Comprehensive Wildlife Management and Monitoring Plan Report for the Construction Phase of the Tłı̨chǫ All-Season Road

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Executive Summary

Scope and purpose of the report

The Tłı̨chǫ All-Season Road [ASR] (now referred to as the Tłı̨chǫ Highway or Highway 9) is a new all-season road that connects the community of Whatì to Highway 3, approximately 30 km southwest of Behchokǫ̀, and located in the Wek'èezhìı region of the Northwest Territories (NWT). An environmental assessment (EA1617-01) of the project concluded that construction and operation of the road could cause direct and indirect habitat loss for wildlife, sensory disturbance, wildlife mortality, and increased access for harvesting. A Wildlife Management and Monitoring Plan (WMMP) was required for the project in order to mitigate and monitor these potential impacts and to address several of the Measures required under the Report of Environmental Assessment. This report provides a comprehensive summary of wildlife mitigation and monitoring programs conducted before and during the construction phase of the Tłı̨chǫ ASR. This report includes analyses of monitoring data used to assess potential effects of road construction on key wildlife species such as boreal caribou, moose and wood bison. A second comprehensive report will be produced following the first 5 years of operation of the Tłı̨chǫ ASR.

Wildlife surveillance monitoring and pre-disturbance surveys

Construction of the Tłı̨chǫ ASR began on September 3, 2019, and was completed on November 20, 2021. Construction of the road involved clearing a 60-m wide road right-of-way as well as clearings for borrow sources, camp facilities and associated access roads. In total, the Tłı̨chǫ ASR resulted in 550 hectares (ha) of new disturbance footprint (accounting for overlap with the existing Old Airport Road alignment). This was less than the 784 ha of new habitat disturbance predicted during the EA. During construction, North Star Infrastructure (NSI) undertook routine wildlife surveillance programs to document the presence of wildlife along the road alignment and also maintained a wildlife sightings log to record wildlife incidentally observed by construction staff. Observations from these programs were compiled and mapped to show the distribution and number of sightings of different species and species groups along the road alignment. The maps provide a baseline against which to assess changes in where wildlife is seen along the road now that it is open for public use. For example, wood bison were the most frequently observed big game species during construction, with most sightings occurring south of km 45. Overall, more than 30 different species were documented from these programs.

A number of specific pre-disturbance surveys were carried out to identify the potential need for mitigations such as implementing buffers around sensitive wildlife features or delaying blasting events. As all vegetation clearing for the project occurred outside of the migratory bird nesting season, no pre-clearing bird nesting surveys were undertaken. Pre-clearing surveys to detect presence of large mammals were conducted on 123 occasions, but no large mammals were detected during those surveys. An aerial bear den survey was conducted within an 800 m buffer around the proposed project footprint in October 2019 prior to most of the right of way being cleared. Two potential bear dens were detected, but upon further investigation from the ground they were determined to be unoccupied. A total of 140 pre-blast surveys were completed by searching areas within a 500-m radius of the blast zone. A moose was observed during one of the pre-blast surveys in 2019, but otherwise no other large mammals were detected. Maps of GPS locations from collared boreal caribou relative to 4 and 6 km cautionary zones around the proposed project footprint were provided to NSI every 2 days during the calving season and on a weekly basis throughout the year. Throughout the 2-year construction phase, collared boreal caribou were present in a cautionary zone within at least one road segment every week. When collared caribou were present within a cautionary zone along one or more of the 4 segments of the road alignment, site personnel were notified and traffic speeds were reduced along those segments. Aside from these mitigations, the overlap of collared caribou with the cautionary zones did not result in any reported suspensions or delays to vegetation clearing, blasting or other construction activities.

During construction there were no wildlife incidents or mortalities involving large mammals or predators; however, four mortality events involving ptarmigan, spruce grouse, and snowshoe hare due to wildlife-vehicle collisions were reported, as well as two mortality events involving fish.

Wildlife Effects Monitoring Programs

Wildlife effects monitoring programs were implemented by GNWT-ECC and the Tłı̨chǫ Government to establish pre-construction baseline conditions and to assess broader scale effects of the construction of the Tłı̨chǫ ASR on key wildlife such as caribou, wood bison, moose and predators like wolves.

Harvest monitoring

The Tłı̨chǫ ASR alignment was closed to public use during the construction phase. Monitoring programs to detect changes in wildlife harvest pressure along the road will commence after the road opens for public use. However, steps were taken to prepare these programs. This included hiring a new GNWT Renewable Resources Officer based in Whatì and providing funding to the Tłı̨chǫ Government to develop voluntary harvest reporting, road dust vegetation impact monitoring, and training community monitors to conduct road surveys. An assessment of sustainable harvest levels for boreal caribou within different regions of the southern NWT was also completed.

Boreal caribou

To monitor the population trend of boreal caribou along the Tłı̨chǫ ASR corridor and surrounding region, as well as their interactions with the road corridor, GPS collars were deployed on adult female caribou beginning in 2017. Population trend is monitored using annual survival rates of collared adult females and annual calf recruitment rates (calf:cow ratios) through late-winter classification surveys. These two indices are used to calculate lambda (λ) which is a measure of the rate of population change from one year to the next. Lambda values above 1 indicate an increasing population, and values below 1 indicate a decreasing population. Between March 2017 and March 2022, annual lambda values varied between 1.02 to 1.16, indicating that the population was stable or increasing each year.

In February-March 2020, an aerial boreal caribou abundance survey was completed to get an estimate of the density and number of boreal caribou with Tłįchǫ ASR/North Slave study area. The first phase of the survey involved flying in fixed-wing aircraft along transects spaced 2-km apart to locate areas with caribou track networks and groups of caribou. During the second phase of the survey, a helicopter then returned to those areas to find the groups of caribou and count and classify them (bulls, cows, and calves). The proportion of GPS-collared caribou found without the aid of radio telemetry was used to estimate how many caribou might have been missed overall on the survey. A total of 577 caribou were recorded in 104 groups during the survey, resulting in a minimum density estimate of 2.74 caribou/100 km^2 within the 21,071 km^2 survey area. After accounting for sightability using two different methods, caribou density in the study area was estimated to be as much as 4.6-8.2 caribou/100 km^2. Based on these density estimates, there could be 965-1725 caribou within the study area.

GPS locations from collared boreal caribou were used to evaluate whether construction of the Tłįchǫ ASR affected how often boreal caribou crossed the road alignment and how their movement behaviours changed in proximity to the road alignment using several different statistical approaches. The collars were equipped with a 'geofence' function that increased the frequency of fix rates to record 1 location every hour when caribou were within a 10 km buffer around the Tłįchǫ ASR and HWY3. Movement behaviours were characterized using step lengths (the distance between two successive GPS collar locations) and turning angles between steps. Crossing rates and movement behaviours along the Tłįchǫ ASR alignment were also compared against those of Highway 3, an operational highway with much higher traffic volumes than anticipated for the Tłįchǫ ASR. Consistent trends were found across different methods. Boreal caribou frequently crossed the Tłįchǫ ASR alignment before and during construction, although crossing rates during the pre-calving season decreased after construction began. Crossing rates during other seasons did not significantly differ between the pre-construction and construction phases. Boreal caribou crossed the Tłįchǫ ASR much more frequently than Highway 3, which was rarely crossed. During both the pre-construction and construction period of the Tłįchǫ ASR, caribou moved faster and straighter when they were closer to the road. This behaviour became more pronounced during the construction phase. Caribou also moved faster when crossing the Tłįchǫ ASR alignment than when they were not crossing it. In contrast, boreal caribou exhibited shorter and less directed movements in response to Highway 3. Barrier behaviour analysis showed that boreal caribou exhibited fewer 'quick cross' events and more 'bounce' events (i.e., getting close to the road then quickly moving away from it without crossing) during the Tłįchǫ ASR construction period compared to before construction. Boreal caribou movements in proximity to Highway 3 consisted mostly of 'bounce' events, consistent with there being very few observations of collared caribou crossing Highway 3. Overall, these analyses showed that construction of the Tłįchǫ ASR had modest effects on caribou crossings and movement behaviour near the road alignment compared to before construction, and that Highway 3 represented a much greater barrier to movement than the Tłįchǫ ASR. These analyses will be repeated after the first 5 years of operation of the Tłı̨chǫ ASR to evaluate whether public use of the road further alters caribou crossing and movement behaviours.

Barren-ground caribou

Collar data from GNWT's existing barren-ground caribou monitoring programs showed that collared caribou from both the Bathurst and Bluenose-East herds remained >100 km away from the Tłı̨chǫ ASR alignment, and consequently no additional mitigation or monitoring measures for barren-ground caribou were triggered under the WMMP.

During the construction phase, GNWT provided funding to the Tłı̨chǫ Government to develop monitoring programs to assess impacts of the road on winter habitat of barren-ground and boreal caribou and to establish baseline conditions before the road opened for public use. This also included winter track surveys conducted along the Tłı̨chǫ ASR alignment. Vegetation survey transects were established perpendicular to the road in two locations, to document vegetation cover and dust deposition. Winter track surveys conducted during the construction phase documented tǫdzı (boreal caribou), dedìı (moose), nǫ̀da (lynx), dechı̨ta gojıe (bison) and nǫhwhe (marten), and a group of 30 dechı̨ta gojıe (bison).

Wood bison and moose

Aerial surveys were conducted to document abundance of wood bison from the Mackenzie bison herd and moose in the Tłı̨chǫ ASR corridor area before and during construction. Bison observations from these surveys, as well as incidental bison observations made during other wildlife surveys (e.g boreal caribou composition surveys) were compiled to document whether bison are moving northward beyond their current known range boundary.

A combined wood bison and moose aerial survey was conducted in February/March 2018 within an ~11,000 km^2 area centered on the Tłı̨chǫ ASR alignment. Fixed-wing aircraft flew along transects spaced 2 km apart and recorded groups of moose and bison using a distance-based sampling design. No bison were observed along the northern half of the study area. There was an estimated 197 bison (3.28 bison per 100 km2) within the southern half of the survey area (5,998 km^2) which has been included in more recent Mackenzie bison population surveys. The most northerly bison observations from all the different aerial surveys conducted by GNWT-ECC before and during construction of the Tłı̨chǫ ASR were made between KM 46 and KM 48 and were within the northern extent of the current know Mackenzie Bison range. However, there were two bison observed by NSI construction staff at KM 76 in September 2021.

Moose abundance estimated for the entire Tłı̨chǫ ASR 2018 survey area was 113 moose (1.03 moose / 100 km^2). Moose abundance was estimated again in March 2021 as part of the larger North Slave Region aerial moose abundance survey. This survey yielded an estimate of 183 moose (1.55 moose/100 km^2) within the Tłı̨chǫ ASR survey area stratum (11,830 km^2). Moose densities in the Taiga Plains ecoregion (within which the Tłı̨chǫ ASR is situated) appear to have declined since earlier surveys conducted 2004 (3.6 moose/100 km^2), 2007 (3.2 moose/100 km^2) and 2012 (2.9 moose/100 km^2). The 2018 and 2021 estimates for the Tłı̨chǫ ASR area are similar to moose densities recorded during recent Mackenzie bison population surveys (2016: 1.5 moose/km^2; 2019: 1.7 moose/100 km^2) which cover a broader area of the Taiga Plains ecoregion.

Predator abundance

An aerial wolf abundance survey was completed in February/March 2020 within two 5000 km^2 blocks, one centered over the Tłı̨chǫ ASR alignment, and the other in the Mackenzie boreal caribou monitoring study area southeast of Highway 3. Wolf density within the Tłı̨chǫ ASR area was estimated to be 1.4 wolves / 1000 km^2, while the density in the Mackenzie survey area was estimated at 1.6-2.0 wolves / 1000 km^2.

Effectiveness of Mitigation Measures and Adaptive Management

Section 6.2 of this report includes a review by NSI and those GNWT staff involved in the implementation of the WMMP, of all of the mitigation measures required for the construction phase of the Tłı̨chǫ ASR. The assessment summarizes whether each mitigation measure was implemented, a qualitative assessment of whether it was effective, and if it could be improved in any way. Out of the 82 mitigation measures reviewed, 67 were implemented as planned, 11 were not implemented (because they weren't triggered), and 4 will be applied during the operations phase of the road. Of those mitigation measures that applied to the construction phase, fifty-seven (57) were deemed to be effective and 21 could not be assessed for their effectiveness. No mitigation measures were assessed as ineffective. Of those mitigation measures that were implemented, 7 were identified as having potential for improvements. Recommended improvements included:

- the use of drones to conduct pre-disturbance surveys for large mammals,
- more detailed methodology and reporting for pre-disturbance bird nesting surveys,
- dedicated bat roosting/hibernacula surveys, and
- better two-way communication and adding details on boreal caribou movement rates to improve the utility of collar data maps and ability to track compliance with required mitigation measures in response to collared caribou proximity to construction activity.

