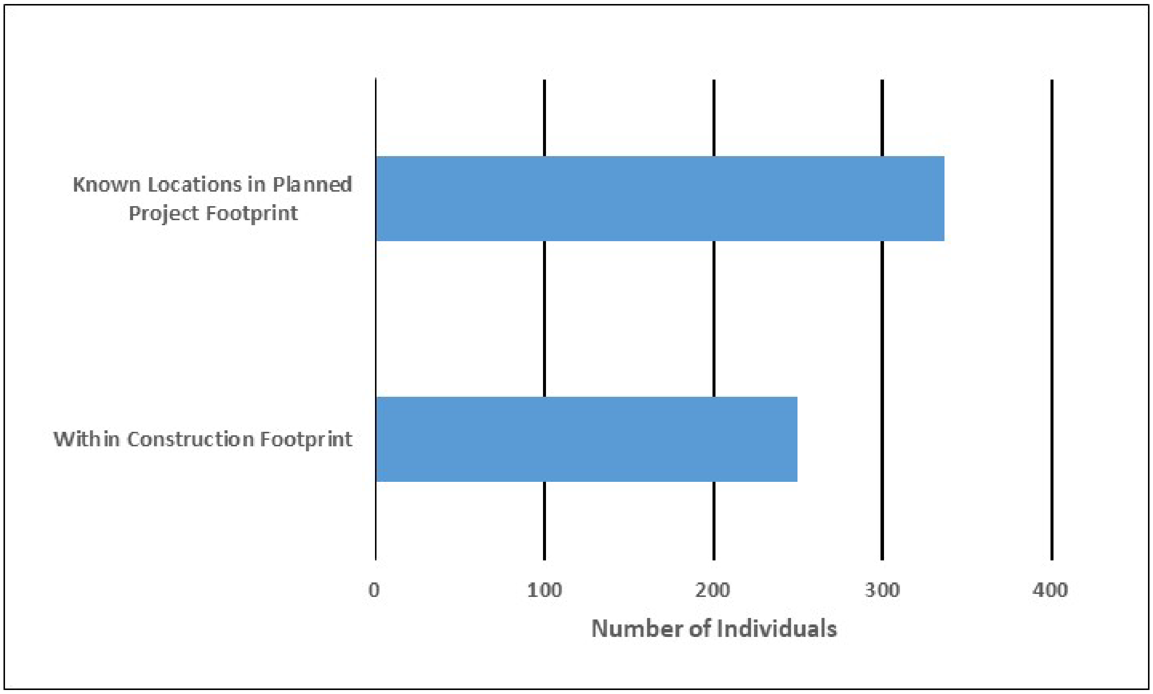


Figure 3-3: Total known locations of priority plants in the planned Project footprint (at the time of the EIS) and Locations within the actual Construction Footprint

An additional 29 priority plant locations were found during pre-clearing surveys or construction monitoring. As expected, none of these species were endangered or threatened.

The Construction Footprint included either fewer or the same number of locations as predicted for 24 of the 28 priority plant species. Four species had more locations than predicted because additional locations were found during pre-clearing surveys.

Muskeg lousewort was the only species for which additional surveys and potential mitigation was implemented. This occurred because new locations were found within the Project footprint and this species was classified as Imperiled at the time (MBCDC has since reclassified it to Potentially Imperiled). Results from the surveys confirmed that additional mitigation was not required for muskeg lousewort as additional surveys outside of the Project areas had identified 14 other locations for muskeg lousewort, increasing the total number of known locations outside the terrestrial plants zone of influence to 22.

Construction monitoring identified one unanticipated Project effect, which was a positive effect. Project disturbance appeared to have facilitated the emergence of elegant hawksbeard, which is a critically imperiled species in Manitoba.

As expected, Project construction affected low percentages of priority plant habitats. The total amount of priority habitat in the Construction Footprint was 39% lower than predicted in the EIS (ECOSTEM 2022b). As plant species tend to be as common as the habitat in which they are found, actual construction effects on the rare to uncommon habitat types were of particular interest. Actual direct Project effects were lower than predicted for 33 of these types and the same for five types. While actual effects were higher than predicted for three habitat types, the increases in area were very small (ranging from 0.05 to 0.2 ha).

3.1.4.2 CONCLUSIONS

Construction monitoring has shown that the EIS predictions for construction phase effects on priority plants were consistent with what was observed and were cautious overall. Project effects on priority plants and their habitat were lower than predicted, and much lower for priority plant habitat.

3.1.4.3 FUTURE MONITORING

Priority plant monitoring will continue during the operation phase.

The construction phase monitoring did not identify the need to alter any of the methods for the operation phase.

3.2 INVASIVE PLANTS

3.2.1 BACKGROUND

Non-native plants (Photo 3-11) are those plants that are growing outside of their country or region of origin. Invasive plants are non-native plants that can out-compete or even replace native plants. Invasive plants are of concern because they can crowd out other plant species and, in extreme cases, change vegetation composition or other ecosystem attributes. Invasive plants have been described as one of the greatest threats to natural areas in Canada.

Photo 3-11: Field sow-thistle (level 2 concern) growing in a Project area

The EIS studies recorded 19 invasive plant species within the non-native plants Regional Study Area (i.e., Study Zone 5 in Map 1-2) prior to construction. The majority of these species were generally found in disturbed areas. The species with of highest management concern included reed-canary grass, smooth brome grass, Canada thistle, yellow and white sweet-clover.

The Project could cause invasive plants to become a problem if it directly and/or indirectly: (i) introduced or spread large numbers of seeds or other types of propagules; and/or (ii) created a large area with ideal conditions for the colonization of invasive species.

Mitigation implemented during construction to minimize the risk of introducing, spreading or promoting invasive plants included revegetating or treating temporarily cleared areas with a non-invasive ground cover as soon as practicable. This mitigation built on that implemented for terrestrial habitat as a whole (Section 2.1).

3.2.2 MONITORING

Construction monitoring focused on determining the degree to which the Project contributed to introducing and spreading non-native plants; and evaluating the effectiveness of mitigation measures.

Ground and vehicle surveys of the Project areas were conducted during the late summer in each construction year (Photo 3-12). Additional ground surveys were completed in the early summer of each year until 2019. A pre-impoundment boat survey was done along the Nelson River shore zone in 2019. An area was not included in the surveys if there was a safety concern (e.g., active construction area, bear present). Surveys were not conducted in the reservoir clearing area because the understorey vegetation and ground cover were not disturbed.

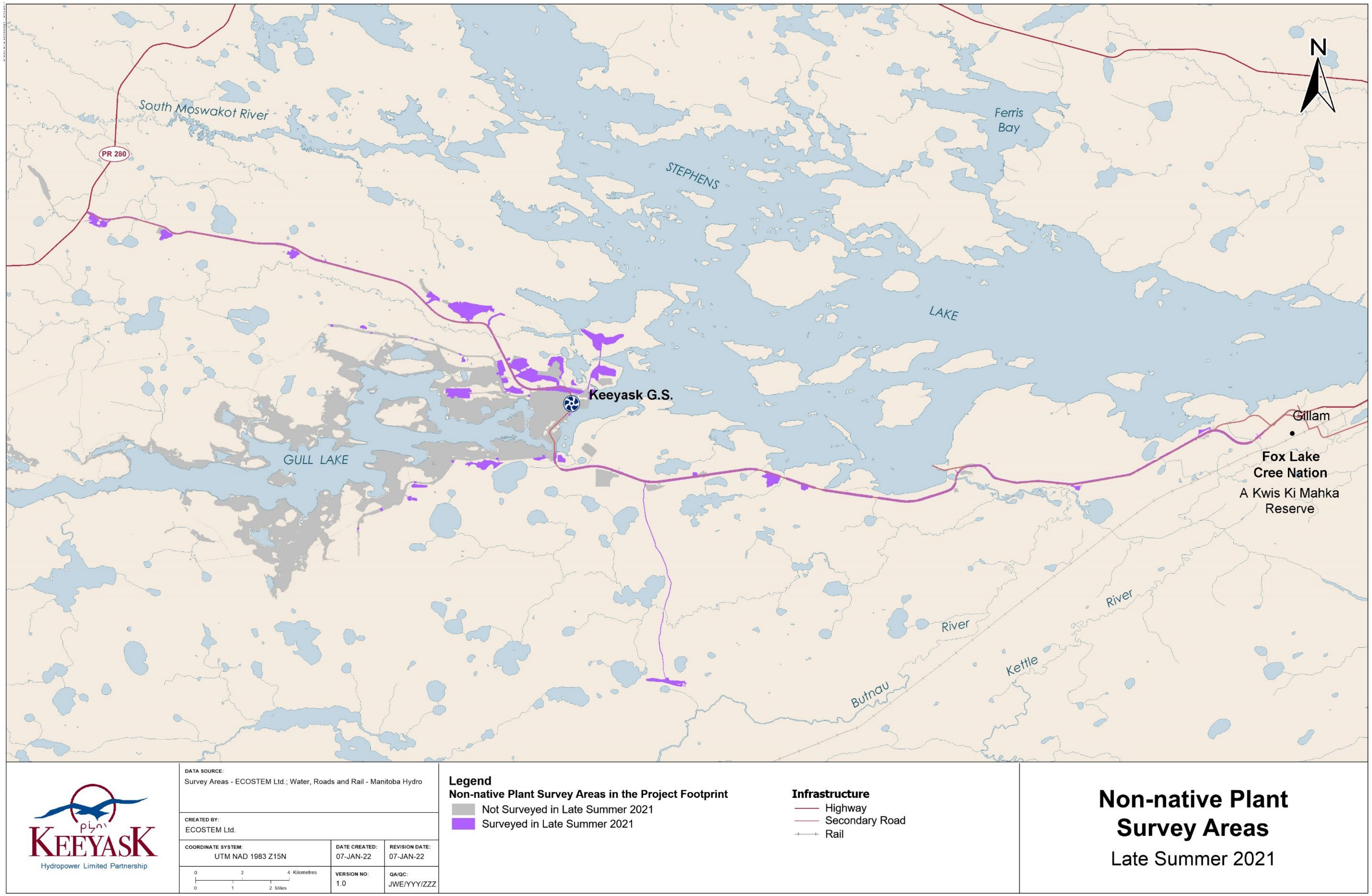
Photo 3-12: An area along the South Access Road surveyed for non-native plants, as seen in 2018

Data recorded for each species during ground surveys included spatial extent and abundance. These data were used to create species distribution and abundance maps for each species.

The non-native plant species recorded during monitoring were classified into four levels of invasive concern for the Project area. The invasive concern levels guided the mitigation recommendations.

3.2.3 RESULTS

Approximately 12% (695 ha) of the total Construction Footprint area was surveyed in September 2021, the last year of construction monitoring (Map 3-2). The vast majority of the unsurveyed Construction Footprint was in the reservoir clearing area, which was almost entirely inundated as of 2021. The reservoir clearing area was not surveyed prior to inundation because there was very limited opportunity for non-native plants to establish as the understory vegetation and ground cover were not disturbed. This assumption was verified through a reconnaissance helicopter survey.



Map 3-2: Late summer non-native plant survey areas in 2021

The surveyed portion of the Construction Footprint included 25 non-native plant species.

Non-native plants covered 1.4% (9.8 ha) of the surveyed area (Figure 3-4). As a percentage of total area surveyed within each component type, non-native plant cover was highest in the following areas: along the south dike (3.7%), along the South Access Road (3.6%), along the North Access Road (3.5%) and in the camp and work areas (1.8%).

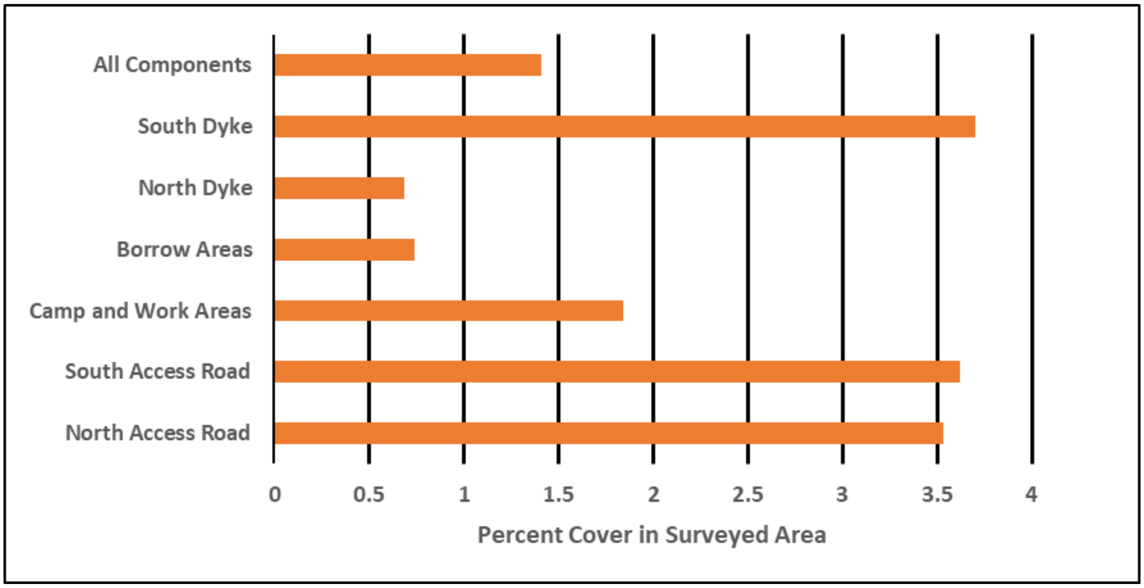
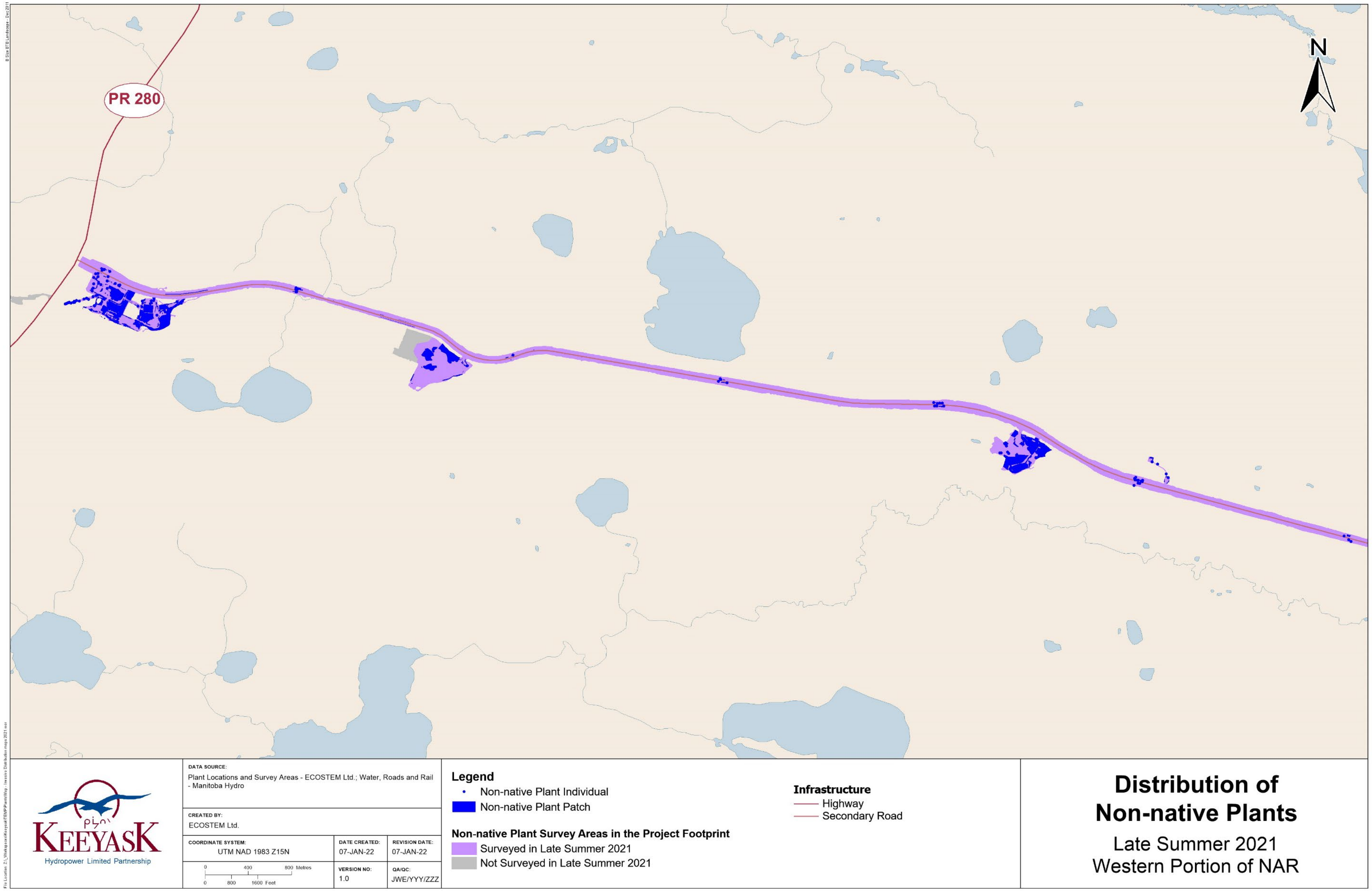
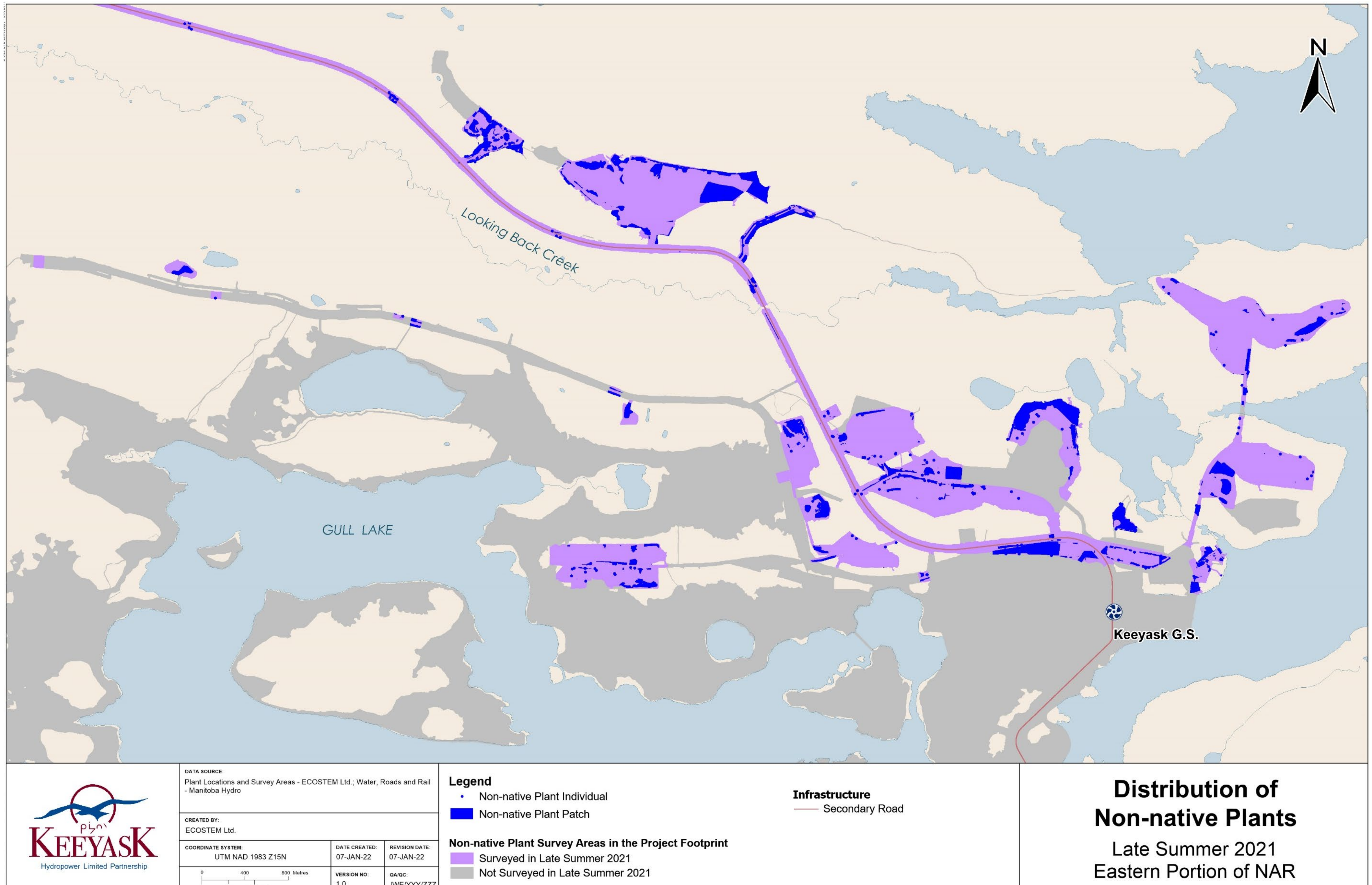


Figure 3-4: Non-native plant cover in total area surveyed during the summer 2021

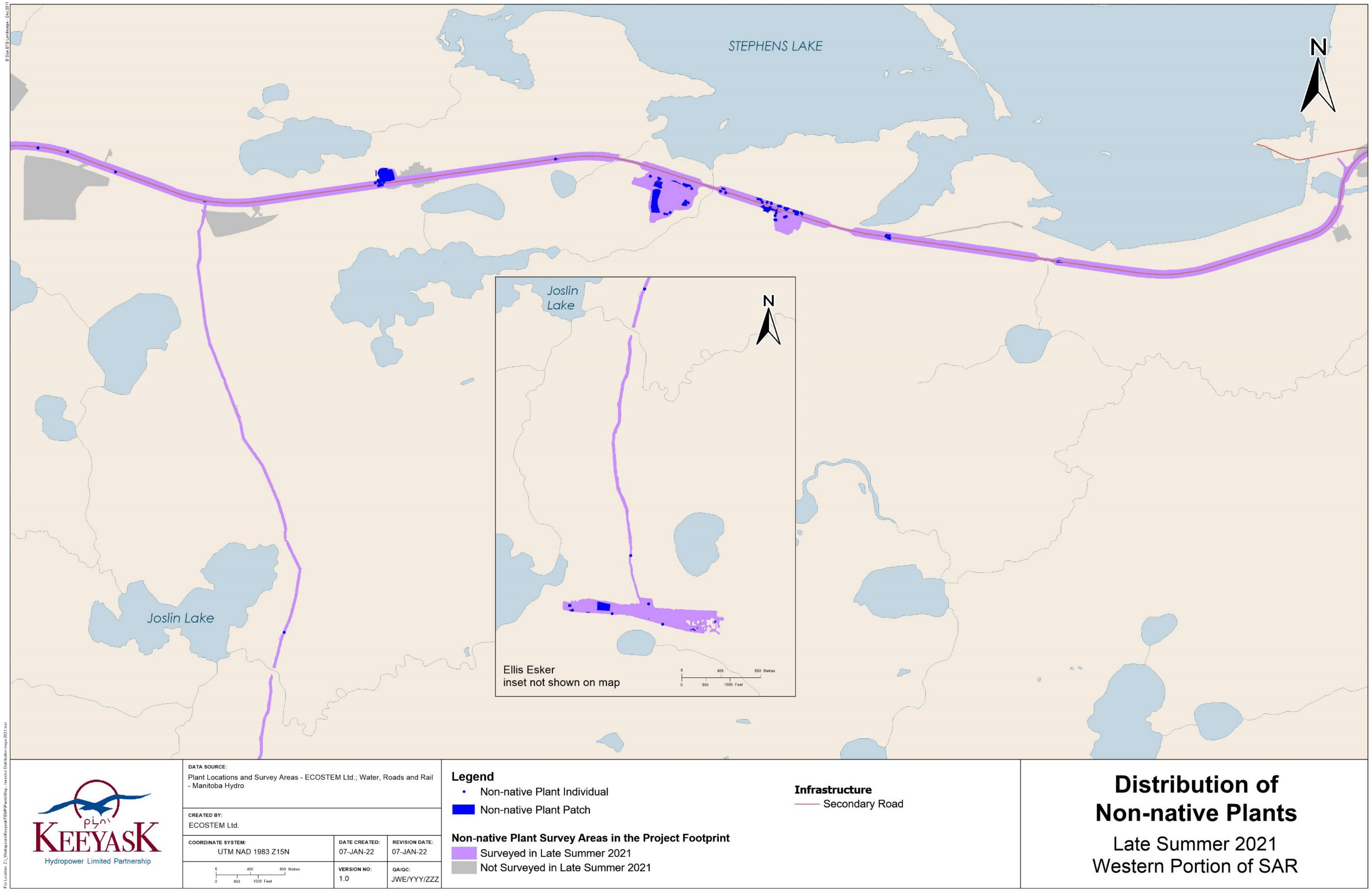
Non-native plants were present in all surveyed Project components (Map 3-3 to Map 3-7). Non-native plant extent and cover were highest in areas used either for the KIP development only, or areas minimally affected by the Project. Non-native plant extent and cover were lowest in areas used by the Project only (and not developed during the KIP). Non-native plant distribution and cover were higher in 2021 (the last year of construction monitoring) than in previous years, particularly in components where construction activity had stopped or decreased more recently (2019).



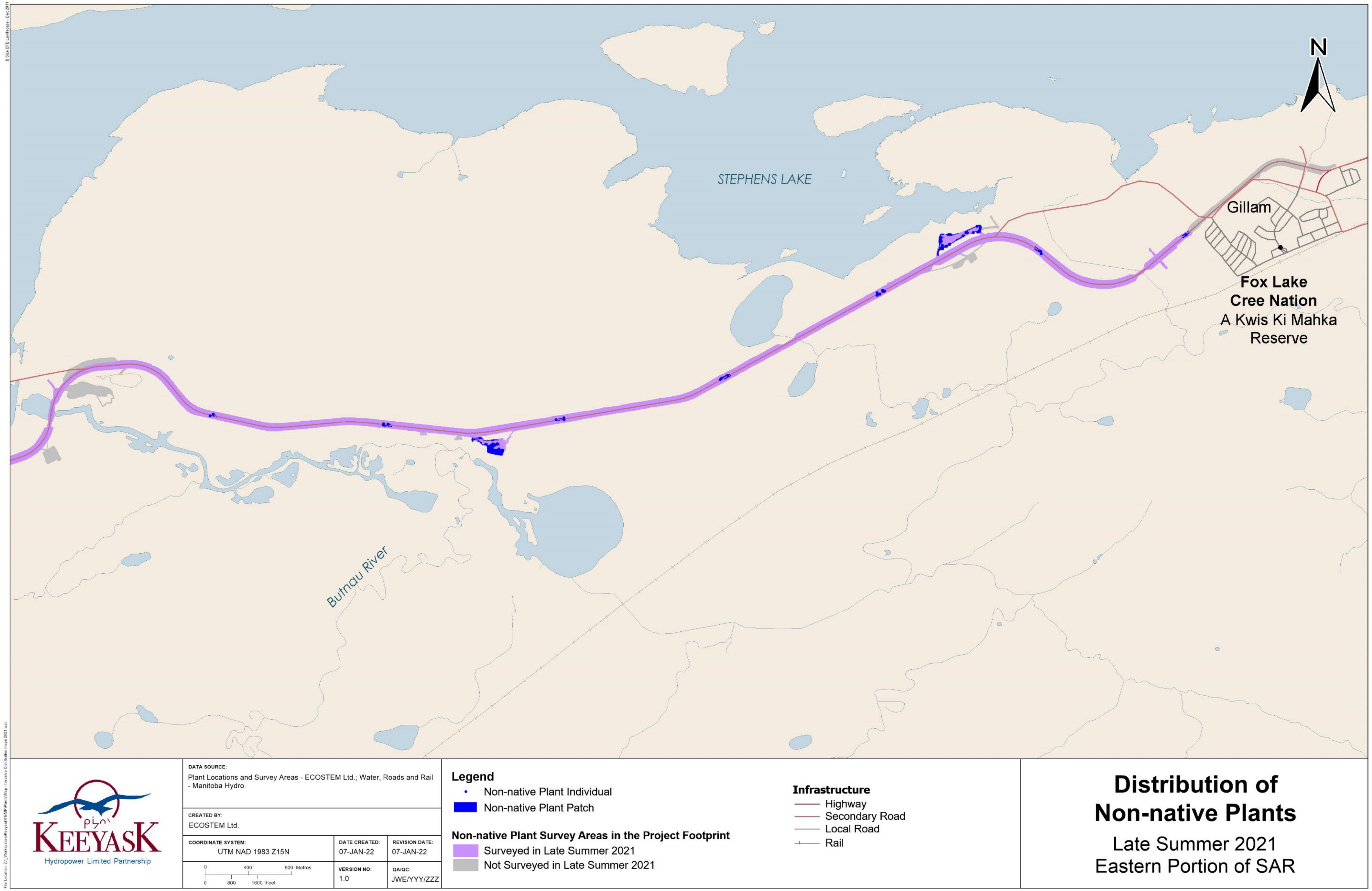
Map 3-3: Distribution of non-native plants during late summer 2021, in the Project footprint along the western portion of the North Access Road



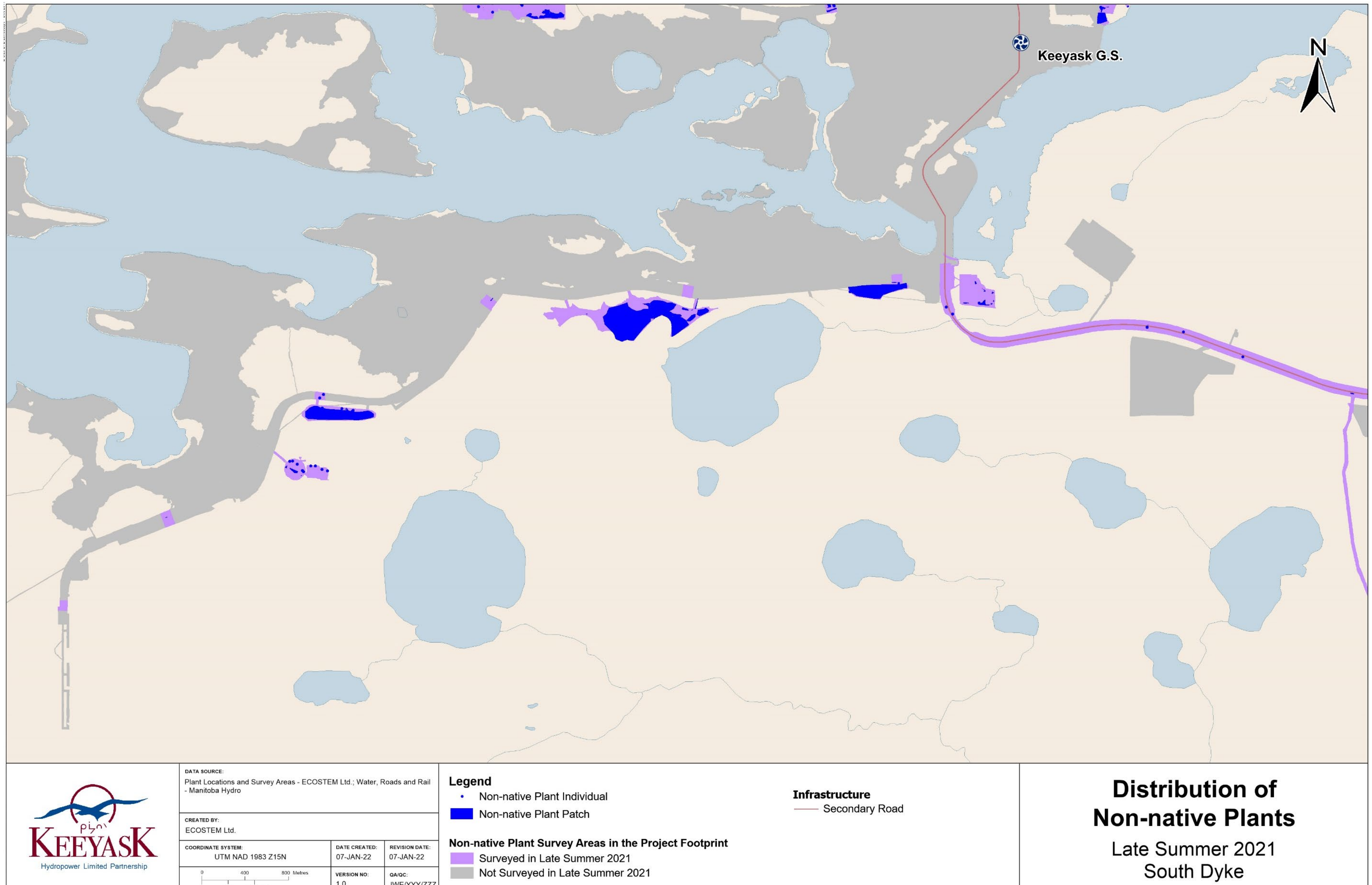
Map 3-4: **Distribution of non-native plants during late summer 2021, in the Project footprint along the eastern portion of North Access Road**



Map 3-5: Distribution of non-native plants during late summer 2021, in the Project footprint along the western portion of the South Access Road

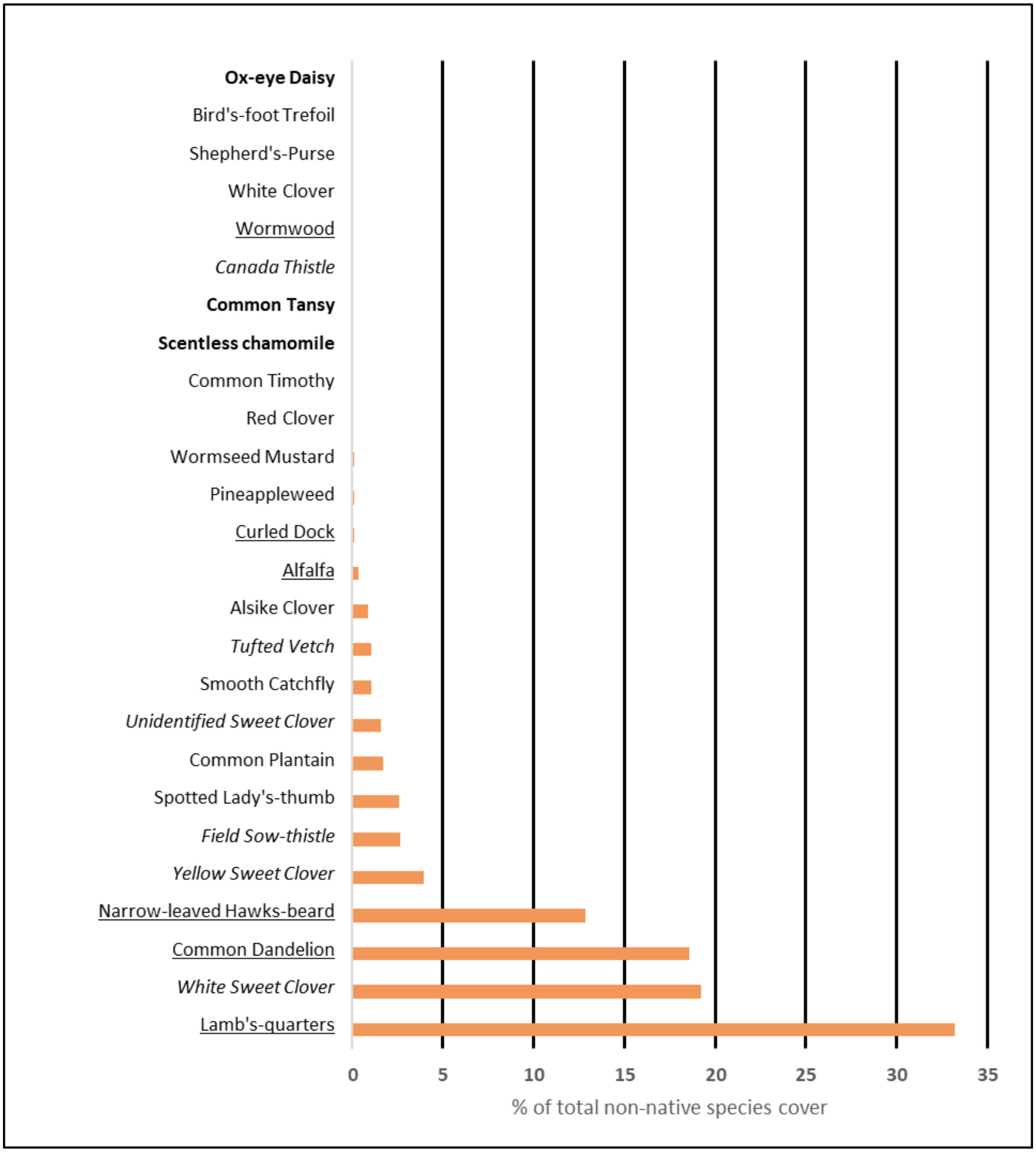


Map 3-6: Distribution of non-native plants during late summer 2021, in the Project footprint along the eastern portion of the South Access Road



Map 3-7: Distribution of non-native plants during late summer 2021, in the Project footprint in the South Dike area

Five non-native species accounted for 88% of all non-native plant cover as of September 2021 (Figure 3-5). These species were lamb's-quarters (*Chenopodium album*), white sweet clover (*Melilotus albus*), common dandelion (*Taraxacum officinale*), narrow-leaved hawks-beard (*Crepis tectorum*) and yellow sweet clover (*Melilotus officinalis*).



Notes: Bolded species are Level 1 invasive concern. Italicized species are Level 2 invasive concern. Underlined species are Level 3 invasive concern. Remaining species are non-native species that may become problematic in some sites and/or condition. Similar species that are difficult to distinguish until they flower are combined into a broader taxon. Unidentified Sweet Clover includes White and Yellow Sweet Clover.

Figure 3-5: Total approximate cover of non-native species as a percentage of total cover for all non-native species as of 2021

The species of Level 1 and Level 2 invasive concern were the focus of management efforts during construction. Level 1 species included ox-eye daisy (*Leucanthemum vulgare*; Photo 3-13), scentless chamomile (*Tripleurospermum inodorum*; Photo 3-14) and common tansy (*Tanacetum vulgare*; Photo 3-15). Level 2 species included Canada thistle (*Cirsium arvense*: Photo 3-16), field sow-thistle (*Sonchus arvensis*; Photo 3-11), tufted vetch (*Vicia cracca*: Photo 3-17) and white and yellow sweet clover (Photo 3-18).

Photo 3-13: Ox-eye daisy (Level 1 invasive concern) growing in the Construction Footprint

Photo 3-14: Scentless chamomile (Level 1 invasive concern) growing in the Construction Footprint

Photo 3-15: Common tansy (Level 1 invasive concern) growing in the Construction Footprint

Photo 3-16: Canada thistle (Level 2 invasive concern) growing in the Construction Footprint

Photo 3-17: Tufted vetch (Level 2 invasive concern) growing in the Construction Footprint

Photo 3-18: Yellow sweet clover (Level 2 invasive concern) growing in the Construction Footprint

Efforts to manage invasive plants included rapid manual removal, herbicide application and mowing.