None of the pre-determined adaptive management thresholds that were identified in the WMMP were triggered during the construction phase, and therefore no additional review of the WMMP was triggered beyond the regular WMMP reviews conducted annually.

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Glossary

AGL	Above ground level
AIC	Akaike Information Criterion
BaBA	Barrier behaviour analysis
BC	British Columbia
CIMP	Cumulative Impacts Monitoring Program
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CV	Coefficients of variation
CWG	Tłı̨chǫ All-Season Road Corridor Working Group
DCLP	Tłı̨chǫ Government Department of Culture and Lands Protection
DFO	Fisheries and Oceans Canada (aka Department of Fisheries and Oceans)
EA	Environmental assessment
ECC	Department of Environment and Climate Change, Government of the Northwest Territories
ECCC	Environment and Climate Change Canada, Government of Canada
ENR	Department of Environment and Natural Resources (former name), Government of the Northwest Territories
Ft	Feet
GAM	Generalized additive model
GNWT	Government of the Northwest Territories
GPS	Global positioning system
Ha	Hectare
Hr	Hour
HT	Horvitz-Thompson estimator of abundance
INF	Department of Infrastructure, Government of the Northwest Territories
KM	Kilometer markings along highways
Km	Kilometer
m	Meter
m^2	Square meter
MRDS	Mark-recapture distance sampling
MVEIRB	Mackenzie Valley Environmental Impact Review Board
MVI	Multisource vegetation inventory
NSI	North Star Infrastructure
NWT	Northwest Territories
ROC	Receiver operation characteristic curve
RoW	Right of way
RSF	Resource selection function
TASR	Tłı̨chǫ all-season road
Tłı̨chǫ ASR	Tłı̨chǫ all-season road
Tłı̨chǫ ASR-NSR	Tłı̨chǫ all-season road, North Slave Region study area
VECs	Valued ecosystem components
VHF	Very high frequency (collar)
WLWB	Wek'èezhìı Land and Water Board
WMMP	Wildlife monitoring and management plan
WMZ	Wildlife Management Zone
WRRB	Wek'èezhìı Renewable Resources Board
YKDFN	Yellowknives Dene First Nation

1.0 INTRODUCTION

1.0 Introduction

The Tłı̨chǫ All-Season Road (Tłı̨chǫ ASR) is a new all-season road that connects the community of Whatì to Highway 3, approximately 30 km southwest of Behchokǫ̀, and is located in Wek'èezhìı, within the Northwest Territories (NWT). The Government of the Northwest Territories (GNWT) began construction of the Tłı̨chǫ ASR on September 3, 2019, and completed construction on November 20, 2021. In November 2020, the GNWT and Tłı̨chǫ Government announced the official name of the new Tłı̨chǫ ASR: the Tłı̨chǫ Highway, or Highway 9. Because this report addresses the pre-construction and construction phases of the road, and for consistency with the Wildlife Management and Monitoring Plan (WMMP), we refer to the pre-construction alignment, and the road under construction, as the Tłı̨chǫ ASR throughout this report.

This Construction Phase Comprehensive Monitoring Report is mandated by the Tłı̨chǫ ASR WMMP and was designed to meet requirements of s.95(2) of the NWT *Wildlife Act*, (SNWT 2013, c. 30), and other legislation, as well as measures and commitments in the environmental assessment (EA) process (Mackenzie Valley Environmental Impact Review Board (MVEIRB) public registry for EA1617-01).

The purpose of this report is to summarize the wildlife mitigation and monitoring programs that took place during the construction phase of the Tłı̨chǫ ASR, and the observed impacts of the construction phase on wildlife, as set out in EA1716-01. EA1716-01 noted that the construction of the Tłı̨chǫ ASR can impact wildlife and wildlife habitat in a number of ways, including: direct habitat loss, habitat degradation, and functional habitat loss due to noise or other sensory disturbances, dust, accidental spills of toxic or hazardous substances, injury or mortality due to vehicle collisions, increased mortality associated with improved access for harvesters or wildlife-human interactions, increased mortality from facilitated predator movements, and wildlife attraction to construction camps. Of particular concern are the impacts on caribou from increased harvesting pressure, increased predation resulting from new access, increased road-induced mortality, and barrier effects, in addition to uncertainty regarding the effectiveness of mitigation measures. These issues were cited by MVEIRB as reasons for referring the project to EA (MVEIRB 2016 *in* WMMP 2022).

1.1 Development of the WMMP

A WMMP for the Tłı̨chǫ ASR was required under s.95(1) of the NWT *Wildlife Act* and under Measure 10-2 of MVEIRB's *Report of Environmental Assessment and Reasons for Decision* (Report of EA) for the Tłı̨chǫ ASR. A first draft of the plan was submitted in 2016 with applications for permits and licenses for the project (version 1) and updated again during the EA process in 2017 to incorporate proposed wildlife effects monitoring programs (version 2). Following the EA, the WMMP underwent further updates to incorporate developer commitments, to address measures from the Report of EA, and feedback received during a public review of the WMMP as part of the permitting phase for the project (versions 3.1 to 3.4). Versions 3.3 and 3.4 of the WMMP were approved by the GNWT Department of Environment and Climate Change (ECC) (formerly the Department of Environment and Natural Resources [ENR]) and the Wek'èezhìı Land and Water Board (WLWB), respectively, in 2019. As required by Measure 10-2, Part 3 of the Report of EA, ECC works with the WLWB and the Wek'èezhìı Renewable Resources Board (WRRB) to coordinate an annual public review of the WMMP. At the time construction of the Tłı̨chǫ ASR was completed, version 4.2 of the WMMP was being implemented and version 5.0 was under public review. Version 5.2 of the WMMP was approved by GNWT-ECC on March 21, 2022, and is the version of the WMMP referenced in this report. The current version of the WMMP, available on ECC's WMMP resources webpage[1], contains a table documenting the complete revision history of the WMMP.

The WMMP is being implemented by the company contracted to build the road (North Star Infrastructure [NSI]), GNWT-Infrastructure and GNWT-ECC. GNWT-ECC has a lead role in monitoring the impacts of the project on wildlife at a regional scale, while NSI was mainly responsible for managing and monitoring wildlife in and around areas where they were building the road.

The Tłı̨chǫ Government is also responsible for implementing some of the EA measures pertaining to monitoring the state of winter habitat for caribou (ʔekwǫ̀) and a non-mandatory Aboriginal harvest monitoring and reporting program.

Annual reporting on implementation of mitigation measures under the WMMP and annual results of wildlife monitoring programs are included in annual water license reports submitted to the WLWB. Copies of these annual reports are also available on ECC's WMMP Resources website (see footnote 1). Three annual reports were submitted covering the construction phase of the project.

1.2 Scope of this Report

As outlined in section 6.1.3 of the WMMP, this Construction Phase Comprehensive Monitoring Report presents a formal comprehensive analysis and reporting of all monitoring during the construction phase, in addition to other relevant issues. Table 1-1 outlines specific issues this report is required to address (WMMP 5.2, section 6.1.3), and where they are found in this report.

This report, including elements that are specific to the project, and some that are extensions of existing GNWT-ECC programs, compiles and synthesizes information to help understand the impacts of the Tłı̨chǫ ASR construction phase on wildlife and to inform adaptive management. In some cases, this report summarizes information from WMMP programs previously reported in annual water license reports and reporting provided to comply with wildlife research permits obtained to carry out the WMMP programs. Additionally, this report includes wildlife data analyses that are required by the WMMP to be included in this comprehensive report. A second comprehensive monitoring report will be required after five years of operation.

This report is structured as follows: sections 1.0 (Introduction) and 2.0 (Road Construction) provide information and context about the project; section 3.0 (Mitigation of Potential Impacts) describes

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[1] https://www.gov.nt.ca/ecc/en/services/wildlife-management-and-monitoring-plans/wmmp-resources

how the pathway categories identified for mitigation are addressed in this report and documents the as-built footprint of the road; section 4.0 (Mitigation Monitoring) and 5.0 (Wildlife Effects Monitoring) summarize the monitoring activities and results associated with the Tłı̨chǫ ASR. Following the structure of the WMMP, section 4.0 addresses mitigation monitoring that was done by NSI in association with the road construction. Section 5.0 describes monitoring done by GNWT and the Tłı̨chǫ Government related to the effects of the road on wildlife more broadly. Sections 6.0 (Reporting and Adaptive Management) and 7.0 (Wildlife Conservation Concerns) document reports produced, address the effectiveness of mitigation measures, and describe adaptive management and wildlife conservation concerns raised in relation to the project throughout this period.

Table 1-1. Information the Tłı̨chǫ ASR WMMP stated would be included in the construction phase comprehensive report, and where it is found in this report.

Comprehensive reports will include analysis of the following:	Construction phase	Documented in this report
The efficacy of mitigation	√	Section 6.0, Table 6-1
Road-related mortalities	√	Section 4.3
Available information on changes in wildlife distribution, trend and abundance	√	Sections 4.0 and 5.0
Answers to the specific wildlife effects monitoring questions posed in section 5.2	√	Section 5.0 (see tables in section 5.0 with those questions)
Wildlife conservation concerns related to the Tłı̨chǫ ASR	√	Section 7.0
Suggested mitigation for any unacceptable effects observed	√	Section 6.0, Table 6-1
Description of total direct habitat loss	√	Section 3.2
Relevant scientific or traditional knowledge reports for the Tłı̨chǫ ASR area	√	Section 6.0

2.0 ROAD CONSTRUCTION

2.0 Road Construction

2.1 Description of Project

Peter Kiewit Sons (ULC) was retained by the GNWT Department of Infrastructure (INF) to construct the Tłı̨chǫ ASR. Road construction was completed by North Star Infrastructure (NSI), which is a joint venture between Kiewit and the Tłı̨chǫ Government.

The Tłı̨chǫ ASR is a 97-km gravel road that connects Whatì to Highway 3, approximately 30 km southwest of Behchokǫ̀ (Figure 2-1). The road starts at kilometre 196 on Highway 3 and extends to the Community Government of Whatì boundary, following a winter road alignment (i.e., the Old Airport Road). Approximately 17 km (18%) of the alignment is located on Tłı̨chǫ lands, and the remaining 77 km (82%) of the route is located on territorial lands.

The new two-lane gravel road (8.5 m road surface) consists of a maximum 60 m wide right-of-way (RoW; including the 8.5 m road surface) and includes 12 culverts and four bridges at major crossings (Duport River, Woodland Caribou Creek, James River, and La Martre River). In addition, six borrow source locations and one camp area were used to provide appropriate fill for the road construction. Clearing and grubbing of the RoW was the first step and happened in advance of the subgrade placement. Pits and quarries were accessed and developed moving northward to provide the necessary material if the RoW did not have the quantities needed. Blasting and crushing was part of the quarry development. Progress varied throughout and depended on terrain and whether the Tłı̨chǫ ASR straddled the existing winter road. A general construction timeline is outlined in Table 2-1 and illustrated in Figure 2-1.