Manual removal (Photo 3-19) appears to have been effective for Level 1 species, but not for Level 2 species in most cases. Level 2 species that tended to be problematic were those where plant root systems were already well-established, seeds from the seed bank had germinated and/or plants in the area had already produced seed.

The effectiveness of herbicide treatments varied. This was largely due to herbicide application accuracy and weather issues (Photo 3-20).

The effectiveness of mowing could not be determined at the time that the last construction phase annual report was completed. Although it was noted that mowing had been carried out just prior to the late summer 2021 survey, there was no evidence of mortality of the target species. Basal leaves appeared to still be alive, however there were not yet signs of regrowth at the time of the last survey.

Photo 3-19: Canada thistle being manually removed by ECOSTEM staff from the Start-up Camp, August 22, 2021

Photo 3-20: Herbicide treatment within area marked for treatment in the Start-up Camp

3.2.4 DISCUSSION

3.2.4.1 COMPARISON WITH PREDICTED PROJECT EFFECTS

The EIS predicted that Project construction was not expected to substantially increase the rate at which non-native plants are introduced to or spread in the Local Study Area provided mitigation measures were implemented, and that non-native plants would generally be confined to human created features.

Construction monitoring found that the mitigation measures prescribed for construction were implemented and have been effective in controlling non-native plants. Total non-native plant cover within the entire Project footprint was less than 1.5% of the surveyed area, and this percentage is expected to overestimate non-native plant cover within the entire Project footprint. Additionally, the species of the highest invasive concern have been controlled.

After considering mitigation, the EIS predicted that:

1. Project construction was not expected to substantially increase the rate at which non-native plants are introduced to or spread in the Local Study Area provided mitigation measures are implemented, and that non-native plants would generally be confined to human created features.
2. A severe accidental Project-related fire could create ideal conditions for some invasive species by killing off a high proportion of the plant propagules and/or burning off the surface organic layer to expose the mineral soil; and,
3. Temporarily cleared areas could become non-native plant colonization centres as exposed mineral substrates provide ideal sites for plant establishment.

Construction monitoring found no evidence that the Project led to spread of non-native plants outside of the Construction Footprint, with one exception. Non-native plants have been recorded in a small non-cleared area adjacent to Borrow Area G-1 at KM-17 that was burned down to mineral substrate during the 2013 wildfire.

No Project-related fire effects occurred during construction (Section 2.6).

As expected, non-native plants established in the temporarily cleared Project areas. The conditions where establishment and expansion were highest included areas where vegetation was cleared and material was excavated. In these areas, non-native plant cover tended to establish shortly after disturbance, but only increased where construction and excavation activity were low. Non-native plants were found to increase for a few years in these areas, before peaking and then declining as native vegetation developed.

3.2.4.2 CONCLUSIONS

Construction monitoring found that Project effects on non-native plants were consistent with EIS predictions. Of particular interest was that with one small exception, there was no evidence that construction spread non-native plants into areas outside of the Construction Footprint. Also, Project mitigation measures have been effective at controlling total non-native plant cover and confining the vast majority of the small area of non-native plant cover to the Construction Footprint.

3.2.4.3 FUTURE MONITORING

Non-native plant monitoring will continue during the operation phase.

The construction phase monitoring did not identify the need to alter any of the methods for the operation phase.

3.3 SYNTHESIS

Adverse Project effects on priority plants during Project construction were lower than predicted in the EIS, and much lower for priority plant habitat. Construction monitoring identified one unanticipated Project effect, which was a positive effect. Project disturbance appeared to have facilitated the emergence of elegant hawksbeard, which is a critically imperiled species in Manitoba. No additional mitigation is recommended.

Project effects on non-native plants were consistent with EIS predictions. Mitigation measures employed during Project construction were effective at confining non-native plant cover to the Construction Footprint with one small exception. There were no unexpected Project effects on non-native plant cover during construction.

Monitoring of terrestrial plants will continue during Project operation.

4.0 AMPHIBIAN MONITORING

4.1 HABITAT ENHANCEMENT

4.1.1 BACKGROUND

Boreal chorus and wood frog breeding habitat consists of shallow, permanent or temporary, fish-free waterbodies. A nearby water source is required by foraging adults and juveniles to avoid dehydration. Slash (woody debris) piles may benefit frogs by providing nursery cover, food for juveniles, winter cover, and temporary connectivity between breeding ponds. Woody debris from Project clearing was piled in a Project borrow area near suitable breeding habitat, to provide some cover for frogs until vegetation in the borrow area re-establishes.

Project effects on boreal chorus and wood frogs predicted in the EIS were the loss and degradation of some foraging, breeding, and overwintering habitat. The EIS predicted a loss and/or degradation of 2% of regional frog habitat. The values presented here were adjusted to account for a decimal place error and the addition of potential frog habitat lost for the development of the Ellis Esker. The objective of the habitat enhancement monitoring was to determine if frogs used the temporary habitat provided by slash piles during Project construction.

4.1.2 MONITORING

Six pitfall traps were installed in each of four slash piles in the KM-4 borrow area off the North Access Road (Photo 4-1). Each wood slash pile was about four metres in diameter and one metre tall (Photo 4-2). Each of the 24 traps consisted of a 2.4 litre plastic bucket (deep enough to keep frogs from escaping) that was placed flush with the surrounding ground (Photo 4-3). Four traps were installed at the edges of each slash pile corresponding with the four cardinal directions (north, east, south, and west) and two were installed toward the centre of the piles. Wetted soil was added to the traps and it was ensured that each trap was shaded to prevent trapped frogs from dehydrating.

Photo 4-1: Water ponding and temporary frog breeding habitat in KM-4 borrow area, 2017

Photo 4-2: Slash pile for amphibian habitat enhancement in KM-4 borrow area, 2017

Photo 4-3: Pitfall trap in KM-4 borrow area, 2019

In 2017, traps were set twice in July and were checked and removed the following morning. In 2019, traps were set twice in July and were checked daily for four days during each survey. The species, age (mature or juvenile), and condition of trapped frogs was recorded. All trapped frogs or other organisms were released unharmed.

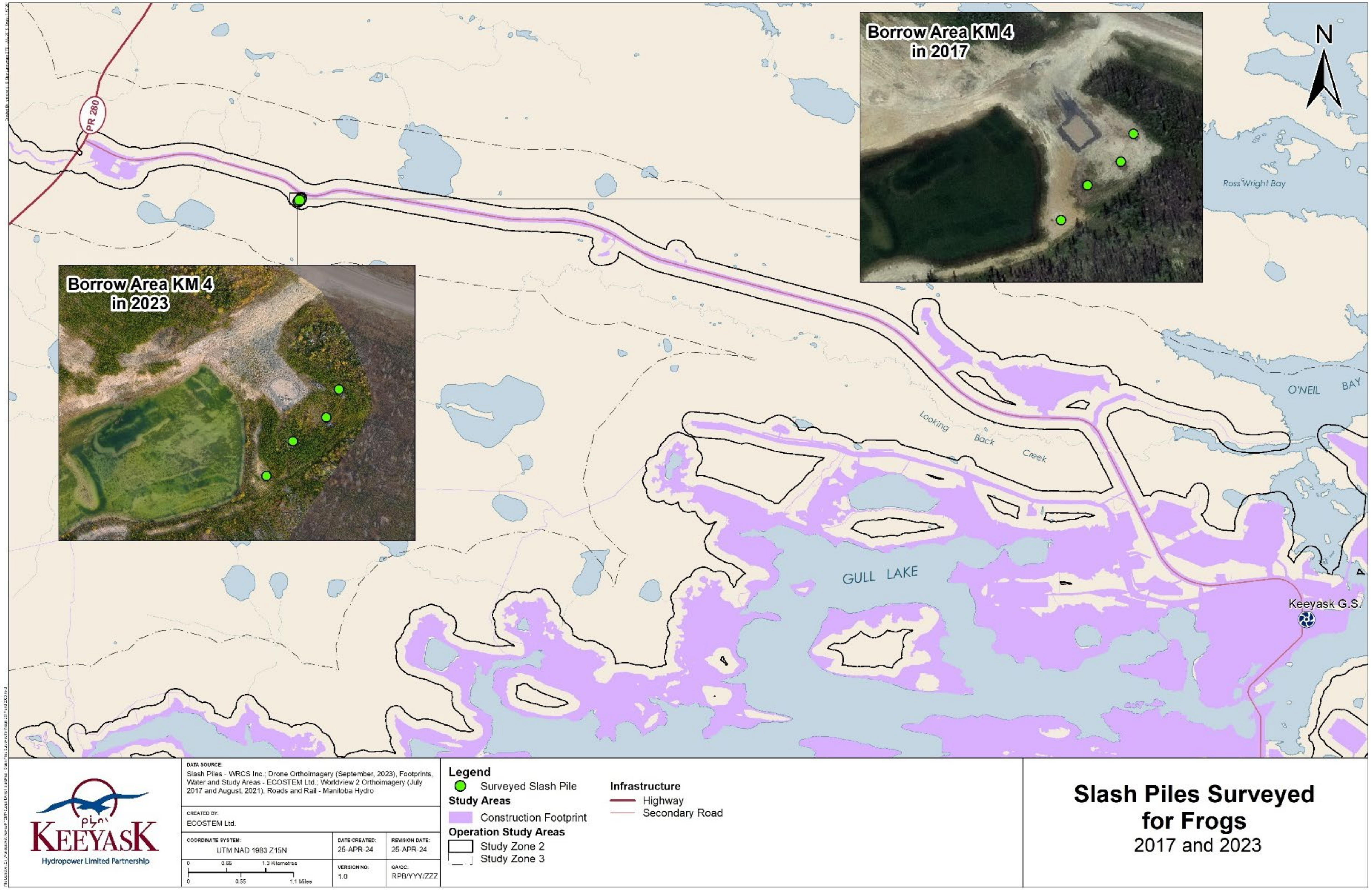
4.1.3 RESULTS

No frogs were trapped in the slash piles during the two surveys in 2017. A wood frog was observed at one site and three wood frogs were observed at the edge of the water near another site during the first survey. No frogs were observed in or near the slash piles during the second survey.

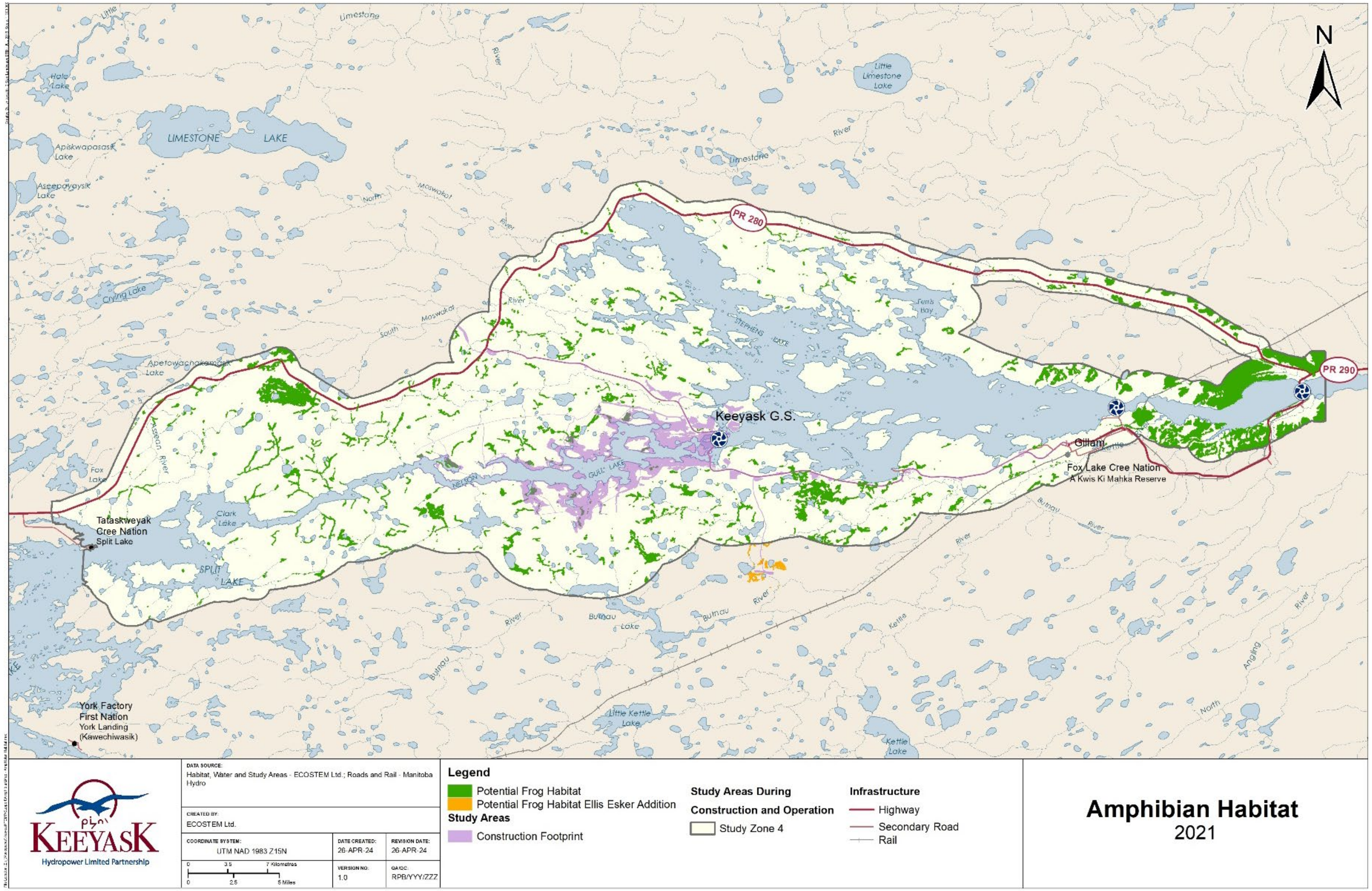
A single wood frog was found in a trap during the first survey in 2019 (Photo 4-4). No other frogs were observed in or near the slash piles during either survey period in 2019 (Map 4-1).

For habitat loss during the construction period, the revised predicted loss of frog habitat in Study Zone 4 was 229.1 ha, or about 2.4% of the total amphibian habitat (originally noted in the EIS as 2%). Including the Ellis Esker, the actual habitat lost was 214.2 ha, or only 2.2% (Map 4-2).

Photo 4-4: Wood frog in a pitfall trap, 2019



Map 4-1: Location of frog slash pile surveys at KM-4 borrow area



Map 4-2: Amphibian habitat in Study Zone 4

4.1.4 DISCUSSION

4.1.4.1 COMPARISON WITH PREDICTED PROJECT EFFECTS

For the habitat prediction in the EIS, the revised predicted loss of amphibian habitat was 229.1 ha, or about 2.4% in Study Zone 4. Including development of the Ellis Esker (originally thought to be very unlikely to be used), only 2.2% (214.2 ha) of the amphibian habitat in Study Zone 4 was actually affected by Project construction. Overall, the magnitude of effect in the region was at or less than predicted.

Water retention in the KM-4 borrow area provided temporary frog breeding habitat during Project construction. The presence of a wood frog in one of the slash piles suggests that the amphibian habitat enhancement piles were used as stop-over habitat during movements toward upland areas, but to a limited extent. The presence of frogs in the KM-4 borrow area in 2017 and 2019 suggests that the area provided some suitable habitat for frogs as the vegetation was re-establishing within the site. The survey time in 2017 was limited to two non-consecutive nights, and it was thought that a longer survey period would increase the probability of trapping frogs that used the piles. The increased survey time in 2019 did not substantially increase the number of frogs trapped, suggesting that suitable habitat was likely available in the surrounding area, resulting in the slash piles not being commonly used as stop-over habitat or as nursery habitat.

4.1.4.2 CONCLUSIONS

Overall Project effects to amphibians were the loss and degradation of frog habitat in Study Zone 4. Actual habitat losses were less than what was predicted in the EIS. Construction monitoring showed that the amphibian habitat enhancement measures provided temporary stop-over habitat for frogs moving throughout the area. The cover provided by vegetation following rehabilitation at the site appeared to provide sufficient habitat for frogs in the area and resulted in limited use of the slash piles.

4.1.4.3 FUTURE MONITORING

Amphibian population monitoring is planned for the operations phase.

4.2 SYNTHESIS

Adverse Project effects on amphibians during Project construction were lower than predicted in the EIS. The lower than predicted effects primarily resulted from the actual Construction Footprint being 28% smaller than assumed in the EIS, as well as the implementation of effective mitigation measures.

Construction monitoring showed that the amphibian habitat enhancement measures provided temporary stop-over habitat for frogs moving throughout the area. The cover provided by vegetation following rehabilitation at the site appeared to provide sufficient habitat for frogs in the area and resulted in limited use of the slash piles. No additional mitigation is recommended.

Monitoring of amphibians will continue during Project operation.

5.0 BIRD MONITORING

5.1 CANADA GOOSE AND MALLARD

5.1.1 BACKGROUND

Canada geese and mallards are common species in the Keeyask region and were chosen as Valued Environmental Components (VECs) based on their importance to local communities and their protection under the federal *Migratory Birds Convention Act*. Canada geese and mallards use the Keeyask region for staging, while travelling between their summer and winter ranges, and breeding. While most Canada geese continue through the region and nest further north, some stay in the Keeyask region to breed, usually nesting near marshes, fens, and shoreline wetlands, and less frequently near lakes and rivers. Like Canada geese, mallards use wetlands and shallow open water areas and typically arrive in the region in May.

Predicted Project effects on Canada geese and mallard included avoidance of suitable breeding and staging habitat due to sensory disturbance during construction and mortality due to increased harvest along the North and South Access Roads. For mallard, a loss of breeding habitat was also anticipated. To evaluate Project effects on Canada goose and mallard and to verify EIS predictions, two studies were conducted for which one benchmark was identified. The habitat effects study assessed how the Project changed the distribution and abundance of Canada goose and mallard staging and breeding habitat. The EIS considered that a 20% loss of existing habitat area for each species was the benchmark that triggered management concern, which was applied for Canada goose and mallard habitat effects monitoring. The mortality study qualitatively evaluated the effects of harvest on the local Canada goose and mallard populations during construction.

5.1.2 MONITORING

Aerial (helicopter) surveys for waterfowl were conducted in April or early May, late May, June, July, and September in 2015, 2017, 2019, and 2021 (Photo 5-1). An aerial survey for waterfowl was also conducted along the new reservoir shoreline in September 2020, shortly after it was impounded. From 2015 - 2019, waterbodies throughout Study Zone 5 were surveyed. In 2021, the survey was limited to the reservoir and surrounding area, including Clark Lake and Gull Rapids. During the surveys all waterfowl observations were recorded and bird species and sex were identified where possible. The total density of ducks, geese, and swans (individuals/km of shoreline surveyed) was calculated and compared with results from pre-construction surveys. Data from the late May or June surveys were used to determine the number of indicated breeding pairs (IBPs) of all waterfowl in the reservoir and surrounding area to estimate the number of breeding waterfowl in the study area (Lemelin et al. 2010; Messmer et al. 2015). Indicated breeding pair density was calculated as the number of IBPs per kilometre of shoreline surveyed during construction monitoring. Observations of Canada goose and mallard broods were also recorded.

The EIS classified mallard nesting habitat as areas within 300 m of inland lakes, wetlands, and creeks (Photo 5-2). Brood-rearing habitat was identified along creeks and edges of inland lakes filled with sedges. For mallard, a loss of 1,840 ha (3%) of physical breeding and brood-rearing habitat in Study Zone 5 was anticipated. No breeding habitat for Canada goose was identified in the EIS. Habitat effects monitoring was conducted to evaluate how the Project changed the amount and location of mallard nesting habitat and staging habitat for both species. A habitat quality model was applied to the monitoring data and used to compare actual with predicted Project effects.

For mortality monitoring, instances of accidental Canada goose and mallard mortality were documented during Project construction. Waterfowl hunting groups observed during aerial surveys for waterfowl were recorded and harvest records from resource use surveys were compiled. Resource use by the Project workforce was monitored as part of the Keeyask Generation Project Resource Use Monitoring Plan.

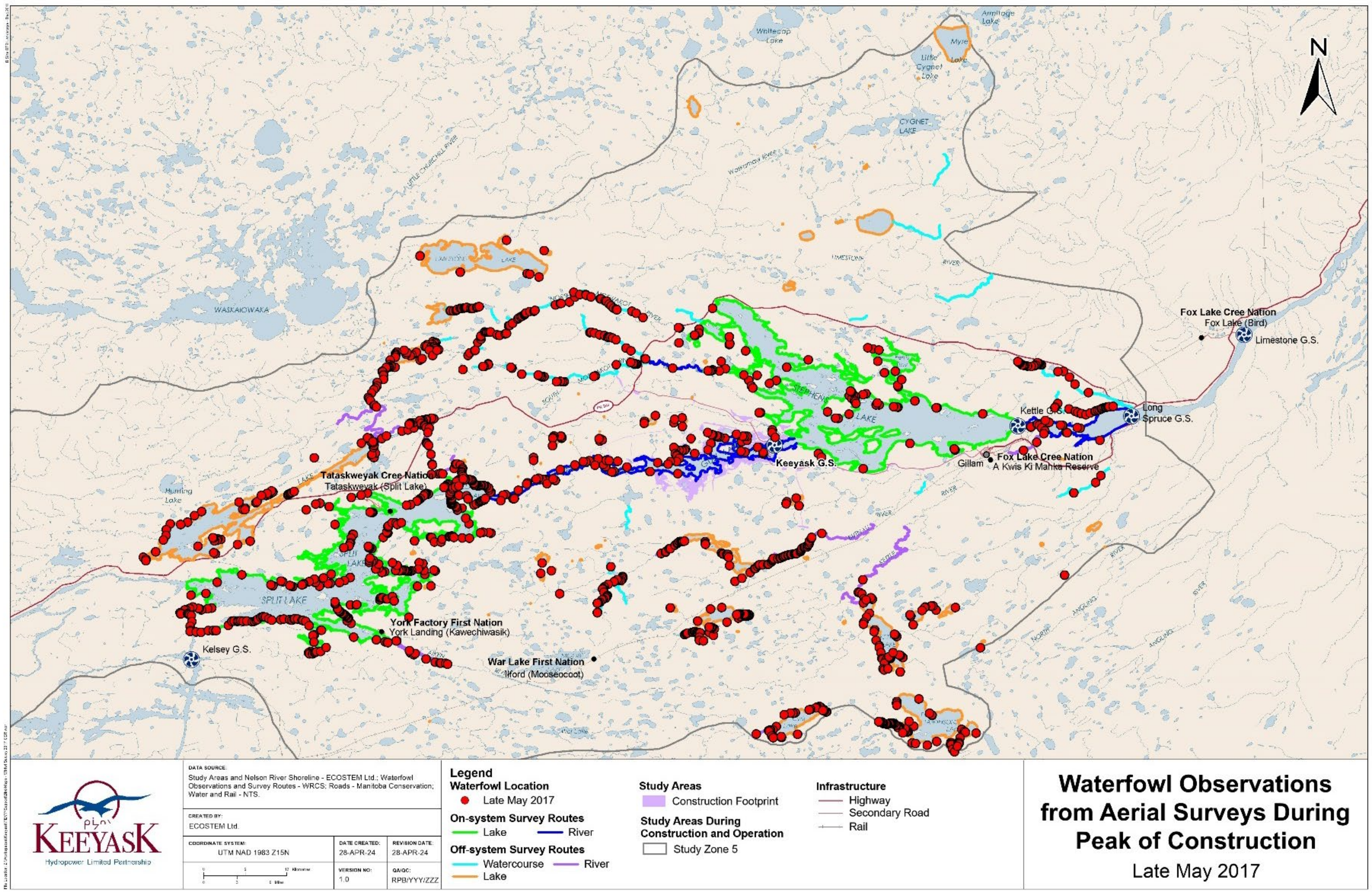
Photo 5-1: Helicopter survey for waterfowl, 2015

Photo 5-2: Mallard nesting habitat, 2019

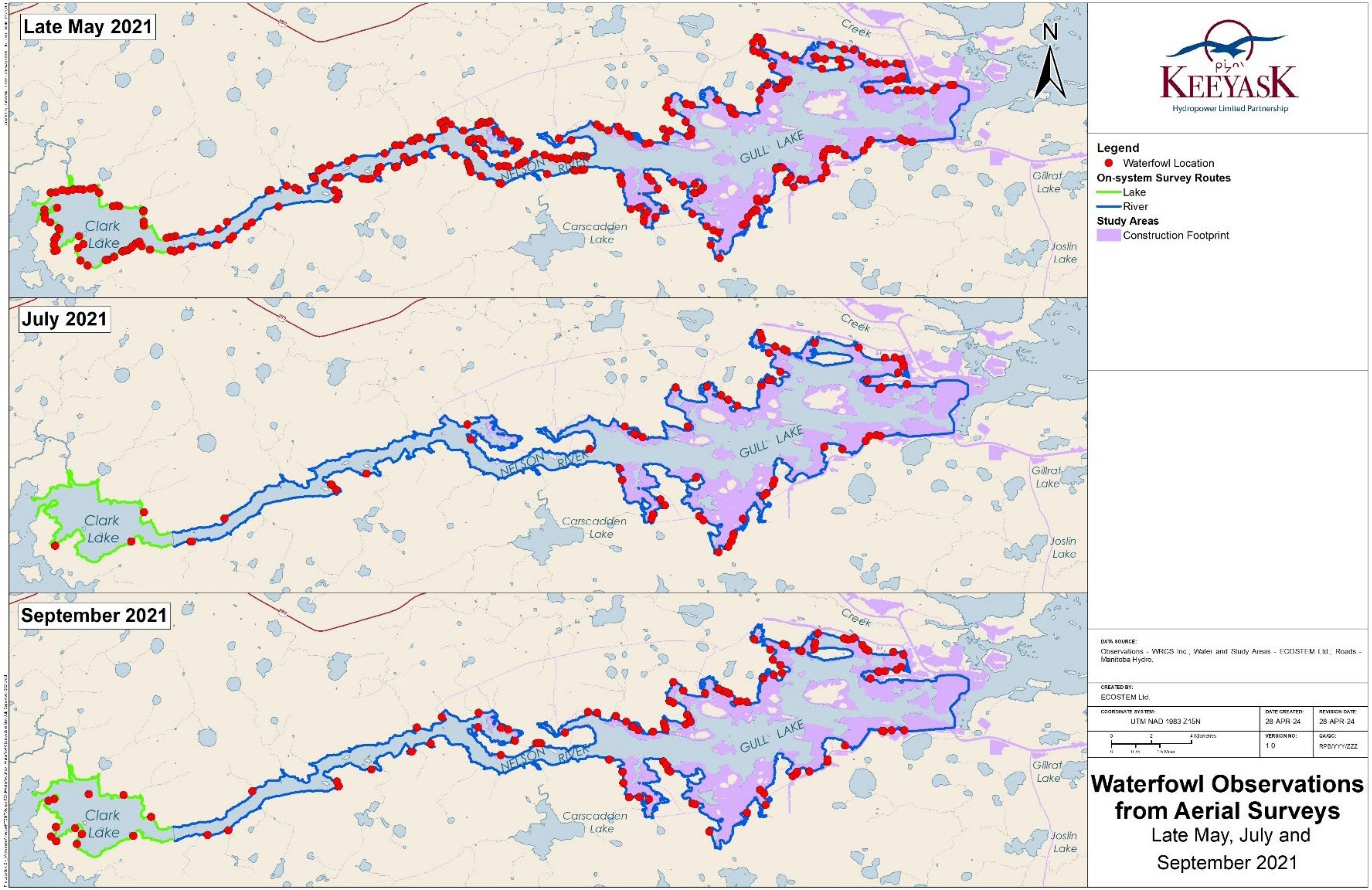
5.1.3 RESULTS

During the construction period (Map 5-1), the densities of all ducks, geese (Photo 5-3 to Photo 5-6), and swans were within the ranges observed during the pre-construction period or were higher (Table 5-1). Following impoundment, waterfowl densities in 2021 were some of the greatest observed during any of the pre-construction or construction surveys (Map 5-2). During Project construction waterfowl density in the reservoir and surrounding area ranged from 0.20 birds/km in April/May 2021 to 7.68 birds/km in May 2021. During the pre-construction period, waterfowl density ranged from 0.25 birds/km in August 2011 to 6.92 birds/km in June 2002.

The actual loss of mallard breeding and brood rearing habitat in Study Zone 5 was less than anticipated. It was estimated in the EIS that 1,840 ha of this habitat would be lost, but post-construction monitoring of the actual Construction Footprint found that 1,521 ha was lost.



Map 5-1: Waterfowl observations during peak construction in 2017



Map 5-2: Waterfowl observations in 2021 post reservoir impoundment

Photo 5-3: Canada geese beside the North Access Road, 2017

Photo 5-4: Canada geese on the Nelson River during spring surveys, 2019

Photo 5-5: Canada geese staging in the newly formed reservoir, 2020

Photo 5-6: Canada geese observed in the reservoir during summer surveys, 2021

Table 5-1: Total density of ducks, geese, and swans during aerial surveys in the reservoir and surrounding area before (2001–2011) and during (2015–2021) Project construction

Period	Year	Density (birds/km)					
		April/May	May	June	July	August	September
Pre-construction[1]	2001	–	3.95	–	0.47	–	2.43
	2002	–	–	6.92	2.28	–	6.31
	2003	–	6.05	–	1.55	–	5.98
	2011	–	5.82	–	0.33	0.25	0.52
Construction (pre-reservoir)	2015	0.52	3.63	1.24	0.66	–	1.65
	2017	1.24	8.75	1.18	0.61	–	1.09
	2019	0.63	0.95	1.06	0.68	–	2.34
Construction (reservoir present)	2020	–	–	–	–	–	0.84
	2021	0.20	7.68	1.81	1.42	–	4.42

1. From 2001 to 2003 waterfowl counted on Gull Lake also included segments of inland lakes that were predicted to be inundated following reservoir impoundment.

Prior to reservoir impoundment, the density of waterfowl IBPs ranged from 0.14 to 0.36/km between 2015 and 2019 (Table 5-2). Following reservoir impoundment in 2021, IBP density increased to 0.67/km. Indicated breeding pair density was 86% greater after reservoir impoundment than in 2015, when the next-greatest density was observed.

Table 5-2: Indicated breeding pair density of waterfowl in the reservoir and surrounding area during Project construction (2015, 2017, 2019, and 2021)

Period	Year	Indicated Breeding Pairs/km Shoreline
Construction (pre-reservoir)	2015	0.36
	2017	0.14
	2019	0.16
Construction (reservoir present)	2021	0.67

Few Canada goose broods were observed during construction monitoring surveys in and near the reservoir area (Photo 5-7). The greatest number was in 2019, when 13 were observed (Table 5-3). The greatest number of mallard broods was also observed in 2019. No Canada goose broods were observed in 2021, after reservoir impoundment, and only one mallard brood was recorded.

Photo 5-7: Canada goose broods observed during summer surveys, 2019

Table 5-3: Number of Canada goose and mallard broods observed in the reservoir and surrounding area during Project construction (2015, 2017, 2019, and 2021)

Year	Canada Goose	Mallard
2015	1	4
2017	1	0
2019	13	8
2021	0	1

A total of 16 waterfowl hunting parties were observed in Study Zone 5 in 2015, 34 in 2017 (Photo 5-8), and 26 in 2019. Two or three waterfowl hunting groups were observed near the Nelson River and Gull Lake during each of the 2015, 2017, and 2019 aerial surveys. The groups were generally observed on Clark Lake at the mouth of the Assean River and on the Nelson River between Birthday Rapids and Clark Lake. No waterfowl hunting groups were observed during surveys in 2021. In 2015, local members of the Project workforce reported harvesting 66 geese and ducks in the region and other members harvested 10 waterfowl from areas near Thompson. Local members of the Project workforce reported harvesting 27 geese in 2019. Harvesting most likely occurred on days off from work as no firearms were allowed at the Keeyask site. A mallard mortality was recorded in 2020 at the Main Camp, but its cause was unknown. No other Project-related Canada goose or mallard mortality was reported during Project construction.

Photo 5-8: Spring goose hunt with blinds and decoys near York Landing, 2017

5.1.4 DISCUSSION

5.1.4.1 COMPARISON WITH PREDICTED PROJECT EFFECTS

Waterfowl staging and breeding habitat did not appear to be affected by Project construction. The predicted habitat loss of breeding and brood-rearing mallard habitat was less than anticipated based on post-construction monitoring results. Waterfowl densities observed during Project construction were not significantly different from those observed during the pre-construction period, and some of the highest waterfowl densities were observed in the reservoir in spring 2021, the year after impoundment. The increased amount of shoreline created by reservoir impoundment and the inundation of peatland areas appeared to have provided increased foraging opportunities for waterfowl. These findings contrasted the predictions of the EIS, which suggested Canada goose and mallard use of the reservoir would be minimal until wetland vegetation was re-established in the area. The newly flooded areas are expected to disintegrate over time and will likely become less attractive to waterfowl in the long-term.

Project construction did not appear to increase hunter access or result in increased mortality of Canada geese or mallards. While some Project-related Canada goose and mallard mortality occurred during Project construction, most of the waterfowl harvest was conducted by local resource users who would likely have harvested in the region whether they were members of the Project construction workforce or not.

A single mallard mortality was reported during Project construction by site staff. Because of the small number of waterfowl mortalities reported annually, there was no indication of significant Project effects on the Canada goose or mallard populations. Additionally, the number of hunting groups observed near the Project did not increase during construction, and appeared to decrease in 2021, the last year of construction. As some areas of the Project site still had restricted access to the public (i.e., North Access Road, Main Camp), it is possible that waterfowl hunting pressure may increase in these areas once the area is accessible by the public.

5.1.4.2 CONCLUSIONS

Monitoring has shown that actual Project effects on Canada goose and mallard during construction were less than predicted in the EIS. The amount of mallard breeding and brood-rearing habitat loss was less than predicted. Additionally, Canada goose and mallard use of the reservoir remained high following impoundment, which contrasted the prediction that waterfowl use would be minimal.

Waterfowl mortality did not increase during Project construction. Access to some areas of the Project site were still restricted to the public during this time, but it is possible hunting pressure may increase when these areas are accessible.

5.1.4.3 FUTURE MONITORING

Canada goose and mallard monitoring will continue during the Project operation phase.

Additional monitoring in years 1 and 3 of operation were added to the TEMP to confirm there were no unexpected effects in the first few years following reservoir impoundment. The survey area for these two years was reduced in size to focus on the reservoir and Clark Lake. Following this, the same methods for the regional study area will be employed during future surveys and limited to the spring breeding, brood rearing, and fall staging periods.

Waterfowl mortality monitoring is now complete, but locations of hunting blinds will continue to be incidentally collected.

5.2 COLONIAL WATERBIRDS

5.2.1 BACKGROUND

Colonial waterbirds are loosely defined as waterbird species that breed in large aggregations and feed or nest in aquatic habitat. Seven species of colonial waterbirds occur in the Keeyask region including ring-billed gull and common tern, which typically use reefs and islands for nesting. Ring-billed gulls are common in the Keeyask region and common terns are less numerous. Project effects on colonial waterbirds predicted in the EIS were the physical loss of potential breeding habitat and the avoidance of otherwise suitable habitat due to sensory disturbance during construction.

To evaluate Project effects on colonial waterbirds and verify EIS predictions, two monitoring studies were conducted during construction, for which one benchmark was identified. The habitat effects study assessed how the Project changed the distribution and abundance of ring-billed gull and common tern breeding habitat and the effects of sensory disturbance on habitat use. The EIS considered that a 20% loss of existing habitat area for the species was the benchmark that triggered management concern, which was applied for colonial waterbirds habitat effects monitoring.

Mitigation efforts such as a bird deterrent program was implemented to prevent gulls and terns from nesting directly in active construction zones during the nesting season. The program ran from 2015 – 2021. The habitat enhancement study evaluated the effectiveness of the Habitat Compensation Island, temporary habitat replacement areas, and floating nesting platforms built by the Project to mitigate the effects of habitat loss, including the temporary loss of colonial waterbird habitat in construction areas during Project construction.

5.2.2 MONITORING

Aerial (helicopter) and unmanned aerial vehicle (UAV/drone) surveys for colonial waterbirds were conducted annually in Study Zone 5 in June and July from 2015 to 2021. Gulls and terns were counted at colony (nesting) and congregation (activities other than nesting) sites in the Keeyask region during aerial surveys. Photographs of colonial waterbird colonies and potential nesting areas in the Gull Rapids area taken by the UAV were reviewed to determine the number of individuals, nests, chicks, and species present on each of the islands.

The EIS described ring-billed gull breeding habitat as exposed ice-scoured rocky reefs with a nearby food source (e.g., fish) and rocky islands surrounded by deep water. Breeding habitat for common terns was small islands and reefs between Gull Rapids and Birthday Rapids and islands within 9 km of primary forage areas (e.g., rapids or areas with fast-flowing water). Predicted Project effects on colonial waterbirds were the loss of 2.7 ha of potential breeding habitat and changes in their distribution and abundance caused by sensory disturbances during construction. Project-related colonial waterbird mortality was recorded as part of habitat effects monitoring.

Habitat enhancement areas were created in Gull Lake beginning in 2015, to offset the loss of gull and tern nesting habitat during Project construction. For gulls, a portion of William Smith Island was cleared and graded with rocky substrate to mimic a natural nesting island. Large shipping containers were added and topped with rocky substrate to provide temporary elevated nesting habitat protected from potential predators (Photo 5-9). One or two floating nesting platforms topped with gravel were deployed upstream of Gull Rapids in spring 2015, 2016, and 2017 to provide replacement nesting habitat for terns (Photo 5-10). A Habitat Compensation Island was built in the future reservoir area that became suitable for nesting after it was surrounded by water during reservoir impoundment in 2020 (Photo 5-11).

To evaluate the effectiveness of replacement habitat, trail cameras and UAVs were used to photograph colonial waterbird activity at each site. The William Smith Island Habitat Enhancement Area for gulls ("Habitat Enhancement Area") was monitored from 2015 to 2018, the Habitat Compensation Island was monitored in 2020 and 2021, and the floating nesting platforms were monitored from 2015 to 2017.

Photo 5-9: William Smith Island Habitat Enhancement Area, 2017

Photo 5-10: Common tern nesting platform with decoys and terns, 2017

Photo 5-11: Pre-impoundment construction of colonial waterbird Habitat Compensation Island, 2019

5.2.3 RESULTS

Colonial waterbirds continued to be widespread in the Regional Study Area. During pre-construction aerial surveys, most ring-billed gull and common tern colonies were observed on on-system lakes and rivers (Map 5-3). Few ring-billed gulls were observed off-system relative to the number observed on-system (Table 5-4). The length of shoreline surveyed on-system was considerably longer than that surveyed off-system; however, the large, on-system waterbodies appeared to be occupied by more gulls than the smaller, off-system waterbodies. Due to the relatively high-water levels in the Nelson River in 2020, many of the islands in the Gull Rapids area were submerged or partially submerged, reducing the amount of habitat for ring-billed gulls. As a result, approximately half of ring-billed gull observations were made on two on-system islands. After the reservoir was impounded in late 2020, ring-billed gulls continued to congregate and nest on on-system islands, including a newly formed island in the reservoir.