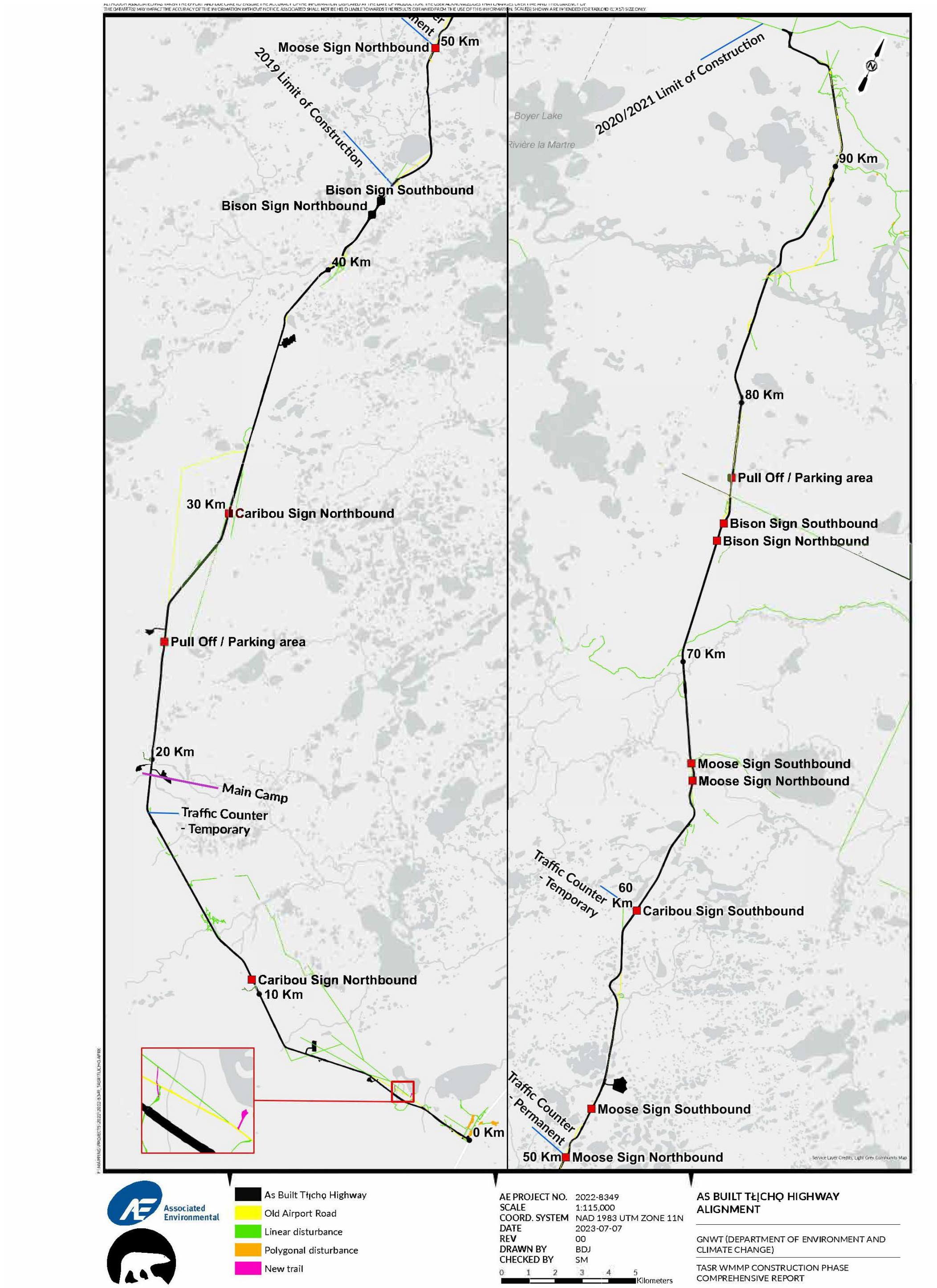

Figure 2-1. As-built Tłı̨chǫ ASR alignment.

Table 2-1. General Tłı̨chǫ ASR construction timeline from annual reports.

Date	Work completed	Limits of construction
September 3 - December 31, 2019	Construction activities on the Tłı̨chǫ ASR commenced on September 3, 2019, between KM 0+000 up to KM 83+375 and included vegetation clearing, stripping, pioneering, blasting operations, roadway embankment, drainage works and crushing.	By the end of 2019, Pit #33A was active and fill was being placed between KM 42 to 48. Geotextile was being placed from KM 39 to 45. Vegetation clearing took place up to KM 54, with pioneering between KM 75 to 85+350. The limit of construction for 2019 is considered to be KM 45.
January 1 - December 12, 2020 (on December 12, 2020, the project entered a temporary shut-down for the Christmas holidays)	Construction activities on the Tłı̨chǫ ASR were conducted between KM 0+000 up to KM 96+200 and included: pioneering, vegetation clearing (RoW and pits/quarries), stripping of RoW, establishing borrow sources, roadway embanking, blasting operations, temporary crossings and permanent bridges (including the push to pioneer access to LaMartre River so the bridge girders could be placed), installation of culverts, ditch slope finishing and road topping.	In 2020, pits #68A, 76 and 105 were utilized as RoW expansions and Pit #48A and its access road were established. Cut and fill operations continued up to KM 97, as did blasting. In fall 2020, there was a push to get the fiber optic cable laid all the way to KM 96, so one side of the ditching/road was completed quite a bit faster. The limit of construction for 2020 is considered to be KM 97.
January 1 – April 3, 2021	Project operations were suspended during this period due to Covid-19.	
April 3 – November 20, 2021	Construction activities on the Tłı̨chǫ ASR were conducted between KM 0+000 up to KM 97+000 and included: vegetation clearing, crushing operations (KM 79+000 road cut and Pit #105), ditch line and slope finishing, subgrade preparation, gravel placement, drill-and-shoot operations (ditch lines and quarry expansions), bridge structures completion (tensioning, deck panel grouting, approach slab placements and tensioning), removal of temporary bridges and accesses (Duport River and Woodland Caribou Creek), fiber conduit installation, testing and pull box installation, signage and guardrail installation, pit reclamation, deficiency corrections and demobilization.	In November 2021, the primary activities included camp demobilization and maintenance/equipment demobilization.

2.2 Wildlife Signage

Wildlife signage reminding drivers of the presence of bison was recommended in the WMMP as part of the "Drive Alive" Program. Wildlife signage can prepare drivers to be vigilant in high-wildlife use areas and minimize the risk of collision. Four bison crossing signs and four moose crossing signs were included in the design of the road (NSI 2020). Three additional caribou signs were since included and the as-built Tłı̨chǫ ASR has a total of 11 wildlife signs installed (three caribou, four moose, and four bison signs), as shown in Table 2-2. The signs were installed by NSI. The locations of these wildlife signs were selected in consultation with GNWT-ECC, and on the advice of the Tłı̨chǫ Government (B. Bey, pers. comm. 2023).

Table 2-2. Location and direction of as-built signage on the Tłı̨chǫ ASR.

Signage	KM marker	Latitude	Longitude	Direction
Caribou	10+500	62.500	-116.677	Northbound
Caribou	30+000	62.639	-116.834	Northbound
Bison	42+700	62.750	-116.831	Northbound
Bison	43+300	63.018	-116.930	Southbound
Moose	49+970	62.809	-116.840	Northbound
Moose	52+060	62.942	-116.872	Northbound
Caribou	60+000	62.894	-116.869	Southbound
Moose	65+500	62.947	-116.787	Northbound
Moose	66+180	62.828	-116.838	Southbound
Bison	74+700	62.755	-116.829	Northbound
Bison	75+400	63.024	-116.931	Southbound

3.0 MITIGATION OF POTENTIAL IMPACTS

3.0 Mitigation of Potential Impacts

3.1 Measures to Mitigate Impacts to Wildlife

Section 3.0 of the WMMP (version 5.2) acknowledges that the construction and operation of the Tłı̨chǫ ASR can impact wildlife and wildlife habitat in a number of ways, including direct habitat loss, habitat degradation and functional habitat loss due to noise, dust, spills of toxic or hazardous substances or other sensory disturbances, injury or mortality due to vehicle collisions, increased mortality associated with improved access for harvesters or wildlife-human interactions. As part of the EA, these potential impacts from the project on wildlife are described in detail in the Project Description Report (GNWT 2016) and the Adequacy Statement Response (PR #110) or are derived from traditional knowledge (Tłı̨chǫ Government 2014, NSMA 2018). Follow-up monitoring under the *Mackenzie Valley Resource Management Act* is intended to evaluate the soundness of the EA.

The WMMP explains how its proposed monitoring actions relate to the EA by linking the effects pathways identified for wildlife in the Adequacy Statement Response (PR #110) to the associated monitoring that will address each identified pathway (Table 4 in the WMMP). The effects pathways are based primarily on the MVEIRB Terms of Reference and were developed using science and available traditional knowledge reports.

Section 4.0 of the WMMP describes specific mitigation actions for each of the effects pathway categories identified in section 3.0. Mitigation actions were derived from current standard practices on other NWT roads and highways, best practices or guidelines listed in section 2.3 of the WMMP, through recommendations provided to the developer through the EA process, through measures from the Report of EA (MVEIRB 2018) or from suggestions emanating from traditional knowledge studies (Tłı̨chǫ Government 2014, NSMA 2018). The pathway categories identified for specific mitigation actions are listed in Table 3-1. Each pathway category had several mitigation actions identified. Each of these mitigation measures are evaluated in Table 6-1 of this report, which documents whether the mitigation was implemented, whether the mitigation was effective, and whether the mitigation could be improved (see section 6.0, Reporting and Adaptive Management).

For two of these pathways (mitigation for direct habitat loss, and caribou mitigation), further reporting was required (sections 3.2 and 3.3 of this report). In addition to these mitigation measures directly related to road construction and operation activities, the WMMP also outlined required mitigation monitoring and wildlife effects monitoring, which are addressed in sections 4.0 and 5.0 of this report.

Table 3-1. Primary pathway categories identified for mitigation as outlined in the Tłı̨chǫ ASR WMMP, their relevance to the construction and/or operations phase of the Tłı̨chǫ ASR, and documentation in this report.

Pathway categories identified for mitigation	Construction phase	Operations phase	Documented in this report
Mitigation for direct habitat loss	√	√	Section 3.2, disturbance footprint mapping; section 4.2, pre-disturbance clearing surveys; Table 6-1.
Mitigation for indirect habitat loss or alteration	√	√	Table 6-1; APPENDIX E.
Mitigation for sensory disturbance	√	√	Table 6-1; section 4.2, pre-disturbance wildlife surveys; section 3.3, using collared caribou maps to reduce disturbance
Mitigation for direct wildlife mortality	√	√	Table 6-1; section 4.3, wildlife mortalities; section 4.2, pre-disturbance wildlife surveys
Mitigation for access and harvesting	√	√	Table 6-1; section 5.2
Caribou mitigation	√	√	Section 3.3, collared caribou maps; section 4.2, pre-disturbance surveys; section 5.0, wildlife effects monitoring
Education and training	√		NSI was required to provide project staff with awareness training regarding wildlife monitoring and mitigation actions. Training is not reported on in this report.

3.2 Mitigation of total direct habitat loss

Site preparation, construction and operation activities can result in the loss or alteration of vegetation and topography that may change habitat availability, use and connectivity, and may influence wildlife abundance and distribution (adequacy statement response effects pathway in WMMP Table 4). Mitigation for direct habitat loss included minimizing the amount of new disturbance associated with the project footprint by following the existing Old Airport Road route to Whatì and intersecting areas previously burned where feasible, limiting the cleared Tłı̨chǫ ASR corridor to 60 m wide (not including the borrow sites and access corridors), and minimizing borrow source areas as well as locating them close to the Tłı̨chǫ ASR RoW so that access roads are short. Most of the borrow sources overlapped the Tłı̨chǫ ASR alignment, which limited additional disturbance to access these areas.

The WMMP required that spatial data for the footprint of the project be collected and reported when construction was completed to provide a precise record of direct habitat loss (sections 3.2.1 and 3.2.2).

3.2.1 Existing Disturbance Mapping Methods

Section 6.1.3 of the WMMP requires that this comprehensive report provide a description of total direct habitat loss resulting from the construction of the Tłı̨chǫ ASR. For this report, total direct habitat loss is defined as the amount of new disturbance caused by construction of the Tłı̨chǫ ASR, considering the degree of existing disturbance on the landscape prior to construction.

During the development of the Tłı̨chǫ Highway Boreal Caribou Habitat Offset Plan in 2021, using imagery dated prior to any Tłı̨chǫ ASR construction disturbance, GNWT-ECC began mapping the amount of existing disturbance on the landscape within 10 km of the proposed Tłı̨chǫ ASR alignment and the existing Highway 3 corridor. Mapping was completed using ESRI ArcMap and included GNWT-ECC's Cumulative Impact Monitoring Program (CIMP) land and water board permit registry data to ensure no data duplication occurred from what had already been mapped. All existing disturbance, including the Old Airport Road route, logging operations, linear corridors, and polygonal disturbances such as borrow sources or clearings were delineated at map scales between 1:5,000 and 1:1,000, where imagery was of sufficient resolution to do so. Spatial data attributes for the existing disturbance mapping were as follows:

- Linear feature (roads, trails)
- Polygonal feature (landings, cutblocks, quarries)
- Old Airport Road (existing Old Airport Road route alignment)
- Highway 3 (existing Highway 3 corridor including cleared RoW)

3.2.2 As-Built Mapping

In 2023, following construction, the as-built disturbance was mapped using the same methods as the pre-disturbance mapping (Associated Environmental 2023). Initially, GNWT-ECC began mapping with Planet Labs imagery that was expected to have 3.0 m resolution. The available image resolution from Planet Labs was not sufficient to map at as fine a scale as the pre-disturbance mapping; however, ESRI incidentally updated their available imagery to be higher resolution and better quality than previously available imagery. The ESRI imagery was used instead of Planet Labs because the updated version included the entire Tłı̨chǫ ASR alignment following construction (i.e., the as-built disturbance was visible along the entire length). Some shifts in the imagery between the Planet Labs and ESRI imagery used for pre-construction, and the post-construction ESRI imagery was evident when comparing the two products; in these instances, the ESRI imagery took precedent over the Planet Labs imagery.