Table 5-4: Number of ring-billed gulls in congregations and colonies in two hydraulic zones in Study Zone 5, 2015–2021

Year	June		July	
	On-system	Off-system[1]	On-system	Off-system[1]
2015	2,878	148	3,338	101
2016	4,817	205	9,802	47
2017	5,596	239	7,541	239
2018	4,394	203	7,708	235
2019	5,104	410	7,007	588
2020	6,393	84	5,228	411
2021[2]	4,305	–	2,882	–

1. Length of shoreline surveyed was considerably greater on-system than off-system.
2. No off-system waterbodies were surveyed in 2021 as the focus was on the reservoir.

Ring-billed gulls were consistently photographed on four of the islands in Gull Rapids (Photo 5-12 and Photo 5-13) before the reservoir was impounded (Table 5-5). Nesting was observed on all four islands (islands 83, 226, 224 and 225 (Map 5-3) during Project construction. No ring-billed gull nests were photographed in Gull Rapids in 2020 however, nesting was observed again in 2021. Island 83 was flooded following reservoir impoundment and was unavailable as habitat in 2020 and 2021. Island 226 was consistently used by ring-billed gulls for nesting over the construction period. The number of ring-billed gulls on island 224, where large congregations were observed from 2015 to 2018 and which was occasionally used for nesting, declined from 2019 to 2021. The number of gulls on island 225 also declined in 2018 and afterward. Nesting was photographed on the constructed Habitat Compensation Island in 2021, when two nests were observed.

Table 5-5: Maximum number of ring-billed gulls, nests, and chicks photographed by UAV in Gull Rapids, 2015–2021

Observation	Year						
	2015[1]	2016	2017	2018	2019	2020	2021
Ring-billed gull	4,978	5,092	1,900	7,030	7,227	2,744	4,902
Ring-billed gull with nest	81	851	852	3,171	3,820	0	1,566
Ring-billed gull chick	42	1,774	0	1,009	474	0	42

1. Ring-billed gulls and herring gulls were counted together in 2015.

One ring-billed gull mortality as a result of natural predation was recorded in 2016 and 2017. A mortality of unknown cause was also noted in 2016. A collision with a vehicle and an unknown mortality were recorded in 2018. Three collisions or suspected collisions with vehicles were recorded in 2019, plus an unknown mortality.

During aerial surveys, few common terns were observed off-system relative to the number observed on-system (Table 5-4). The length of shoreline surveyed on-system was considerably greater than that surveyed off-system; however, the large, on-system waterbodies appeared to be occupied by more terns than the smaller, off-system waterbodies. After the reservoir was impounded, common terns continued to congregate and nest on on-system islands, including floating peat islands in the reservoir.

Table 5-6: Number of common terns in congregations and colonies in two hydraulic zones in Study Zone 5, 2015–2021

Year	June		July	
	On-system	Off-system[1]	On-system	Off-system[1]
2015	416	35	572	0
2016	688	100	435	100
2017	1,355	22	820	159
2018	824	182	263	128
2019	930	141	783	137
2020	539	13	1,270	0
2021[2]	78	–	780	–

1. Length of shoreline surveyed was considerably greater on-system than off-system.
2. No off-system waterbodies were surveyed in 2021 as the focus was on the reservoir.

Common terns made limited use of the islands in Gull Rapids during Project construction (Table 5-7). Before the reservoir was impounded, terns (more than one) and nests were photographed on two islands (83 and 224), which were also used by ring-billed gulls for nesting. No terns were photographed on the islands in 2019, before the reservoir was impounded, or afterward in 2020. However, there was more nesting on the Habitat Compensation Island in 2021 than on any other island over the survey period. The EIS reported that depending on water levels, Gull Rapids supported 50 to 100 common tern pairs before Project construction began. No common tern mortality was recorded during the construction period.

Table 5-7: Maximum number of common terns, nests, and chicks photographed by UAV in Gull Rapids, 2015–2021

	Year						
Observation	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Common tern	61	138	10	60	0	0	109
Common tern with nest	0	10	21	105	0	0	171
Common tern chick	0	0	0	0	0	0	11

The effectiveness of the colonial waterbird Habitat Enhancement Area was monitored throughout the Project construction period. There was no evidence of gulls nesting at the Habitat Enhancement Area from 2015 to 2018. Common terns were photographed loafing on the floating nesting platforms each year from 2015 to 2017. A pair of common terns nested successfully on a platform in 2016; three eggs and then three chicks were photographed in June and July, respectively. A common tern appeared to be nesting in 2017 but no eggs were visible in the photographs and the number of days it spent on-nest was insufficient for incubation. Due to the limited use of the nesting platforms by common terns, they were not deployed in subsequent years. No gulls nested on the Habitat Compensation Island in 2020, but ring-billed gulls were observed loafing on it in June. Two ring-billed gulls nested on the Habitat Compensation Island in 2021. Approximately 170 nesting common terns and 11 chicks were also photographed, which was the greatest number of nesting common terns observed in the Gull Rapids area during construction monitoring (Photo 5-14).

Other colonial waterbirds observed nesting in the Gull Rapids area from 2015 to 2021 included herring gull. American white pelicans also frequented the area (Photo 5-15) but they did not nest.

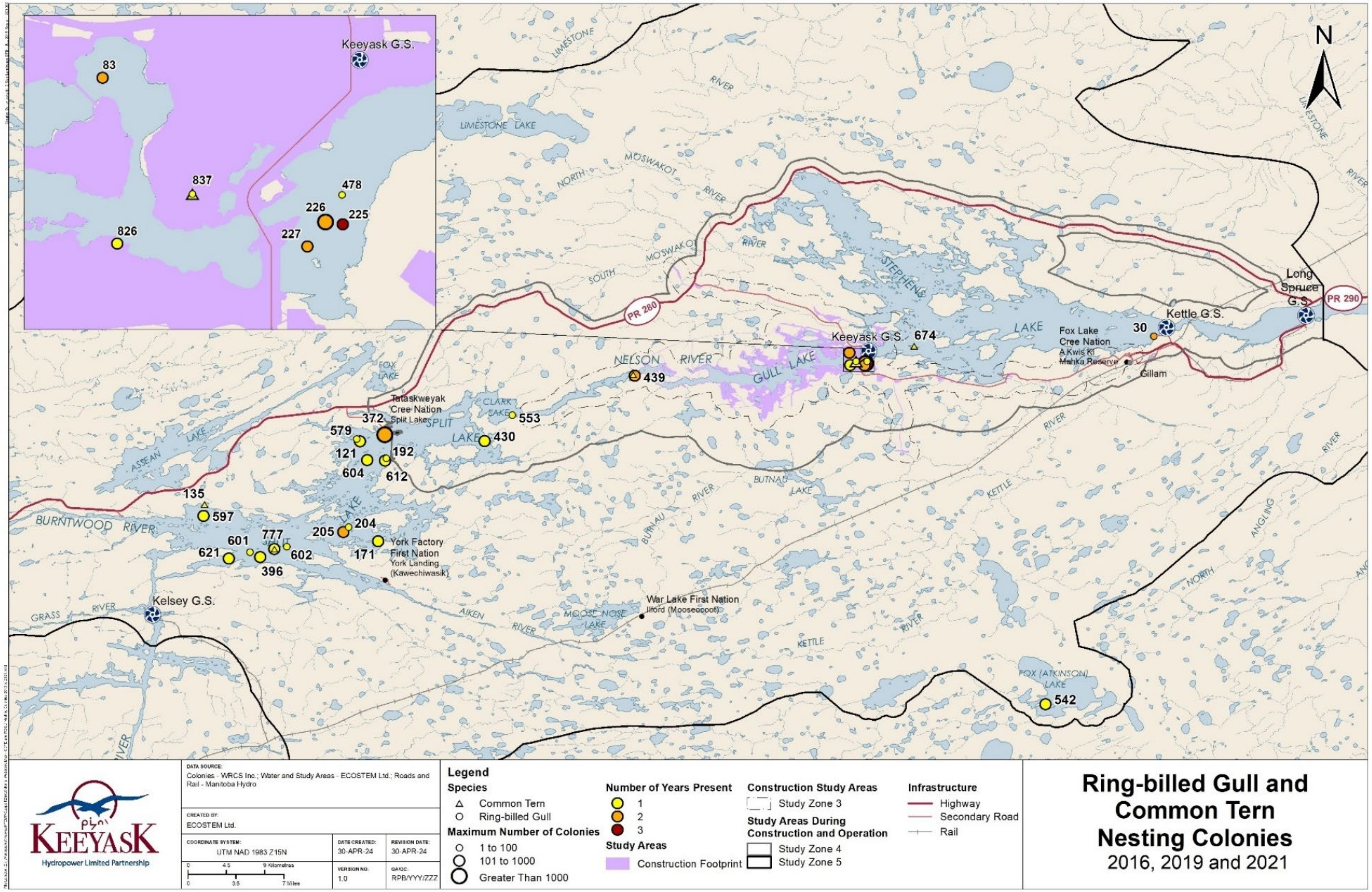
The actual total physical changes to islands in the former Gull Rapids area that include important colonial waterbird nesting areas, other potential nesting areas without enhancement, and those where partial nesting has occurred (Map 5-4), was 8.54 ha, the same area that was available for nesting pre-Project. The area of the Habitat Compensation Island constructed was 1.46 ha. The net difference of island area lost and/or altered at Gull Rapids was 7.08 ha. Excluding downstream water effects following Project development, the actual net change of potential nesting habitat was 5.33 ha.

Photo 5-12: Colonial waterbird nesting islands in Gull Rapids, 2015. (Note Project cofferdam construction in background.)

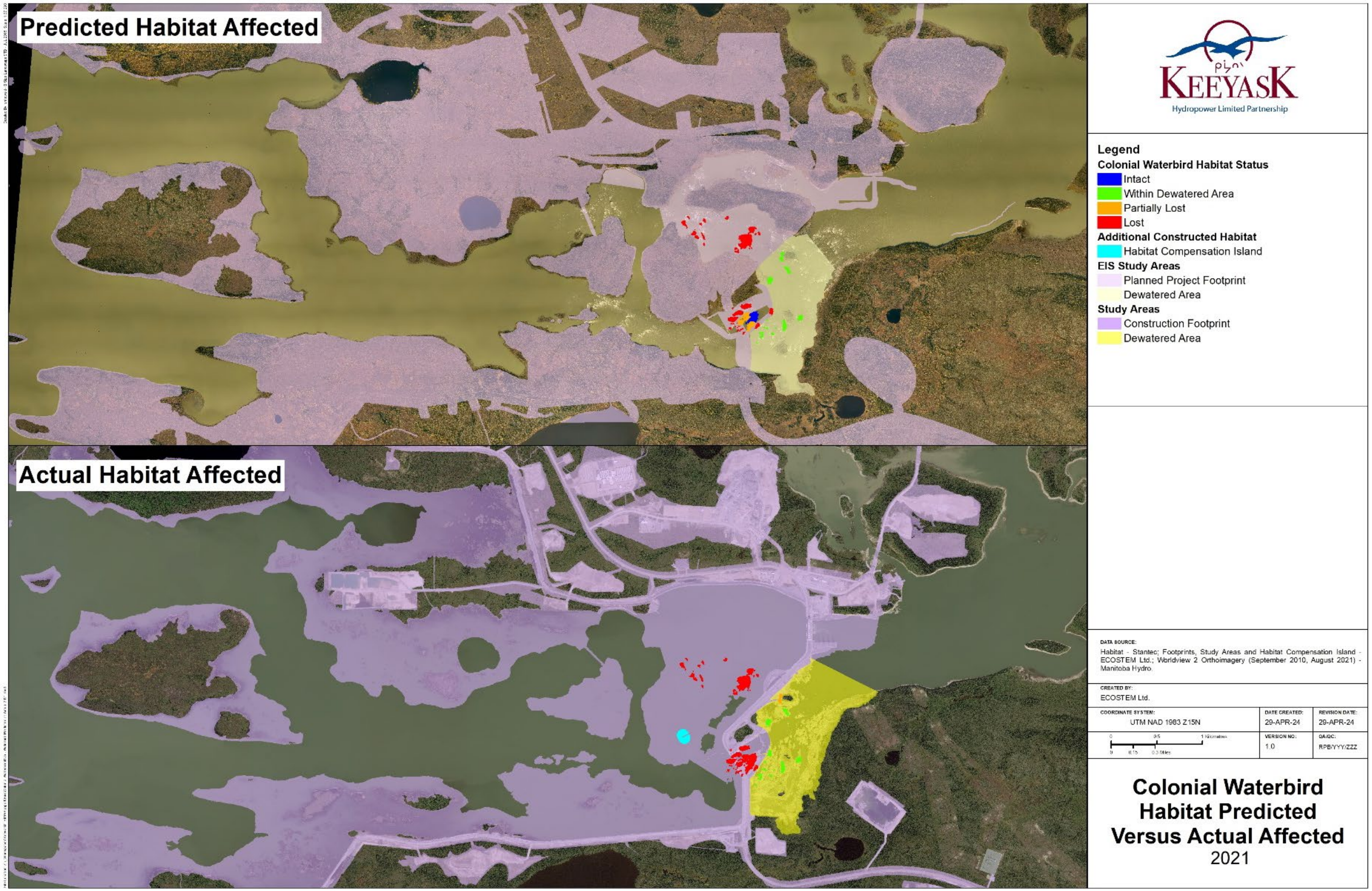
Photo 5-13: UAV photo of ring-billed gulls nesting on an island, 2018

Photo 5-14: Colonial waterbird Habitat Compensation Island post-impoundment, 2021

Photo 5-15: American white pelicans gathering at Keeyask, 2016



Map 5-3: **Ring-billed gull and common tern nesting colonies in 2016, 2019 and 2021**



Map 5-4: Predicted versus actual loss of colonial waterbird nesting habitat during Project construction

5.2.4 DISCUSSION

5.2.4.1 COMPARISON WITH PREDICTED PROJECT EFFECTS

As predicted in the EIS, reservoir impoundment resulted in the loss of some colonial waterbird habitat and the displacement of ring-billed gulls and common terns from Gull Rapids. During Project construction, colonial waterbird populations were primarily affected by water levels in the Nelson River and to a lesser degree by sensory disturbance from Project construction.

During years with higher-than-average water levels (*i.e.,* 2017 and 2020), most available habitat in Gull Rapids and some habitat in the Nelson River, was under water and could not be used by colonial waterbirds. Also, in 2021, very low water levels resulted in poor habitat conditions in Gull Rapids. When this occurred, ring-billed gulls and common terns relocated to nearby islands that were directly upstream of Gull Rapids, including the Habitat Compensation Island. During years with average water levels (*i.e.,* 2018 and 2019), larger amounts of habitat were available in the Gull Rapids area and ring-billed gulls nested on the islands in the area and produced relatively high numbers of chicks.

Although the EIS focused on important nesting areas and other potential nesting areas without enhancement for the predicted Project effects, it is important to consider other physical changes to all Gull Rapids islands, including those islands where partial nesting has been documented in the past. The total area lost in the Construction Footprint (including downstream water effects) was 8.54 ha. With the construction of the Habitat Compensation Island (1.46 ha in size), the actual net loss was 7.08 ha of potential nesting habitat.

The Habitat Compensation Island supported congregations of ring-billed gulls in 2020 and in 2021 supported two ring-billed gull nests and the most common tern nests (171) observed in the area during the entire construction period. The presence of successful colonial waterbird nests indicates that the Habitat Compensation Island is providing alternative nesting habitat in the Gull Rapids area.

Despite attempts to attract gulls to the Habitat Enhancement Area and terns to the floating nesting platforms (e.g., gull and tern decoys and broadcasts of the birds' sounds), each species preferred natural nesting habitat in the area, which monitoring showed was still available during most of the construction period. The Habitat Enhancement Area and floating nesting platforms were not required as alternative nesting habitat for colonial waterbirds.

5.2.4.2 CONCLUSIONS

Construction monitoring has shown that the EIS predictions for construction phase effects on colonial waterbirds were consistent with what was observed. Overall Project effects on colonial waterbirds were the loss and degradation of colonial waterbird habitat in the former Gull Rapids area and within the reservoir. Some of these habitat changes were successfully mitigated by the construction of the Habitat Compensation Island. Other, alternate habitat was occupied by gulls and terns upstream of the Project.

5.2.4.3 FUTURE MONITORING

Colonial waterbird monitoring will continue during the operation phase.

The construction phase monitoring did not identify the need to alter any of the methods for the operation phase. Additional monitoring in years 1 and 3 of operation were added to the TEMP schedule to confirm there were no unexpected effects in the first few years following reservoir impoundment. During these two years, the survey area will be focused on the reservoir and Clark Lake.

5.3 BALD EAGLE

5.3.1 BACKGROUND

The bald eagle (Photo 5-16) is a large bird of prey that inhabits forested areas along large waterbodies, which are used for nesting and foraging. A bald eagle nest typically consists of a platform of sticks near the top of a large tree that may be used for many years (Photo 5-17). Nearby waterbodies provide bald eagles with fish, their main prey, but a variety of other foods are predated or scavenged.

A loss of trees used for perching and nesting was the main Project-related effect on bald eagles predicted in the EIS. The Project was expected to increase bald eagle habitat along the longer shoreline created by the reservoir. To evaluate Project effects on bald eagle and verify EIS predictions, two monitoring studies were conducted during construction. The habitat effects study identified bald eagle nest locations and associated habitat conditions and quantified the amount of breeding habitat lost, altered, or gained during Project construction. The EIS considered that a 20% loss of existing habitat area for bald eagle was the benchmark that triggered management concern, which was applied for the bald eagle habitat effects monitoring. The habitat enhancement study evaluated whether the artificial nesting platforms installed by the Project were used by bald eagles. Because there was a reasonable expectation that artificial nesting habitat would be used by bald eagles, benchmarks described in the TEMP were that at least 50% of the nesting platforms were used for nesting and that at least 50% of the nesting pairs had young that fledged.

Photo 5-16: Pair of bald eagles near Gull Rapids, 2016

Photo 5-17: Bald eagle nest, adult, and eaglets in the Keeyask area, 2019

5.3.2 MONITORING

Aerial (helicopter) surveys for bald eagle were conducted in May, June, and July of 2015, 2017, 2019, and 2021, along the shorelines of Split, Gull, and Stephens lakes, the Nelson River, and a sample of waterbodies in Study Zone 5. The waterbodies were categorized by hydraulic zone, either Project-affected, Nelson River, or off-system (randomly selected waterbodies that were unaffected by hydroelectric development). Bald eagle nests were recorded, and their positions marked with a Global Positioning System (GPS) unit. The status of the nests was also noted. A nest was considered active if two mature bald eagles were present on or near it or at least one adult was observed in incubating posture. An active nest was considered successful if it was occupied by at least one late-stage nestling or if a fledged juvenile was observed nearby. A nest was considered inactive if one or no mature bald eagles were observed at the nest over the season.

To mitigate the loss of five recently active bald eagle nests in the Project footprint during construction, five artificial nesting platforms were installed in winter 2017 to provide alternative nesting sites in areas of suitable habitat (Photo 5-18). The nesting platforms were surveyed in 2019 and 2021, to determine if they were occupied. Other mitigation measures included leaving nest trees in place during initial reservoir clearing (Photo 5-19) and removing them just prior to reservoir impoundment (when they were inactive).

Bald eagle nesting habitat was described in the EIS as trees at least 25 cm in diameter with a minimum of six trees larger than 40 cm in diameter per hectare in the surrounding area. The Project was expected to increase bald eagle habitat by 380 ha (0.03% of habitat in Study Zone 5) due to the longer shoreline created by the reservoir. Habitat effects monitoring was conducted to evaluate how the Project changed the amount and location of bald eagle nesting habitat.

Photo 5-18: Artificial bald eagle nesting platform installed along the future reservoir shoreline, 2017

Note adult bald eagle and two eaglets.

Photo 5-19: Nest tree left within the future reservoir area until just prior to impoundment, 2017

5.3.3 RESULTS

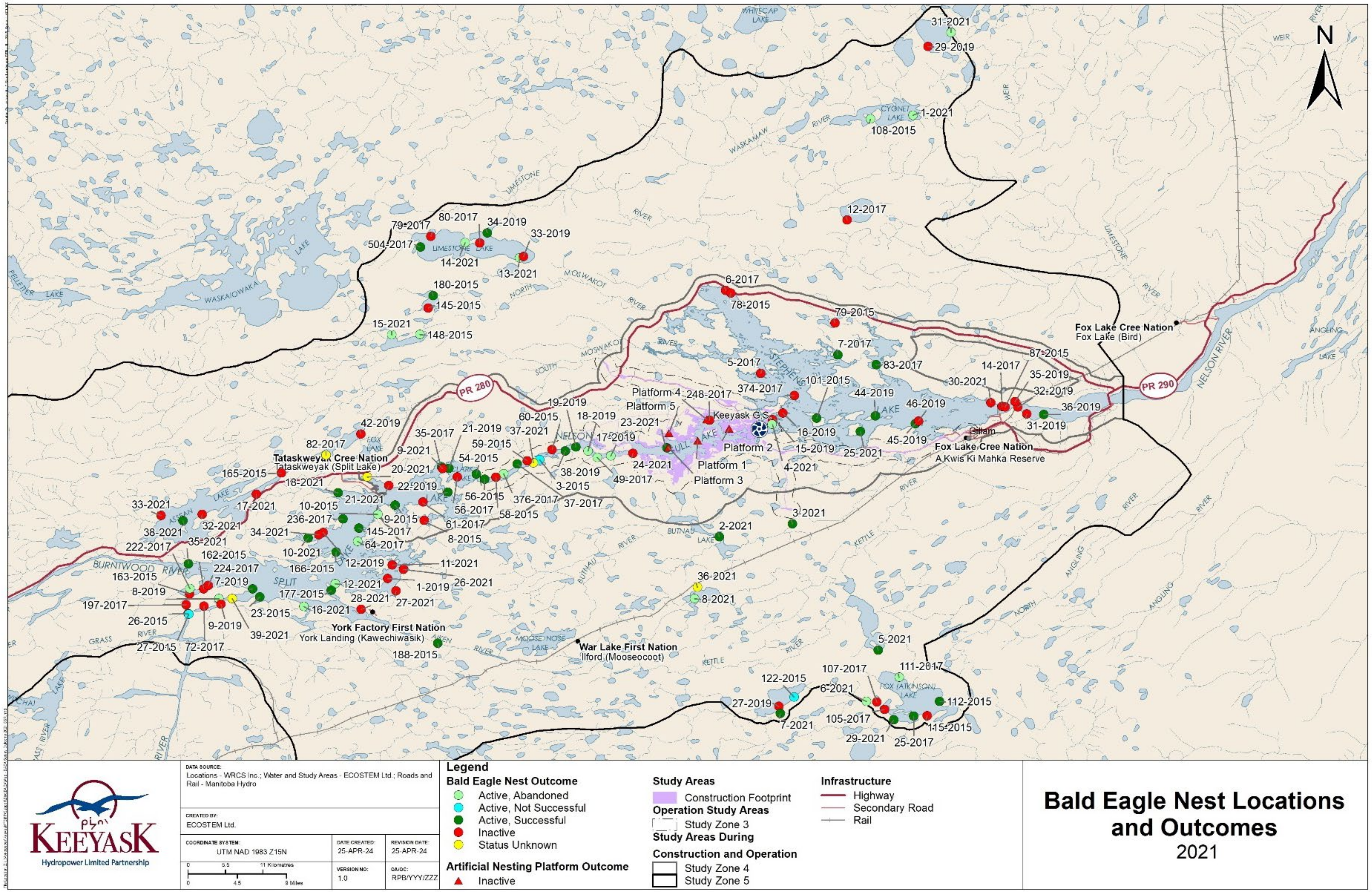
A total of 183 bald eagle nests were observed in Study Zone 5 between 2015 and 2021 (Photo 5-20). The distribution of nests was relatively consistent in the three hydraulic zones during Project construction. The total number of nests observed in Study Zone 5 increased each survey year, mostly due to the accumulation of active and inactive nests (Map 5-5).

In the Project-affected area, the number of active nests decreased by one from 2015 to 2017 and remained the same in subsequent survey years (Table 5-8). Three nests were recorded in 2021 that had not been observed before; one was active and successful, one was inactive, and the status of the third was unknown. Five nests that were inactive in 2019 were active in 2021 (Map 7). Between 30% and 78% of active nests in the Project-affected area were successful over the survey period. Eight active bald eagle nests were observed in the Project-affected area in 2011 and 2014, during pre-construction EIS field studies.

Photo 5-20: Successful bald eagle nest at the top of a conifer tree, 2017

Table 5-8: Bald eagle nests in three hydraulic zones in Study Zone 5 during construction (2015, 2017, 2019, and 2021)

Hydraulic Zone	2015			2017			2019			2021		
	Total	Active	Successful	Total	Active	Successful	Total	Active	Successful	Total	Active	Successful
Project-affected	16	10	3	23	9	7	18	9	4	15	9	4
Nelson River	26	16	12	43	28	17	59	34	27	64	30	22
Off-system	22	16	10	31	18	12	29	19	13	41	23	12



Map 5-5: **Bald eagle nest locations and outcomes, 2021**

No active bald eagle nests were observed on the artificial nesting platforms in 2017, 2019, or 2021. However, two platforms contained inactive bald eagle nests in 2021 and common raven nests were observed on two other artificial nesting platforms (Table 5-9). Another platform contained some sticks that were likely brought by bald eagles or common ravens. A bald eagle was observed incidentally on a platform that contained sticks during impoundment in 2020 (Photo 5-21). By 2021, bald eagles had used 40% of the nesting platforms (see Map 7). Although no bald eagle young fledged from the platforms, at least one pair of common ravens were successful.

Table 5-9: Artificial bald eagle nesting platform contents during construction (2017, 2019, and 2021)

Platform	2017	2019	2021
1	Empty	Active common raven nest	Potential unused bald eagle nest
2	Empty	Empty	Empty
3	Empty	Sticks	Potential unused bald eagle nest
4	Sticks	Sticks	Active common raven nest
5	Empty	Empty	Sticks

Photo 5-21: Incidental observation of bald eagle perched on platform with nesting material, 2020

5.3.4 DISCUSSION

5.3.4.1 COMPARISON WITH PREDICTED PROJECT EFFECTS

Vegetation clearing in the Project footprint removed some bald eagle nesting and perching habitat. Between 2015 and 2021, the net decrease of bald eagle nests was only 6%, which is less than the management concern threshold of a 20% habitat loss. Because the number of active nests in the Project-affected area was similar before and during Project construction, and considering the range of natural variation, no effect on the local bald eagle population and nesting habitat was observed.

The prediction that the Project was expected to increase bald eagle habitat by 380 ha (0.03% of habitat in Study Zone 5) due to the longer shoreline created by the reservoir, cannot be determined until the shorelines stabilize. In Study Zone 5, the bald eagle population is stable to possibly increasing. Between 2015 and 2021, a sample of the Nelson River and Off-system bald eagle nests increased by 119%. The number of nests in the Project-affected zone remained the same or declined slightly. The relatively consistent distribution of nests in the three hydraulic zones during Project construction suggested that bald eagles nesting in the Project-affected zone did not relocate to other areas and that sufficient nesting habitat remained in the Project-affected area and in the region during construction.

No active bald eagle nests were observed on the artificial nesting structures in 2017, 2019, or 2021. The structures were inland from the Gull Lake shoreline in 2020, before the reservoir was impounded, which likely limited their attractiveness to bald eagles between 2017 and 2020. Natural nesting sites are typically preferred over artificial ones, and it can take many years for bald eagles to use nesting platforms. Although the predictions of 50% platform use and 50% nesting success on used platforms was not achieved by the end of construction, based on the observations in 2021, including two nesting starts (but as yet unused by bald eagle), it is likely that two or more of the artificial nesting platforms will support bald eagle nests in the future.

5.3.4.2 CONCLUSIONS

Project construction resulted in changes to bald eagle habitat in the reservoir. Some of the habitat changes, including nest loss, were mitigated by the construction of artificial nesting platforms in nearby areas.

Project construction did not appear to affect bald eagle nest numbers or productivity in the study area and the overall population appears to be sustainable and slightly increasing. The number of active nests within the Project-affected zone has remained consistent with the pre-construction surveys conducted in 2011 and 2014, as well as the construction-phase surveys conducted from 2015-2021.

There were no significant differences in the percent of active, successful nests or the number of late-stage nestlings produced in the Project-affected zone compared to other zones in the study area. This suggests that sufficient nesting habitat and foraging opportunities exist within the study area for bald eagles to successfully nest and raise young.

5.3.4.3 FUTURE MONITORING

Bald eagle monitoring will continue during the operation phase.

The construction phase monitoring did not identify the need to alter any of the methods for the operation phase.

5.4 BIRD SPECIES AT RISK

5.4.1 OLIVE-SIDED FLYCATCHER

5.4.1.1 BACKGROUND

The olive-sided flycatcher (Photo 5-22) is a migratory songbird that breeds in mature coniferous forest with open patches created by natural disturbance (e.g., fire), wetlands, or forestry clear-cuts. Snags (dead standing trees) and live trees left behind after disturbance are important for perching while foraging for flying insects in open areas. The olive-sided flycatcher is listed as Special Concern under the federal *Species at Risk Act*. In Manitoba, it is listed as Threatened under *The Endangered Species and Ecosystems Act*.

Project effects on olive-sided flycatcher were expected to include habitat loss or alteration and avoidance of otherwise suitable habitat due to sensory disturbance, with a moderate degree of uncertainty regarding the predictions. To evaluate Project effects on olive-sided flycatcher and verify EIS predictions, two monitoring studies were conducted during construction, for which one benchmark was identified. The sensory disturbance study evaluated how sensory disturbance from the North and South access roads and accidental Project-related mortality influenced the abundance and distribution of olive-sided flycatchers in Study Zone 4. The habitat effects study included several components to quantify Project effects on the amount of olive-sided flycatcher habitat in the region. The EIS considered that a 10% loss of existing habitat area for bird species at risk was the benchmark that triggered management concern, which was applied for olive-sided flycatcher habitat effects monitoring.

Photo 5-22: Olive-sided flycatcher at Keeyask, 2016

5.4.1.2 MONITORING

The EIS classified olive-sided flycatcher breeding habitat as old and mature spruce-dominated coniferous or mixedwood forests with open or semi-open canopies; areas within 50 m of the edge of a natural opening; areas within 50 m of wooded fen and wooded swamp; and areas with tall trees, including snags, where birds can perch to forage. Approximately 4% (350 ha) of olive-sided flycatcher breeding and foraging habitat in Study Zone 4 was expected to be lost or altered during Project construction.

As olive-sided flycatchers were infrequently detected during EIS studies, having been observed at approximately 3% of the sites surveyed from 2001 to 2014, a pilot study was conducted in 2015 to determine whether there were enough nesting pairs to implement the full monitoring study. The pilot study indicated that it was likely that sufficient replication was available to meet the study objectives.

The study design was a census of roadside territories and used a paired design with undisturbed and road disturbed territories. In spring 2016, 2017, and 2019, birds' territories near the North and South access roads were mapped (Photo 5-23). Automated recording units (ARUs) (Photo 5-24) were positioned perpendicular to the road within the territories, to record olive-sided flycatcher calls at various distances from the access roads. ARUs were also placed in territories near Provincial Road (PR) 280, and next to other linear features. Each disturbed territory was paired with an undisturbed reference area for comparison. The undisturbed pair was the closest territory with habitat similar to the disturbed habitat.

To examine olive-sided flycatcher response to Project disturbance and other explanatory factors during the nesting season, mixed effects multivariate statistical modeling was applied to the dataset. Data were standardized for effort. The multivariate statistical modeling included habitat types as variables. Calls per day was used as the response variable for the models. Explanatory variables tested for possible effects on bird behaviour were treatment type (i.e., road disturbed or undisturbed or other human factors), year (2017 or 2019), location (North Access Road, South Access Road or PR 280), effort (number recording days), and habitat type. An interaction term for Treatment Type by Year was included once the full model was determined. Territory was the random effect in the models.

Photo 5-23: Mapping olive-sided flycatcher territories, 2015

Photo 5-24: Automated recording units used to record olive-sided flycatcher calls, 2016

5.4.1.3 RESULTS

Olive-sided flycatchers were infrequently detected during EIS studies, having been observed at approximately 3% of the sites surveyed from 2001 to 2014. Focused efforts from 2016 to 2019 found that olive-sided flycatchers were more common and widespread than anticipated. The number of olive-sided flycatcher calls per day were initially explored using heat mapping (Map 5-6).

The average number of calls per day across territories in the paired locations was higher in 2017 but lower in 2019 (Table 5-10). However, the response was different depending on which road was considered. Locations along the North Access Road had fewer calls per day in 2017. These differences in means could be at least somewhat due to differences in habitat composition along the roads.

Heat mapping of the data suggested that olive-sided flycatchers were not avoiding or limiting their use of habitat near the Project access roads. The question to be answered in this context was whether this pattern was the result of the spatial distribution of habitat types.

Mixed effects multivariate statistical modeling subsequently estimated the effects of variables on olive-sided flycatcher distribution and abundance, and whether habitat composition rather than sensory disturbance was causing the patterns observed in the heat maps. Although territories were located along the North Access Road, PR 280 and other linear features in the region (Table 5-11), the number of territories actually found and those with usable recorder data were less than the desired number, which complicated and precluded some types of statistical analyses.

In the multivariate statistical modeling that identified the habitat types associated with higher olive-sided flycatcher call density, the significant variables were Tall Shrub on Wet Peat, Old Needleleaf Upland Forest, and Low Vegetation on Wet Peat habitat types. The coefficients for all habitat types were positive, indicating that an increasing amount of the habitat type increased the likelihood of higher olive-sided flycatcher call density. The significant intercept in the model indicated that one or more important influences on olive-sided flycatcher abundance were not in the model and the intercept was capturing their influence. It appeared that habitat type was not a good proxy for perch density. These habitat types appeared to support the EIS model categorized as primary habitat.

The subsequent multivariate statistical modeling of treatment effects controlled for habitat composition and other confounding factors (Location (i.e., which road), Year, Effort). The intercept was significant, as expected from the habitat modeling results. Location, Year and Effort were not significant. Treatment, the variable of interest for this study, was far from being significant ($p>=0.75$).

Table 5-10: Average number of olive-sided flycatcher calls per day, by treatment type, location and year

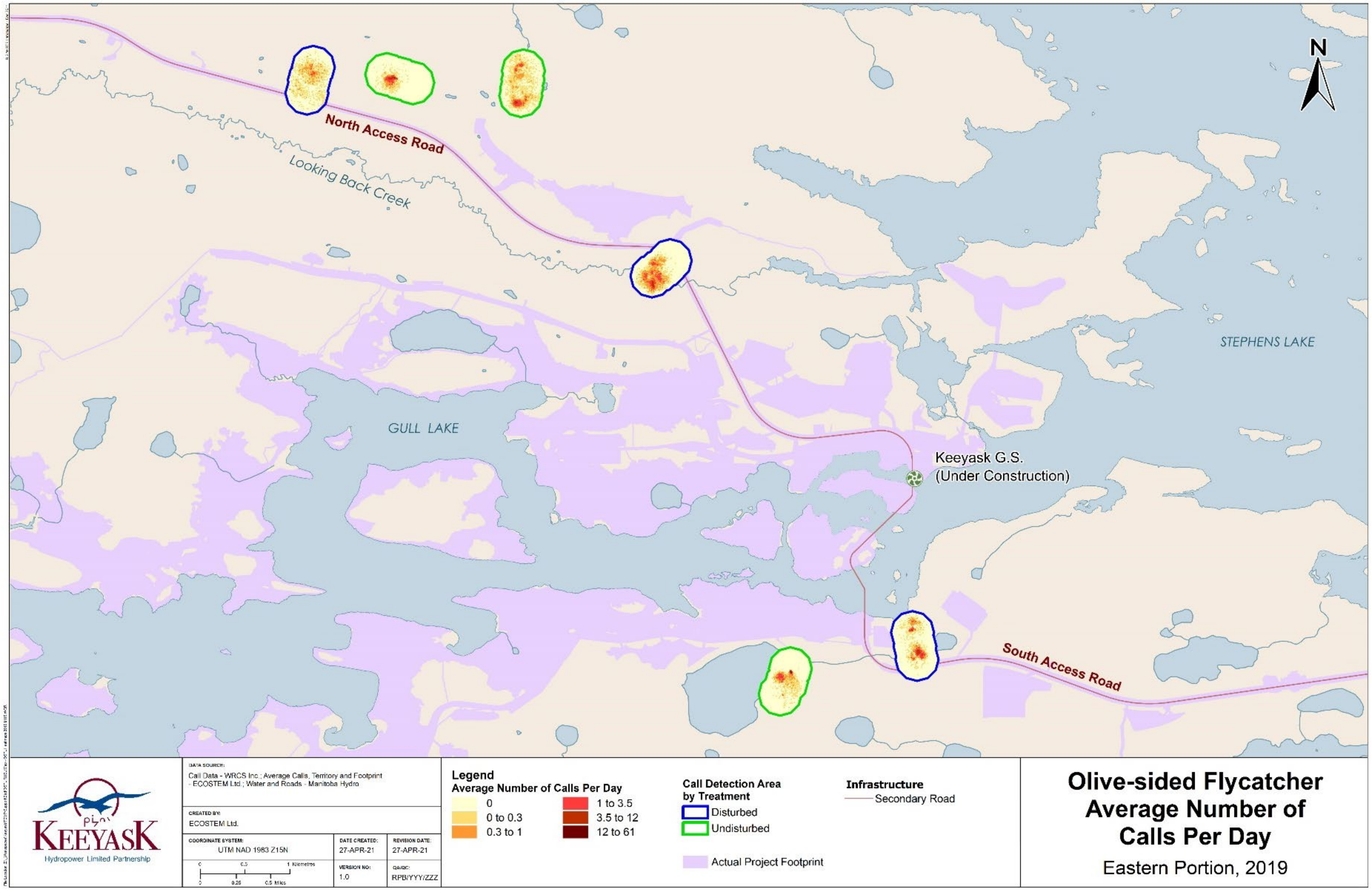
		2017		2019	
Impact Type	**Location**	**Disturbed**	**Undisturbed**	**Disturbed**	**Undisturbed**
Generating Station	NAR	98	82	100	120
	SAR	na	na	156	73
	PR 280	72	227	27	105
Total		**89**	**118**	**89**	**107**
Transmission Line	L	113	261	219	126
	Construction	na	na	144	130
Total		**113**	**261**	**181**	**128**

Table 5-11: Number of olive-sided flycatcher recorders with adequate data

		2017		2019	
Impact Type	**Location**	**Disturbed**	**Undisturbed**	**Disturbed**	**Undisturbed**
Generating Station	NAR	17	13	16	9
	SAR	0	0	2	3
	PR 280	6	5	5	8
Total		**23**	**18**	**23**	**20**
Transmission Line	L	10	10	10	7
	Construction	0	0	8	9
Total		**10**	**10**	**18**	**16**

The loss of olive-sided flycatcher breeding and foraging habitat in Study Zone 4 was less than anticipated. It was estimated that 350 ha of this habitat would be lost, but post-construction monitoring of the actual construction footprint found that 298 ha was lost.