Once the as-built disturbance of the Tłı̨chǫ ASR was completed, GNWT-ECC mapped any new trails or disturbance that was visible in the imagery and coded these new disturbances separately from the as-built disturbance (to meet one of the monitoring requirements of section 5.2.2 of the WMMP – Access and Harvest Monitoring).

Spatial data attributes for the as-built disturbance mapping were as follows (Table 3-2Figure 3-1):

- As-built (the total new disturbance, including quarries, resulting from the Tłı̨chǫ ASR construction)

- Highway 3 (existing Highway 3 corridor including cleared RoW)
- Linear disturbance (all roads and trails existing pre-construction of the Tłı̨chǫ ASR)
- New trail (any new trails created since construction began)
- Old Airport Road (existing Old Airport Road route, pre-construction of the Tłı̨chǫ ASR)
- Polygonal disturbance (all landings, cutblocks, quarries existing pre-construction of the Tłı̨chǫ ASR)

In total, the Tłı̨chǫ ASR resulted in 550 hectares (ha) of new footprint development that was previously undisturbed habitat. This was less than the estimated footprint of 784 ha in the Report of EA (page 1): "The estimated footprint of the proposed road corridor is approximately 564 hectares, with an additional 220-hectare footprint estimated for the borrow sources and access roads (PR#7)."

At the end of the construction phase, new trails originating from the Tłı̨chǫ ASR were not extensive, based on the imagery available, and only 0.3 ha (2,968.5 m^2) of new trails were identified in the updated mapping. It appears that the new trails may have been used as access to water sources, and it is not clear if these new trails were a component of construction or a result of other human activities. In reviewing the disturbance footprint data, GNWT-ECC noticed some minor disturbance features that were not captured in the dataset and based on the date of the underlying imagery (2021), it is likely that these features were associated with the Tłı̨chǫ ASR project. These additional features will be captured in the next comprehensive report.

Table 3-2. Breakdown of disturbances mapped within 10 km of the Tłı̨chǫ ASR.

Disturbance footprint type	Area (ha)
Tłı̨chǫ ASR as-built	549.97
Highway 3	555.62
Linear disturbance	386.28
New trail	0.30
Old Airport Road	73.48
Polygonal disturbance	305.56

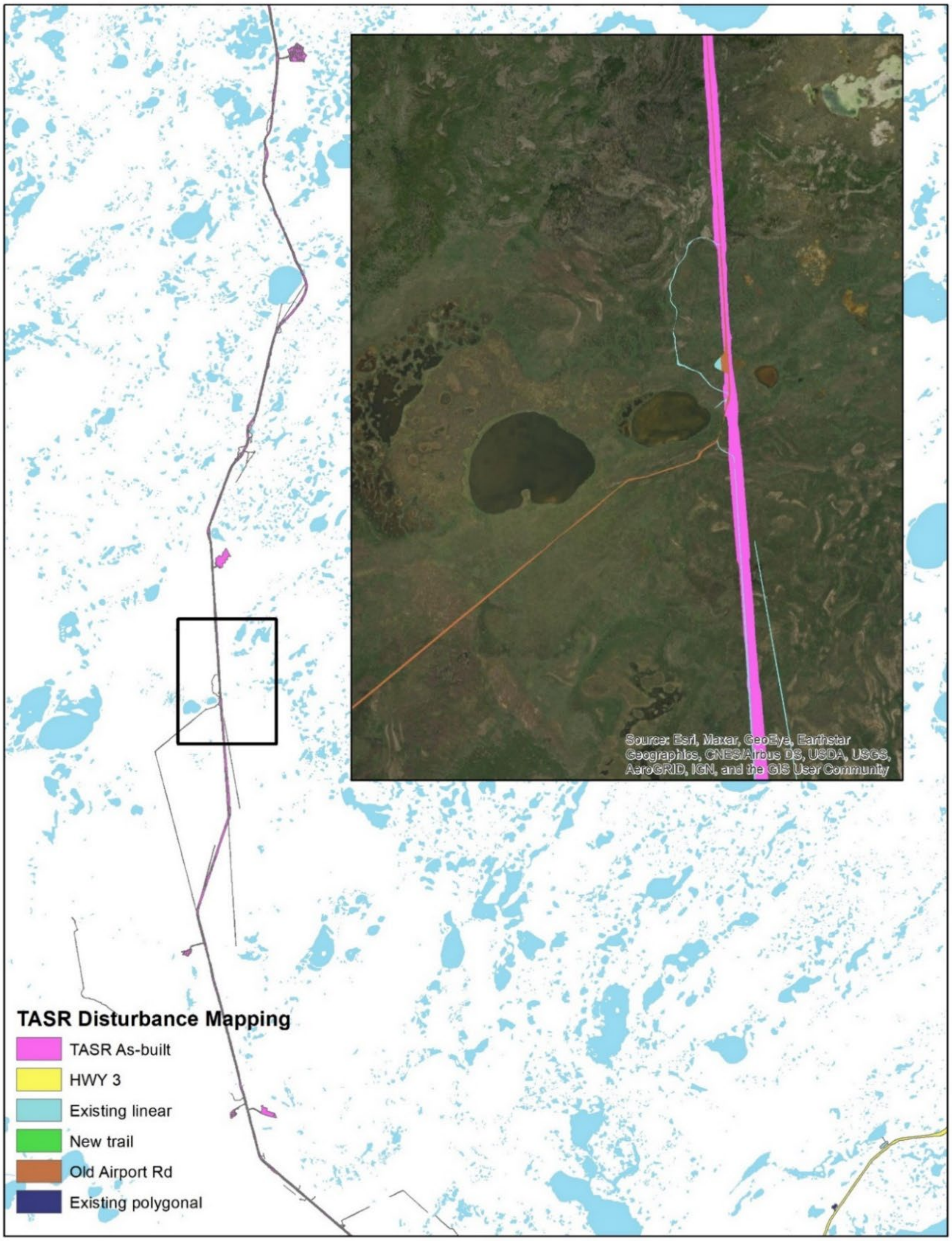

Figure 3-1. Example of disturbance mapping completed within 10 km of the Tłı̨chǫ ASR corridor.

3.3 Caribou Mitigation

The WMMP required mitigation measures specific to boreal and barren-ground caribou during the construction phase. If any caribou were observed on the RoW, they would have the right of way on the road, sightings would be communicated to other project staff in the area via radio, GNWT-ECC would be notified of the location and number of individuals, speed limits would be decreased to 30 km/h within 1 km on either side of the observation for 30 minutes after the caribou left the RoW. Additionally, the NSI Environmental Manager could temporarily suspend construction traffic and other activities if caribou were on the road or within an active construction area like a borrow source (WMMP section 4.6).

Boreal caribou collar data was also used to mitigate potential impacts during construction. A component of boreal caribou monitoring in the Tłı̨chǫ ASR area included fitting boreal caribou cows with GPS collars that provided movement, habitat use and survival information (see section 5.3). These GPS collars provided information about when those animals were near the Tłı̨chǫ ASR alignment. A process was established between GNWT-ECC and NSI to alert project staff when collared caribou approached construction activities within pre-defined distances, or "cautionary zones", so that mitigation measures could be implemented. Mitigation measures that could be triggered from the presence of collared caribou within the cautionary zones ranged from potential suspension of activities such as vegetation clearing and blasting during the most sensitive seasons (late-winter and calving), to the issuance of notifications to personnel about which sections of the road had collared caribou present within the cautionary zones and applying reductions in speed limits along those sections (WMMP Appendix D – Operating Procedure for Use of Boreal Caribou Collar Data to Mitigate Impacts from Construction of the WMMP).

3.3.1 Maps of Collared Boreal Caribou to Mitigate Potential Disturbance

GNWT-ECC provided NSI with maps of boreal caribou collar locations on a weekly basis during the summer, fall, and early to mid-winter periods (16 July – 16 March), and every two days during the late-winter and calving periods (16 March – 15 July). Each collar data map provided displayed collar locations from a one-week period buffered by 3 km, and the most recent collar location for each individual. The collar data maps indicated if there were collared caribou within the 4 and 6 km "cautionary zones" along the Tłı̨cho ASR, and in which segment (1-4) of the Tłı̨cho ASR they occurred. An example map is provided in Figure 3-2.

<u>Results</u>:

In 2019, collar data maps were provided from September 24 through December 20, 2019, when the project shut down for the holiday season. NSI weekly environmental reports from October 6-12, 2019, onward noted which maps were reviewed that week. In 2019, collared caribou overlapped with the 4-km road buffer most frequently in segment 2 and occasionally in segment 1 and 3. In September and October 2019 there were some weeks where no collared caribou overlapped with the 4 km road buffer (Table 3-3). When collared caribou overlapped with the buffer zones, appropriate site personnel were notified. When blasting occurred in segments where collared caribou overlapped with the 4 km buffer, weekly reports noted that all pre-blast clearance protocols were followed. No blasts occurred during the late-winter and calving caribou seasons in 2019 when more stringent protocols would have been required.

In 2020, collar data maps were provided from the first week of January until December 12, 2020, after which the project entered a temporary shut-down for the holiday season. Collared caribou were most frequently reported within the 4-6 km buffer along segments 1-3 (KM 0-85), and infrequently along segment 4 (KM 85-97) of the road (Table 3-3). Appendix G of the 2020 Annual Water License Report for the Tłı̨chǫ ASR provides a detailed summary of the weekly environmental reporting periods and whether collared boreal caribou were present within the 4-6 km buffer along any of the four road segments, and which mitigation measures were implemented as a result. Project activities were suspended for part of May 2020 due to the COVID-19 pandemic. During 2020, collared boreal caribou occurred within the 4-6 km buffer along at least one of the four segments of the Tłı̨cho ASR corridor during every weekly reporting period (2020 Annual Water License Report for the Tłı̨chǫ ASR).

In 2021, project operations were suspended during the January 1- April 3, 2021, period due to Covid-19, so no collar data maps were provided during that period. Collar data maps were thereafter provided to NSI from the first week of April until November 30, 2021, after which the road opened for public use. Collared caribou were most frequently reported within the 4-6 km buffer along segments 1-3 (KM 0-85), and infrequently along segment 4 (KM 85-97) of the road (Table 3-3). Appendix G of the 2021 Annual Water License Report for the Tłı̨chǫ ASR provides a detailed summary of the weekly environmental reporting periods and whether collared boreal caribou were present within the 4-6 km buffer along any of the four road segments, and which mitigation measures were implemented as a result. During 2021, collared boreal caribou occurred within the 4-6 km buffer along at least one of the four segments of the Tłı̨chǫ ASR corridor during every weekly reporting period (2021 Annual Water License Report for the Tłı̨chǫ ASR).

Buffered caribou collar locations most commonly overlapped with road segments 2 and 3 (between KM 25-85), and to a slightly lesser extent segment 1 (km 0 to 24) during the construction phase (Table 3-3). There were only nine occurrences of collared locations overlapping with the northernmost segment of the road (segment 4, KM 85-97) and these tended to be towards the southern end of segment 4. From October 3, 2019, to the end of construction, collared boreal caribou occurred within the 4-6 km buffer along at least one of the four segments of the Tłı̨chǫ ASR during every weekly reporting period.

The general mitigation response throughout the construction phase was to notify appropriate site personnel about which sections of the road had collared caribou present within the cautionary zones and to reduce traffic speeds. Any notifications to project staff were recorded in the weekly reports provided by NSI.

The presence of collared caribou within the 4-6 km buffers did not result in any reported suspensions or delays to vegetation clearing, blasting or other construction activity based on weekly reporting provided by NSI.

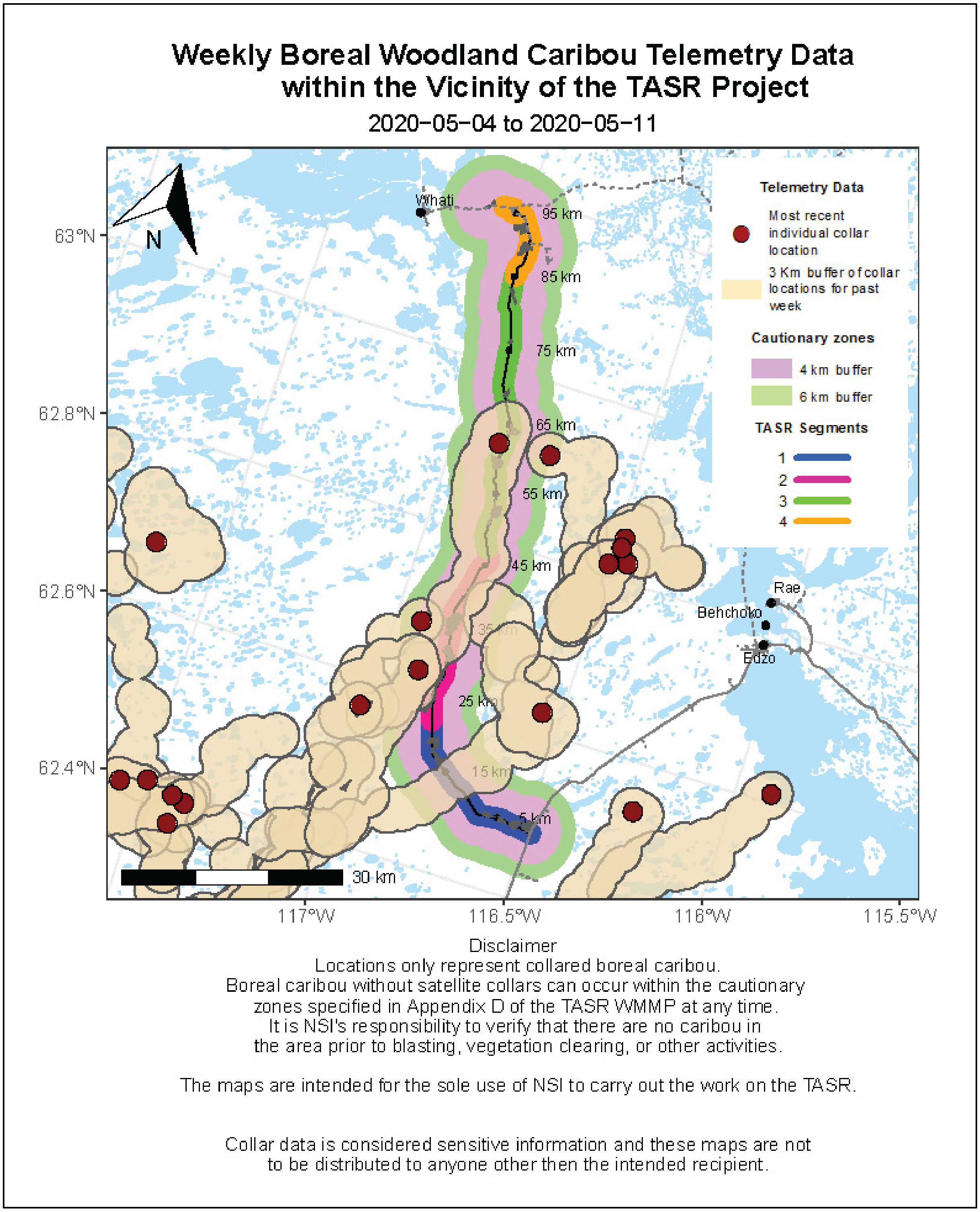

Figure 3-2. Example of a weekly boreal caribou collar data map provided to NSI for the week of May 5-11, 2020.

Table 3-3. Number of times collared boreal caribou were reported within the 4 or 6 km cautionary buffer zones within four different segments along the Tłı̨chǫ ASR during the construction phase.

	Number of times collared boreal caribou reported within 4 or 6 km cautionary zones			
	Road segment			
Period	**Segment 1 (KM 0 to 24)**	**Segment 2 (KM 25 to 46)**	**Segment 3 (KM 47 to 85)**	**Segment 4 (KM 85 to 97)**
September 3 - December 31, 2019	8	11	10	0
January 1 - December 12, 2020	45	49	50	7
April 4 - November 20, 2021	44	47	47	2
Total	97	107	107	9

4.0 MITIGATION MONITORING

4.0 Mitigation Monitoring

Section 4.0 describes the results of wildlife mitigation monitoring outlined in section 5.1 of the WMMP. This monitoring was identified to: 1) ensure that the wildlife and wildlife habitat protection measures identified for the Tłı̨chǫ ASR were being implemented and functioning as intended during construction, 2) provide advance warning of wildlife issues that required further mitigation, and 3) identify opportunities to improve mitigation through adaptive management. Mitigation monitoring was largely the responsibility of NSI, the joint venture company constructing the road.

4.1 Wildlife Surveillance Monitoring and Incidental Sightings

Wildlife observations during the construction phase were documented using wildlife sightings logs (WMMP 5.1.1), during road surveys (WMMP 5.1.2) and during wildlife surveillance surveys (WMMP 5.1.2).

In this section we first summarize the number of each type of wildlife survey completed by NSI staff during construction, and then combine the wildlife sightings from the three types of surveys and present the results spatially along the Tłı̨chǫ ASR, first focusing on the wildlife valued ecosystem components (VECs) that were also the subject of wildlife effects monitoring programs, and then on other species groups such as birds and furbearers.

This information was compiled from information provided by NSI in weekly environmental reports and annual water license reports. This compilation of wildlife observations by NSI does not include sightings from all pre-clearing and pre-disturbance surveys, so it is not an exhaustive list. Tables of wildlife sightings are included in APPENDIX A.

4.1.1 Wildlife Sightings Log

Rationale:

Wildlife sightings logs provided a simple means for all NSI staff to contribute to tracking wildlife activity during the project. During the construction phase, staff on the Tłı̨chǫ ASR recorded incidental observations of wildlife. Wildlife sightings logs were compiled weekly and documented the observations made by field crews. The value of the data is limited in that it is not systematically collected and contains repeated observations, but it could provide an indication of the potential for wildlife incidents or problem wildlife and areas of concern at the project.

Results:

The highest number of entries into wildlife sightings logs and highest number of different species recorded occurred in 2020, likely reflecting that this corresponded to the year with the highest number of active construction days (Table 4-1). Incidental sightings recorded in wildlife sightings logs are included in wildlife observation maps in section 4.1.4.

Table 4-1. Number of wildlife sighting log entries, and number of different species of birds and mammals recorded, for each year of the Tłı̨chǫ ASR construction phase (2019-2021).

Period	Number of wildlife sighting log entries	Number of different species of birds and mammals recorded
September 4 – December 31, 2019	75	26
January 1 – December 12, 2020	326	34
April 4 – November 20, 2021	164	25

4.1.2 Road Surveys

Road surveys were conducted by NSI Environmental Monitors during the construction phase of the project. Unlike the wildlife sightings logs, this task was only completed by the Environmental Monitors. Environmental Monitors drove the project site regularly and documented wildlife observations along the road to help identify wildlife risks and communicate them to project staff in the area, or to identify areas with higher presence of wildlife. Environmental Monitors were required to drive the full length of the constructed portion of the road at least once per week (see Table 2-1 for limits of construction). Observations of wildlife on project roads (including all spur roads such as quarry and water source roads), within the cleared RoW adjacent to the road, or within borrow pits, were documented (Table 4-2). When species were observed near the RoW, call outs over the radio to all staff were implemented to create zones of reduced speed and to educate people on crossing locations.

Results:

Wildlife sightings recorded during road surveys are included in wildlife observation maps in section 4.1.4.

Table 4-2. Number of road surveys completed, and number of different species of birds and mammals recorded, for each year of the Tłı̨chǫ ASR construction phase (2019-2021).

Period	Number of road surveys completed	Number of different species of birds and mammals recorded
September 4 – December 31, 2019	72	18
January 1 – December 12, 2020	237	33
April 4 – November 20, 2021	157	16

4.1.3 Wildlife Surveillance Surveys

Wildlife surveillance monitoring was intended to provide systematic and current information about wildlife activity at the project construction camps and to provide direct feedback regarding the effectiveness of wildlife mitigation. These surveys were specified for areas of the project where there was risk of wildlife attractants (e.g., food) or risk of wildlife finding shelter or denning sites and were to be conducted weekly by maintenance staff when camps were operational. Examples of wildlife activities that were required to be documented through wildlife surveillance monitoring included presence of wildlife within camp areas, any instances where food or domestic waste were improperly stored and use of buildings by wildlife for shelter or nesting. Environment Monitors undertook systematic tours of the project construction camps to record all wildlife observations or recent wildlife sign (e.g., tracks and scat).

Results:

Wildlife sightings recorded during wildlife surveillance surveys are shown in Table 4-3 and included in wildlife observation maps in section 4.1.4.

Table 4-3. Number of wildlife surveillance surveys completed, and number of different species of birds and mammals recorded, for each year of the Tłı̨chǫ ASR construction phase (2019-2021).

Period	Number of wildlife surveillance surveys completed	Number of different species of birds and mammals recorded
September 4 – December 31, 2019	17	0
January 1 – December 31, 2020	17	3
January 1 – November 20, 2021	45	1

4.1.4 Compiled Wildlife Observations from Mitigation Monitoring along the Tłı̨chǫ ASR

Wildlife observations from the wildlife sightings logs, wildlife road surveys and wildlife surveillance surveys were compiled from weekly and annual reports into a final table that was used to analyse wildlife sightings and observation trends. Within this wildlife observation data there were 24 incomplete observations. The missing data were omitted from this report so as not to show inconsistent or inaccurate data representations. A total of 81 individual wildlife sightings were not accounted for in the data analysis in this report due to missing information (see Tables A-1 to A-7 in APPENDIX A).

The WMMP (section 2.8) identified focal wildlife species for mitigating and monitoring impacts, including caribou, moose, bison, and black bear, as well as species at risk and broader ranges of species included under the NWT *Wildlife Act*, the federal *Species at Risk Act*, the *Species at Risk (NWT) Act,* and the *Migratory Birds Convention Act*. Wolves were identified in the WMMP as important to monitor as a predator of other species (WMMP 5.2.7). In this report, the distribution of observations of five focal wildlife species (boreal caribou, wood bison, moose, wolves and black bears) during the construction phase were mapped by year of construction. Maps were also created from compiled observations of bird species and from compiled observations of furbearers and other species.

4.1.4.1 Observations of Boreal Caribou During Project Construction

A summary of the boreal caribou observations made during the construction phase (September 4, 2019 - November 20, 2021) is provided below.

Figure 4-1 shows caribou sightings by season during project construction (2019-2021). There were 37 discrete caribou observations during project construction (plus three incomplete records from May 2020, not included in this analysis [Table A-1 in APPENDIX A). The majority (54%) of caribou sightings during construction of the Tłı̨chǫ ASR occurred during the summer season[2] (July 16 – September 12). All of these sightings were between one and two individuals. The next most frequent (32% of observations) period was post-calving (June 1 – July 15). These sightings were between one and four individuals and were mainly concentrated along the center of the road alignment (KM 53-68); however, at least two (if not more) of these sightings may have been the same individual over the same or consecutive days (Table A-1 in APPENDIX A).

There were two sightings of boreal caribou during the calving season (May 1 – 31), at KM 36 and KM 56.

Boreal caribou sightings in late fall were few (one in 2019 and one in 2020) but group size was larger (12 individuals in 2020). Caribou sightings in winter were confined to one sighting in mid-winter (January 30, 2020) of eight individuals. Caribou sightings in fall and winter were only in the southern sections of the project (KM 10-28).

There were no boreal caribou observations during the rut season (September 13 – October 4).

The highest concentration of sightings was from the center of the road alignment, approximately KM 45 to 70. Crossings of collared boreal caribou also occurred in this area, but during the construction period collared boreal caribou most often crossed the road alignment between KM 0 and KM 40 (see section 5.3.3).

[2] Caribou seasonality was taken from DeMars et al. (2020) for the southern NWT (Dehcho, North Slave, and South Slave regions).

Figure 4-1. Boreal caribou seasonal observations during project construction (2019-2021).

Figure 4-2 maps boreal caribou observation density per km² during construction (2019-2021). This figure used a 2-km radius for a Kernel Density Estimate, restricted to within 500 m of the Tłı̨chǫ ASR.

The existing winter road was upgraded up to the La Martre River crossing in 2020 to place bridge girders across to the north side of the river. This was done well ahead of the actual Tłįchǫ ASR construction. However, KM 68 is the farthest north that caribou were recorded in 2020. There is some further progression of caribou observations northward in 2021, with three sightings beyond those in 2020, up to KM 93. It should be noted though that most human activity and thus observations took place from the south up to where construction was active, which may skew these observations.