No olive-sided flycatcher mortality was recorded during Project construction.



Map 5-6: **Example of heat map of olive-sided flycatcher calls per day**

5.4.1.4 DISCUSSION

5.4.1.4.1 COMPARISON WITH PREDICTED PROJECT EFFECTS

While olive-sided flycatcher detections were few during EIS studies, construction monitoring suggested that there was a well-established population in Study Zone 4. The population persisted over the construction period and no olive-sided flycatcher mortality was recorded during Project construction.

Based on the EIS habitat model, the loss of olive-sided flycatcher breeding and foraging habitat in Study Zone 4 was less than anticipated. It was estimated that 350 ha of this habitat would be lost, but post-construction monitoring of the actual Construction Footprint found that 298 ha was lost. As a result, the magnitude of effect in the Regional Study Area was less than the 4% habitat loss predicted.

Modelling identified three habitat types as having a statistically significant positive effect on the number of olive-sided flycatcher calls per day - Tall Shrub on Wet Peat, Old Needleleaf Upland Forest and Low Vegetation on Wet Peat. Old Needleleaf Upland Forest habitat was expected to have a relatively high perching snag density and/or suitable nesting habitat. Tall Shrub on Wet Peat habitat could be significant because it is foraging habitat and/or it has a positive correlation with adjacent treed vegetation. In the Project region, Tall Shrub on Wet Peat habitat often quickly transitions into a treed habitat type. A clear interpretation of Low Vegetation on Wet Peat was not apparent; it could be another foraging habitat if next to snags, as this habitat class typically has open water patches in addition to its ability to support invertebrates. Overall, the habitat associations identified by the modeling were not clear, but they do support the EIS model as a primary habitat. The intercept of the model was highly significant, indicating that one or more important influences on olive-sided flycatcher abundance were not in the model. Omitted variables were thought to include forest/non-forest edge length and snag/perch density. More detailed habitat mapping would be required to refine an olive-sided flycatcher habitat quality model.

Territorial singing male olive-sided flycatchers, and by extrapolation, breeding pairs, did not appear to be affected by sensory disturbance from roads, including Project roads (ECOSTEM Ltd. and Wildlife Resource Consulting Services MB Inc 2021). The question to be answered in this context was whether this pattern was the result of the spatial distribution of habitat types. Using the number of olive-sided flycatcher calls per day, the treatment effect was far from being significant in the multivariate statistical modeling, which controlled for the effects of other explanatory variables. This result was expected from the pattern of olive-sided flycatcher observations near the linear features. The multivariate statistical modeling demonstrated that differences in habitat composition away from roads was not pushing breeding pairs into sub-optimal habitat.

5.4.1.4.2 CONCLUSIONS

Monitoring has shown that actual Project effects on the olive-sided flycatcher during construction were less than what were predicted in the EIS. The physical amount of breeding and foraging habitat loss was less than predicted. Multivariate statistical modeling indicated that olive-sided flycatchers did not appear to be affected by sensory disturbance from roads, including Project roads and other linear features. This result is contrary to the EIS where loss of effective habitat was predicted up to 400 m from linear features.

5.4.1.4.3 FUTURE MONITORING

Olive-sided flycatcher monitoring will continue during the Project operation phase.

The construction phase monitoring did not identify the need to alter any of the methods for the operation phase.

5.4.2 RUSTY BLACKBIRD

5.4.2.1 BACKGROUND

Rusty blackbirds (Photo 5-25) breed in the boreal forest, using wetland habitat such as sedge meadows, beaver ponds, muskegs, swamps, riparian scrub, and shrubby patches of willow and alder. The rusty blackbird is listed as a species of Special Concern under the federal *Species at Risk Act* and has no designation under *The Endangered Species and Ecosystems Act* of Manitoba. Despite being a migratory bird, the rusty blackbird is not protected under the federal *Migratory Birds Convention Act*.

Predicted Project effects on rusty blackbird were mainly habitat loss or alteration. The effects of sensory disturbance were expected to be short-term and temporary, with no adverse effects on reproductive success. To evaluate Project effects on rusty blackbird and verify EIS predictions, two monitoring studies were conducted during construction, for which one benchmark was identified. The sensory disturbance study evaluated how sensory disturbance from the North and South access roads and Project-related accidental mortality influenced the abundance and distribution of rusty blackbirds in Study Zone 4. The habitat effects study included several components to quantify Project effects on the amount of rusty blackbird habitat in the region. The EIS considered that a 10% loss of existing habitat area for bird species at risk was the benchmark that triggered management concern, which was applied for rusty blackbird habitat effects monitoring.

Photo 5-25: Rusty blackbird at Keeyask, 2015

5.4.2.2 MONITORING

The EIS classified rusty blackbird habitat as needleleaf tree or tall shrub on deep wet peatland; black spruce and tamarack-dominated; wet or deep peatland associated with horizontal or riparian fens; mixedwood and needleleaf on shallow peatland; needleleaf dominant with some bog birch; ground ice present in peatland; and habitat associated with a collapse scar or peat plateau bog. Approximately 3% (547 ha) of rusty blackbird breeding habitat in Study Zone 4 was expected to be lost or altered during Project construction.

As rusty blackbirds were infrequently detected during EIS studies, having been observed at approximately 4% of the sites surveyed from 2001 to 2014, a pilot study was conducted in 2015 to determine whether there were enough nesting pairs to implement the full monitoring study. The pilot study indicated that it was likely that sufficient replication was available to meet the full study objectives.

The study design was a census of roadside territories and used a paired design with undisturbed and road disturbed territories. In spring 2016, 2017, and 2019, birds' territories near the North and South access roads were mapped (Photo 5-26). Automated recording units (ARUs) (Photo 5-24) were positioned perpendicular to the road within the territories, to record rusty blackbird calls at various distances from the access roads. ARUs were also placed in territories near Provincial Road (PR) 280, and next to other linear features. Each disturbed territory was paired with an undisturbed reference area for comparison. The undisturbed pair was the closest territory with habitat similar to the disturbed habitat.

To examine rusty blackbird response to Project disturbance and other explanatory factors during the nesting season, mixed effects multivariate statistical modeling was applied to the dataset. Data were standardized for effort. A sufficient number of replicates were available to evaluate habitat effects in the multivariate statistical modeling. The multivariate statistical modeling included habitat types as variables. Calls per day was used as the response variable for the models. Explanatory variables tested for possible effects on bird behaviour were treatment type (i.e., road disturbed or undisturbed or other human factors), year (2017 or 2019), location (North Access Road, South Access Road or PR 280), effort (number recording days), and habitat type. An interaction term for Treatment Type by Year was included once the full model was determined. Territory was the random effect in the models.

Photo 5-26: Mapping rusty blackbird territories, 2015

5.4.2.3 RESULTS

Rusty blackbirds were infrequently detected during EIS studies, having been observed at approximately 4% of the sites surveyed from 2001 to 2014. Focused efforts from 2016 to 2019 found that rusty blackbirds were more common and widespread than anticipated. The number of rusty blackbird calls per day were initially explored using heat mapping (Map 5-7).

The average number of calls per day across territories was substantially higher in 2019 than in 2017 (Table 5-12). However, the response was different depending on which road was considered. In 2017, calls per day were highest along PR 280 and lowest along the South Access Road. While this ordering continued in 2019, the difference between the South Access Road and the others increased substantially and the difference between the South Access Road and the North Access Road almost disappeared.

Heat mapping for rusty blackbirds was unclear. The question to be answered in this context was whether this pattern was the result of the spatial distribution of habitat types or whether they were avoiding or limiting their use of habitat near the Project access roads.

Mixed effects multivariate statistical modeling subsequently estimated the effects of variables on rusty blackbird distribution and abundance, and whether habitat composition rather than sensory disturbance was causing the patterns observed in the heat maps. Although territories were located along the North Access Road, PR 280 and other linear features in the region (Table 5-13), the number of territories actually found were less than the desired number, which complicated and precluded some types of statistical analyses. The significant model variables were treatment (undisturbed/disturbed), year, and Broadleaf habitat type. All had positive coefficients, which means that all variables increased the odds of higher rusty blackbird calls per day. The year effect was expected as the mean number of calls in undisturbed areas was more than double that in disturbed areas in 2019. In both years, the difference was pronounced along PR 280.

The Broadleaf habitat type was highly significant, and considerably more so than the other variables. This habitat type includes all broadleaf vegetation except that growing on wet peat. Broadleaf habitat type could be significant because it is highly desirable foraging habitat for beaver. Primary rusty blackbird foraging habitat is directly associated with beaver floods. This habitat type does not appear to support the EIS model as primary or secondary habitat.

The significant treatment effect must be interpreted with caution as model diagnostics suggested potential estimation issues arising from the highly unbalanced dataset or the technical capabilities of the audio recorders.

Table 5-12: Average number of rusty blackbird calls per day, by year, treatment type and location

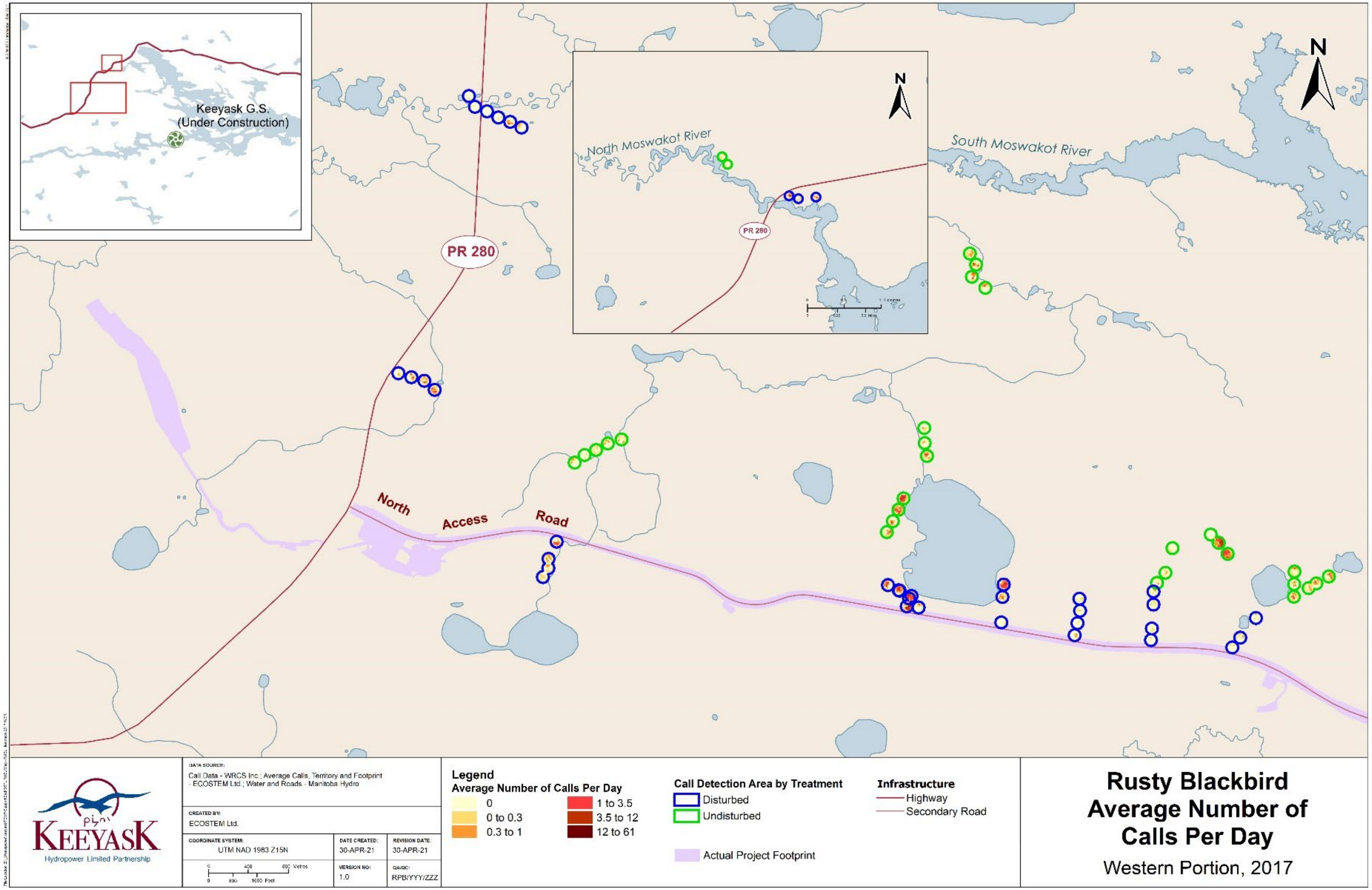
	2017		2019	
Location	**Disturbed**	**Undisturbed**	**Disturbed**	**Undisturbed**
NAR	6	8	12	18
SAR	5	3	1	26
PR 280	7	33	10	114
All	**6**	**12**	**11**	**28**
Construction	na	na	7	25
L	5	1	3	18
All	**5**	**1**	**6**	**24**

Table 5-13: Number of rusty blackbird recorders with adequate data

	2017		2019	
Location	**Disturbed**	**Undisturbed**	**Disturbed**	**Undisturbed**
NAR	44	44	24	29
SAR	12	6	5	5
PR 280	11	11	4	3
Total	**67**	**61**	**33**	**37**
Construction	na	na	18	14
L	22	10	7	6
Total	**22**	**10**	**25**	**20**

The loss of rusty blackbird breeding and foraging habitat in Study Zone 4 was less than anticipated during construction. It was estimated that 547 ha of this habitat would be lost, but post-construction monitoring of the actual construction footprint found that 517 ha was lost.

No rusty blackbird mortality was recorded during Project construction.



Map 5-7: Example of rusty blackbird calls per day, 2017

5.4.2.4 DISCUSSION

5.4.2.4.1 COMPARISON WITH PREDICTED PROJECT EFFECTS

While rusty blackbird detections were few during EIS studies, construction monitoring suggested that there was a well-established population in Study Zone 4. The population persisted over the construction period. No rusty blackbird mortality was recorded during Project construction.

Based on the EIS habitat model, the loss of rusty blackbird breeding and foraging habitat in Study Zone 4 was less than anticipated. It was estimated that 547 ha of this habitat would be lost, but post-construction monitoring of the actual construction footprint found that 517 ha was lost. As a result, the magnitude of effect in the Regional Study Area was less than the 4% habitat loss predicted.

Rusty blackbirds may have been affected by sensory disturbance from roads. Being in undisturbed habitat significantly increased the odds of higher rusty blackbird calls per day. In addition, the variables that significantly increased the odds of finding a higher number of rusty blackbird calls per day were the study year and Broadleaf habitat type. The fact that year was significant was not surprising given that the mean number of calls per day detected in 2019 was more than double that in 2017. Even though the treatment effect (disturbed/undisturbed) was significant, these results could have been produced by a data bias, such as the unbalanced data structure and/or potential issues with the data.

Broadleaf vegetation on all site types except for wet peat was the only habitat type that significantly increased the odds of finding a higher number of rusty blackbird calls per day. Broadleaf habitat could be significant because it is highly desirable foraging habitat for beaver. Primary rusty blackbird foraging habitat is directly associated with beaver floods. Rusty blackbirds also tend to nest on the ground at the base of stumps or low in dense shrubs. Broadleaf vegetation on all site types may account for some of these habitat needs. This habitat type does not support the EIS model as a primary or secondary habitat type.

5.4.2.4.2 CONCLUSIONS

Monitoring has shown that actual Project effects on the rusty blackbird habitat during construction were less than what were predicted in the EIS. The physical amount of breeding and foraging habitat loss was less than what was predicted. Multivariate statistical modelling suggested that Project-related sensory disturbance may have reduced habitat effectiveness for rusty blackbird during the breeding season, as predicted in the EIS.

5.4.2.4.3 FUTURE MONITORING

Rusty blackbird monitoring will continue during the Project operation phase.

The construction phase monitoring did not identify the need to alter any of the methods for the operation phase.

5.4.3 COMMON NIGHTHAWK

5.4.3.1 BACKGROUND

The common nighthawk is listed as Special Concern under the federal *Species at Risk Act* and Threatened under *The Endangered Species and Ecosystems Act* of Manitoba (Photo 5-27). Common nighthawks nest on the ground in a range of open habitats such as forest clearings and edges, and they forage on flying insects. Their breeding activity can be detected by calls and by the booming sound made by territorial males as air rushes through their feathers. Very few common nighthawks were observed during EIS studies, likely because they are most active at dusk and dawn and are difficult to detect during typical breeding bird surveys.

As described in the EIS, predicted Project effects on common nighthawks during construction included a temporary increase of breeding habitat during reservoir and infrastructure clearing followed by a loss of habitat after reservoir impoundment, avoidance of otherwise suitable habitat due to sensory disturbance, and a negligible increase in accidental mortality. Habitat effects monitoring was conducted to verify the habitat association assumptions used to predict Project effects on common nighthawk breeding habitat, quantify the amount of breeding habitat lost or altered during construction, and to assess accidental mortality. The general EIS approach for bird species at risk was that a 10% loss of existing habitat area would trigger management concern, which was also the benchmark for common nighthawk.

Photo 5-27: Common nighthawk at Keeyask, 2016

5.4.3.2 MONITORING

Common nighthawks are expected to be found in a higher proportion of their preferred nesting habitat types than in less suitable habitat types. The EIS predicted that a total of 925 ha would be lost or reduced in quality after reservoir impoundment during Project construction. To validate the habitat quality model for common nighthawk and evaluate Project-related habitat effects, automated recording units (ARUs) were placed in a stratified random sample of potential nesting and unsuitable nesting habitat types in summer 2016, 2017, and 2018. Recordings were analyzed for common nighthawk vocalizations and detections of foraging birds were used to identify the general nesting area and associated habitat type.

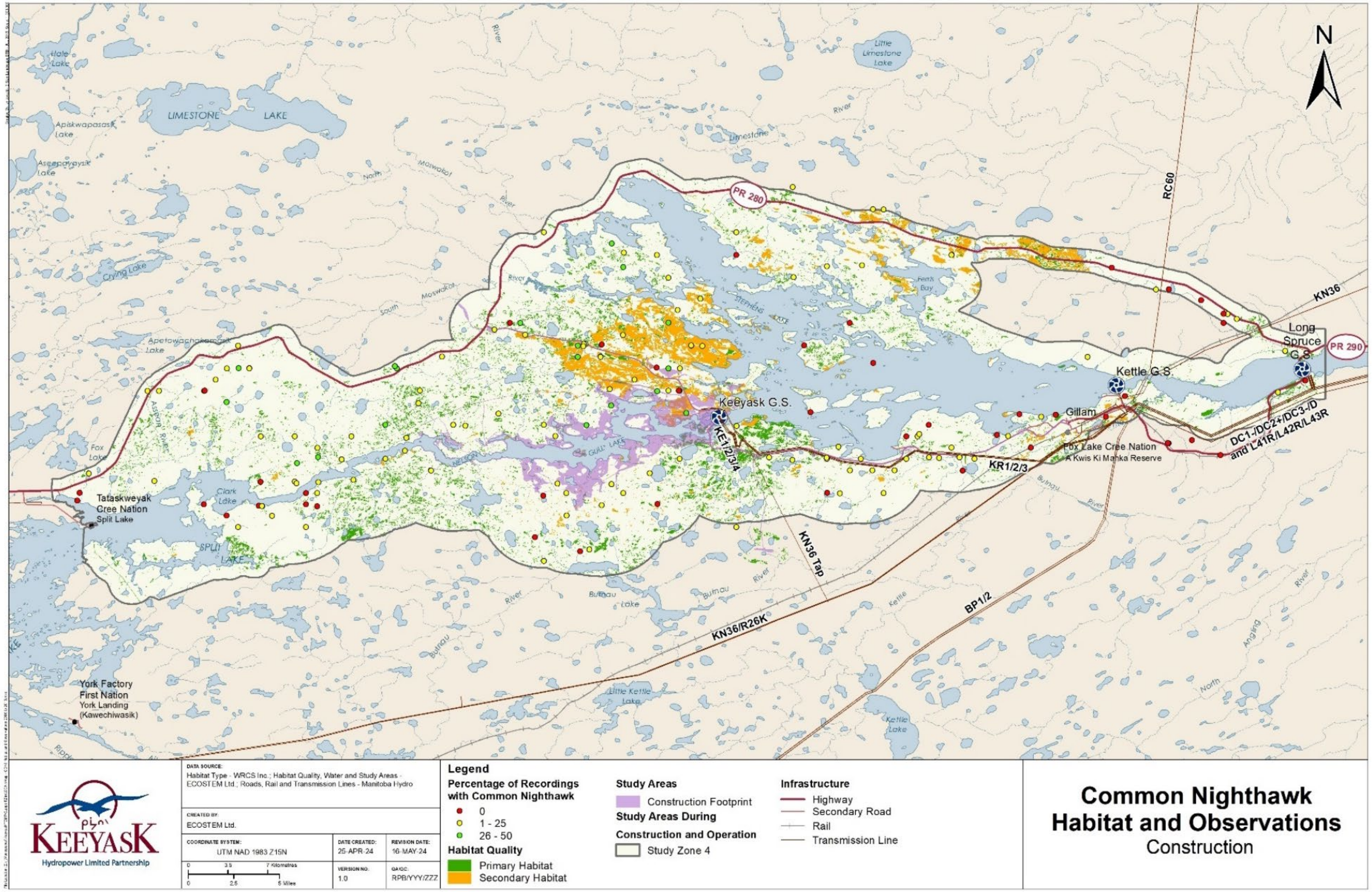
Mitigation efforts during Project construction included the protection of nests during nest sweeps of Project areas and of some birds that were found incidentally by site staff. Active nests were buffered from construction activities with flagging tape to prevent their destruction or disturbance.

5.4.3.3 RESULTS

Common nighthawk habitat loss following Project construction was slightly more (972 ha) than the amount predicted in the EIS (925 ha).

Common nighthawks were widely distributed and abundant in Study Zone 4 in 2016, 2017 and 2018 (Map 5-8). There was little difference in the percentage of sites at which the species was detected in habitat considered suitable for nesting and in unsuitable habitat in all survey years. The percentage of sites at which common nighthawks were recorded declined from 2016 to 2018. A larger decline was observed from 2017 to 2018 than from 2016 to 2017. Common nighthawks were identified at a greater percentage of sites inside Study Zone 3 than outside.

A common nighthawk mortality was recorded in each of 2016, 2018, and 2020, whose causes were either natural or not identified. In 2017, a mortality due to a collision with a vehicle was recorded. From 2015 to 2021, a total of four active common nighthawk nests were buffered in borrow areas or along dikes to prevent destruction or disturbance during construction (Photo 5-28).



Map 5-8: **Predicted common nighthawk habitat and actual observations during construction**

Photo 5-28: Common nighthawk nest with eggs in Keeyask borrow area, 2017

5.4.3.4 DISCUSSION

5.4.3.4.1 COMPARISON WITH PREDICTED PROJECT EFFECTS

The EIS predicted that land clearing would result in a temporary gain of breeding habitat, but construction noise was expected to deter nesting in areas near Project activities. The EIS also predicted a permanent loss of 925 ha of breeding habitat. Although slightly more common nighthawk breeding habitat was lost (972 ha) than predicted, the percentage lost was still far from the benchmark value that would raise it to a moderate magnitude adverse effect. By extrapolation, the magnitude of effect on common nighthawk habitat was as predicted in the EIS.

Common nighthawk calls were identified at sites throughout Study Zone 4, in habitat that is likely suitable for nesting and in areas considered to be less suitable habitat. Common nighthawks foraging near unsuitable nesting habitat may have been recorded, or habitat thought to be unsuitable for breeding may have been adequate for foraging.

5.4.3.4.2 CONCLUSIONS

Common nighthawks were somewhat widely distributed in Study Zone 4 and were recorded in areas of habitat expected to be suitable and also those considered unsuitable for nesting. Individuals were detected at two borrow areas that had been cleared and may have been subject to disturbance from construction activities. The decline in common nighthawks observed in 2018 did not appear to be related to Project construction as the decline was throughout the survey area in both suitable and unsuitable habitat.

5.4.3.4.3 FUTURE MONITORING

Habitat enhancement monitoring for common nighthawks is planned for the operation phase.

The construction phase monitoring did not identify the need to alter any of the methods for the operation phase.

5.5 OTHER PRIORITY BIRDS

5.5.1 RUFFED GROUSE

5.5.1.1 BACKGROUND

Ruffed grouse are year-round residents at the edge of their range in the Keeyask region. They have been identified as important birds that are harvested by members of the partner First Nations. Aspen forest or mixed forest with a large proportion of aspen is preferred for breeding. During the breeding season, males drum by standing on a log and beating their wings. Predicted Project effects on ruffed grouse were mainly loss or alteration of some breeding and foraging habitat, with a possible increase in mortality due to traffic on the North and South access roads and to harvest through increased access to the area. Ruffed grouse were rarely detected in the Keeyask region during EIS studies and suitable breeding habitat, much of which was temporarily removed by forest fires in 2013, appeared to be limited.

The objectives of ruffed grouse monitoring were to evaluate whether the species can be detected in sufficient numbers to verify the predictions of the expert information habitat quality model defined in the EIS and to estimate how Project-related harvest and accidental mortality affected ruffed grouse abundance.

5.5.1.2 MONITORING

The EIS described ruffed grouse breeding habitat as broadleaf forests with downed woody debris measuring 35-40 cm in diameter and dense, tall shrub understory with 18,000–20,000 stems/acre. A loss of 70 ha (10%) of breeding habitat was anticipated in Study Zone 4. Automated recording units (ARUs) were placed in ruffed grouse breeding habitat in Study Zone 4, to detect the presence of ruffed grouse. Twenty-two sites were surveyed in 2018 and 26 were surveyed in 2021; 18 sites were surveyed both years. ARUs were placed in balsam poplar dominant or mixedwood, tall shrub, trembling aspen dominant or mixedwood, and white birch dominant or mixedwood habitat Recordings were visually reviewed for ruffed grouse drumming.

Reports of ruffed grouse mortality and harvest were compiled over the construction period. Resource use by the workforce was monitored as part of the Keeyask Generation Project

Resource Use Monitoring Plan. Reports of ruffed grouse mortality and harvest were reviewed over the construction period.

5.5.1.3 RESULTS

Ruffed grouse habitat loss following Project construction was less (39 ha) compared to the amount predicted in the EIS (70 ha).

Ruffed grouse drumming was recorded at a total of nine of 30 sites in Study Zone 4. Pre-construction ruffed grouse surveys were conducted near Gull and Stephens lakes in spring 2012. Ruffed grouse were found at six of the 24 stops surveyed, all immediately north of Gull Lake in trembling aspen or white birch mixedwood habitat. Three sites surveyed in 2018 and 2021 were in the same area but ruffed grouse was only detected at one during Project construction monitoring. While ruffed grouse were found at the same number of sites in in 2018 and 2021 as in 2012, the sites were more widely distributed during construction monitoring and grouse were found over a larger area.

One confirmed and one suspected ruffed grouse mortality were reported in 2021, during Project construction. In 2016, a spruce or ruffed grouse mortality was noted, whose cause was unknown. No grouse harvest was reported near the Project footprint. Ten unidentified grouse were harvested in the Thompson area by members of the workforce in 2015. Harvesting most likely occurred on days off from work; no firearms were allowed at the Keeyask site. No Project-related effects on ruffed grouse abundance were observed during construction.

5.5.1.4 DISCUSSION

5.5.1.4.1 COMPARISON WITH PREDICTED PROJECT EFFECTS

Ruffed grouse were found at the same number of sites in 2018 and 2021 as in 2012. However, the greater distribution of sites surveyed during construction monitoring resulted in a wider distribution of the grouse detected. In 2018, ruffed grouse were absent from the area north of Gull Lake, the only place they were found during the 2012 surveys. As the forest habitat at these sites still appeared to be suitable for ruffed grouse breeding, Project-related disturbances could have resulted in ruffed grouse avoiding the area, as predicted in the EIS. Ruffed grouse were detected in the area in 2021, suggesting that the habitat remains suitable and that Project-related disturbances have subsided. Less ruffed grouse habitat was lost than was originally predicted in the EIS. No Project-related effects on ruffed grouse mortality were identified.

5.5.1.4.2 CONCLUSIONS

Project-related sensory disturbances may have affected the suitability of ruffed grouse breeding habitat north of Gull Lake. However, the physical habitat appeared to remain suitable, as breeding activity was detected in 2021. A small amount of ruffed grouse mortality (one confirmed and one suspected mortality) has been identified due to the Project, which would not affect the overall population.

5.5.1.4.3 FUTURE MONITORING

Ruffed grouse monitoring will continue during the Project operation phase.

The construction phase monitoring did not identify the need to alter any of the methods for the operation phase.

5.5.2 BANK SWALLOW

5.5.2.1 BACKGROUND

Bank swallows (Photo 5-29) are colonial breeders that excavate nesting burrows in steep sandy riverbanks (Photo 5-30) and gravel pits. Many burrows may be excavated in a single colony, but up to two thirds are unoccupied in a typical breeding season. Bank swallow is a priority bird for Project monitoring because it was assessed as Threatened by the Committee on the Status of Endangered Wildlife in Canada in 2013 and was officially listed as Threatened under the federal *Species at Risk Act* in 2017. It is not listed as a species at risk under *The Endangered Species and Ecosystems Act* of Manitoba.

Relatively few bank swallows were observed in the region during pre-Project EIS field studies for other birds from 2001 to 2014; at most 40 individuals were identified in the Clark, Gull, and Stephens lakes area in a single year. No surveys targeting bank swallow were conducted during the EIS field studies and all observations were incidental. As described in the TEMP, potential construction-related effects on bank swallow were loss or alteration of some breeding or foraging habitat; sensory disturbances from people, machinery, and equipment near breeding colonies; and possible mortality due to traffic on the access roads. The main objectives of bank swallow monitoring was to evaluate their presence or absence in Study Zone 4 during construction, map the locations of nesting colonies relative to the Project, and assess accidental mortality associated with the Project. The general EIS approach for bird species at risk was that a 10% loss of existing habitat area would trigger management concern, which was also the benchmark used for bank swallow.

Photo 5-29: Bank swallows at Keeyask, 2016

Photo 5-30: Large bank swallow colony on an island in Stephens Lake (Colony 12), 2016

5.5.2.2 MONITORING

The EIS predicted a general loss of bank swallow nesting habitat in riparian areas within the Project footprint. In 2016, a preliminary aerial survey was conducted by helicopter to identify bank swallow nesting colonies in the study area as this had not previously been documented. Surveys continued in 2018, 2020, and 2021, when each of the colonies were surveyed by boat or on foot (Photo 5-31) in June and again in July, during the primary breeding season. Birds and nesting burrows were counted, and a series of photographs was taken at most sites. Two independent observers also counted the burrows in the photographs, and the mean of the three counts was considered the number of burrows during each survey. Because it has most recently been suggested that there are approximately twice as many burrows as breeding pairs in a colony (Wright et al. 2011; Falconer et al. 2016), the larger mean (from June or July) of the three burrow counts at each colony was multiplied by 0.5 to provide a reasonably conservative estimate of the number of breeding pairs in Study Zone 4.

Photo 5-31: Surveying a bank swallow colony at Keeyask, 2016.

5.5.2.3 RESULTS

A total of 19 bank swallow colonies were observed in Study Zone 4 over the construction monitoring period (Table 5-14; Map 5-9). Three Project borrow areas and one previously developed borrow area were colonized by bank swallows early in the construction period, but the temporary habitat created by Project development was not available after 2020 due to subsequent material sloping and rehabilitation activities at these sites. Rip rap was placed at site 08 in winter 2017 for bank stabilization and the area was no longer suitable for bank swallow nesting.

The bank swallow colony at site 06, on the southeastern shore of what was a single large island in Gull Lake before the reservoir was impounded, was substantially smaller and spanned a shorter distance in 2021, after reservoir impoundment, than in 2020. The height of the bank in 2021 was also reduced relative to the previous year. At site 07, which was on the same large island in Gull Lake as site 06 before impoundment, a small increase in the mean number of burrows was observed. At Stephens Lake, which was not affected by reservoir impoundment, small declines in the mean number of burrows were observed at six of seven colonies from 2020 to 2021. The loss or reduction of habitat at one of the 15 colonies that were not in temporary borrow areas represented 7% of the bank swallow habitat in Study Zone 4.

Table 5-14: Mean number of bank swallow burrows at 19 colonies in Study Zone 4 during construction (2016, 2018, 2020, and 2021)

Location	Colony	2016	2018	2020	2021
Reservoir or upstream	01	5	4	2	5
	02	313	357	505	413
	04	183	386	288	302
	06	69	292	343	8
	07	139	486	359	381
	08	125	0	–	–
	09	10	151	132	126
	20	–	11	–	253
Stephens Lake	10	2	5	14	6
	11[1]	421	373	536	403
	12	1,600	1,694	956	835
	13	89	135	186	223
	14	180	53	174	122
	15[2]	463	446	547	421
	17	12	14	24	11
Borrow areas	05	84	26	–	–
	G1	–	33	–	–
	G3	–	53	0	–
	KM-1	–	3	0	–

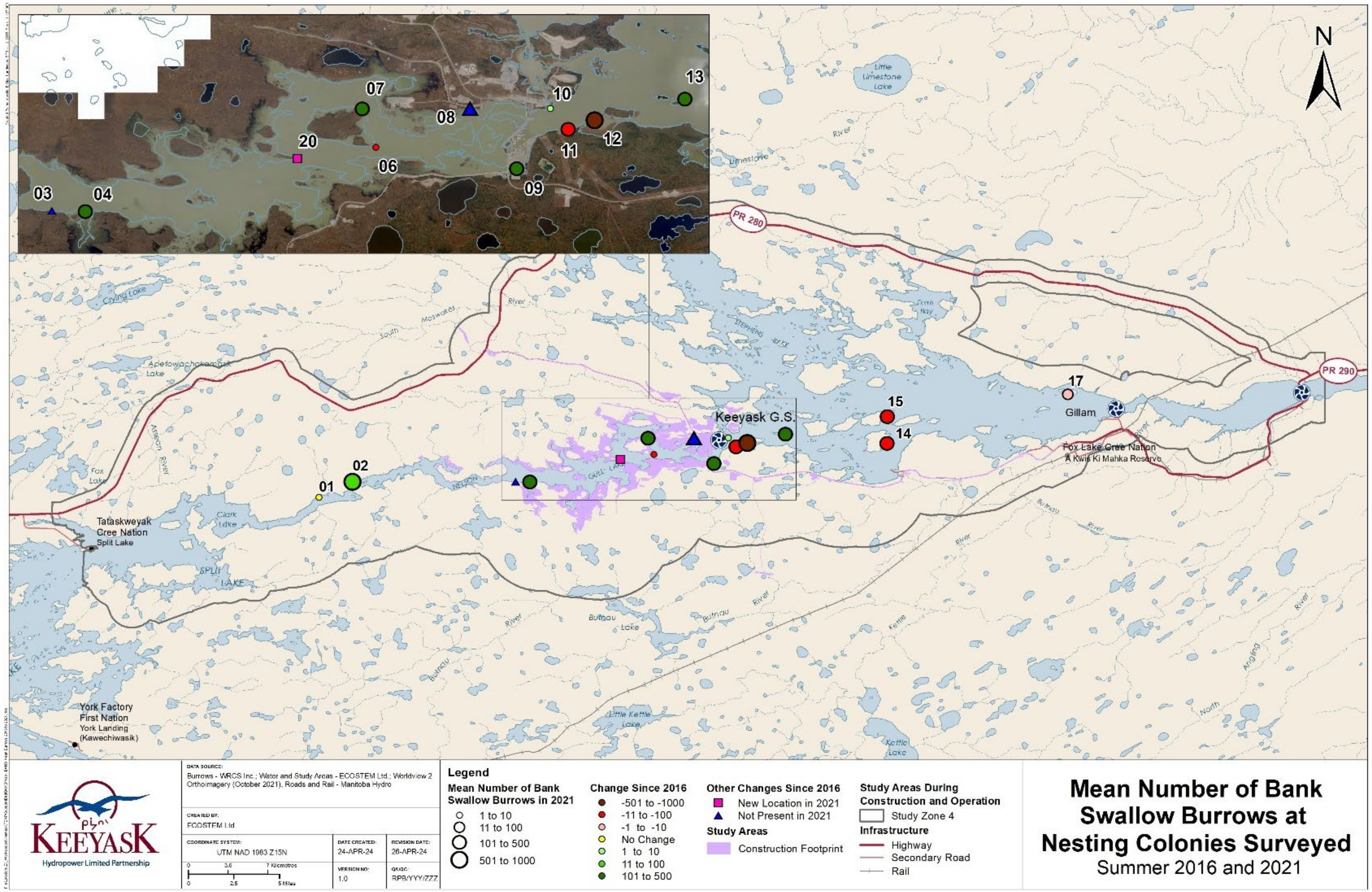
1. Includes former sites 18 and 19.
2. Includes former site 16.

The total estimated bank swallow population in Study Zone 4 ranged from 1,641 breeding pairs in 2021 to 2,261 pairs in 2018 (Table 5-15). The population increased from 2016 to 2018 and then declined in 2020 and 2021. The estimated number of breeding pairs was 11% lower in 2021 than when surveys began in 2016.

Table 5-15: Estimated bank swallow population in Study Zone 4 during construction (2016, 2018, 2020, and 2021)

Year	Number of Breeding Pairs	Number of Individuals	Percentage Change from Previous Year
2016	1,848	3,696	–
2018	2,261	4,522	+22
2020	2,033	4,066	-10
2021	1,641	3,282	-19

Along with the nest and eggs, a bank swallow mortality due to nest depredation was observed in in a borrow area in 2016. A bank swallow mortality was reported on the Project site in 2017, when an individual was found trapped under a box. Another mortality was noted in 2020, near the Project's Site Support office. Its cause was unknown. No collisions with the communications tower were observed during construction monitoring.



Map 5-9: **Bank swallow nesting colonies during construction**[1]

[1] Temporary borrow area bank swallow colony found in 2021 not shown on map

5.5.2.4 DISCUSSION

5.5.2.4.1 COMPARISON WITH PREDICTED PROJECT EFFECTS

Overall, the regional Keeyask bank swallow population appeared stable during Project construction, but there was some decline noted in the latter years. A small decrease in the estimated bank swallow population was observed in Study Zone 4 from 2018 to 2020 and a larger decrease was observed from 2020 to 2021. Reduced numbers of burrows at most sites could be due to the collapse of older nesting holes because of localized bank erosion, which maintains the bank face at the steep angle required for bank swallow nesting. Bank swallows often return to previous nesting sites but because of the unstable nature of their nesting habitat, colony sites may change from year to year, or individuals will relocate if habitat becomes unsuitable.