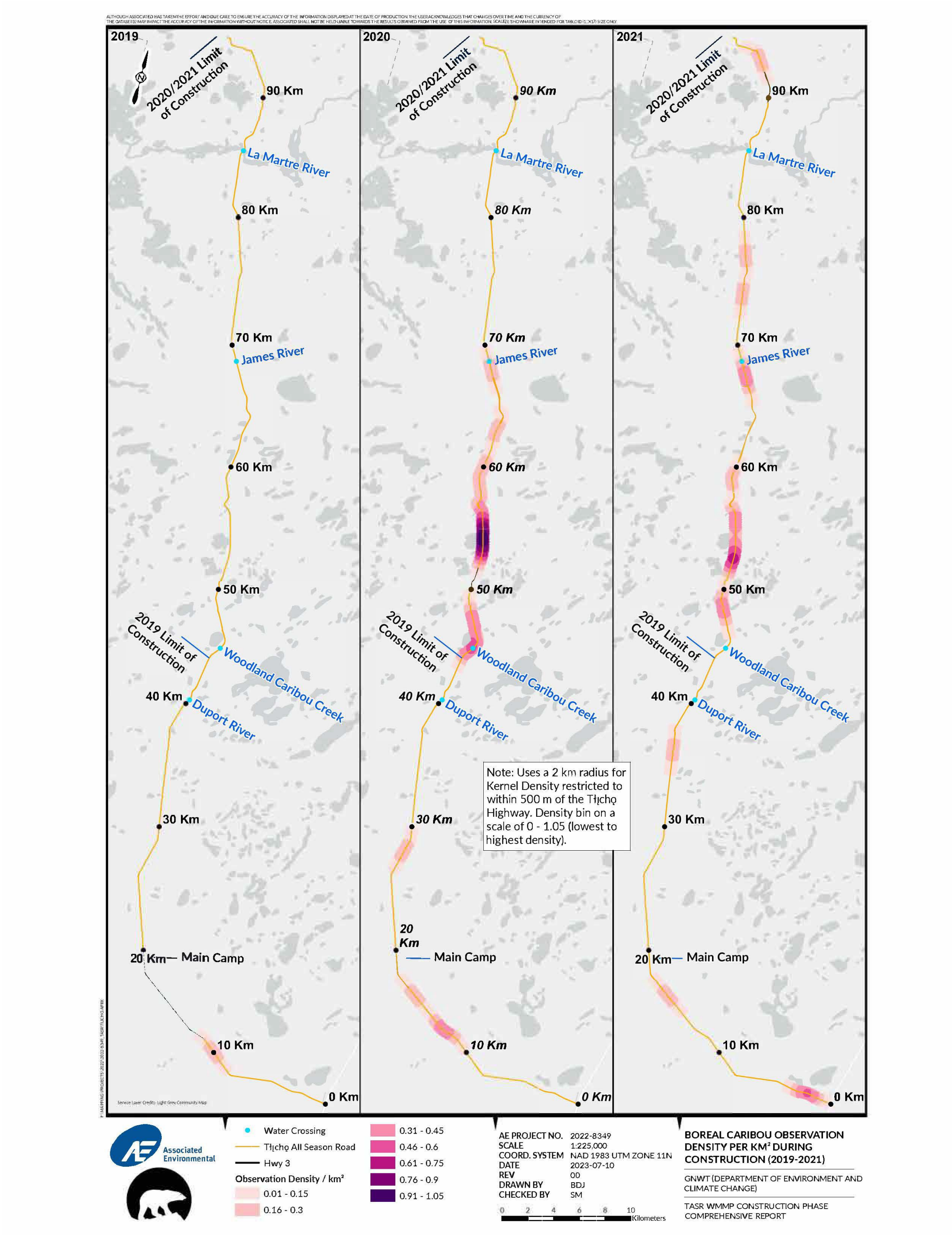

Figure 4-2. Boreal caribou observation density per km² during construction (2019-2021).

4.1.4.2 <u>Observations of Wood Bison During Project Construction</u>

A summary of the wood bison observations made during the construction phase (September 4, 2019 – November 20, 2021) is provided below.

Figure 4-3 shows wood bison observations per km during project construction in both snow (October to April) and snow-free conditions (May to September). Apart from one, all sightings of bison were confined to KM 0 to KM 45, which is consistent with the Mackenzie wood bison population range. Both 2020 and 2021 recorded a similar number of bison observations, although herd size was frequently larger (up to 50 individuals) during the snow-free period of 2020 than in 2021 (largest herd size was 16 individuals). In 2021, there was no project activity from December 12, 2020, to April 3, 2021, and road construction ended on November 20, 2021, which likely accounts for fewer bison observations recorded in the winter/snow season (October to April) in 2021 compared to 2020.

Figure 4-4 shows wood bison observation density per km^2 over time (2019-2021). This figure used a 2-km radius for developing a Kernel Density Estimate, which was restricted to within 500 m of the Tłįchǫ ASR. Wood bison are currently known to occupy the southern portion of the Tłįchǫ ASR, but there are historical reports of bison as far north as Lac la Martre (ENR 2010a *in* GNWT Department of Transportation 2016). The abundance of wood bison observations along the Tłįchǫ ASR during construction declines sharply after KM 40. Two bison were observed at KM 76 on September 21, 2021, the most northerly observation during construction (Table A-2 in APPENDIX A). During winter months in 2020, bison sightings were largely clustered around KM 26 to KM 40, while winter sightings were evenly spread out from KM 5 to KM 43 in 2021.

In the Report of EA and Reasons for Decision (2018), the Mackenzie Valley Environmental Impact Review Board (MVEIRB) accepted that the project would likely increase the number of bison in the area. This may in turn attract more predators such as wolves, resulting in additional pressure on alternate prey species such as caribou and moose. Bison are also effective at dispersing plant materials, including seeds of invasive alien plant species. The introduction of and/or spread of alien plants should be monitored in conjunction with bison observations.

An additional 40 wood bison were observed (location not recorded) on May 7, 2020 (Table A-2 in APPENDIX A) that are not included in the mapped data.

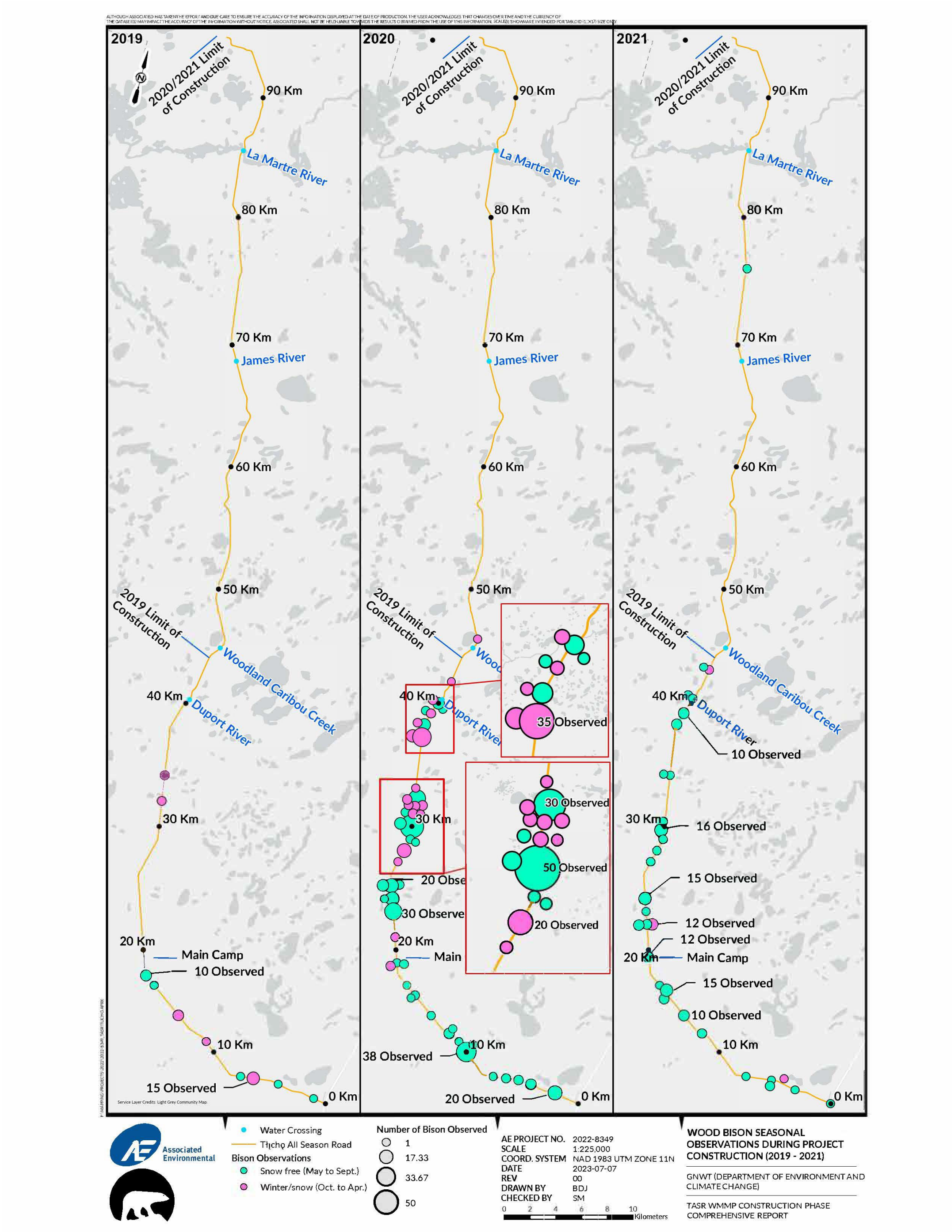

Figure 4-3. Wood bison seasonal observations during project construction (2019-2021).

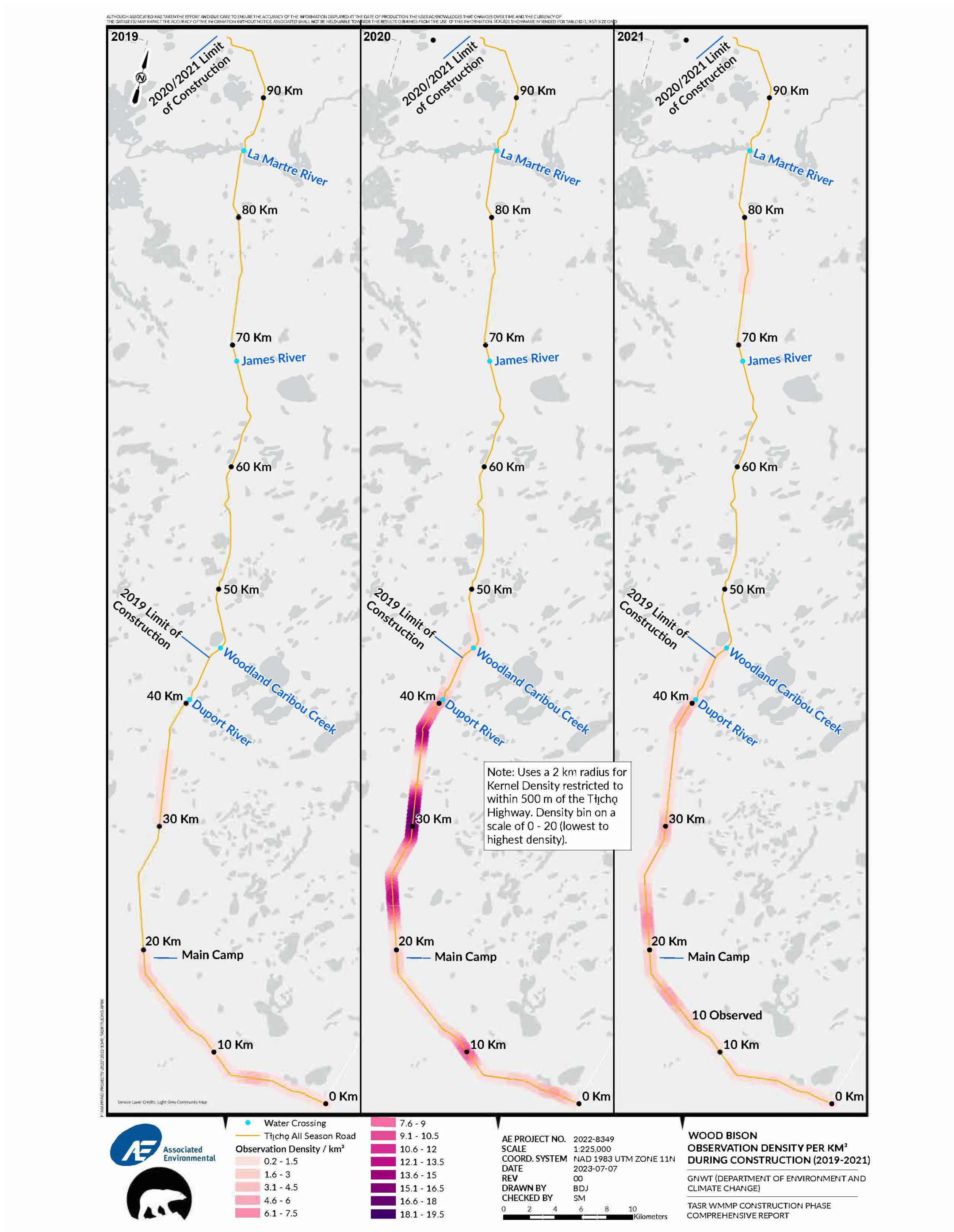

Figure 4-4. Wood bison observation density per km² during construction (2019-2021).