A new bank swallow colony formed at a new location (site 20) in 2018 after the shoreline at site 8 was rip-rapped in winter 2017. Although it is unclear if the same individuals moved from one location to another, by 2021, the number of burrows present at the new location doubled over the maximum number observed at site 8 by 2021. A large decline of burrows occurred at Site 6 in 2021, the same year with substantial increase of burrows at site 20.

A large decrease in the number of burrows was observed at site 06, within the reservoir. Approximately 350 burrows, at least half of which were likely unoccupied during the breeding period, collapsed during or after reservoir impoundment; only eight burrows were counted the following year. The site appeared to be considerably less suitable for nesting in 2021 than in previous years due to the reduced height of the bank following impoundment. However, a small number of bank swallows were observed at the site during the during the 2021 breeding season, suggesting that it was still active. No substantial declines in the number of burrows at other colonies in the reservoir were observed in 2021; the number of burrows increased or was similar to the previous year.

5.5.2.4.2 CONCLUSIONS

The loss or reduction of habitat at one bank swallow colony in the newly formed reservoir represented 7% of the 15 colonies (excluding those in the temporary habitat created in borrow areas) in Study Zone 4, which is below the benchmark of 10% habitat loss and represents a moderate magnitude of effect. The mean number of burrows decreased at six of seven colonies in Stephens Lake, suggesting that the decline in the estimated bank swallow population from 2020 to 2021 was not due to reservoir impoundment alone. There are numerous other natural bank swallow sites available for nesting in the region, and it is uncertain if the decline in the bank swallow population observed in 2021 was due to the relocation of colonies to new nesting areas.

Project-related bank swallow mortality was minimal and no substantial effect on the regional population was observed.

5.5.2.4.3 FUTURE MONITORING

Bank swallow monitoring will continue during the Project operation phase.

Additional monitoring in year 5 of operation was added to the TEMP to confirm there were no unexpected effects in the first few years following reservoir impoundment.

The construction phase monitoring did not identify the need to alter any of the methods for the operation phase.

5.6 BIRD COLLISIONS WITH LIGHTED TOWERS

5.6.1 BACKGROUND

Bird collisions with stationary objects, such as communications towers, are a significant source of mortality for birds in North America. Characteristics including height, lighting, and the presence of guywires influence the risk towers pose to flying birds. As part of Project construction, a communication tower was erected on the powerhouse in the winter of 2019/2020. The tower is self-supporting (not guyed), made of steel lattice, and stands 53.6 m tall (215 metres above sea level), making it the highest point at the Project site. The objectives of the bird collisions monitoring were to document the number of bird fatalities associated with the lighted communications tower and to identify mitigation measures if it appeared to attract birds.

5.6.2 MONITORING

A 50 m radius area around the communication tower, including the powerhouse roof, deck, and the ground surrounding the powerhouse (Photo 5-32), was searched in the spring (April 10 and April 26) and the fall (September 14, 19, and 24) of 2020. Searches were conducted by one or two observers who walked parallel lines spaced 10 m apart. Observers searched the area for signs of bird collisions (carcasses and clusters of feathers). There was no vegetation on site and visibility was generally unobstructed. A collision was recorded when the remains found consisted of more than five feathers in a square meter area (Barrientos et al. 2012). If a carcass or collision evidence was found it was photographed, the location was recorded using a handheld global positioning system (GPS) unit, and any bird remains were collected under a federal scientific permit. Remains were to be identified to species, where possible, by a qualified biologist and were to be disposed of according to permit conditions.

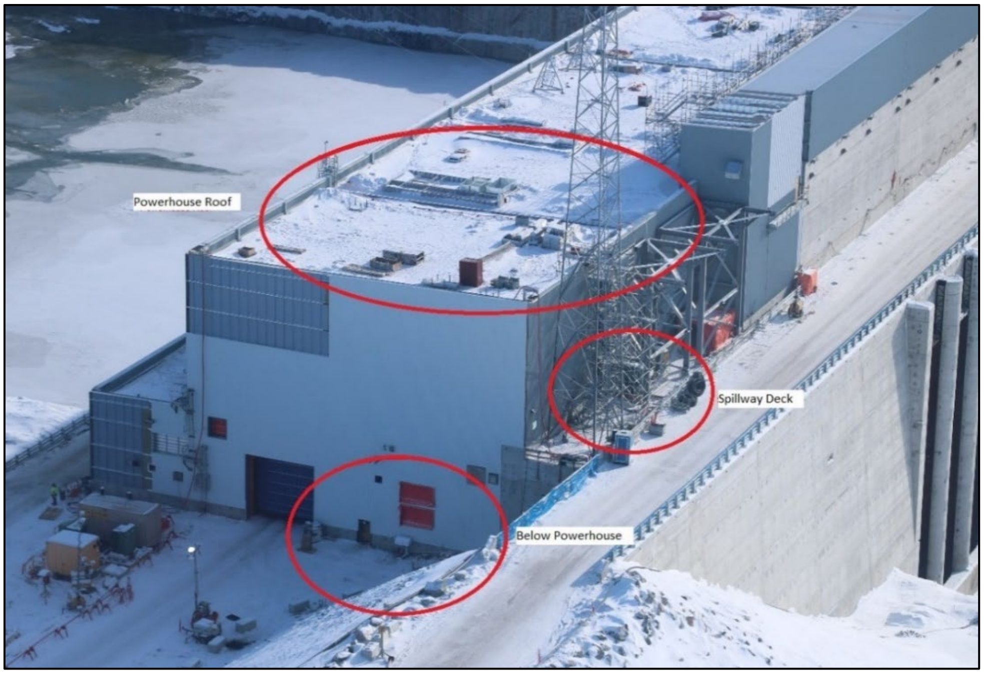


Photo 5-32: Communication tower on the powerhouse and approximate search areas for bird collisions, 2020

5.6.3 RESULTS

No evidence of bird collisions was found near the communication tower in 2020. On April 26, several grey and white feathers were found on powerhouse roof. There were not enough feathers to be interpreted as a collision and they were likely from a gull or gulls preening on the roof.

5.6.4 DISCUSSION

5.6.4.1 COMPARISON WITH PREDICTED PROJECT EFFECTS

No evidence of bird collisions was found in 2020 around the communication tower, but due to the evidence of preening birds on the powerhouse roof and the proximity of the communication tower to gull nesting colonies, there remains a risk of bird collisions occurring at the site.

5.6.4.2 CONCLUSIONS

No mitigation is currently recommended, and further monitoring is required.

5.6.4.3 FUTURE MONITORING

Bird collision monitoring will continue during the Project operation phase.

The construction phase monitoring did not identify the need to alter any of the methods for the operation phase.

5.7 SYNTHESIS

Adverse Project effects on birds during Project construction were the same or lower than predicted in the EIS, with one exception. Slightly more common nighthawk breeding habitat was lost than predicted, but the percentage lost was still far from the benchmark value that would raise it to a moderate magnitude adverse effect. In most cases, the lower than predicted effects primarily resulted from the actual Construction Footprint being 28% smaller than assumed in the EIS, as well as the implementation of effective mitigation measures.

There were no unexpected Project effects on birds during construction, other than the higher than expected use of staging and foraging by waterfowl in the newly formed reservoir. These findings contrasted with the predictions of the EIS, which suggested Canada goose and mallard use of the reservoir would be minimal until wetland vegetation was re-established in the area. No additional mitigation is recommended.

Monitoring of birds will continue during Project operation.

6.0 MAMMALS MONITORING

6.1 CARIBOU

6.1.1 BACKGROUND

As described in the EIS, the winter 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. 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. Qamanirjuaq and Cape Churchill caribou are uncommon in the region. The number of Pen Islands caribou in Study Zone 6 varies from year to year, typically ranging from none to hundreds of animals. On occasion, larger numbers (in the thousands) migrate into the Keeyask region.

A small number of caribou, referred to as summer residents in the EIS and as woodland caribou by partner First Nations members, occupy the Keeyask region in spring and summer. They 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 are provided a physical barrier by the surrounding habitat and offer some protection from predators such as black bear and gray wolf. Summer resident caribou move within and likely beyond the Keeyask region, but their herd association and the extent of their core range are uncertain.

Predicted Project effects on caribou included the physical loss or alteration of winter and calving habitat; the avoidance of otherwise suitable habitat due to sensory disturbance; a reduction in habitat intactness; and mortality due to increased predation, harvest, or accidents such as collisions with vehicles. To evaluate Project effects on caribou and verify EIS predictions, five monitoring studies were conducted during construction:

- The Winter Abundance Estimates study monitored the number and distribution of the Southern Hudson Bay caribou subpopulation migrating through Study Zone 5 in winter;
- The Summer Resident Range study evaluated the distribution of summer resident caribou in early winter;
- The Sensory Disturbance study examined if and how Project-related sensory disturbance altered the use of calving habitat by summer resident caribou;
- The Habitat Effects study included several components to quantify Project effects on the amount of caribou habitat in Study Zones 5 and 6. The EIS considered that a 10% cumulative loss of historical habitat area for caribou, a disturbance of more than 45% of the region’s habitat, and a linear feature density of more than 1.2 km/km² were the

benchmarks that triggered management concern, which were applied for caribou habitat effects monitoring; and

- The Mortality study identified sources of caribou mortality during construction, including accidental mortality, harvest, and predation by black bears and gray wolves. A gray wolf density of more than six individuals/1,000 km² was the benchmark that triggered management concern, which was applied for caribou mortality monitoring.

6.1.2 MONITORING

6.1.2.1 WINTER ABUNDANCE ESTIMATES

Aerial surveys for Southern Hudson Bay caribou were conducted in January 2016 and February 2019, to estimate the abundance of caribou in the eastern portion of Study Zone 5 in winter. Because a complete census of the population in the study area was not possible, caribou were counted and an estimate of the total number in the region was generated statistically. Areas where caribou crossed the Nelson River, Stephens Lake, Split Lake, and Clark Lake were also identified to address concerns regarding mortality associated with potential drownings.

6.1.2.2 SUMMER RESIDENT RANGE

Aerial surveys for summer resident caribou were conducted in November 2015 and December 2016 and 2017 to evaluate their distribution in Study Zone 4 and part of Study Zone 5 in early winter, before the Southern Hudson Bay subpopulation migrated into the area. The winter locations of summer residents and their tracks were mapped and compared with their summer distribution in known calving areas in Gull and Stephens lakes. Fecal samples were collected, genetically tested, and compared with samples collected during EIS terrestrial fieldwork to determine whether individuals that remain in the region in summer also remain in winter, and what area they may occupy. No large groups of migratory caribou were known to occupy the Keeyask region at the time of the early winter surveys and it was believed that all observations were those of summer residents.

6.1.2.3 SENSORY DISTURBANCE

Two separate studies were conducted for caribou sensory disturbance: one along the Project access roads; and another on treed islands in lakes and peatland complexes. The roadside study specifically focused on reduced habitat effectiveness due to Project sensory disturbance from roads, which included the GS as well. The island study focused on effects on caribou use of previously mapped calving and rearing habitat during the calving and rearing season. Caribou calving islands in lakes and on raised peat islands in peatland complexes were also surveyed because these habitats are known to be used by caribou during the calving and calf-rearing periods, when they are most sensitive to disturbance.

Tracking transect surveys for both studies were conducted in April (Photo 6-1), July, and September in 2015, 2017, 2018, 2020, and 2021. Automated recording units (ARUs) were positioned perpendicular to the access roads on a subset of the sample transects to record construction and vehicle noise levels at various distances from the access roads. Project noise and activity varied throughout the construction phase. Project construction commenced in July 2014. Overall Project activity then ramped up and peaked in 2018.

Trail camera surveys were conducted over the same period as the tracking transect surveys, but in all years from 2015 through 2021; these data could be used to corroborate tracking results in islands in lakes and in peatland complexes.

To examine caribou response to Project disturbance and other explanatory factors during the calving season, mixed effects multivariate statistical modeling was applied to the datasets. This modeling estimates caribou responses to disturbance while statistically controlling for the effects of habitat and other influences. The middle of the calving and calf-rearing period (i.e., visit 2, July) was selected for analyses. Separate multivariate statistical modeling was completed for the roadside transect, island transect and island camera datasets.

Caribou presence on a 1 km long transect was the response variable for most of the analyses and modeling. The modeling of the two transect datasets included a core set of explanatory variables: distance from the Project Footprint (the proxy for Project sensory disturbance), distance from highways, year (2015, 2017, 2018, 2020, 2021), moose (i.e., caribou may avoid areas with moose as moose attract wolves), bear (predator), within the 2013 burn, and habitat type. Additional explanatory variables for the roadside statistical modeling included calving habitat, geographic zone, effort, and whether it was within the reservoir area.

The EIS predicted a decline in caribou activity in calving habitat within 2 km of Project borrow areas or the North and South access roads and within 4 km of the generating station site due to construction-related sensory disturbance.

6.1.2.4 HABITAT EFFECTS

The EIS classified primary calving habitat as islands larger than 10 ha in lakes and peatland complexes larger than 2,000 ha. Islands between 0.5 and 10 ha in lakes and peatland complexes between 30 and 2,000 ha in area were considered secondary habitat. Two islands in Gull Lake were expected to be lost during Project construction, representing less than 1% of the primary calving habitat for caribou in Study Zone 5. Islands would form in the reservoir post-impoundment, and they would eventually be used by caribou for calving and rearing during operations. No direct effects on primary and secondary peatland complexes were anticipated.

Of the winter habitat for caribou in the Keeyask region, approximately 6% was expected to be affected in Study Zone 4 and 1% was expected to be affected in Study Zone 5. By extrapolation, less than 1% of winter habitat was expected to be affected in Study Zone 6.

Linear feature density and core area and intactness results were reviewed (Section 2.4). Before the Project, linear feature density, including roads, trails and transmission lines, was 0.45 km/km^2.

A small net decrease (less than 1%) in linear feature density to 0.44 km/km^2 for the entire Regional Study Area, was predicted to have a negligible to small positive benefit to caribou. The EIS also considered habitat intactness for summer resident caribou at Keeyask. The number of core areas larger than 200 ha or 1,000 ha that caribou were most likely to use was expected to decrease by only 1% in Study Zone 5. As 82% of the largest core areas would remain intact, the overall effect of habitat fragmentation would likely be small.

Photo 6-1: Ground tracking transect survey, 2018

6.1.2.5 MORTALITY

For the caribou Mortality study, predator (black bear and gray wolf) and alternate prey (moose) abundance and distribution data collected for sensory disturbance monitoring were incorporated into the analyses of Project effects. Waterbody crossing attempts by caribou and accidental mortalities observed during the Winter Abundance Estimates study, resource use by the workforce (monitored as part of the *Resource Use Monitoring Plan*), and accidental mortality reported during construction were also evaluated.

6.1.3 RESULTS

6.1.3.1 WINTER ABUNDANCE ESTIMATES

Winter abundance surveys were initiated in a given survey year based on local reports that caribou from the Southern Hudson Bay sub-population were moving into the Regional Study Area

(Study Zone 5). Two winter surveys were carried out during the Project construction period, in 2016 and 2019. A third survey was planned for early 2017, but very few caribou were present in the region that winter, so the survey was not carried out. In January 2016, a total of 84 caribou were observed in 13 groups during aerial surveys, including 32 caribou in two groups that were off-transect. All but one group were south of the Nelson River. Too few caribou were observed to estimate the number of individuals in the region. A single ice crossing site was recorded, between the Kettle and Long Spruce generating stations, and two caribou were observed incidentally on the frozen Nelson River. In February 2019, a total of 3,684 caribou in 280 groups were counted in the study area, including 662 animals in 32 groups that were off-transect. Most observations were made south of the Nelson River. It was estimated that 6,665 individuals were in the Regional Study Area. Track sets and caribou were observed at 10 ice crossing sites.

Various groups have monitored the abundance of caribou near Keeyask since the winter of 2003-2004. The Keeyask Caribou Coordination Committee (KCCC) was formed in 2014, and it is dedicated to caribou monitoring in the region. The KCCC formed a very successful network to collectively monitor migratory caribou, near Keeyask, over the last few winters. Winter caribou abundance reports before and after the network was formed are shown in Figure 6-1. During construction, migratory caribou movements into the area were highly variable, ranging from low to very high.

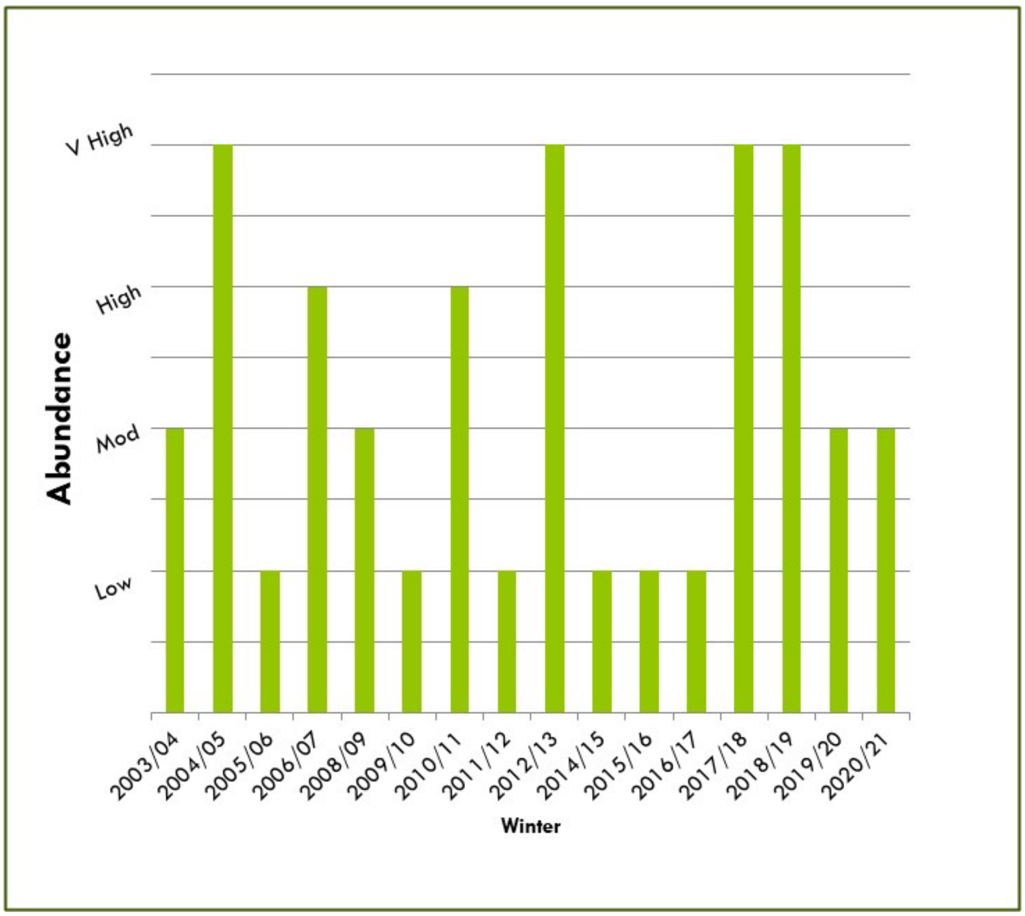


Figure 6-1: Abundance of caribou from winter, 2003 – 2021 (Construction 2014-2021)

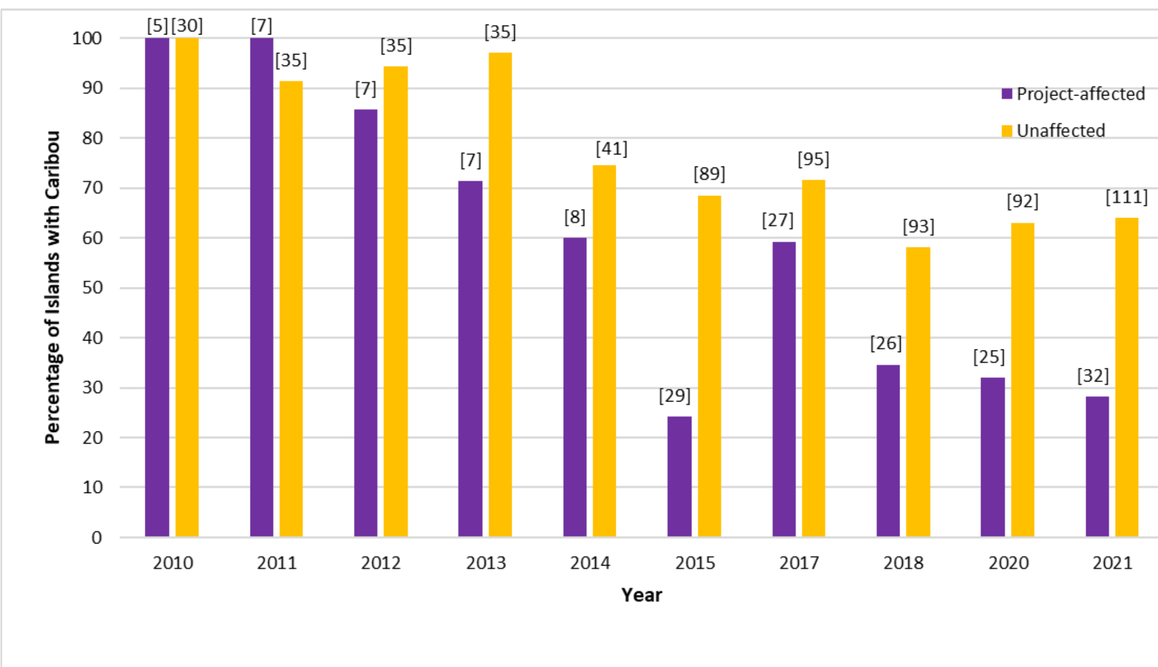
6.1.3.2 SUMMER RESIDENT RANGE

Caribou or their signs were observed at 28 locations during the November 2015 aerial survey for summer resident caribou, all south of the Nelson River between Gull and Clark lakes. Observations were made at five locations during the December 2016 survey, all south of the Nelson River between Stephens and Clark lakes. Most signs and observations were south or west of the summer resident caribou calving range and were in a relatively small area. No caribou or their signs were observed during the December 2017 survey. Twenty-nine fecal pellet samples were collected where caribou were observed in 2015, eight in 2016, and none in 2017. Sixteen samples were collected opportunistically during other terrestrial fieldwork in summer and fall 2014, 2015, and 2017. A total of 50 samples were successfully analyzed and 25 unique caribou were distinguished. A male and a female were each identified on islands in Stephens Lake during more than one summer. Two males were identified in summer and winter, confirming that the winter range of some summer resident caribou includes the Keeyask region and that some individuals remain in the region year-round. Approximately 30 km separated the summer and winter locations of each individual. The winter range of these summer resident caribou extends at least 40 km southwest and 17 km southeast of the Project site and the nearby calving habitat.

6.1.3.3 SENSORY DISTURBANCE

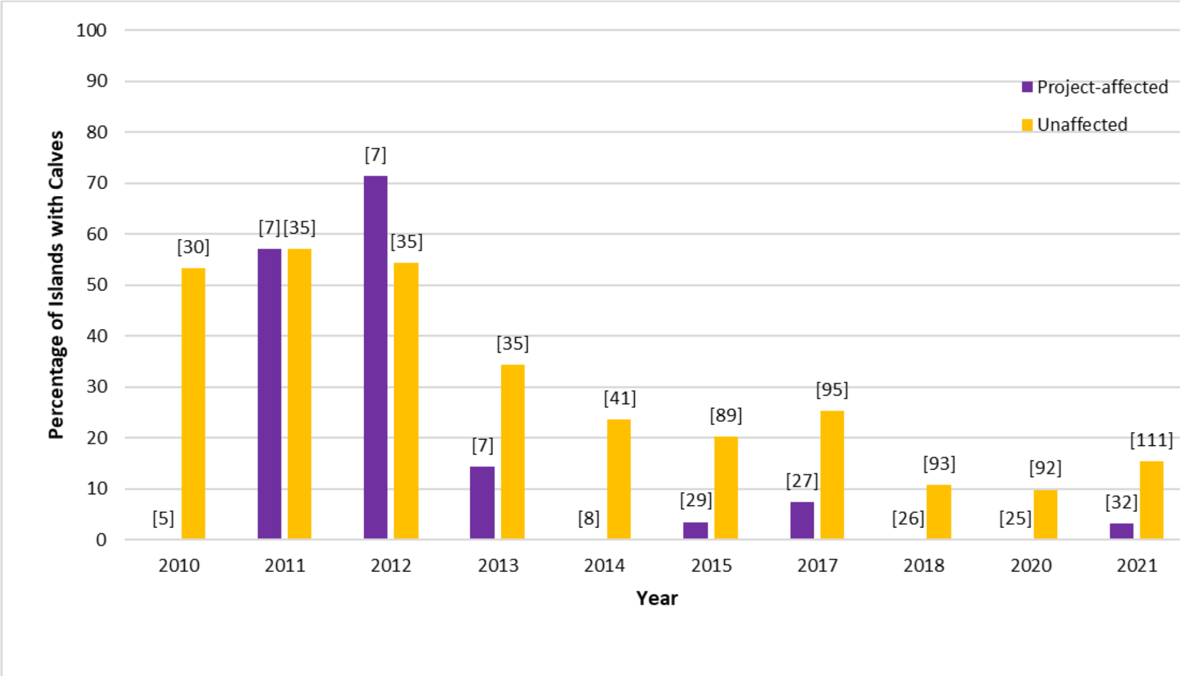
Tracking transect and trail camera data were combined to indicate caribou use of islands in lakes. An island was classified as being used if there was at least one presence in either dataset. The percentage of islands in lakes on which caribou and calf activity (Photo 6-2) was observed declined during both the pre-construction (2010–2014) and construction (2015–2021) periods (Figure 6-2, Figure 6-3).

Photo 6-2: Caribou cow and calf on an island in Gull Lake, 2019



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

Figure 6-2: Percentage of Project-affected and unaffected islands in Study Zone 4 on which caribou activity was observed from combined trail camera and tracking transect data before (2010–2014) and during (2015–2021) Project construction



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

Figure 6-3: Percentage of Project-affected and unaffected islands in Study Zone 4 on which caribou calf activity was observed from combined trail camera and tracking transect data before (2010–2014) and during (2015–2021) Project construction

6.1.3.3.1 ISLANDS AND PEATLAND COMPLEXES

The islands in lakes and peatland complex transect datasets had the highest number of caribou presences and counts early in the construction phase.

The multivariate statistical modeling indicated that islands in lakes are preferred over peatlands for calving, by a substantial margin. Perhaps this was because a lake matrix provided better protection from predators than a wet peat matrix.

For islands in lakes, increased island size increased the likelihood of a caribou presence. This result was likely because an island in a lake must be a minimum size to support calving, and larger size (up to a point) provides more habitat to support the cow and calf until the calf is able to sustainably leave an island. In contrast, an island in peatland is embedded in untreed, wet peat habitat which increases the total area with food.

Overall, 2015 had the highest number of caribou presences and counts (Table 6-1), 2018 had the lowest numbers, and amounts increased in 2020 and 2021. The multivariate statistical modeling confirmed that these year-to-year differences were highly significant (Figure 6-4). For islands in Stephens Lake, the total number of caribou counts per 1 km of transect was highest in 2015 by far, and then increased from 2018 to 2021. This was also consistent with the camera data.

Habitat type was important, and several types were significant in the multivariate statistical modeling. However, even the highly significant habitat variables had little effect on the likelihood of a caribou being present. This result was not surprising. Since all the islands included in the study were treed, the habitat variables were investigating the importance of their co-occurrence with treed habitat. The key level for habitat selection was the landscape where females select islands for calving to provide landscape level protection from predators, and a selected island will have to have some tree cover to provide local protection and shelter.

Distance from the Project Footprint (i.e., the GS, North Access Road and South Access Road) was one of the two variables that most highly increased the likelihood that a caribou was present on a 1 km long transect. On average, the effect of increasing distance from the Project Footprint was slightly higher in 2015 compared with the last three years included in the dataset, and slightly lower in the last year.

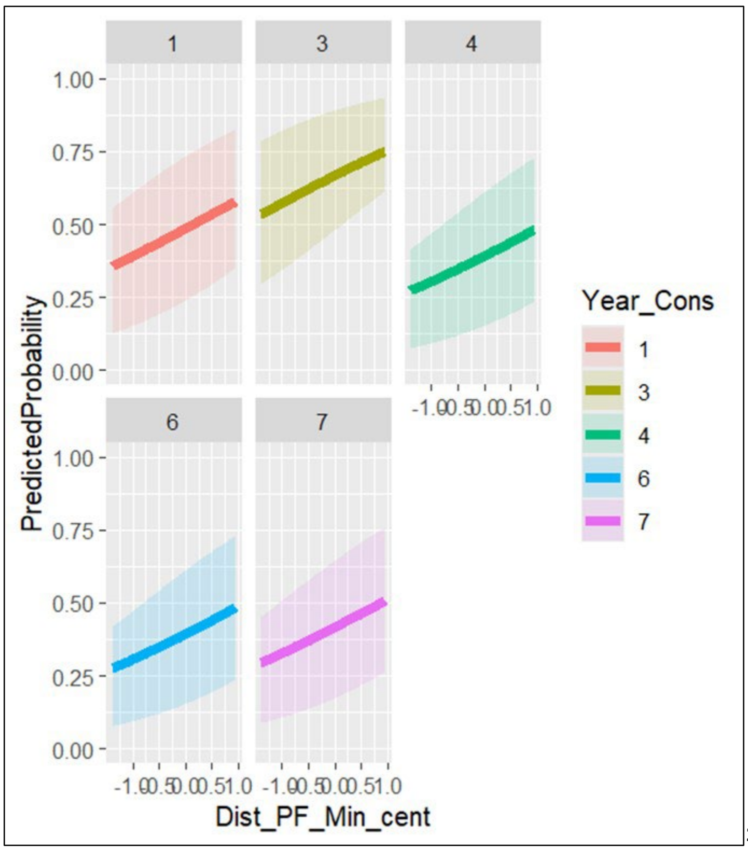
The Stephens Lake island data provided the best representation of caribou response to Project disturbance in conjunction with other explanatory factors due to its level of replication for the various combinations of explanatory variables. While the camera dataset was too sparse for multivariate analysis, it was suitable to supplement the transect dataset to better understand the response of caribou, and female caribou in particular, to Project sensory disturbance. Examination of the islands where caribou were found indicated that, depending on the dataset, caribou either avoided or severely reduced use in areas close to the Project Footprint in every study year (Map 6-1). The degree of this reduced habitat effectiveness varied with construction year, roughly tracking the general overall level of Project activity each year.

Islands within 2 km of the Project Footprint had the lowest number of caribou counts by far. For cameras, there was only one caribou noted within 4 km of the Project Footprint during the seven years of construction, and this event could simply have been an animal moving across the island to get somewhere else rather than using the island for calving. A review of data for the islands within 2 km of the Project roads and generating station suggested that most of the observations were from transient movements rather than habitat use.

Caribou counts steadily increased from 2 km from the Project Footprint, peaking at 9 km to 11 km, depending on the dataset. Depending on the dataset, caribou presence was either absent or very low at the greatest distances from the Project Footprint (14 to 16 km). The reason for the pattern of increasing, peaking and then decreasing caribou counts with distance from the Project was the combined effects of other sources of human disturbance. This will be explained below.

Table 6-1: Caribou presences and counts on a 1 km island transect, by matrix type and construction year

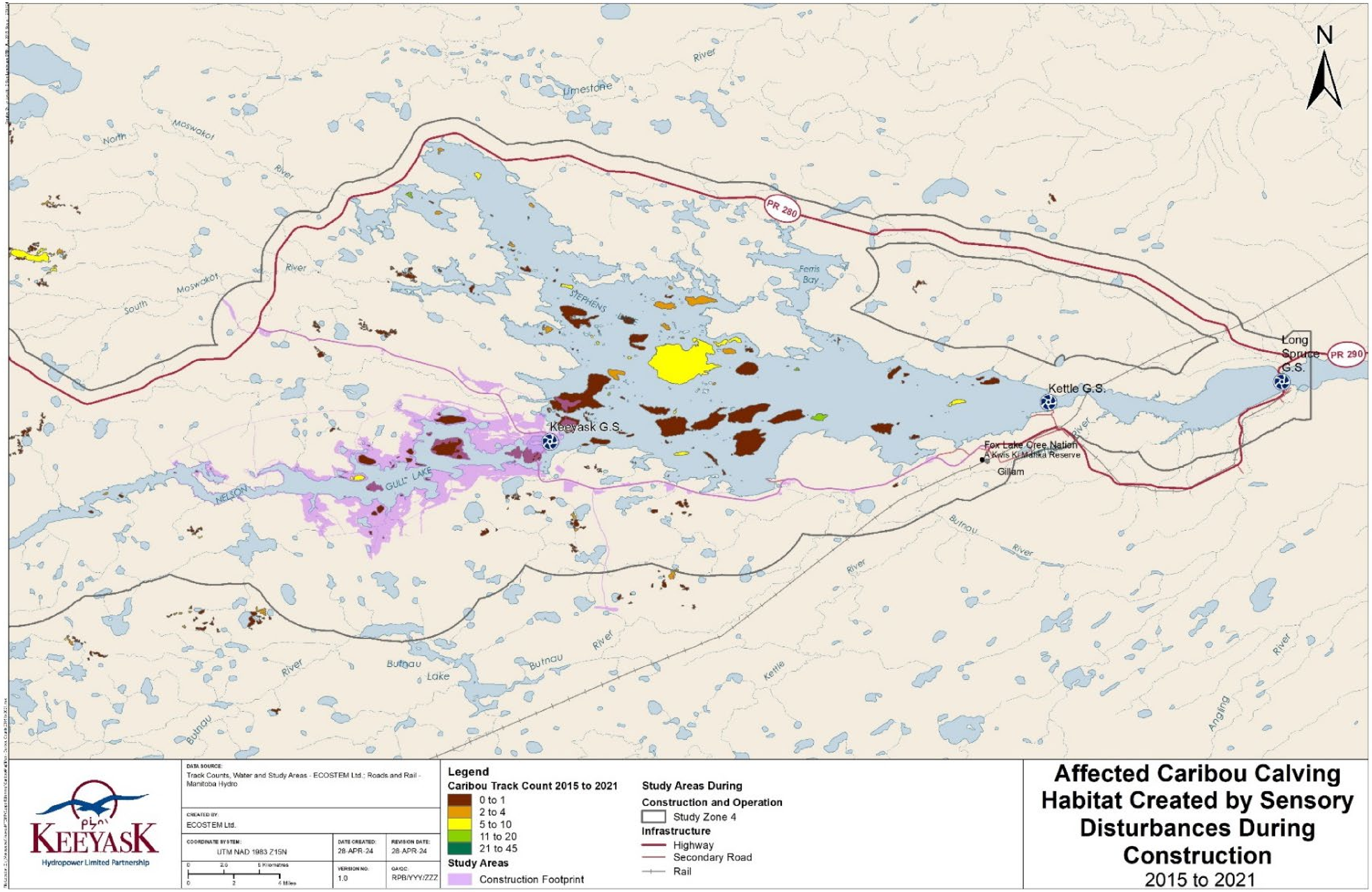
Construction Year	1	3	4	6	7
Matrix Type	**2015**	**2017**	**2018**	**2020**	**2021**
Presences					
Stephens Lake	56	79	45	45	47
Keeyask	3	2	3	2	1
Mainland	62	84	30	47	60
Total	**121**	**165**	**78**	**94**	**108**
Counts					
Stephens Lake	534	244	324	243	449
Keeyask	35	3	14	12	5
Mainland	373	152	149	250	300
Total	**942**	**399**	**487**	**505**	**754**



[2]

Figure 6-4: Average marginal predicted probabilities of caribou presence with distance to Project Footprint, by year of construction, with lower and upper quartile bars

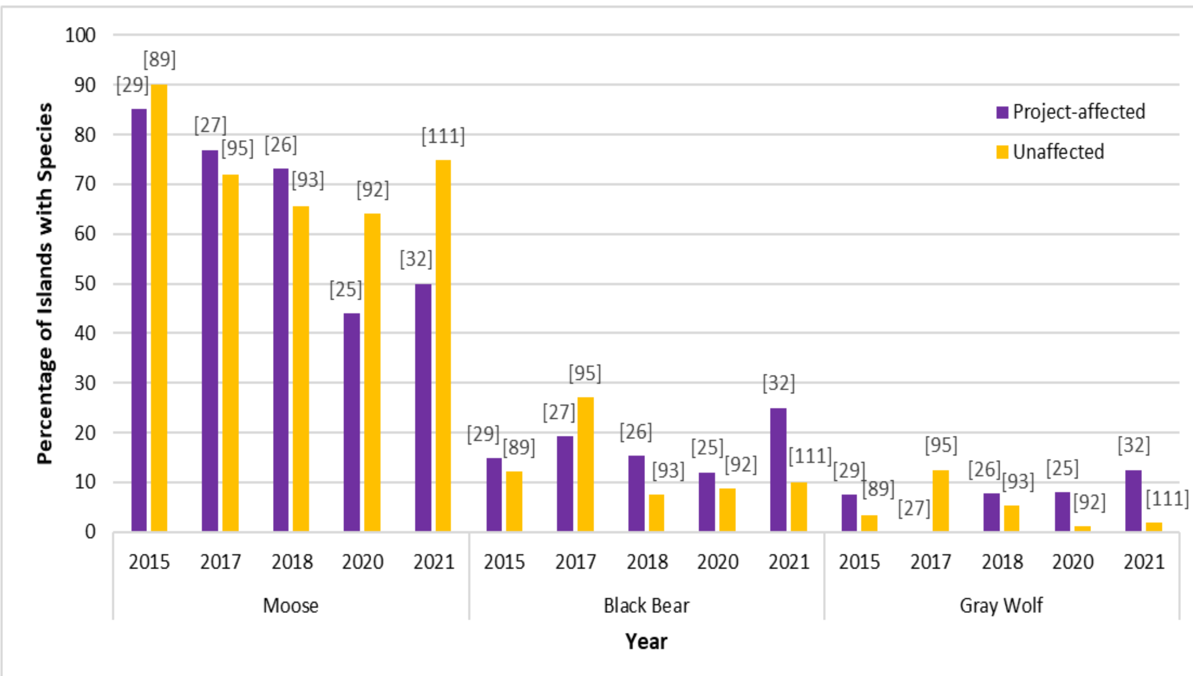
[2] Note that the higher line for Year 3 (2017) is due to a data collection bias in that year.



Map 6-1: **Caribou use of calving habitat during construction, 2015 to 2021**

Moose were widely distributed on islands in lakes (Figure 6-5) and in peatland complexes during the Project construction monitoring period. There was strong statistical support showing that caribou less frequently used islands where moose were present. The average marginal predicted probability of caribou presence was around 0.95 if a moose was absent but decreased to 0.18 if a moose was present. The results also suggested that moose presence was much more important for whether or not an area was selected than for how often it was used if it was selected.

Black bear activity was substantially less frequently observed than moose, and gray wolf activity, even less so (Figure 6-4). Black bear presence/abundance was not significant in any of the modeling results. Gray wolf data were too sparse to analyze in detail.



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

Figure 6-5: Percentage of Project-affected and unaffected islands in Study Zone 4 on which moose, black bear, and gray wolf activity was observed from combined trail camera and tracking transect data during Project construction (2015–2021)

6.1.3.3.2 ACCESS ROADS

The roadside transect dataset had the highest number of caribou presences and counts early in the construction phase. The number of caribou presences was relatively low within the first km of the Project Footprint. This was most prominent after 2015 (Table 6-2). By far, the lowest percent of caribou presences, as a percentage of the total, was within 1 km of the access roads.

The overall pattern of results for year of construction and distance from the Project Footprint was the same for roadsides as it was for islands. Distance from the Project Footprint had one of the three highest odds ratios[3]. Construction year odds ratios for caribou presence show an overall increasing trend from 2018 to 2021, which was thought to reflect the declining levels of Project noise and activity. While the habitat variables in the final version of each model were different, all of the odds ratios were close to 1, indicating that had a limited effect on caribou behavior.

The remaining significant variables were unique to the roadside model. These variables included caribou calving habitat (as mapped for the EIS) and wildlife burn with an age class of 23. There was also some support that caribou less frequently used roadside areas where moose are present.

Caribou calving habitat had one of the three very high odds ratios. Peatland complexes that met the criteria for calving and rearing habitat increased the likelihood of a caribou presence by approximately 1.83 times. This confirmed the assumptions made for the EIS.

The remaining variable with a very high odds ratio was whether the habitat had been burned by a wildfire 23 years ago (age class 23). This condition increased the likelihood of caribou presence on a transect by approximately 1.94 times. It was difficult to disentangle whether this reflected a difference in food availability at that age, a landscape-level correlation with certain habitat types, moose prevalence in habitat of this age, or some other factors.

Table 6-2: Number of caribou presences by distance from Project Footprint and year of construction

Distance from Project Footprint (1 km class)	2015	2018	2020	2021	
Presences					**Total**
1	11	1	1	2	15
2	45	4	10	14	73
3	32	9	7	6	54
4	34	5	10	11	60
Total	**122**	**19**	**28**	**33**	**202**
Percentages					**Average**
1	9	5	4	6	6
2	37	21	36	42	34
3	26	47	25	18	29
4	28	26	36	33	31
Total	**100**	**100**	**100**	**100**	**100**

[3] An odds ratio (OR) is a statistic that quantifies the strength of the association between two events, A and B.

6.1.3.3.3 COMBINED EFFECTS

Multivariate statistical analysis of the island and roadside datasets told the same overall story for the effects of Project construction and other factors on caribou behavior during the calving season. Caribou avoided areas close to the Project Footprint in all study years. The degree of this avoidance varied with construction year, roughly in accordance with the level of Project activity over time. In all datasets, distance from the Project Footprint was one of the strongest influences on the likelihood that a caribou was present.

In the Stephens Lake island transect data, caribou counts steadily increased from 2 km from the Project Footprint, peaked at 12 to 14 km and then declined. This pattern can be explained by considering other sources of disturbance in the area. At a given geographic location, a female caribou may be exposed to noise and disturbance from sources in addition to the Project. The combined effects of the Project and highways (which captures the Town of Gillam as one passes through it) on caribou events was strong. Island use was most frequent at the highest distances from both the Project Footprint and a highway. The results suggested that the simultaneous minimum distances from the Project and a highway to avoid caribou disturbance could be 7 km and 9 km, respectively. This finding will be further examined when the operation monitoring data are added to the datasets. Camera data corroborated the tracking results.

For peatland complexes, there was a single female camera presence at each of the 2 km and 3 km classes during the first three years. It is possible that these events were not representative of summer resident caribou behavior because they may have been females from the Pen Islands winter migration that stayed in the Regional Study Area to calve the next summer. The next presences after 3 km did not appear until 16 km from the Project Footprint. Ignoring the possible exception described in the previous paragraph, there was a suggestion that the combined effects of the Project and highways on female caribou events appeared strong. All events were both at least 16 km from the Project Footprint and 12 km from a highway. However, this result must be interpreted cautiously as replication was quite low.

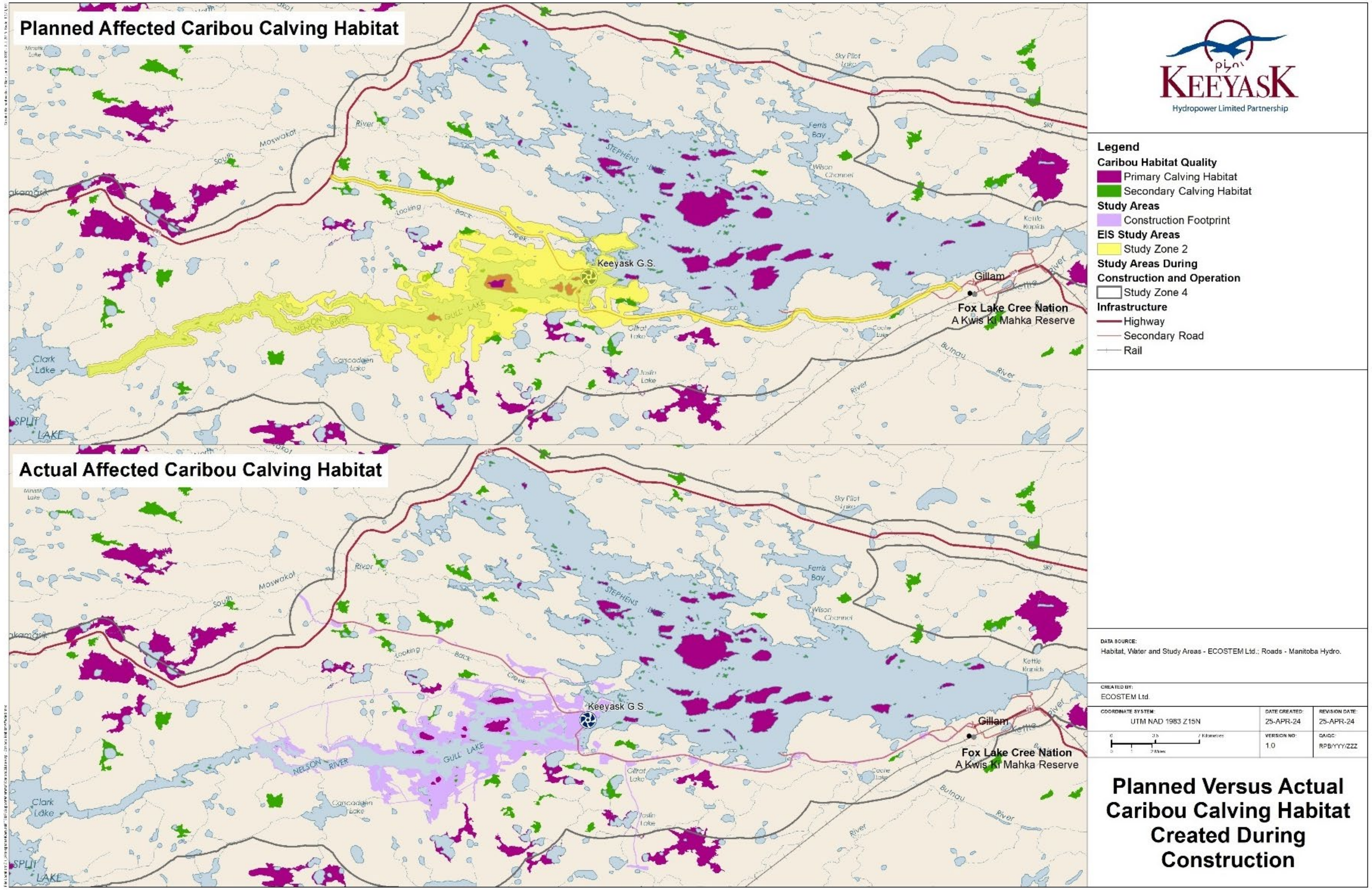
6.1.3.4 HABITAT EFFECTS

As predicted in the EIS, two primary calving islands were inundated during reservoir impoundment in late 2020 and there was no physical loss of mainland calving habitat in primary or secondary peatland complexes (Map 6-2). Island size was one variable in the multivariate statistical model that was identified as having an important influence on caribou. The larger the island, the more likely it had caribou present. Increased island size supported the EIS caribou habitat model.

It was predicted that 6,825 ha (approximately 6%) of physical winter habitat for caribou in Study Zone 4 would be affected by the Project. The actual loss of winter habitat during Project construction was 6,254 ha (approximately 5.6% of the habitat in Study Zone 4), which is less than predicted.

As outlined in Section 2.4.4.1, the total linear feature density in the Local Study Area declined from 1.49 km/km^2 to 1.00 km/km^2, as expected. This occurred because: existing cutlines were replaced by Project features such as borrow areas and reservoir clearing; and most of the Project roads were either already existing or were built on existing cutlines. By extrapolation, linear feature density in the Regional Study Area decreased from 0.45 km/km^2 to 0.44 km/km^2 as predicted.

Project construction removed one core area that was slightly larger than 1,000 ha and two core areas that were between 200 ha and 1,000 ha in size. While a few core areas larger than 200 ha were completely removed, the total number of core areas in the Regional Study Area remained at 111 because several other core areas were fragmented into smaller blocks. The decrease from 83% to 82% for intactness remains as predicted in the EIS.



Map 6-2: Planned versus actual physically affected caribou calving habitat during construction

6.1.3.5 MORTALITY

There were no accounts of accidental caribou mortality during Project construction. No collisions with vehicles or drownings during river or lake crossings were reported.

To monitor resource use by the Project workforce, a portion of workers (7 to 23%) completed surveys over a five-year period during Project construction. In the 2019 study year (November 2018 to October 2019), workers reported harvesting seven caribou; six were harvested by partner First Nations participants and one by a non-Indigenous respondent. A total of 19 caribou were harvested in the previous four survey years, 18 by local Indigenous resource users and one by a non-Indigenous respondent. In all, 26 caribou were harvested: none in 2014, five in 2015, one in 2016, 13 in 2018, and seven in 2019 (no survey was conducted in 2017). Harvesting most likely occurred on days off from work; no firearms were allowed at the Keeyask site.

It is not known where caribou harvests by partner First Nations participants or local Indigenous resource users occurred during construction. Licensed non-Indigenous respondents would have harvested caribou outside Study Zone 4 and east of Gillam in Game Hunting Zone (GHZ) 3, GHZ 2 near Churchill, or GHZ 1, north of South Indian Lake. The demand for caribou licenses in the area remained high and was unchanged over the construction period.

6.1.4 DISCUSSION

6.1.4.1 COMPARISON WITH PREDICTED PROJECT EFFECTS

6.1.4.1.1 WINTER ABUNDANCE ESTIMATES

As expected, and observed prior to Project construction, winter abundance estimates highlighted the continued variability in caribou abundance in the Keeyask region outside the calving season. Few were observed in 2016; most were almost certainly from the Southern Hudson Bay sub-population, and some were likely summer resident caribou. In 2018, many caribou occupied the region, but no aerial survey was conducted to avoid disturbing local resource users. Thousands of caribou thought to be from the Southern Hudson Bay sub-population were observed in 2019, after which no large migrations into the region were noted. Based on the sparse observations north of the Nelson River, it did not appear that caribou crossed the ice in large numbers.

6.1.4.1.2 SUMMER RESIDENT RANGE

Genetic analysis of fecal pellet samples confirmed that some summer resident caribou, whose minimum group size was 25 individuals, also occupy the Keeyask region in winter. Their winter locations, up to 40 km from the Project site, suggest that there is suitable winter habitat in the area that was unaffected by the Project. The winter range of summer resident caribou likely extends beyond the areas surveyed in summer and winter, as suggested by the lack of observations of caribou and their signs during the December 2017 aerial survey. The presence of two individuals in both summer and winter indicates that some caribou remain in the region year-round, but it is unknown if they remained in consecutive years.

6.1.4.1.3 SENSORY DISTURBANCE

The goal of the sensory disturbance study was to evaluate the effects of Project disturbance on caribou calving and rearing while controlling for other important or confounding factors through study design and multivariate statistical modeling. The island and roadside datasets told the same overall story for the effects of disturbance from the Project and other factors on male and female caribou behavior during the calving season.

In both datasets, distance from the Project Footprint (i.e., the generation station, and North and South access roads) was one of the strongest influences on the likelihood that a caribou was present on a 1 km long transect.

Project noise and activity varied throughout the construction phase. Project construction commenced in July 2014. Overall Project activity then ramped up and peaked in 2018 based on the number of construction workers. Noise data, which was available for each year from 2016 to 2018, indicated that Project noise was much higher in 2017 than in 2016 or 2018.

Both the island and roadside transect datasets had the highest number of caribou presences and counts in 2015, which was early in the construction phase. For both presences and counts (ignoring 2017 as per above), 2018 had the lowest number, and then amounts increased in 2020 and 2021 (no data collected in 2019). The multivariate statistical modeling confirmed that these year-to-year differences in caribou presence were highly significant.

Caribou prefer some habitat types over others. This habitat selection may be hierarchical during the calving and rearing season, beginning at the landscape level and continuing down to the site level. That is, they select a landscape with treed islands, they then select an island, and the select specific sites within the island that provide food, shelter, etc. Results from the statistical model supported this hierarchical selection. The roadside modeling included a variable indicating whether the observation fell with an area mapped as caribou calving and rearing habitat for the EIS (i.e., whether it was a suitable peatland complex). This variable was highly significant and made a large contribution to predicting whether a caribou was present.

At the island level, some habitat types had highly significant effects in the models, but their influence on the likelihood of a caribou presence was quite low. This result was not surprising. Since all the islands included in the study were treed, the habitat variables were investigating the importance of the co-occurrence of a type with treed habitat.

The statistical modeling provided strong support that caribou less frequently used islands where moose were present. There was also some support that caribou less frequently used roadside areas where moose were present. The literature indicates that caribou tend to avoid moose, because moose more readily attract predators such as wolves or bears, to a lesser degree. The model unexpectedly showed that black bear presence/abundance was not significant; this may have been the result of sparse data, or it may have been related to the removal and relocation of 25 black bears from the Project site, during the construction period.

Overall, the Stephens Lake island datasets (transect and camera data) provided the best representation of caribou response to Project disturbance in conjunction with other explanatory factors. Examination of where the caribou observations were located found that, depending on the dataset, caribou either avoided or severely reduced use in areas close to the Project Footprint in every construction study year. The degree of this reduced habitat effectiveness varied with construction year, roughly tracking the overall level of Project activity. For example, islands within 2 km of the Project Footprint had the lowest number of caribou counts by far. For cameras, there was only one caribou occurrence within 4 km of the Project Footprint during the seven years of construction, and this might have been an animal moving across the island to get somewhere else rather than using the island for calving. Caribou counts steadily increased from 2 km from the Project Footprint, peaking at 9 km to 11 km, depending on the dataset.

The pattern of increasing and then declining caribou response with distance from the Project Footprint cannot be viewed in isolation. At a given geographic location, a caribou may be exposed to noise and disturbance from sources in addition to the Project. The combined effects of the Project and highways (which captures the Town of Gillam) on caribou events was strong. Island use was most frequent at the highest distances from both the Project Footprint and a highway. The results suggested that the simultaneous minimum distances from the Project and a highway to avoid caribou disturbance could be 7 km and 9 km, respectively. Using the camera data for female behavior suggested that the simultaneous minimum distances from the Project and a highway to avoid caribou disturbance could be 16 km and 12 km, respectively. However, this result must be interpreted cautiously as replication was quite low. These findings will be further examined when the operation data are added to the datasets.

The remaining two statistically significant explanatory variables not yet discussed were unique to each of the models. For islands in lakes, island size was a highly significant and important influence on caribou presence. These results were not unexpected and conform closely with the EIS model. For roadside transects, if the habitat was 23 years post-wildfire, it was significant. The reason for this association is unclear and would require a more in-depth analysis.

6.1.4.1.4 HABITAT EFFECTS

The loss of physical winter habitat and summer calving habitat during Project construction conformed with EIS predictions of a low magnitude effect (<1% of physical habitat in Study Zones 5 and 6). As expected, caribou generally occupied fewer Projected-affected islands in lakes and in peatland complexes than unaffected calving habitats during construction, due at least in part to sensory disturbance.

Caribou occupy very large home ranges and require large core areas of unfragmented habitat to survive. As expected, the total linear feature density in the Local Study Area declined from 1.49 km/km^2 to 1.00 km/km^2. Since the same footprints that existed for the EIS analysis are used to compare predicted and actual Project effects, it is reasonable to assume by extrapolation that linear feature density in the Regional Study Area declined from 0.45 km/km^2 to 0.44 km/km^2 as predicted. Project construction removed one core area that was slightly larger than 1,000 ha, as expected. While a few core areas larger than 200 ha were completely removed, the total number of core areas in the Regional Study Area remained at 111 because several other core areas were fragmented into smaller blocks. The exception was that the actual percentage of land area included in core areas larger than 1,000 ha was 1% lower than predicted. Because both linear feature density and intactness were about the same as was predicted in the EIS, the overall effect of habitat fragmentation for summer resident caribou remains small.

6.1.4.1.5 MORTALITY

There was no indication of significant Project-related caribou mortality during construction monitoring. No accidental mortality was reported, and predators appeared to be relatively sparse. As predicted in the EIS, an increase in hunting pressure from rights-based resource users was observed around the South Access Road when it was partially opened to the public, but the average of five caribou harvested annually by workers over four years likely had a small effect on the regional population. The density of gray wolves in Study Zone 5 indicated a low magnitude effect (<4 wolves/1,000 km^2) of predation on regional caribou populations.

6.1.4.2 CONCLUSIONS

Most of the actual Project effects on caribou during construction were at or below than what was predicted in the EIS. The physical amount of caribou calving and winter habitat loss was less than predicted. Multivariate statistical modeling suggested that loss of effective caribou calving habitat due to sensory disturbance from the Project was greater than predicted, with effects possibly extending as far as 7 to 9 km from the Project, compared to only 4 km predicted in the EIS.

6.1.4.3 FUTURE MONITORING

Caribou monitoring will continue during the Project operation phase.

The construction phase monitoring did not identify the need to alter any of the methods for the operation phase.

During Project operation, winter abundance monitoring will occur opportunistically, when the migratory caribou herds enter the Keeyask region. Mortality monitoring will occur incidentally along with other surveys. One year of trail camera monitoring was added to the TEMP to confirm there were no unexpected effects in the first few years following reservoir impoundment.

6.2 MOOSE

6.2.1 BACKGROUND

Moose are widely distributed and common in the Keeyask region. Predicted Project effects on moose included habitat loss and alteration, changes in moose distribution in Study Zone 5, and mortality due to collisions with vehicles and increased harvest by resource users. While there was a high degree of certainty for EIS predictions of Project effects on moose, the partner First Nations expressed concerns about changes to moose habitat and populations.

To assess Project effects on moose and verify EIS predictions, three monitoring studies were conducted during construction. The Population Estimate study quantified trends in the number of moose in Study Zone 5 and evaluated whether winter habitat use was affected by the Project. The Habitat Effects study included several components to quantify Project effects on the amount of moose habitat in the region. The EIS considered that a 10% cumulative loss of historical habitat area for moose was the benchmark that triggered management concern, which was applied for moose habitat effects monitoring. The Mortality study qualitatively evaluated the effects of predation, harvest, and collisions with vehicles on the local moose population during Project construction.

6.2.2 MONITORING

6.2.2.1 POPULATION ESTIMATE

Aerial (fixed-wing and helicopter) surveys for moose were conducted in January 2015, 2018, and 2022, in an area overlapping Study Zone 5. Regularly spaced stratification transects were initially flown with a fixed-winged plane and all instances of moose tracks were recorded. The area was divided into rectangular sample units and the density of moose tracks in each was categorized as low, medium, or high. A random sample of the units from each track density category was intensively searched by a helicopter (Photo 6-3) for moose; these counts were used to estimate the size and composition of the moose population in the Keeyask region.

Photo 6-3: Observer in helicopter during aerial survey for moose, 2018

6.2.2.2 HABITAT EFFECTS

The EIS classified primary moose habitat as forest stands dominated by broadleaf trees, jack pine, and tall shrubs, and secondary moose habitat as forest stands dominated by black spruce and low vegetation. Before Project construction, primary habitat covered 38% of Study Zone 5 and secondary habitat covered the remainder. About 10% of Study Zone 4 was composed of primary habitat and 69% was secondary habitat. A loss of approximately 1% of moose habitat in Study Zone 5 was anticipated in the EIS, and habitat alteration was predicted to be within the range of natural variation; the effect on the regional moose population was expected to be negligible to small. A habitat quality model was applied to the monitoring data and used to compare actual with predicted Project effects.

6.2.2.3 MORTALITY

Project-related moose mortality was expected to have a negligible effect on the regional population. To evaluate the EIS prediction, predator (black bear and gray wolf) abundance and distribution data collected for sensory disturbance monitoring were incorporated into analyses of Project effects. Changes in harvesting pressure were assessed through hunting license and harvest data collected during resource use surveys. Accidental mortality reported by Project staff during construction was also evaluated. Resource use by the workforce was monitored as part of the Keeyask Generation Project *Resource Use Monitoring Plan*.

6.2.3 RESULTS

6.2.3.1 POPULATION ESTIMATE

The moose (Photo 6-4) population in Study Zone 5 ranged between an estimated 1,007 and 1,162 individuals during Project construction (Table 6-3). A small decline was observed over the survey period, but the population was similar in 2018 and 2022 and was 5% higher in 2022 than in 2010, before Project construction began. In Study Zone 4, the population was greatest in 2018 and lowest in 2022. There was a 36% increase in the moose population between 2010 and 2022.

The bull:cow ratio declined in Study Zones 4 and 5 during Project construction in comparison to the ratio observed prior to construction in 2010 (Table 6-4). During the same period the calf:cow ratio varied and compared to the ratio observed prior to construction in 2010, it was lower in 2018, but higher in 2022. For comparison, there were 118 bulls/100 cows and 36 calves/100 cows in the entire Split Lake Resource Management Area during the 2010 survey.

Photo 6-4: Moose observed during aerial survey, 2018

Table 6-3: Estimated moose population in Study Zones 4 and 5 before (2010) and during (2015, 2018, and 2022) Project construction

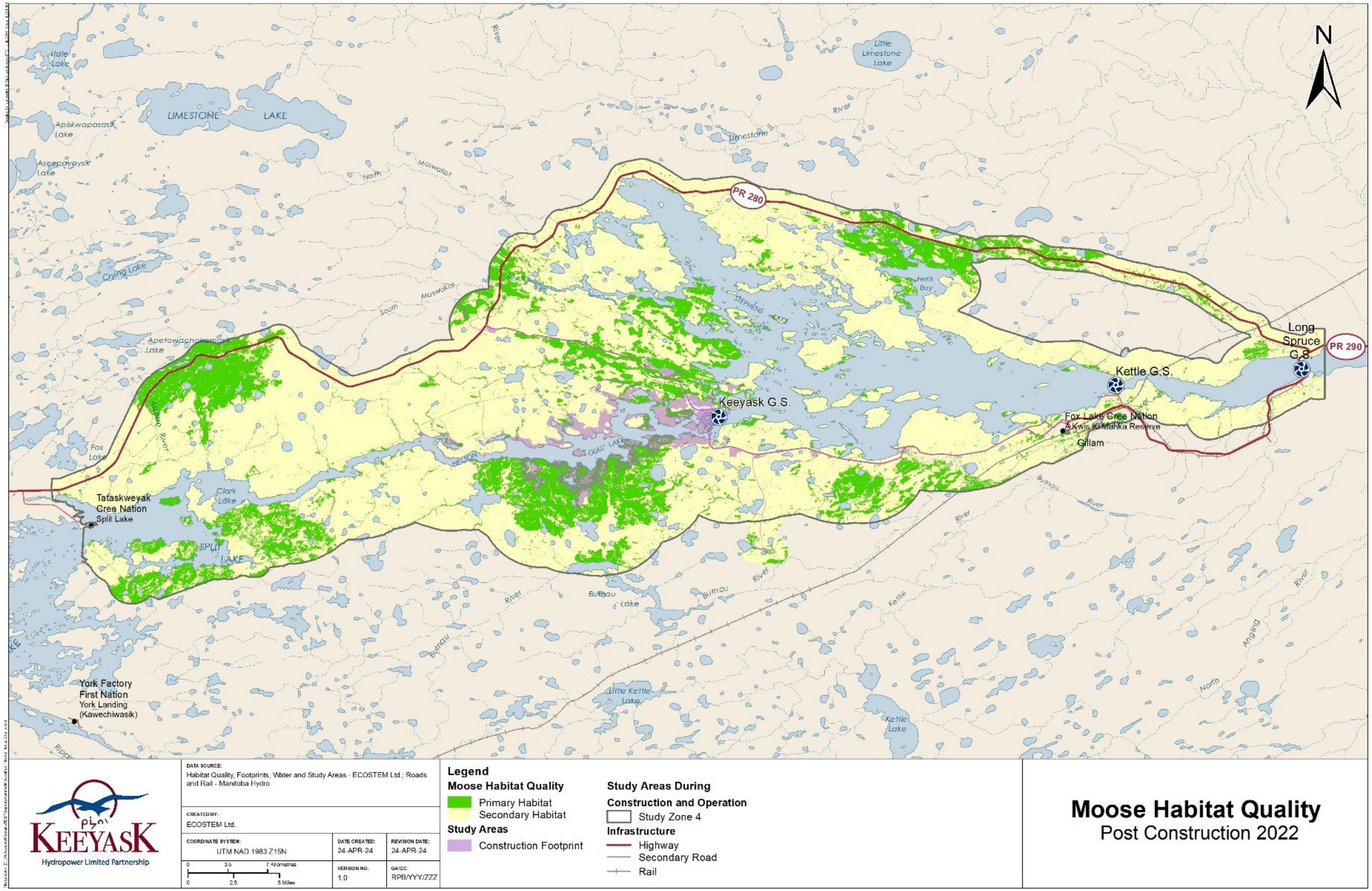
Study Zone	2010	2015	2018	2022	% Change 2015–2018	% Change 2018–2022	% Change 2010–2022
5	961	1,162	1,040	1,007	-10	-3	+5
4	125	176	196	170	+11	-13	+36

Table 6-4: Bull:cow and calf:cow ratios in Study Zones 4 and 5, 2015, 2018, and 2022

Study Zone	2015		2018		2022	
	Bulls/100 Cows	Calves/100 Cows	Bulls/100 Cows	Calves/100 Cows	Bulls/100 Cows	Calves/100 Cows
5	51	50	29	44	38	55
4	51	49	28	43	38	56

6.2.3.2 HABITAT EFFECTS

Pre-construction habitat models for moose indicated that 12,248 ha of primary and secondary moose habitat would be affected by the Project, or approximately 1% of moose habitat in Study Zone 5 (Map 6-3). The actual loss of habitat was slightly less than predicted at 10,796 ha, still at about 1% of moose habitat in Study Zone 5.

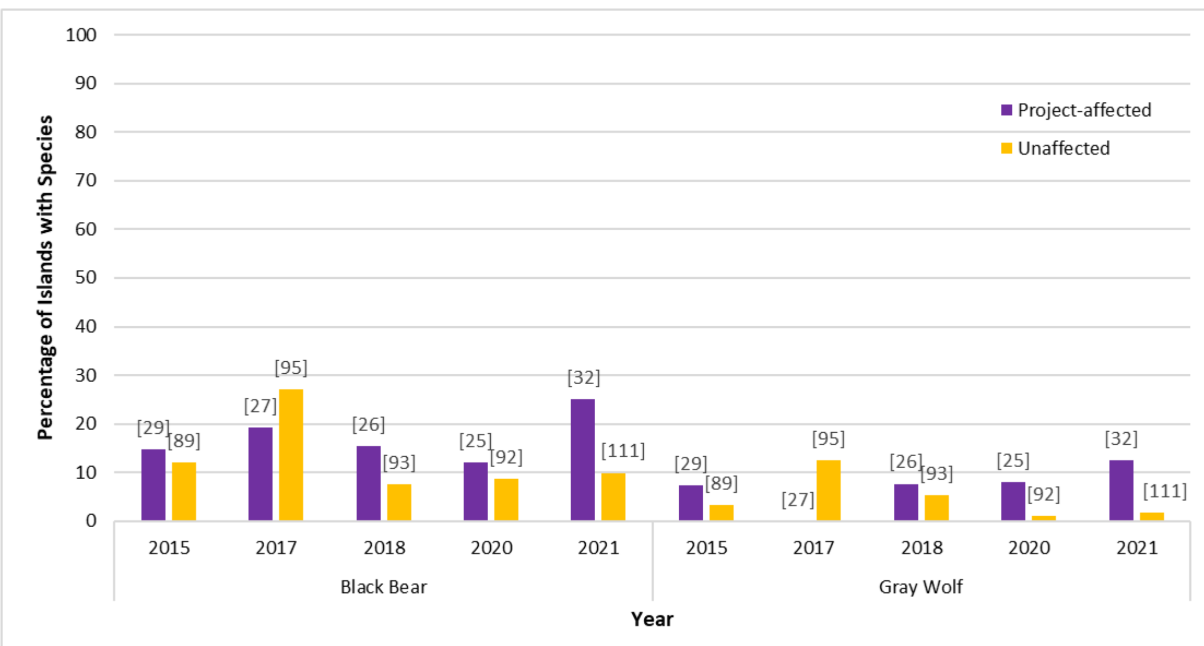


Map 6-3: Moose habitat quality, post-construction, 2022

6.2.3.3 MORTALITY

Moose mortality was monitored during Project construction. A portion of Project workers (7 to 23%) completed resource use surveys over a five-year period. In the 2019 study year (November 2018 to October 2019), workers reported harvesting seven moose; all were harvested by partner First Nations participants. Harvesting most likely occurred on days off from work as no firearms were allowed at the Keeyask site. Manitoba Conservation and Climate indicated that the local demand for moose licences could not be tracked however, they had observed a small increase in hunting pressure from licensed and rights-based resource users around the South Access Road and on a nearby network of trails when the road was partially opened to the public. A total of 19 moose were harvested in the previous four survey years, 14 by local Indigenous resource users. Non-local Indigenous and Métis participants harvested three moose and non-Indigenous respondents harvested two. In all, 26 moose were harvested, three in 2014, four in 2015, two in 2016, 10 in 2018, and seven in 2019 (no survey was conducted in 2017). In 2019, a single moose mortality of unknown cause was reported during the construction period by site staff.

Relatively little black bear and gray wolf activity was observed on islands in lakes (Figure 6-6) and in peatland complexes (Figure 6-7) during caribou sensory disturbance monitoring surveys. No apparent changes in predator abundance and distribution were observed, suggesting that there was no effect on moose mortality.



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

Figure 6-6: Percentage of Project-affected and unaffected islands in Study Zone 4 on which black bear and gray wolf activity was observed from combined trail camera and tracking transect data during Project construction (2015–2021)

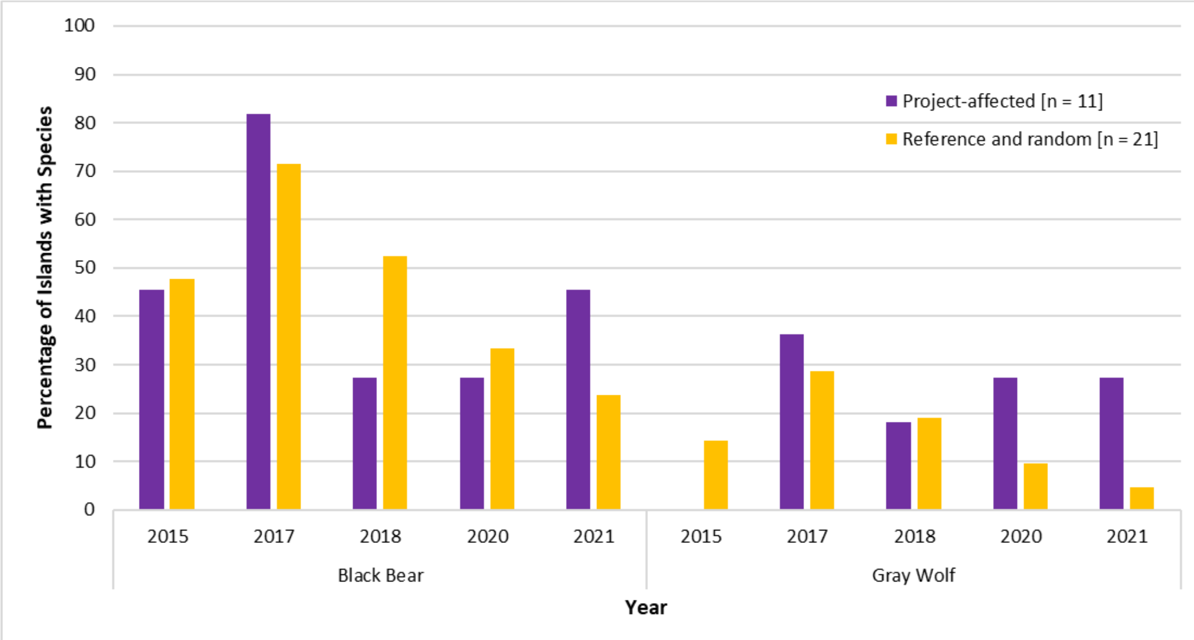


Figure 6-7: Percentage of Project-affected and reference and random peatland complexes in Study Zone 5 on which black bear and gray wolf activity was observed from combined trail camera and tracking transect data during Project construction (2015–2021)

The number of gray wolves observed during aerial surveys for caribou and moose varied during Project construction (Table 6-5). The greatest number (20) was during the 2018 moose survey and coincided with large numbers of migratory caribou in the region. Most gray wolf observations were made south of the Nelson River. Wolf density ranged from less than 1 to 1.2 individuals/1,000 km², and averaged of 0.5 individuals/km².

Table 6-5: Gray wolves observed in Study Zone 5 through aerial surveys for caribou and moose during Project construction (2015–2022)

Year	Number of Wolves	Number of Groups	Area Surveyed (km²)	Density (wolves/1,000 km²)
2015	2	2	16,790	<0.1
2016	4	3	8,400	0.4
2018	20	7	16,790	1.2
2019	5	3	10,530	0.3
2022	7	1	16,790	<0.1

6.2.4 DISCUSSION

6.2.4.1 COMPARISON WITH PREDICTED PROJECT EFFECTS

The moose population in Study Zone 5 declined somewhat from 2015 to 2018 but was stable in 2022. The moose population in Study Zone 4 increased between 2015 and 2018 and declined by a similar percentage in 2022, suggesting that the population was relatively stable over the survey period. The increases in both study zones, particularly in Study Zone 4, from the pre-construction survey in 2010 to the end of construction in early 2022 indicates that Project construction had a minimal effect on the local and regional moose populations and their distributions. The changes in moose habitat along with any sensory disturbance caused by the Project may have been countered by the regeneration of habitat from the large forest fire that occurred in the area in 2013, and the reduction of harvest pressure in the area due to the restricted access to the construction site and the prohibition of hunting by site staff.

The bull:cow ratios in Study Zones 4 and 5 during Project construction were considerably lower than the ratio in the broader Split Lake Resource Management Area in 2010. The high ratio of bulls to cows indicated that too many cows were being harvested. The more recent numbers of bulls suggested that more bulls than cows were being harvested. The selective harvesting of bulls advocated in the Cree Nation Partners' Moose Harvest Sustainability Plan could have accounted, at least in part, for the positive change in population structure.

As predicted in the EIS, approximately 1% of the moose habitat in Study Zone 5 was affected by Project construction. The magnitude of effect was low (<1% of the region). The regional and local moose populations were larger during the final year of construction monitoring than before construction began and the population structure had improved.

A single Project-related moose mortality was recorded over the construction period. As predicted in the EIS, the effects of increased moose mortality on the regional population were negligible. The density of gray wolves in Study Zone 5 indicated a low magnitude of effect (<4 wolves/1,000 km²) of predation on regional caribou populations.

6.2.4.2 CONCLUSIONS

Moose numbers were relatively stable in the Keeyask region during Project construction, as shown during surveys conducted in 2015, 2018, and 2022. Overall moose abundance was higher than seen during the pre-construction survey in 2010. Because the physical effects of habitat loss were at or less than what was predicted, and since the local and regional moose population improved, the magnitude of the actual Project effects was likely lower than predicted during the construction phase.

6.2.4.3 FUTURE MONITORING

Moose population monitoring will continue during the Project operation phase.

The construction phase monitoring did not identify the need to alter any of the methods for the operation phase.

6.3 BEAVER AND MUSKRAT

6.3.1 BACKGROUND

The beaver is a large aquatic furbearer that inhabits waterbodies in forested areas. Beavers are common in the Keeyask region and are an important furbearer species, having cultural, economic, and ecological value. Beavers do not typically inhabit the main channel of the Nelson River due to strong currents. However, the nearby creeks, ponds, and lakes provide suitable habitat. Muskrats, which occupy similar habitat, are also important furbearers in the Keeyask region.

Predicted Project effects on beaver during construction related mainly to mortality in the Project footprint (Study Zone 1). It was expected that 20 to 30 active beaver colonies would be removed from the future reservoir area during pre-impoundment vegetation clearing, which was less than 10% of the estimated regional population in Study Zone 4. Conflicts with humans, particularly in construction areas where beavers could plug culverts and flood the access roads, were expected to result in control measures that would remove some individuals from the local population. Project-related effects on beaver in Study Zone 4 were expected to be small, and similar effects on muskrat were anticipated.