4.1.4.3 Observations of Moose During Project Construction

A summary of moose observations made during the construction phase (September 4, 2019 – November 20, 2021) is provided below.

Figure 4-5 shows moose observations per km during project construction during calving (May 1 – June 1), rut (September 15 – October 15), and all other times of the year. In general, moose observations were widespread along the project alignment. Group size ranged from between one and four individuals (Table A-3 in APPENDIX A). Most moose observations were outside of sensitive periods of calving or rut. The cluster of six sightings around La Martre River crossing were on consecutive days from September 27 to October 1, 2020, and may have been the same 1-3 individuals or may correlate with the start of seasonal rut for moose. Some of the observations during calving season (at KM 36 and KM 66) occurred within a few days of each other at the same or similar locations so could be the same individual.

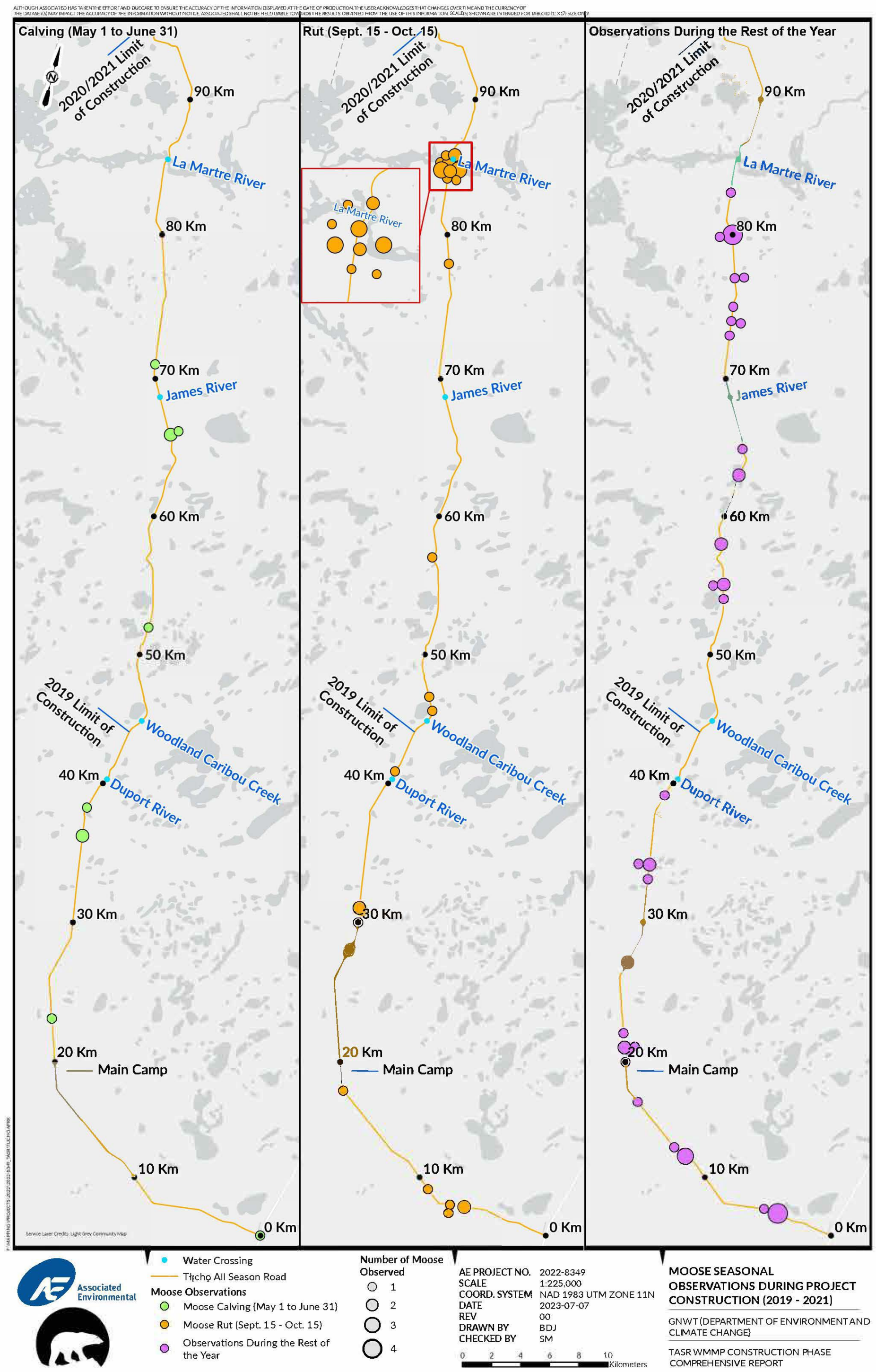

Figure 4-5. Moose seasonal observations during project construction (2019-2021).

4.1.4.4 Observations of Wolves During Project Construction

A summary of the wolf observations made during the construction phase (September 4, 2019 – November 20, 2021) is provided below.

Figure 4-6 shows wolf observation density per km^2 over time (2019-2021). This figure used a 2 km radius for the Kernel Density Estimate, restricted to within 500m of the Tłı̨chǫ ASR. In general, wolf observations were widespread along the project alignment. There were 64 observations of wolves, and a total of 96 individuals recorded. The number of individuals recorded per sighting varied from 1 to 12. These observations could have included repeat sightings of the same individual(s). Wolves were observed as far north as KM 68 in 2019 and KM 91-92 in subsequent years. Areas of greatest density were the James River and Duport River crossings. Wolf data is provided in Table A-4 in APPENDIX A.

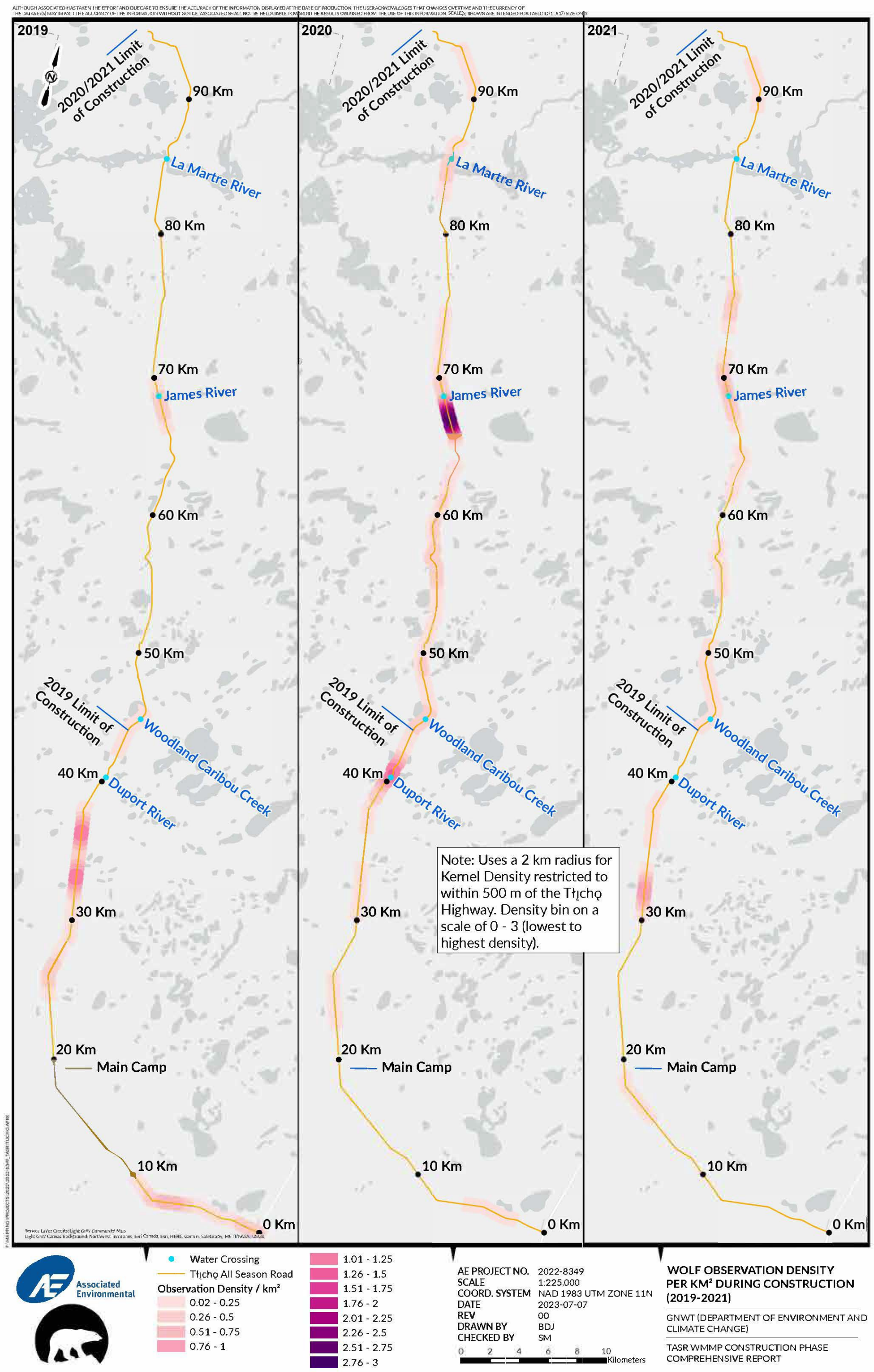

Figure 4-6. Wolf observation density per km^2 during project construction (2019-2021).

4.1.4.5 Observations of Black Bears and Grizzly Bears During Project Construction

A summary of black bear and grizzly bear observations made during the construction phase (September 4, 2019 – November 20, 2021) is provided below.

There were a total of 99 observations of bear species between September 1, 2019, and October 2, 2021. Only one observation of a grizzly bear was reported in the dataset; this report is from the week of October 27 to November 2, 2019, at KM 8. All other observations were of black bears, with the earliest reports of black bears in each of the years recorded between April 5-May 23 and the latest being between October 13 to October 19. There were no observations of either bear species during their typical denning window.

Figure 4-7 shows black bear observation density per km^2. This figure used a 2 km radius for the Kernel Density Estimate and was restricted to within 500 m of the Tłı̨chǫ ASR.

In 2019, the highest density of bear sightings was around Main Camp (KM 19 + 800). This moved further north in subsequent years and is somewhat correlated with areas of high construction activity, such as quarry pits and river crossings. For instance, the highest density in 2020 was around KM 30 and KM 40 near the Duport River crossing; the highest density in 2021 was between KM 60-65 and KM 85. The James River crossing is at approximately KM 68 and La Martre River crossing is at KM 85, suggesting that higher numbers of observations may be linked to areas where construction duration was longer.

Areas with increased human activity offer increased opportunity for wildlife observation. As well, densities of black bears are typically highest around water and where food availability is high. River valleys and shores host waterfowl nests and fish, as well as many grasses and sedges commonly consumed by black bears (ENR 2012b in GNWT Department of Transportation 2016).

Areas of higher black bear density may reflect the same individuals being recorded on the same or subsequent days in the same areas. For example, four bears were recorded at KM 30 on the same day that another individual bear was recorded at KM 30; a single bear was recorded on consecutive days at KM 68 in 2020; and there were two observations of bears on the same day at KM 62 in 2021 (Table A-6 in APPENDIX A).