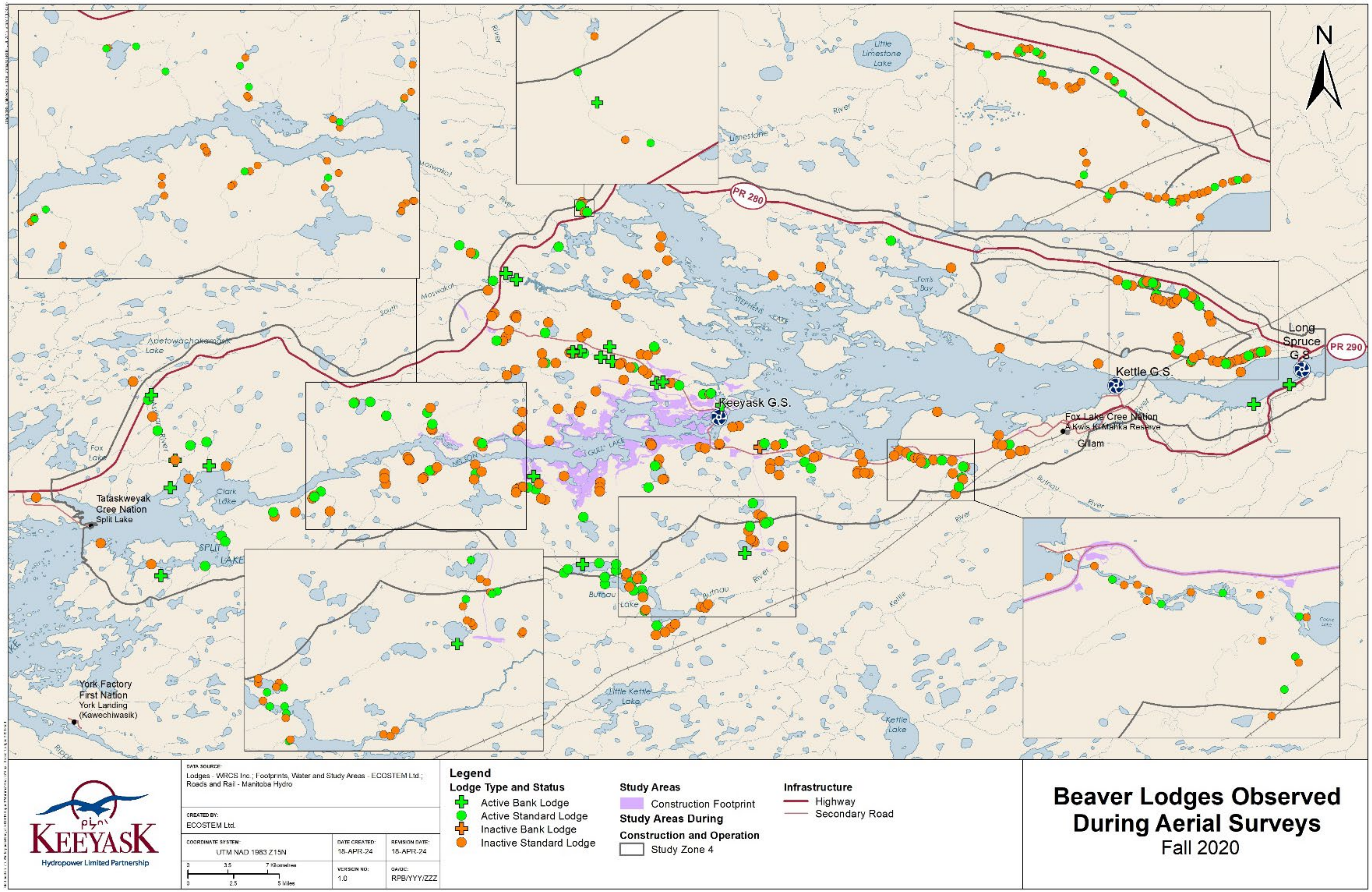
The objectives of beaver and muskrat mortality monitoring were to quantify the removal of individuals from the future reservoir area prior to impoundment and to evaluate beavers' response to beaver baffles installed at blocked culverts, control structures, and bridges if safety hazards for humans were created.

6.3.2 MONITORING

6.3.2.1 HABITAT EFFECTS

Aerial surveys for construction-phase beaver habitat effects monitoring began in fall 2016 and continued in 2017. The survey was expanded in 2018 and repeated in 2019 and 2020 along shorelines in waterbodies and waterways within Study Zone 4. In 2020, a monitoring survey was conducted in early September during reservoir impoundment, and a subsequent survey that focused on the newly expanded Gull Lake shoreline was conducted in October (Map 6-4). A survey of the Keeyask reservoir and the Nelson River upstream to Clark Lake was conducted in 2021, which included a small region in Study Zone 4. The locations of active and inactive beaver lodges were recorded each survey year. Characteristics such as lodge volume, food cache size, and water depth were measured at a sample of lodges. A habitat quality model will be applied to the monitoring data and used to compare actual with predicted Project effects following operation monitoring.

An aerial survey for muskrat push-ups was conducted during Project construction in the spring of 2018, 2019, and 2021 in Study Zone 4. Pre-selected survey routes were flown in a helicopter. Two observers and a pilot searched the shorelines of the Nelson River between the Kettle and Long Spruce generating stations as well as smaller waterways and waterbodies in the region for signs of muskrat activity.



Map 6-4: **Beaver lodges observed during 2020 aerial surveys**

6.3.2.2 MORTALITY

There were two components to beaver and muskrat mortality monitoring. The removal study recorded the number of each species trapped out (Photo 6-5) of the future reservoir area over several years to reduce potential starvation and drowning deaths during and after impoundment. Mitigation efficacy monitoring was intended to examine the response of beavers to beaver deterrents (e.g., beaver baffles and cones). One beaver cone was installed on a culvert along the South Access Road to prevent blockage during Project construction. Project-related beaver and muskrat mortality was also reported.

Photo 6-5: Trapping beaver out of the future reservoir area, 2017

6.3.3 RESULTS

6.3.3.1 HABITAT EFFECTS

The density of active beaver lodges (Photo 6-6) in the Project footprint (Study Zone 1) was similar in 2018 and 2019, before the Keeyask reservoir was impounded, and declined in 2020 due mainly to the submergence of four lodges during reservoir impoundment. There were two additional active lodges in the Project footprint that were beyond the reservoir area in 2020. The density of active lodges increased in Study Zone 1 from 2020 to 2021. Of the nine active lodges observed in Study Zone 1 in 2021, three were identified as inactive the previous year, three were observed in 2018 and 2019 but not in 2020, and three were new (Map 6-6). One of the active lodges observed in 2020 was inactive in 2021 and the other was not observed during the 2021 survey. The density of active lodges in Study Zones 1–3 also declined from 2018 to 2021 (Table 6-6), due in part to reservoir impoundment. The density of active lodges in Study Zones 1–4 was similar before (2018 and 2019) and after (2020) reservoir impoundment, suggesting that the Project effects on the regional beaver population were small, as predicted in the EIS.

Photo 6-6: Active beaver lodge, 2020

Table 6-6: Number and density (lodges/km) of beaver lodges in Study Zones 1 to 4 during Project construction (2018–2021)

Study Zone	Lodge Status	2018		2019		2020		2021[1]	
		Number	Density	Number	Density	Number	Density	Number	Density
1	Active	4	0.02	7	0.03	2	0.01	9	0.03
	Inactive	28	0.12	37	0.16	15	0.07	3	0.01
2	Active	4	0.05	7	0.10	2	0.03	1	0.08
	Inactive	6	0.08	10	0.14	11	0.15	1	0.08
3	Active	47	0.21	42	0.19	33	0.15	7	0.13
	Inactive	43	0.19	78	0.35	72	0.33	23	0.44
1–3	Active	55	0.10	56	0.11	37	0.07	17	0.05
	Inactive	77	0.15	125	0.24	98	0.19	27	0.08
4	Active	59	0.06	56	0.06	51	0.05	1	0.02
	Inactive	60	0.06	104	0.10	78	0.08	3	0.05
1–4	Active	114	0.07	112	0.07	88	0.06	18	0.05
	Inactive	137	0.09	229	0.15	176	0.12	30	0.08

1. The 2021 survey focused on the Keeyask reservoir, so a much smaller portion of Study Zone 4 was surveyed.

In Study Zones 1–3 and 1–4, the density of active beaver lodges was lower in 2020 and 2021, after reservoir impoundment, than in previous survey years (Figure 6-8). There was no significant difference in the mean density of active beaver lodges among the pre-construction (2001, 2003), construction pre-impoundment (2018, 2019), and construction post-impoundment (2020, 2021) phases in Study Zones 1–3. When the combined pre-impoundment phase (2001, 2003, 2018, and 2019) and the post-impoundment phase (2020, 2021) were compared, active lodge density was significantly lower after the reservoir was impounded.

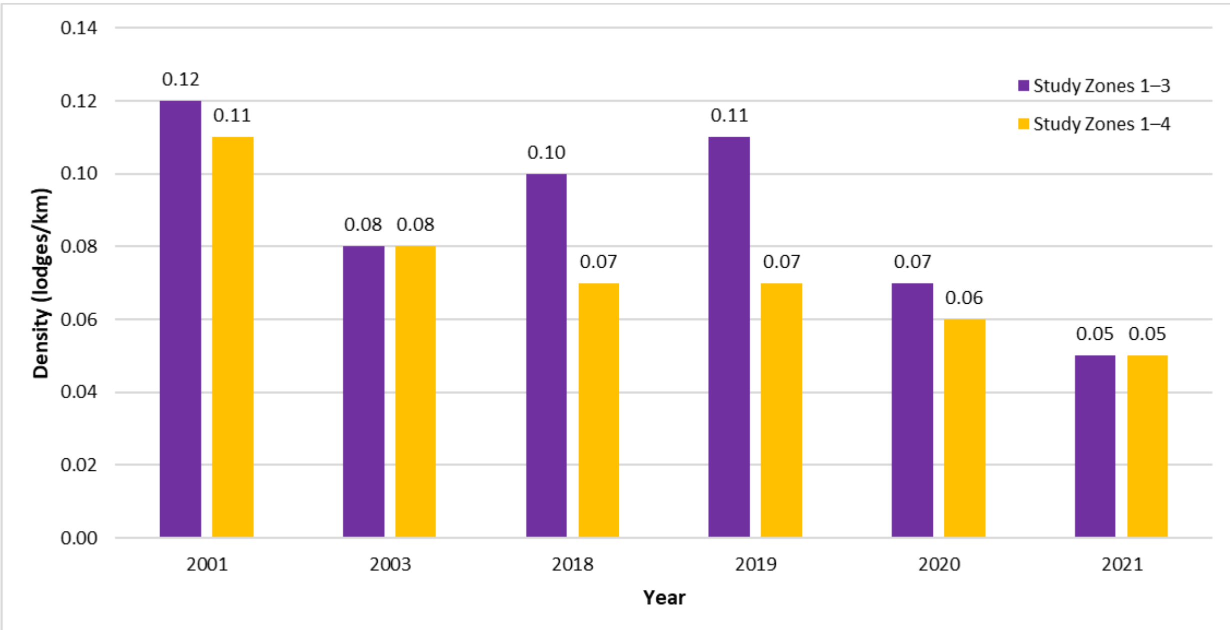


Figure 6-8: Density of active beaver lodges in Study Zones 1–3 and 1–4 before (2001, 2003) and during (2018–2021) Project construction

Muskrats are widely distributed in Study Zone 4 (Map 6-5). Aerial surveys for muskrat were previously conducted in the Keeyask region in spring 2001, 2003, and 2006 for the Project's environmental assessment. On all waterbody types, push-up density increased from 2001 to 2003 and then decreased in 2006. Total push-up density ranged from 0.14 in 2001 to 0.22 in 2003 (Figure 6-9). The total density of muskrat push-ups was lower in 2021 than in all previous survey years, having decreased 90% from 2006 to 2021.

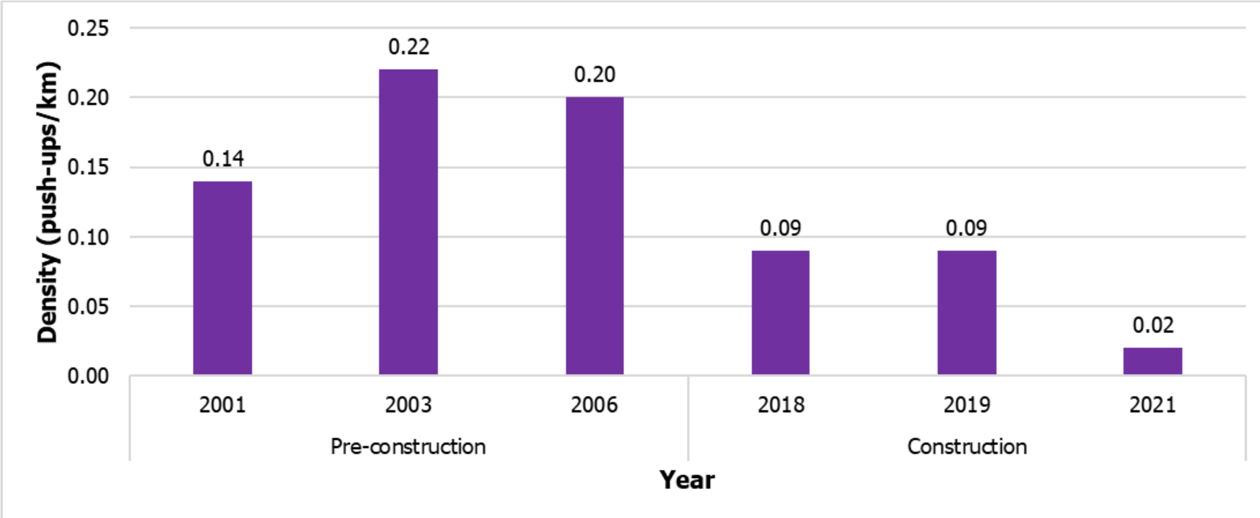
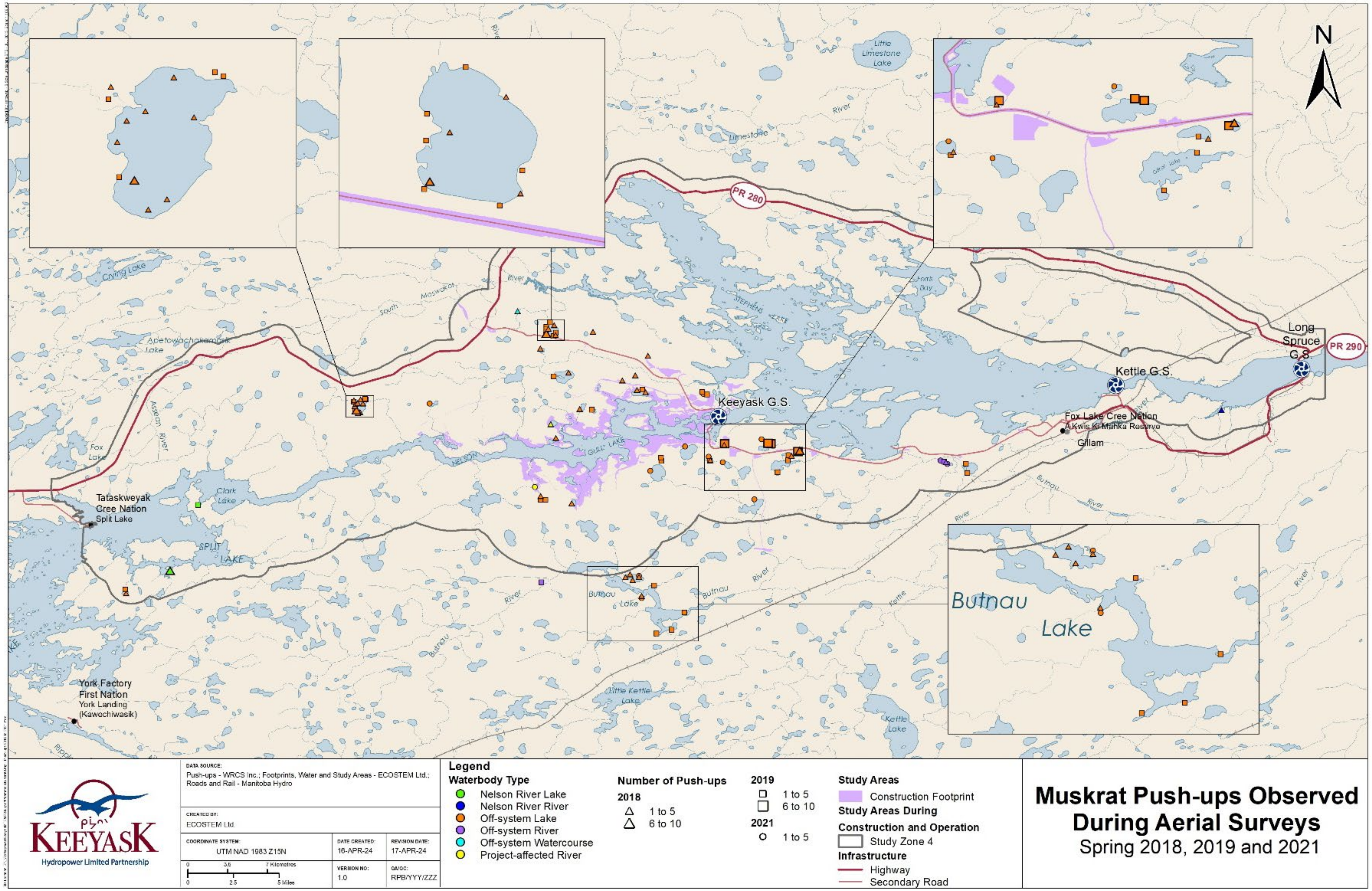


Figure 6-9: Density of muskrat push-ups before (2001, 2003, 2006) and during (2018, 2019, 2021) Project construction

There was no significant difference in the mean density of muskrat push-ups before and during Project construction on lakes and rivers in the Keeyask region (Table 6-7). However, the mean density of muskrat push-ups was significantly lower during Project construction than before on off-system watercourses in the region ($p = 0.02$) and overall ($p = 0.02$).



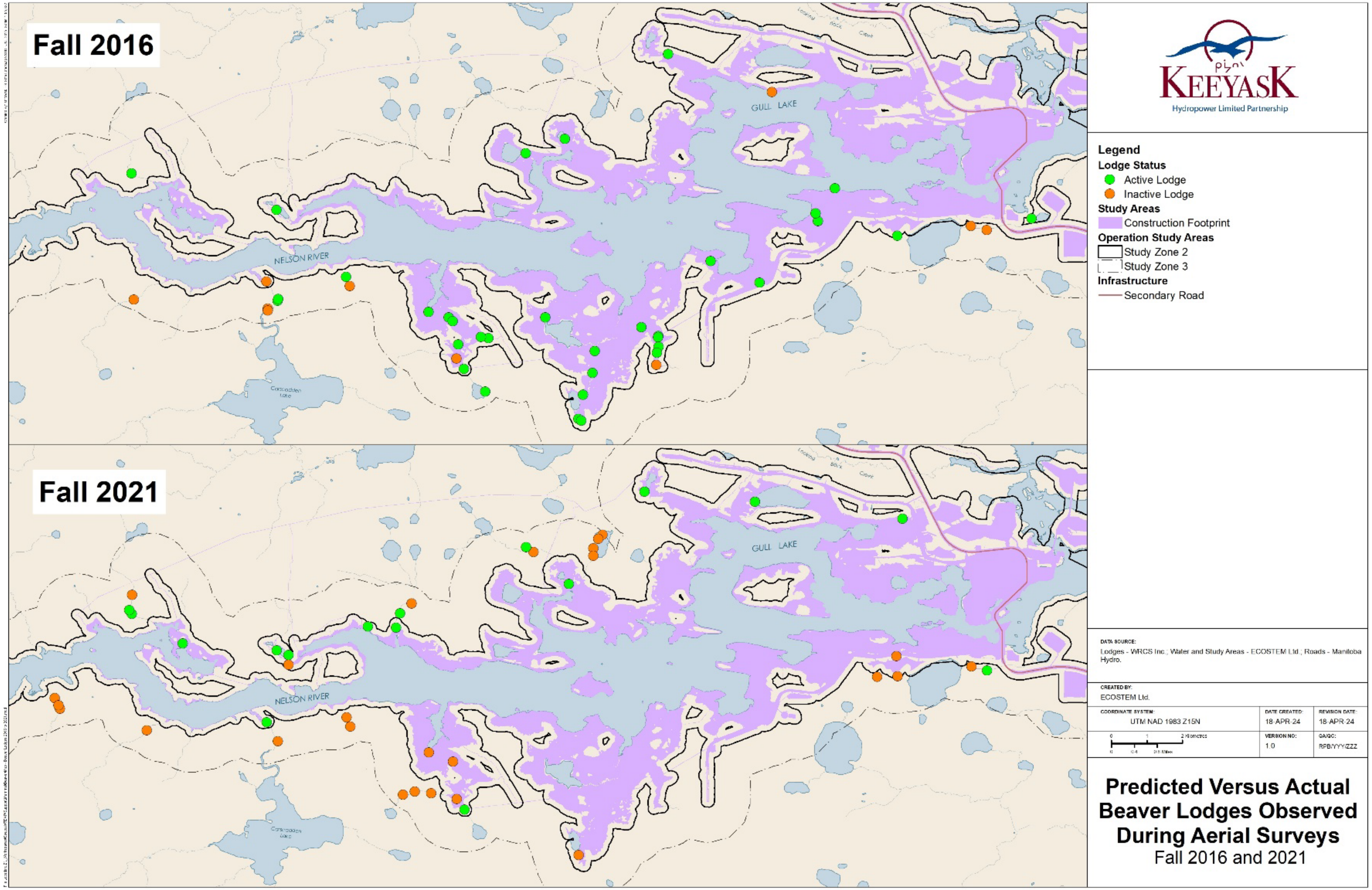
Map 6-5: Muskrat push-ups observed during aerial surveys, spring 2018, 2019 and 2021

Table 6-7: Density of muskrat push-ups in the Keeyask Region before (2001, 2003, 2006) and during (2018, 2019, 2021) Project construction

	Pre-construction		Construction			
Waterbody Type	**Mean**	**Variance**	**Mean**	**Variance**	***t***	***p***
Lake	0.15	<0.01	0.10	0.01	2.78	0.38
River	0.07	<0.01	0.02	<0.01	4.30	0.13
Watercourse	0.31	0.01	<0.01	<0.01	4.30	0.02
Total	0.19	<0.01	0.07	<0.01	2.78	0.02

6.3.3.2 MORTALITY

A total of 45 beavers were removed from 18 lodges in the future reservoir area from 2017 to 2020 during the Project trapping program. Six active lodges were observed in the reservoir area during impoundment monitoring surveys. Three of the active lodges were new and had not been observed in previous survey years, while the other three had either not been completely trapped out or were re-occupied before the reservoir was impounded. In all, 22 lodges were affected by trapping and/or reservoir impoundment. Predicted versus actual beaver lodges observed during aerial surveys in fall 2016 and 2021 are shown on Map 6-6.



Map 6-6: Predicted versus actual beaver lodges observed during aerial surveys, fall 2016 and 2021

Two beaver mortalities were recorded between 2014 and 2021 that included one vehicle collision (Table 6-8). Seven muskrats were trapped out of the future reservoir area during the Project trapping program from 2017 to 2020. Eight muskrat mortalities were recorded between 2016 and 2020, five of which were from or suspected to be from collisions with vehicles on the Project site.

Table 6-8: Beaver and muskrat mortalities reported during Project construction (2014–2021)

Year	Species	Cause	Number
2014	None	No mortality	0
2015	None	No mortality	0
2016	Muskrat	Unknown	1
2017	Beaver	Vehicle collision	1
2017	Muskrat	Vehicle collision	3
2018	Muskrat	Suspected vehicle collision	1
		Unknown	1
2019	Muskrat	Suspected vehicle collision	1
		Likely fell from structure	1
2020	Beaver	Unknown	1
2021	None	No mortality	0

6.3.4 DISCUSSION

6.3.4.1 COMPARISON WITH PREDICTED PROJECT EFFECTS

The number of active beaver lodges observed in Study Zone 1 during fall aerial surveys declined during construction due to: the removal of beavers from lodges in the future reservoir area as part of the Project's pre-impoundment trapping program; tree clearing and noise disturbance in the future reservoir area, which likely reduced the quality of habitat nearby; the inundation of four lodges in the reservoir during impoundment; and another two lodges in the reservoir becoming inactive following impoundment.

The density of active beaver lodges fluctuated in Study Zones 1–3 during the pre-construction (2001, 2003) and construction (2018–2021) periods, due in part to the removal of beavers from the future reservoir area from 2017 to 2020. While active lodge density was lowest after reservoir impoundment, there was no significant difference between the pre-construction and construction periods in Study Zones 1–3. Active lodge density was significantly lower after impoundment than during the combined pre-impoundment period. However, there was a small increase in active lodge density in 2021, when three new lodges were observed in the reservoir, suggesting that suitable habitat was at least temporarily available along the new shoreline and that beavers had begun to re-colonize the area surrounding the reservoir. As predicted in the EIS, Project effects included a small reduction in the local beaver population.

In Study Zones 1–4, the density of active lodges declined somewhat over the pre-construction and construction periods but there was little variation after 2001. As predicted in the EIS, less than 10% of the of the estimated regional beaver population in Study Zones 1–4 was affected; 20 to 30 colonies were expected to be lost and 22 colonies were ultimately removed. No substantial decline was observed, suggesting that reservoir impoundment had a minimal effect on the regional beaver population, as expected.

Reservoir impoundment has resulted in the loss of some muskrat habitat, as predicted in the EIS. Overall, muskrat push-up density in the Keeyask region was lower during Project construction monitoring than in previous years. The difference in regional push-up density could be due to changes in the muskrat population since the early 2000s. The lower density of push-ups during construction monitoring from 2018 to 2021 could be an indication of the regional population at or nearing the low phase of its cycle.

6.3.4.2 CONCLUSIONS

The density of active beaver lodges in the Local Study Area was significantly lower after the reservoir was impounded in 2020 than before. However, there was a small increase in active lodge density in 2021, with three new lodges observed in the reservoir, suggesting that suitable habitat was at least temporarily available along the new shoreline and that beavers had begun to re-colonize the area surrounding the reservoir. As predicted in the EIS, Project effects included a small reduction in the local beaver population.

In the Regional Study Area (Study Zone 4), the density of active lodges declined somewhat over the pre-construction and construction periods but there was little variation after 2001. No substantial decline in lodge density was observed, suggesting that reservoir impoundment had a minimal effect on the regional beaver population, as predicted in the EIS.

Reservoir impoundment has resulted in the loss of some muskrat habitat, as predicted in the EIS. Muskrat activity declined from the pre-construction to construction period, for reasons that are unclear. Because the amount of suitable habitat for muskrats in the Project footprint was limited prior to the start of construction, as described in the EIS, and off-system watercourses also showed a decrease in muskrat push-up density in the broader region, the decrease is likely not primarily attributable to Project-related habitat loss.

6.3.4.3 FUTURE MONITORING

Beaver and muskrat monitoring will continue during the Project operation phase.

The construction phase monitoring did not identify the need to alter any of the methods for the operation phase.

6.4 RARE OR REGIONALLY RARE SPECIES

6.4.1 WOLVERINE

6.4.1.1 BACKGROUND

The wolverine is a medium-sized carnivore with a large home range. It prefers intact habitat and naturally occurs at low densities. The wolverine is listed as a species of Special Concern by the Committee on the Status of Endangered Wildlife in Canada and under the federal *Species at Risk Act*. It is not listed as a species at risk under *The Endangered Species and Ecosystems Act* of Manitoba. It is harvested by registered trappers in Manitoba.

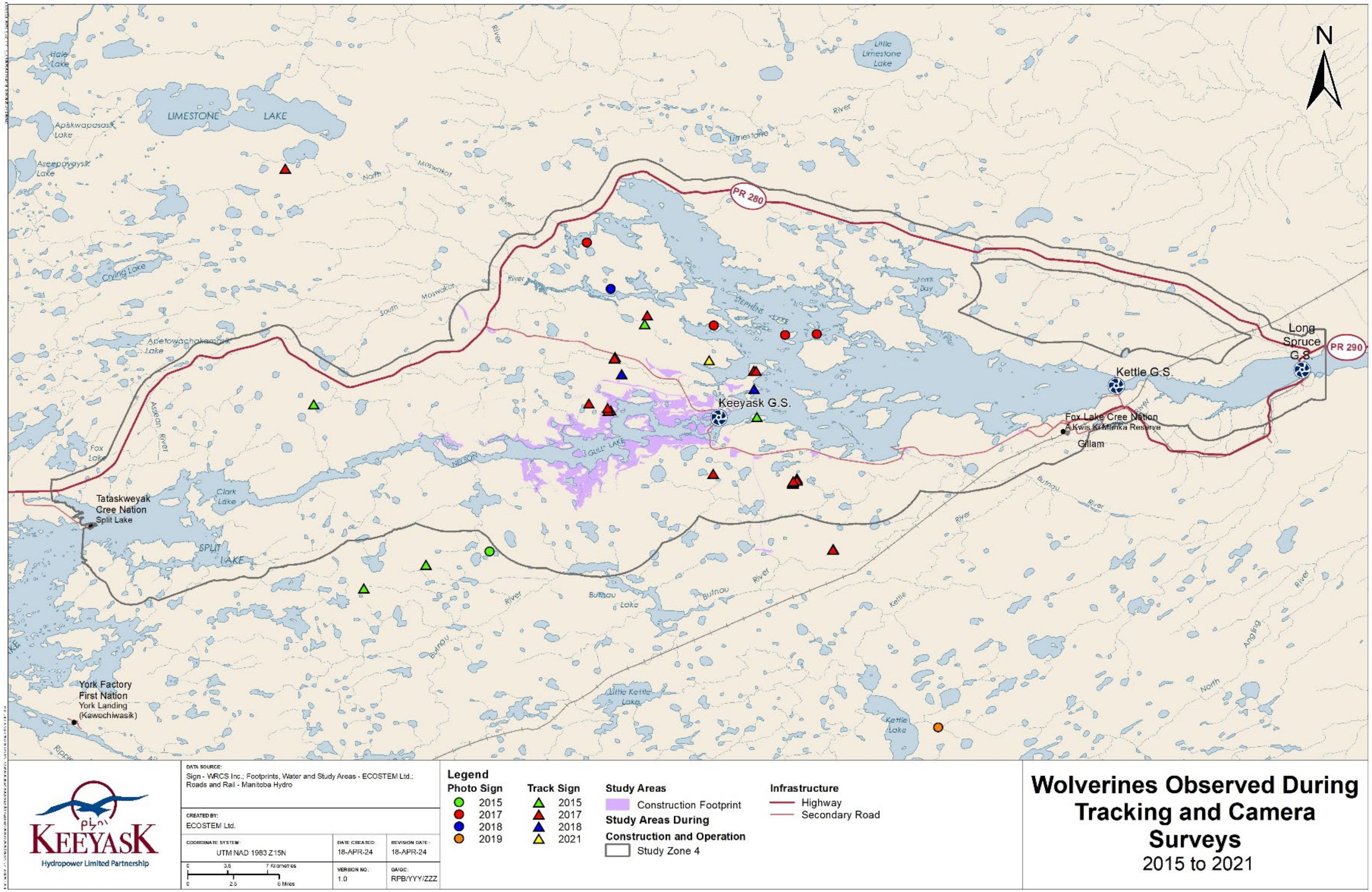
Predicted Project effects on wolverines were reduced habitat intactness and increased mortality from overharvesting due to increased access to the area. The objectives of wolverine monitoring were to evaluate Project-related changes to the density of linear features and core area for wolverine and to estimate how Project-related harvest and accidental mortality affected its abundance. Effects on wolverine were expected to be minimal due to their low density in the Keeyask region.

6.4.1.2 MONITORING

No monitoring studies specific to wolverine were conducted during Project construction. Observations made during surveys for caribou (Section 6.1) and moose (Section 6.2) within Study Zone 6 were compiled. Linear feature density and core area and intactness results were reviewed as per Section 2.4. Harvest records from resource use surveys and accidental mortality reported during construction were reviewed.

6.4.1.3 RESULTS

Wolverine presence (Photo 6-7) was observed on 7 islands in Stephens Lake, in 11 peatland complexes, and on six transects along the North and South access roads during caribou sensory disturbance monitoring surveys from 2015 to 2021 (Map 6-7). Most wolverine activity was observed in 2017 (Table 6-9). No wolverine observations were recorded during caribou winter abundance or summer resident range aerial surveys. A single wolverine was observed during an aerial survey for moose.



Map 6-7: Wolverines observed during tracking and camera surveys, 2015 – 2021

Table 6-9: Number of sensory disturbance monitoring transects on which wolverine activity was observed from trail camera and tracking transect data during Project construction (2015–2021)

Year	Islands	Peatland Complexes	Road
2015	1	4	1
2016	0	0	0
2017	5	5	5
2018	1	1	1
2019	0	1	0
2020	0	0	0
2021	1	0	1

As described in Section 2.4, the net total length of linear features created by the Project during construction was 91.7 km which was 22.8 km higher than assumed for the EIS. The total linear feature density in the Local Study Area declined from 1.49 km/km^2 to 1.00 km/km^2. Project construction removed one core area that was slightly larger than 1,000 ha and two core areas that were between 200 ha and 1,000 ha in size. Additionally, several larger core areas on the north and south sides of the Nelson River became smaller.

No wolverine mortalities were reported during Project construction. Because trapping is conducted by permit holders on registered traplines, there was no wolverine harvest by the workforce.

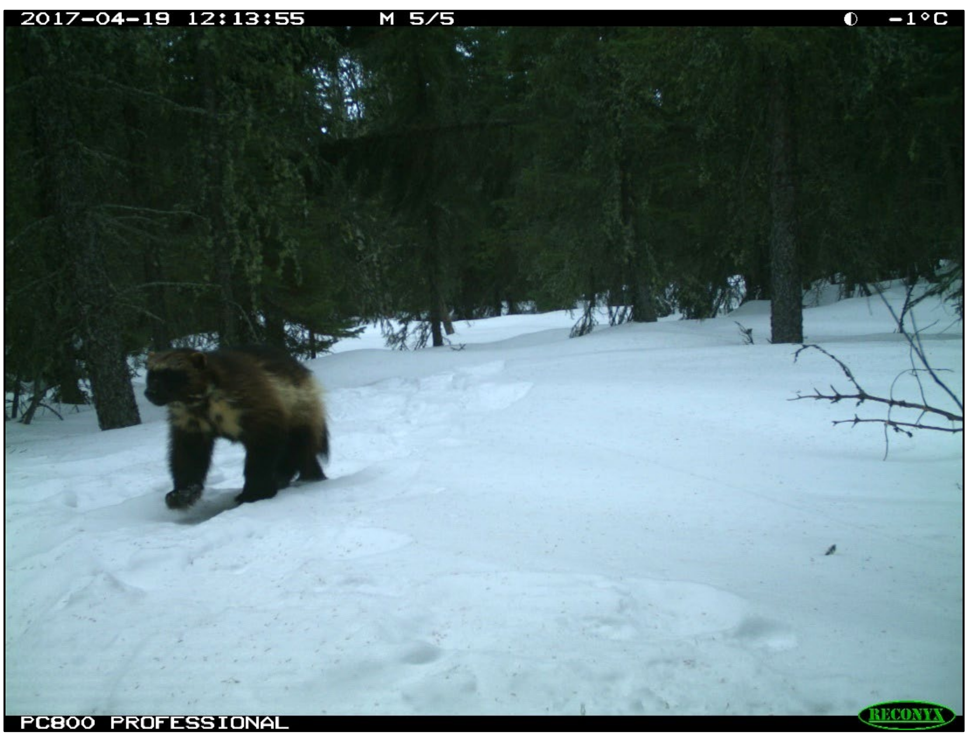


Photo 6-7: Wolverine on an island in Stephens Lake, 2017

6.4.1.4 DISCUSSION

6.4.1.5 COMPARISON WITH PREDICTED PROJECT EFFECTS

As expected, wolverines were sparse in the Keeyask region during Project construction. Wolverines occupy very large home ranges and require large core areas of unfragmented habitat to survive. As expected, the total linear feature density in the Local Study Area declined from 1.49 km/km^2 to 1.00 km/km^2. By extrapolation, it is reasonable to assume that linear feature density in the Regional Study Area declined from 0.45 km/km^2 to 0.44 km/km^2 as predicted. Project construction removed one core area that was slightly larger than 1,000 ha, as expected. While a few core areas larger than 200 ha were completely removed, the total number of core areas in the Regional Study Area remained at 111 because several other core areas were fragmented into smaller blocks. The exception was that the actual percentage of land area included in core areas larger than 1,000 ha was 1% lower than predicted.

Overall, the first measure of linear feature density that was used as a benchmark for intactness, was lower or the same as was predicted in the EIS. Core areas, which was used as a second benchmark for intactness, was marginally higher than predicted. Nevertheless, the percentage was still far from the benchmark value that would raise it to a moderate magnitude adverse effect.

No Project-related effects on wolverine mortality were identified.

6.4.1.6 CONCLUSIONS

As described in Section 2.4, the actual effects of intactness, as measured by linear features or core areas, were either lower or the same as was predicted with one minor exception. The exception was that the actual percentage of land area included in core areas larger than 1,000 ha was 1% lower than predicted. Nevertheless, the percentage was still far from the benchmark value that would raise it to a moderate magnitude adverse effect. By extrapolation, the magnitude of effect on wolverine habitat was as predicted in the EIS.

6.4.1.7 FUTURE MONITORING

Information on wolverine will be collected incidentally during other studies continuing during Project operation.

The construction phase monitoring did not identify the need to alter any of the methods for the operation phase.

6.4.2 LITTLE BROWN MYOTIS

6.4.2.1 BACKGROUND

Little brown myotis is a migrant bat species with limited distribution and potential to breed in the Keeyask region. Potential Project effects on this species, including loss of foraging and roosting habitat and short-term habitat avoidance due to sensory disturbance, were anticipated to be limited to none. However, following the submission of the EIS the little brown myotis was listed as Endangered under the federal *Species at Risk Act* and *The Endangered Species and Ecosystems Act* of Manitoba. Due to its status as a species at risk, a monitoring program was developed to verify whether there is a little brown myotis population present in Study Zone 3 and if so, to design a long-term monitoring program to evaluate how it might be affected by the Project.

6.4.2.2 MONITORING

Between 160 and 184 sites in Study Zone 3 were surveyed twice overnight in summer 2015, 2017, and 2018. Survey sites were 300 m apart along access roads and trails. Additional sites were surveyed where creeks crossed a road or trail, or where two or more trails converged. Surveys were also conducted at the Start-up Camp and Main Camp, where lighting attracted insects and improved bat foraging opportunities. A hand-held bat detector was used to record echolocation calls to be identified with sound analysis software.

6.4.2.3 RESULTS

No bats were detected along the North and South Access Roads, at the Main Camp, or at the Start-up Camp in any of the survey years. No anecdotal observations of bats were reported during Project construction.

6.4.2.4 DISCUSSION

6.4.2.5 COMPARISON WITH PREDICTED PROJECT EFFECTS

Little brown myotis appear to be sparse in Study Zone 3, as described in the EIS. Only one unidentified bat was observed incidentally during EIS field studies. Bat observations near Gillam and in Study Zone 4 were reported anecdotally but were not confirmed. No bats were detected during construction monitoring and no population was identified, therefore predicted Project effects of little to no effect were verified.

6.4.2.6 CONCLUSIONS

As no little brown myotis population was detected in Study Zone 3 during construction, there were no Project effects documented.

6.4.2.7 FUTURE MONITORING

As no bats were detected during construction monitoring, no further bat monitoring is recommended during operation.

6.5 GRAY WOLF, BLACK BEAR, AND OTHER WILDLIFE

6.5.1 BACKGROUND

Black bear and gray wolf are large carnivores found throughout the Keeyask region that generally require large areas of continuous habitat. Both species require dens for the birthing and rearing of young, and in the case of bears, for hibernation. They typically avoid contact with humans but, with red and arctic foxes, may be attracted to human activity, particularly when a food source such as garbage is available. Project effects on large carnivores predicted in the EIS included a small loss of habitat in the Project footprint (Study Zone 1); sensory disturbance at den sites due to clearing and construction activities; and mortality due to encounters with humans, collisions with vehicles on the access roads, and increased harvest.

To evaluate Project effects on large carnivores and verify EIS predictions, two monitoring studies were conducted during construction. The objectives of the Den Survey study were to locate black bear and gray wolf dens near planned construction activities, if any, and to evaluate the response of these large carnivores to den disturbances. The objectives of Human-wildlife Interaction monitoring were to qualitatively evaluate human-wildlife encounters in Study Zone 4 during Project construction and to estimate how Project-related accidental mortality affects gray wolf, black bear, and fox abundance.

6.5.2 MONITORING

6.5.2.1 DEN SURVEYS

Pre-clearing searches for large carnivore dens were conducted in spring and/or fall 2014, 2015, 2016, and 2017, in areas planned to be cleared for Project construction. Habitat in these areas was stratified into low, moderate, and high potential to support large carnivore dens using high-resolution satellite imagery and a geographic information system (GIS). Most high, some moderate, and little of the low potential den habitat was searched prior to vegetation clearing in winter. Search effort in low potential den habitat was minimal due to the small likelihood of large carnivore denning in these areas.

Systematic ground surveys consisting of up to 15 observers spaced 10 to 20 m apart were conducted in the search areas. When a potential black bear den was encountered, observers attempted to determine if it was occupied by searching the surrounding area for signs such as tracks, scat, fur, or claw marks on trees, and by listening at the den entrance for noise. The potential den was georeferenced with a hand-held global positioning system (GPS) unit, photographed, and marked with flagging tape. If the den appeared to be occupied or to have been recently constructed, a pole-mounted camera was placed within to confirm the presence of a black bear. A 100 m buffer was established with flagging tape around active dens to minimize construction-related disturbance to hibernating black bears. Two remote trail cameras were placed nearby to monitor the effectiveness of the buffer and to capture emergence from the den in spring.

6.5.2.2 HUMAN-WILDLIFE INTERACTION

Instances of black bear, gray wolf, red fox, and arctic fox mortality were documented during Project construction. Resource use by the workforce was monitored as part of the Keeyask Generation Project *Resource Use Monitoring Plan*.

6.5.3 RESULTS

6.5.3.1 DEN SURVEYS

An active bear den was found in fall 2014, in a Project borrow area. The den check revealed a single black bear within (Photo 6-8). As described above, mitigation measures were established around this active bear den. No photos of a bear were taken by the trail cameras at the site. No active black bear or gray wolf dens were observed in spring or fall 2015, fall 2016, or fall 2017. Due to the small number of active dens observed during clearing in the Project footprint, the effectiveness of a 100 m buffer to minimize disturbance to denning bears was not assessed.

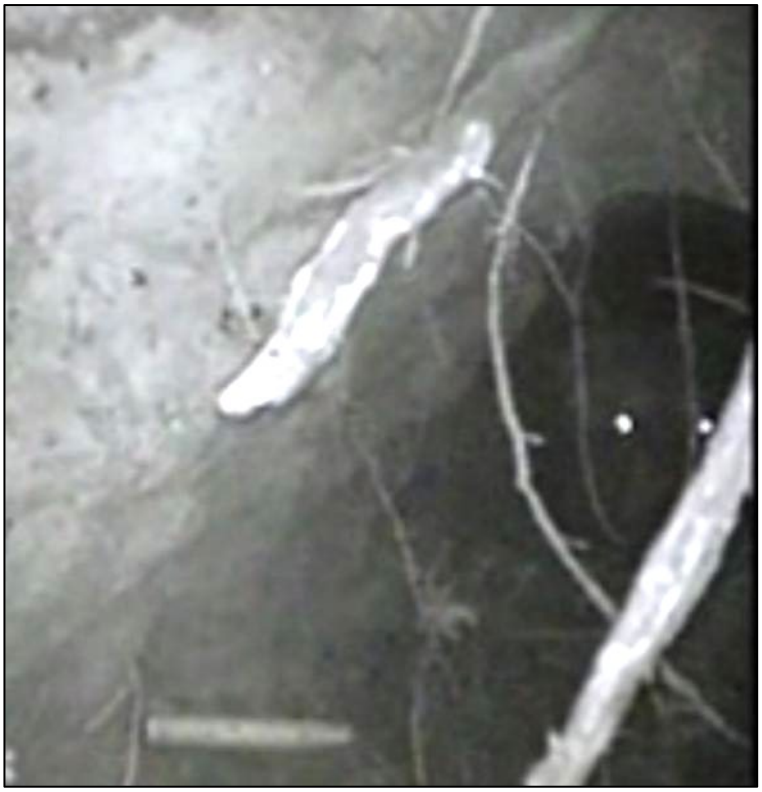


Photo 6-8: Screen shot of video showing a black bear occupying a den in a Project borrow area, 2014

Other observations during the den surveys included inactive and potential black bear dens, black bear excavations, and American marten, mink, and red fox dens (Table 6-10). Several inactive, unidentified species' dens were also observed most years. Large-sized mammal dens were likely gray wolf or black bear, and small- to medium-sized mammal dens were smaller species such as American marten or red fox. Two red fox dens were buffered by 50 m and one successfully raised kits. No buffers were required for inactive dens or excavations, and none were established around other dens because the species are active and mobile in winter and could relocate if disturbed.

Table 6-10: Additional observations during den surveys in the Project footprint during construction (2014–2017)

Observation	2014	2015	2016	2017
Inactive black bear den	1	2	0	1
Black bear excavation	3	7	1	2
American marten den	4	6	2	1
Mink den	1	0	0	0
Red fox den	12	11	2	1
Small- to medium-sized mammal den	4	11	0	19
Large-sized mammal den	0	4	0	0

6.5.3.2 HUMAN-WILDLIFE INTERACTIONS

Project-related large carnivore and other wildlife mortality was recorded during construction. A black bear-vehicle collision was reported in August 2018. Between July 2014 and March 31, 2022, a total of 25 black bears were relocated away from the Project site. A gray wolf that was injured and had become habituated to humans was dispatched by the local Conservation Officer in March 2015. Fox mortalities were considerably more common during Project construction (Table 6-11). A total of 24 were reported, most due to collisions with vehicles. Twelve mortalities were observed for each fox species, with the greatest number in 2017 and 2018. Mortalities whose cause was unknown were found in the construction area, but it was unclear if the deaths were Project-related or due to natural causes. No black bear or gray wolf harvest was reported by the workforce during resource use surveys from 2014 to 2016.

Table 6-11: Red and arctic fox mortalities reported during Project construction (2014–2021)

Year	Species	Cause	Number
2014	Red fox	Vehicle collision	1
2015	None	No mortality	0
2016	Red fox	Vehicle collision	1
2017	Red fox	Vehicle collision	2
	Arctic fox	Vehicle collision	6
2018	Red fox	Vehicle collision	4
		Unknown	1
	Arctic fox	Vehicle collision	1
		Trapped inside trailer or crawl space	2
		Unknown	2
2019	Arctic fox	Unknown	1
2020	Red fox	Unknown	2
2021	Red fox	Unknown	1

6.5.4 DISCUSSION

6.5.4.1 COMPARISON WITH PREDICTED PROJECT EFFECTS

Because a single active bear den was found in the Project footprint over the four-year clearing period, it was presumed that the effects of sensory disturbance on large carnivores was minimal, as predicted in the EIS. No conclusion could be reached about the efficacy of the 100 m buffer around active dens to reduce sensory disturbance to large carnivores. The single black bear and gray wolf mortalities would not have affected the local or regional populations. Fox mortality was more common; however, the average of less than two per year of each species would have had a negligible effect on the local and regional populations. As predicted in the EIS, fox mortality increased because of collisions with vehicles. Two instances of arctic foxes becoming trapped in Project buildings were reported, likely because they were attracted to the area. There were no reports of foxes being dispatched from the camp area. The small number of Project-related fox mortalities distributed over an eight-year period would have had a negligible effect on the local and regional red and arctic fox populations.

6.5.4.2 CONCLUSIONS

Project effects on gray wolf, black bear, and other wildlife conformed to EIS predictions. Sensory disturbance to large mammals was presumed to be minimal. While some mammal mortality was observed during Project construction, effects on local and regional populations were negligible.

6.5.4.3 FUTURE MONITORING

Den surveys will be conducted during Project operation on as needed basis. Mammal mortality and human-interaction data will be collected incidentally during other surveys.

The construction phase monitoring did not identify the need to alter any of the methods for the operation phase.

6.6 SYNTHESIS

Adverse Project effects on mammals during Project construction were the same or lower than predicted, with one exception. The use of islands in lakes and peatland complexes by caribou further from the Project was less than predicted in the EIS. Results suggested that sensory disturbance effects may have extended as far as 7 to 9 km from the Project, compared to only 4 km predicted in the EIS. In most cases, the lower than predicted effects primarily resulted from the actual Construction Footprint being 28% smaller than assumed in the EIS, as well as effective mitigation measures.

There were no unexpected Project effects on mammals during construction, with one exception. Some islands that formed in the reservoir by 2021, following impoundment, were immediately used for calving by caribou and moose. These findings contrasted the predictions of the EIS, which suggested new calving island use was expected to take many years. No additional mitigation is recommended.

7.0 MERCURY IN PLANTS AND WILDLIFE

7.1 MERCURY IN PLANTS

7.1.1 BACKGROUND

Mercury (Hg) is a naturally occurring metal that exists in elemental, inorganic and organic forms in the environment. Methyl-mercury, which is the most common organic form of mercury, is soluble, mobile and can easily enter the aquatic food chain and bioaccumulate.

The partner First Nations expressed deep concerns over the potential effects of mercury in their traditional foods.

The Mercury in Plants monitoring includes the four plant species/groups selected by members of the Keeyask Mercury and Human Health Working Group for monitoring during the environmental assessment. These species are Labrador tea (*Rhododendron groenlandicum;* Photo 7-1), northern Labrador tea (*Rhododendron tomentosum*), blueberries (*Vaccinium* spp.; Photo 7-2) and sweet flag (*Acorus americanus*), which is called *Wihkis* in Cree.

Photo 7-1: Tea leaves, including Labrador tea (wider leaves) and northern Labrador tea (narrow, needle-like leaves)

Photo 7-2: Velvet-leaf blueberry

Prior to Project construction, plant tissue samples were collected in the Regional Study Area to test for mercury levels. All of the blueberry concentrations (16 samples) were below the detection limit of 0.010 ppm, while the mean concentration in northern Labrador tea leaf (13 samples) was 0.014 ppm.

7.1.2 MONITORING

Construction monitoring included the collection of berry or leaf samples at permanent sample locations within two different effects zones: the “Project Effects” zone, and the “Reference” zone. The Project Effects zone was adjacent to the future reservoir shoreline. The Reference zone included areas too far from the existing Nelson River and the future reservoir to be affected by them.

Plant samples were sent to a certified laboratory for mercury testing. Any samples collected and submitted by partner First Nations community members are also submitted for testing.

Species for which sufficient tissue could be collected included Labrador tea (Photo 7-3), velvet-leaf blueberry (*Vaccinium myrtilloides*) and bog-bilberry (*Vaccinium uliginosum*). Velvet-leaf blueberry and bog-bilberry, collectively called “blueberry”, were collected when the berries were ripe (Photo 7-4). Labrador tea leaf collection was done later in the growing season. A minimum of 1/5th of a cup of berries, and 1/3rd of a cup of leaves were gathered in a manner that minimized potential sample contamination.

Photo 7-3: Preparing to collect plant tissue samples for mercury testing

Photo 7-4: Collecting blueberry samples for mercury testing

Plant tissue samples were collected in 2017, 2018 and 2019 during Project construction.

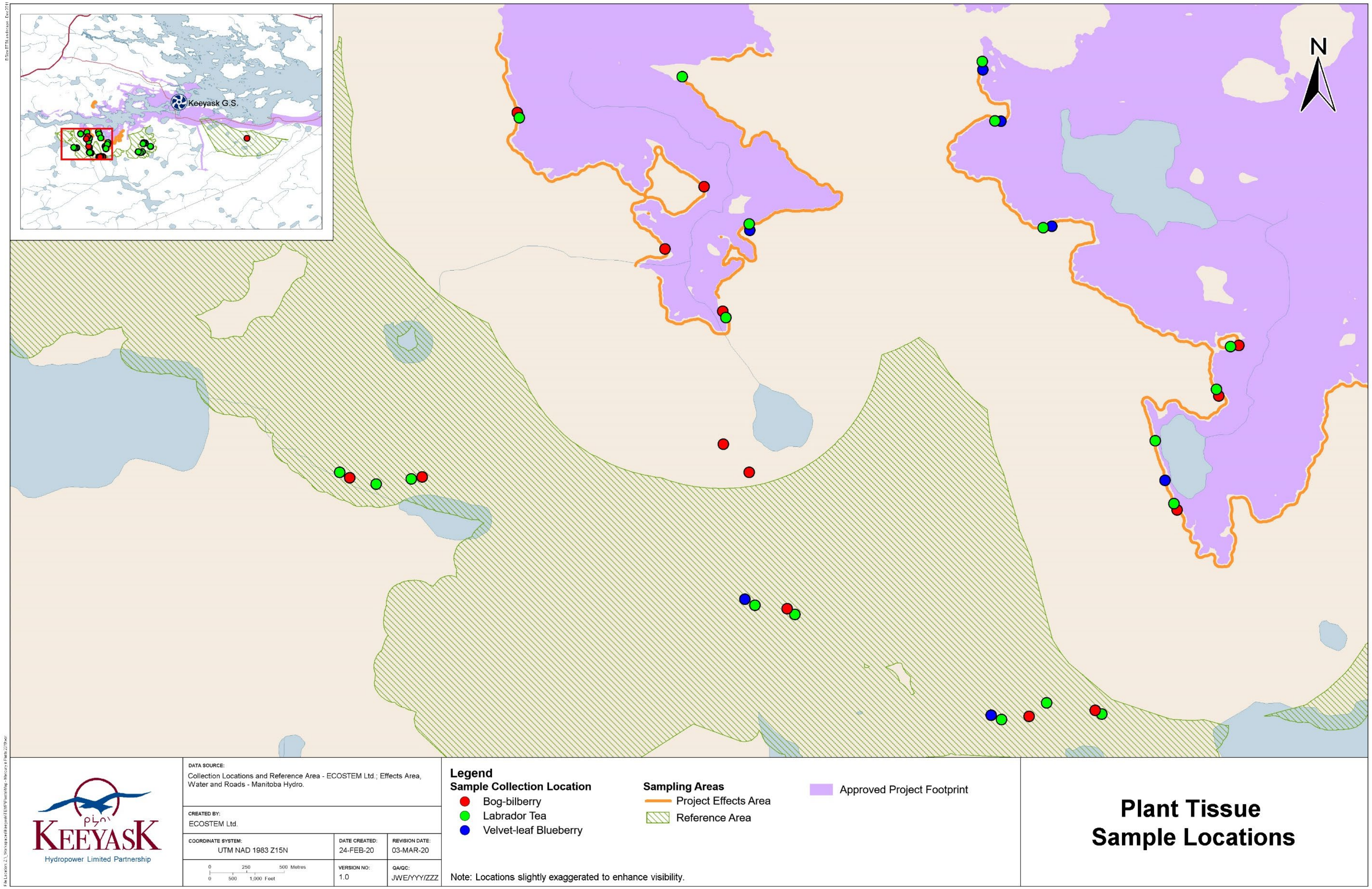
Plant tissue samples were kept frozen until they were analyzed. A certified laboratory measured total dry weight mercury content using cold-vapor atomic absorption spectroscopy (CVAAS; method reference: EPA 200.3/EPA 1631E (modified)).

7.1.3 RESULTS

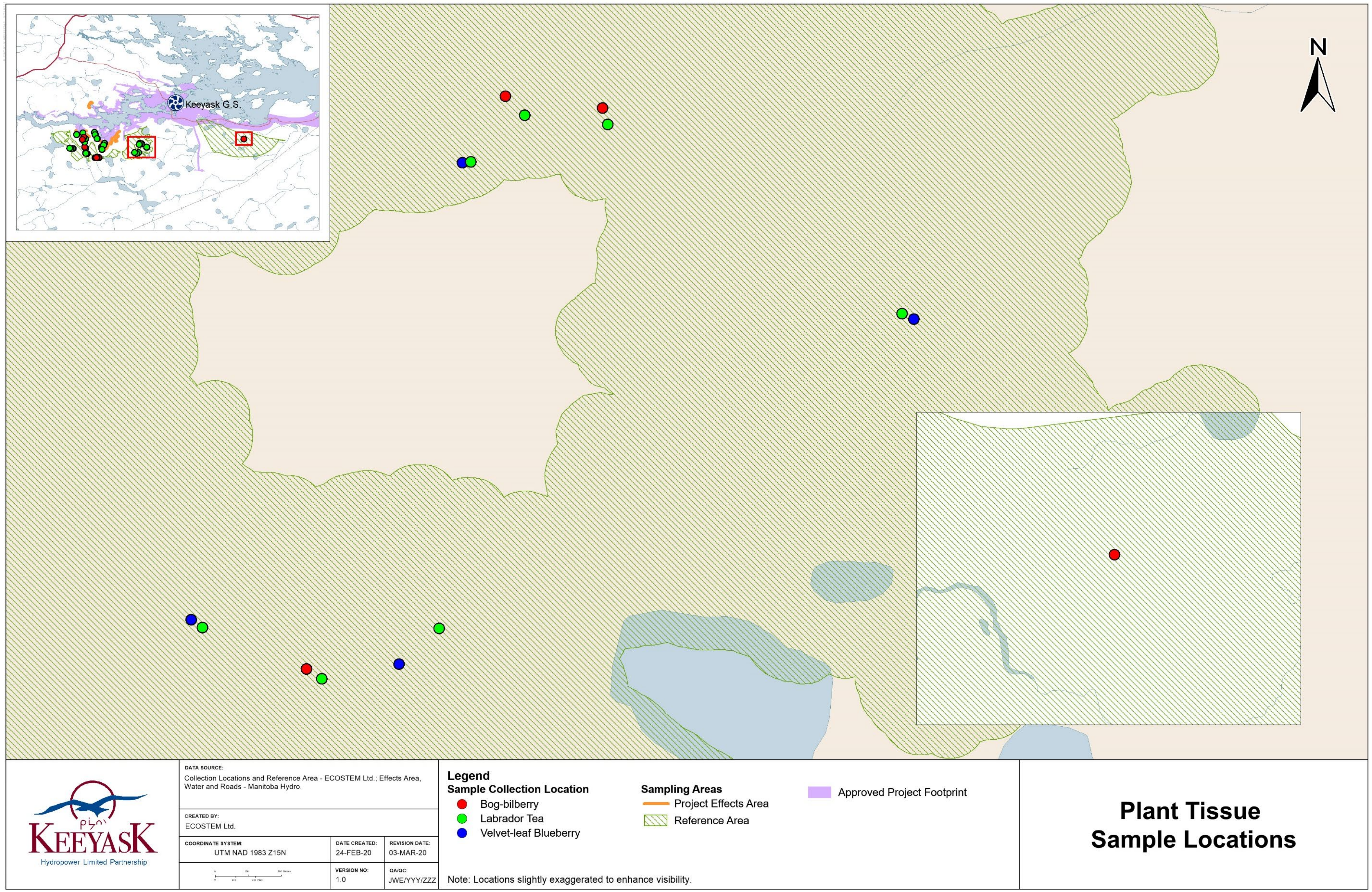
Of the 56 permanent sample locations sampled for 3 years (2017 to 2019), 24 are in the Project Effects zone and 32 are in the Reference zone (Table 7-1; Map 7-1 and Map 7-2).

Table 7-1: Number of locations sampled in from 2017 to 2019 for each species found in the sample zones

Species	Project Effects Zone			Reference Zone			Total
	2017	2018	2019	2017	2018	2019	
Velvet-leaf blueberry	5	5	5	6	6	6	33
Bog-bilberry	6	8	7	10	11	11	53
Labrador tea	11	11	11	15	15	15	78
Total locations	22	24	23	31	32	32	164



Map 7-1: Permanent sample locations for plant tissue collection in western Project area, by species



Map 7-2: Permanent sample locations for plant tissue collection in eastern Project area, by species

For 84 of the 86 blueberry samples collected between 2017 to 2019, the mercury concentration was below detection level (DL; <5 ng/g). The maximum concentration in the remaining two samples was 8.0 ng/g (Figure 7-1; Table 7-2).

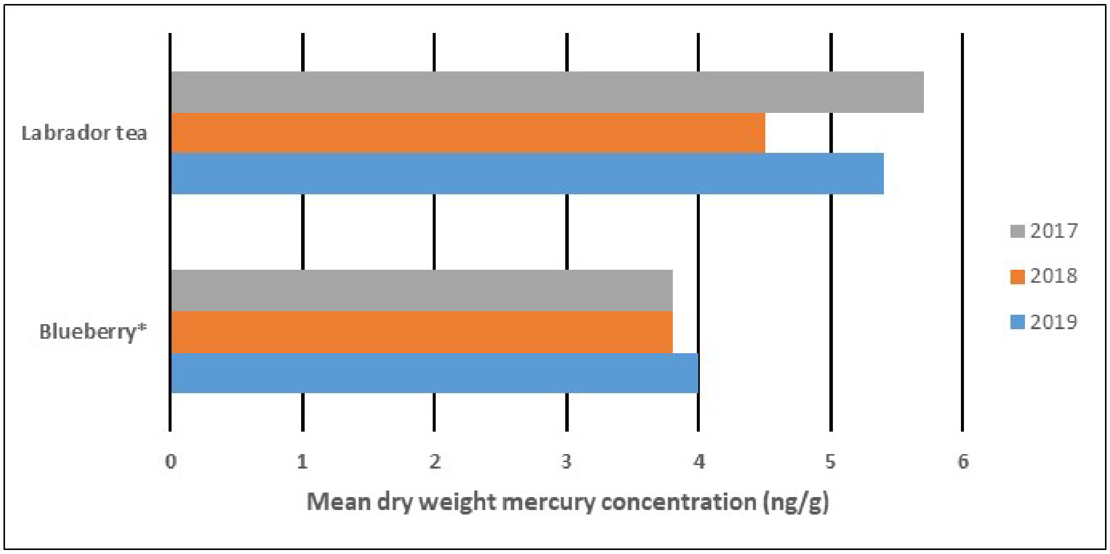


Figure 7-1: Mean dry weight mercury concentration (ng/g) by species between 2017 and 2019 (*samples with concentrations below DL were set to 75% of the DL)

Table 7-2: Mercury analysis results for blueberry and Labrador tea tissue samples collected in 2017, 2018 and 2019

Species	Number of samples across three years	Number of samples above the detection level[1]	Mean dry weight mercury concentration (ng/g)[1]			Maximum dry weight concentration
			2017	2018	2019	
Blueberry	86	2	3.8	3.8	4.0	8.0
Labrador tea	78	50	5.7	4.5	5.4	8.5

[1] Samples with concentrations below DL were set to 75% of the DL.

Of the 78 Labrador tea samples, 50 had a total mercury dry weight concentration that was slightly above the DL (Table 7-2). The highest concentrations were similar in both of the effects zones (8.5 ng/g in Project Effects; 7.5 ng/g in Reference, both in 2017).

7.1.4 DISCUSSION

7.1.4.1 COMPARISON WITH PREDICTED PROJECT EFFECTS

The EIS did not include predictions regarding Project effects on mercury concentrations in plants as there was no predicted increase resulting from reservoir impoundment. This monitoring was included in the TEMP due to concerns expressed by partner First Nations members through the Keeyask Mercury and Human Health Working Group during the latter phase of the Project assessment.

7.1.4.2 CONCLUSIONS

Construction monitoring found that all of the blueberry and Labrador tea mercury concentrations were either below or near the bottom end of the range of mean total dry weight mercury found in other boreal plant species. Only 2% of blueberry samples and 64% of Labrador tea leaves collected over 3 years had a detectable amount of mercury.

7.1.4.3 FUTURE MONITORING

During Project operation, blueberry and Labrador tea leaf sample collection will continue to determine if the Project reservoir increases mercury concentrations in plants. Mercury levels in selected terrestrial plant species will be compared with those in plants that were collected prior to reservoir impoundment.

7.2 MERCURY IN WILDLIFE

7.2.1 BACKGROUND

Mercury (Hg) is a naturally occurring metal that exists in several forms in the environment. Microorganisms in soil and water can transform it from one form to another. Methylmercury, a common form of organic mercury, can easily enter the aquatic food web and bioaccumulate when higher-level organisms absorb it from the lower-level organisms that they consume. Methylmercury levels typically increase in water after flooding, as the inorganic mercury released from inundated soil is converted to organic mercury by bacteria feeding on decomposing plants.

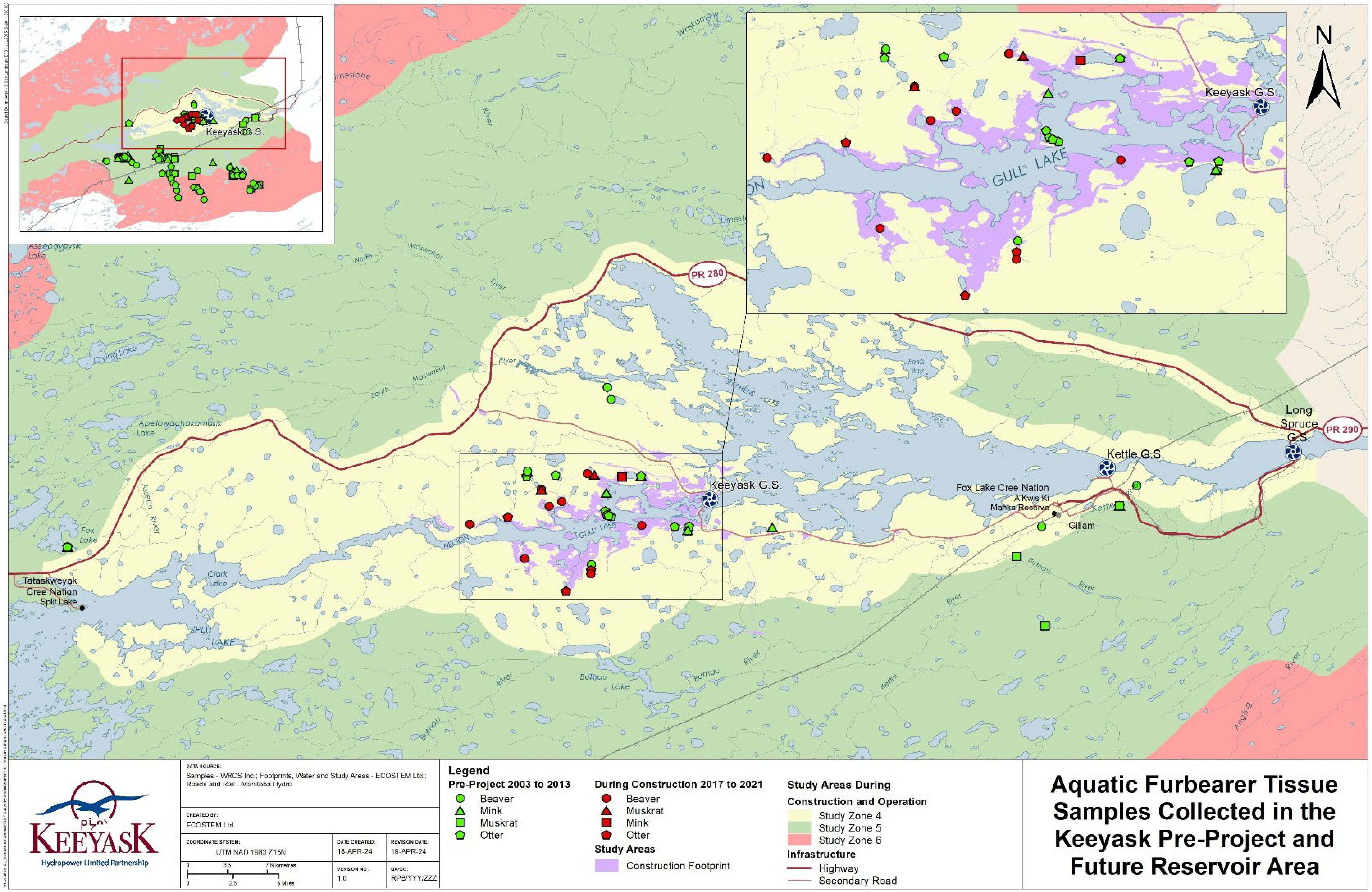
The partner First Nations expressed deep concerns over the potential effects of mercury in their traditional foods.

As described in the EIS, reservoir impoundment was expected to increase mercury levels in the Keeyask reservoir. Predicted Project effects included increased mercury concentrations in fish as well as mink and river otter, the fish-eating aquatic furbearers that consume them. A small increase in mercury in mallards, which forage on fish and aquatic insects, and muskrats, which eat plants and aquatic invertebrates such as molluscs, was also anticipated. No change in plant-eating wildlife such as Canada goose, beaver, caribou, and moose was expected.

The objective of mercury in wildlife monitoring was to establish pre-impoundment mercury levels in the tissues of aquatic furbearers (where an increase was expected) as well as in wild foods including Canada geese, mallards, snowshoe hare, caribou, and moose (if an adequate number of suitable samples were provided during Project construction by the partner First Nations after harvesting), to compare with mercury levels in these species during operation.

7.2.2 MONITORING

Tissue samples (kidney, liver, and/or leg muscle) from beavers, muskrats, mink, and river otters trapped at beaver lodges in the future reservoir area in the winters of 2016/17 and 2017/18 and near the impounded reservoir in the winter of 2021/22 (Map 7-1) were analyzed for mercury by an accredited laboratory. Results were reported as milligrams of mercury per kilogram of wet weight (mg/kg wwt). All individuals were trapped by the registered trapline holder during Project construction. Pre-impoundment results were added to those from aquatic furbearer tissue samples collected voluntarily from traplines overlapping the Nelson River in Study Zone 5 in the Split Lake, York Landing, and Fox Lake resource management areas from February 2003 to April 2008, during the pre-construction period. Any waterfowl, snowshoe hare, caribou, and moose samples collected by local resource users were also to be analyzed; none were submitted during the construction period.



Map 7-3: **Aquatic Furbearer Tissue Samples Collected in the Keeyask Study Area Pre-Project (2003 to 2013) and Future Reservoir Area and During Construction (2017 to 2021)**

7.2.3 RESULTS

Mercury levels in beaver, muskrat and mink tissue (liver and muscle) were similar before and one year after reservoir impoundment, with lower concentrations in the samples collected after (Table 7-1). Mercury levels in beaver and muskrat liver tissue were within the ranges predicted in the EIS (Table 7-2). Mercury levels in river otter tissue (liver and muscle) were greater after the reservoir was impounded but remained within the anticipated peak ranges predicted in the EIS (Table 7-2).

Table 7-3: Mean mercury concentration (mg/kg wwt) in aquatic furbearer liver and muscle tissue before (2003–2008) and after (2021/22) reservoir impoundment

Species	Liver			Muscle		
	Pre-impoundment	Post-impoundment	Percentage Change	Pre-impoundment	Post-impoundment	Percentage Change
Beaver	0.008 (16)[1]	0.005 (5)	-38	0.008 (40)	0.006 (5)	-25
Muskrat	0.022 (5)	0.008 (5)	-64	0.013 (7)	0.008 (5)	-38
Mink	2.310 (9)	0.858 (2)	-63	1.150 (18)	0.599 (2)	-48
River otter	1.708 (14)	5.903 (3)	+246	0.591 (16)	1.198 (3)	+103

1. Number of samples in parentheses.

Table 7-4: Model estimates of mean and most-likely range of total mercury concentration (mg/kg wwt) in the liver of aquatic furbearers that forage within the Keeyask reservoir and/or Stephens Lake

Species	Existing Environment	Peak	Long-term
	Day 1	Year 3 to 7	Years 20–30
Beaver	0.01 (<0.01–0.05)	0.01 (<0.01–0.05)	0.01 (<0.01–0.05)
Muskrat	0.02 (<0.02–0.06)	0.04 (<0.01–0.12)	0.02 (<0.01–0.06)
Mink	1.52 (0.56–3.16)	4.00 (0.56–30.60)	1.52 (0.56–3.16)
River otter	0.55 (0.28–3.97)	6.00 (0.28–17.63)	0.55 (0.28–3.97)

For other wild foods, no change in mercury was anticipated for Canada goose, moose, or snowshoe hare (Table 7-3). A small increase was predicted for mallard, but no samples were submitted during Project construction monitoring to verify these predictions.

Table 7-5: Estimates of mean and most-likely range of total mercury concentration (mg/kg wwt) in the muscle of wild foods

Species	Existing Environment	Peak	Long-term
	Day 1	Year 3 to 7	Years 20–30
Canada goose[1]	0.03	~0.03	0.03
Mallard[1]	0.04	<0.19	0.04
Moose[2]	0.07 (<0.01–0.17)	0.07 (<0.01–0.17)	0.07 (<0.01–0.17)
Snowshoe hare[2]	0.05 (<0.01–0.17)	0.05 (<0.01–0.17)	0.05 (<0.01–0.17)

1. Model-predicted for fish inhabiting the Keeyask reservoir.
2. Mercury concentration was a literature estimate and may have greater uncertainty than other species for which measured values were obtained from the study area.

7.2.4 DISCUSSION

7.2.4.1 COMPARISON WITH PREDICTED PROJECT EFFECTS

No change in mercury levels in beavers was anticipated after reservoir impoundment due to the very small amounts of mercury taken up by the plants that they consume. Small increases in mercury levels in muskrat were expected because they forage on both aquatic plants and animals, the latter of which will likely accumulate mercury following impoundment. Mercury levels in beaver and muskrat tissue collected during Project construction in 2017, 2018, and 2021/22 were low and there was no apparent change in the first year after reservoir impoundment compared with the pre-construction samples collected from 2003 to 2008.

Mercury levels in mink and river otter were expected to increase over pre-Project levels and peak approximately seven years after reservoir impoundment. Mercury levels will likely then decline and reach pre-Project levels, or be considered stable at a new background level, approximately 20 to 30 years post-impoundment. The mean mercury level in mink liver tissue was lower after reservoir impoundment than before Project construction. Because the mink diet is primarily small mammals supplemented with fish and other wildlife, mercury would be expected to accumulate relatively slowly in their tissues. The mean mercury level in river otter liver tissue increased after reservoir impoundment, possibly indicating that some individuals whose ranges overlapped the reservoir were beginning to accumulate mercury in their tissues, or possibly reflecting natural variation in individuals' diets and where their food is obtained. Mercury levels in the livers of river otters sampled during Project construction were within the peak range predicted in the EIS. Because the sample sizes for all aquatic furbearers, particularly mink and river otter, were relatively small, and because the post-impoundment monitoring period was only one year during Project construction, caution should be used in the interpretation of the results.

No tissue samples from wild foods such as Canada goose, mallard, moose, and snowshoe hare have been submitted to date. Small increases in mercury levels in mallard were anticipated after reservoir impoundment; but no changes in Canada goose, moose, and snowshoe were expected.

If tissue samples are submitted by local partner First Nations members during Project operation, they will be analyzed. The results will be provided to the Project toxicologist to assess potential risks to human health because of increased mercury in the environment under the Keeyask Generation Project Socio-economic Monitoring Plan.

7.2.4.2 CONCLUSIONS

Mercury levels in beaver, muskrat and mink remained low throughout the Project construction period, as anticipated in the EIS. One year after reservoir impoundment, there was an increase in mercury levels in river otter, as anticipated, but the post-impoundment monitoring period during construction was short and the sample size was small. Mercury levels in the livers of all four species sampled were within the peak range predicted in the EIS.

7.2.4.3 FUTURE MONITORING

Mercury monitoring in mammals will continue during the Project operation phase.

The construction phase monitoring did not identify the need to alter any of the methods for the operation phase. No country foods tissue sample submissions were received from the partner First Nations under the voluntary sampling program during the construction period.

7.3 SYNTHESIS

The EIS did not include predictions regarding Project effects on mercury concentrations in plants. Construction monitoring found that mercury concentrations were either undetectable, or below or near the bottom end of the range of means for other boreal plant species.

The EIS included predictions regarding Project effects on mercury concentrations in key bird and mammal species. Construction monitoring found that mercury concentrations in three aquatic furbearer species remained low, while river otter mercury concentrations are increasing as anticipated one year after the reservoir was impounded. No country foods tissue sample submissions were received from the partner First Nations under the voluntary sampling program during the construction period.

Monitoring of mercury will continue during Project operation.

8.0 REFERENCES

8.1 TERRESTRIAL PLANTS, HABITAT AND ECOSYSTEMS

ECOSTEM Ltd. 2022a. Keeyask Generation Project Terrestrial Effects Monitoring Plan Report #TEMP-2022-01: Habitat Loss and Disturbance Monitoring. A report prepared for Manitoba Hydro by ECOSTEM Ltd., June 2022.

ECOSTEM Ltd. 2022b. Keeyask Generation Project Terrestrial Effects Monitoring Plan Report #TEMP-2022-02: Priority Habitats Monitoring. A report prepared for Manitoba Hydro by ECOSTEM Ltd., June 2022.

Keeyask Hydropower Limited Partnership (KHLP). 2012a. Keeyask Generation Project Environmental Impact Statement: Response to EIS Guidelines, Winnipeg, Manitoba. June 2012.

Keeyask Hydropower Limited Partnership (KHLP). 2012b. Keeyask Generation Project Environmental Impact Statement: Terrestrial Environment Supporting Volume, Winnipeg, Manitoba. June 2012.

Keeyask Hydropower Limited Partnership (KHLP). 2015. Keeyask Generation Project Terrestrial Effects Monitoring Plan. Winnipeg, Manitoba. December 2015.

8.2 WILDLIFE

Barrientos, R., Ponce, C., Palacin, C., Martin, C. A., Martin, B., and Alonso, J. C. 2012. Wire marking results in a small but significant reduction in avian mortality at power lines: a CACI designed study. PLoS ONE 7: e32569.

ECOSTEM Ltd. and Wildlife Resource Consulting Services MB Inc. 2021. Keeyask Generation Project Terrestrial Effects Monitoring Plan Report #TEMP-2021-13: Olive-sided Flycatcher and Rusty Blackbird Sensory Disturbance Monitoring. A report prepared for Manitoba Hydro by ECOSTEM Ltd. and Wildlife Resource Consulting Services MB Inc., June 2021.

Falconer, M., Richardson, A., Heagy, A., Tozer, D., Stewart, B., McCracken, J., and Reid, R. 2016. Recovery strategy for the bank swallow (*Riparia riparia*) in Ontario. Ontario Recovery Strategy Series. Prepared for Ontario Ministry of Natural Resources and Forestry, Peterborough, ON. 70 pp.

Lemelin, L.-V., Darveau, M., Imbeau, L., and Bordage, D. Wetland use and selection by breeding waterbirds in the boreal forest of Quebec, Canada. Wetlands 30: 321–332.

Messmer, D. J., Petrie, S. A., Badzinski, S. S., Gloutney, M. L., and Schummer, M. L. 2015. Habitat associations of breeding mallards and Canada geese in southern Ontario, Canada. Wildlife Society Bulletin 39(3): 543–552.

Wright, D. H., Lomeli, H., Hofmann, P. S., and Nguyen, C. 2011. Burrow occupancy and nesting phenology of bank swallows along the Sacramento River. California Fish and Game 97(3): 138–147.