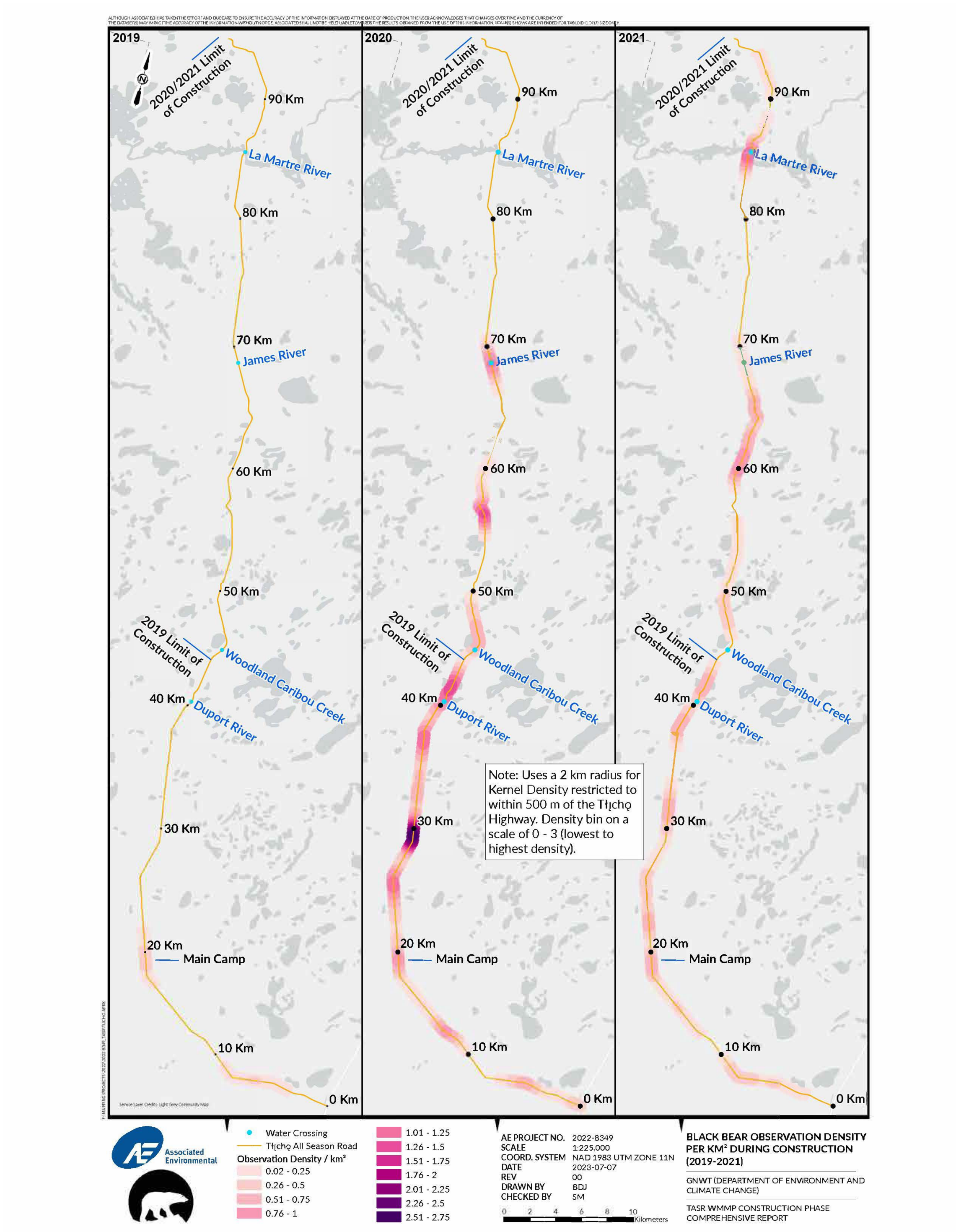

Figure 4-7. Black bear observation density per km^2 during project construction (2019-2021).

4.1.4.6 Observations of Birds During Project Construction

A summary of the bird observations made during the construction phase (September 4, 2019 – November 20, 2021) is provided below.

Figure 4-8 shows bird species observed that are protected under the *Migratory Birds Convention Act*, S.C., 1994, c. 22, in Canada. These include sandhill crane, dark-eyed junco, three-toed woodpecker, snow bunting, and potentially some of the following that were not identified to species: duck, plover, and swan species. A group of 15 sandhill cranes were identified at KM 36 on June 18, 2020 (Table A-5 in APPENDIX A). Other large flocks observed included dark-eyed junco (30), snow bunting (40), and swan species (10).

Figure 4-9 shows raptor and corvid bird species observed along the project during construction. Very few corvids were recorded, suggesting that this species group may have been omitted from observations due to their frequency or observer bias in thinking they are not important to record. Game birds observed included ptarmigan, sharp-tailed grouse, spruce grouse, and ruffed grouse (Figure 4-10). The largest flocks were of spruce grouse (up to 25 individuals) and largely observed between KM 57 and KM 75.

Most bird sightings were of species that are listed as secure (GNWT 2022; Government of Canada 2021). However, due to some observations not being reported to the species level (owl species, duck species, and plover species), there is potential for additional sensitive species to be present, such as short-eared owl, but not reported.

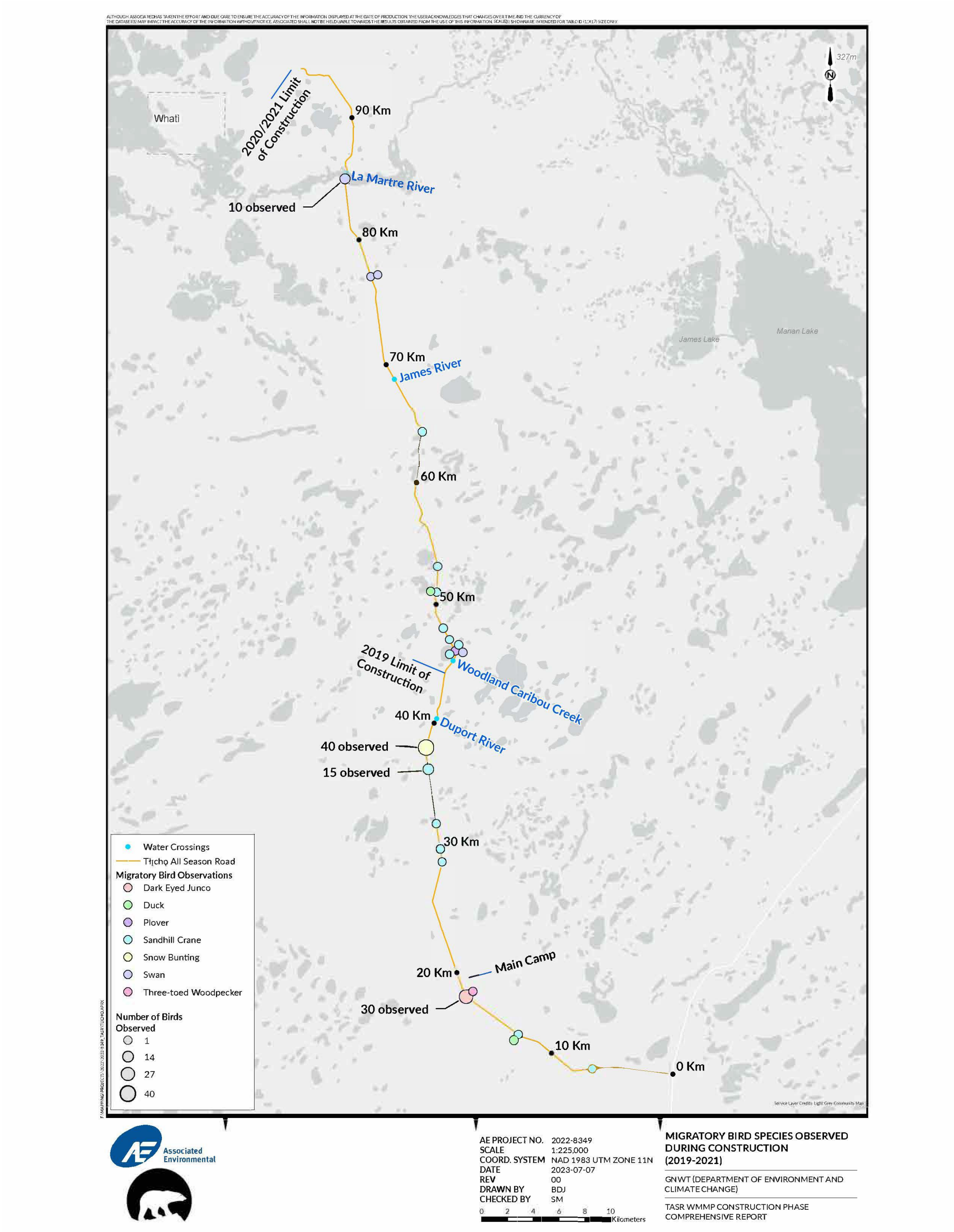

Figure 4-8. Migratory bird species observed during project construction (2019-2021).

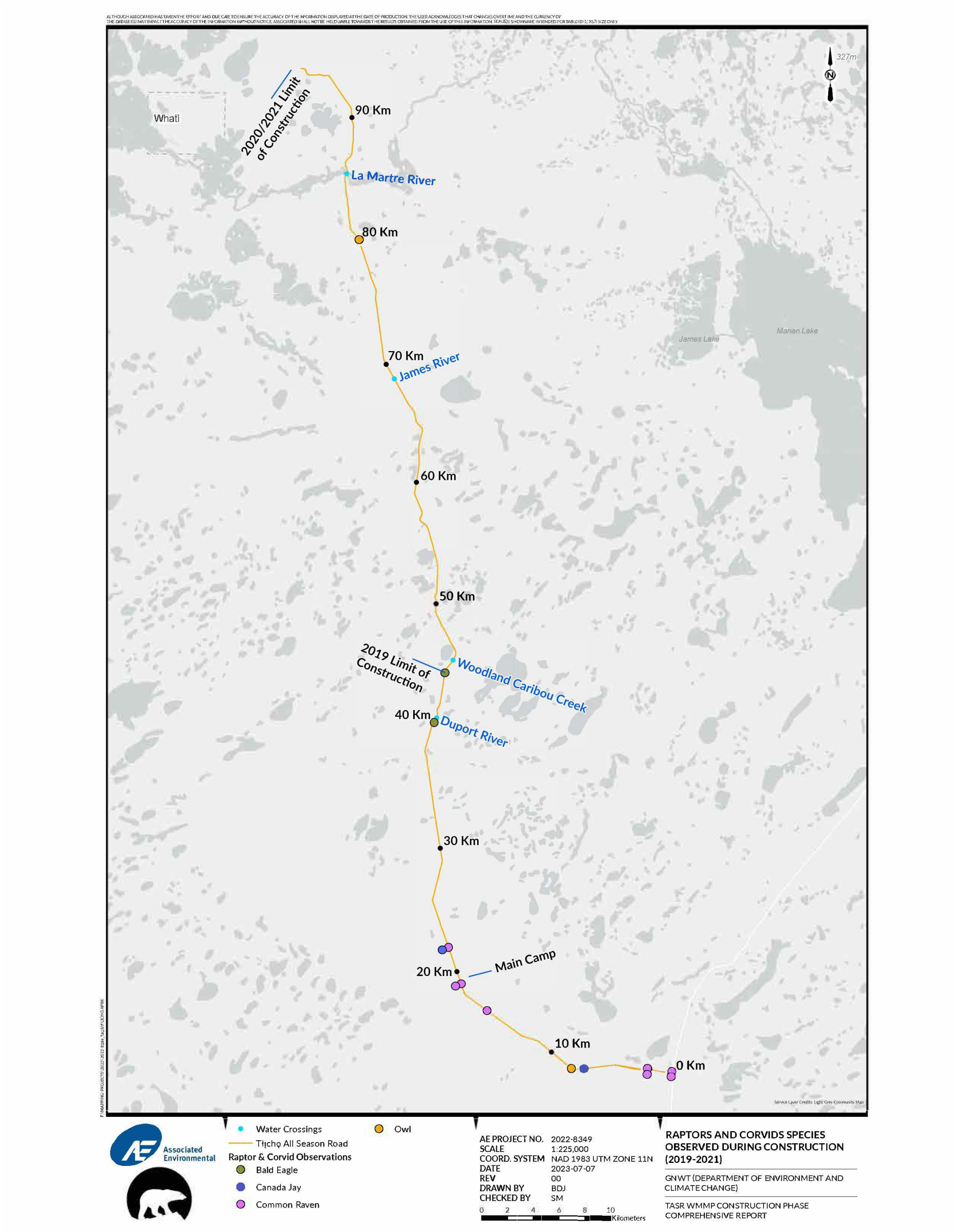

Figure 4-9. Raptor and corvid species observed during project construction (2019-2021).

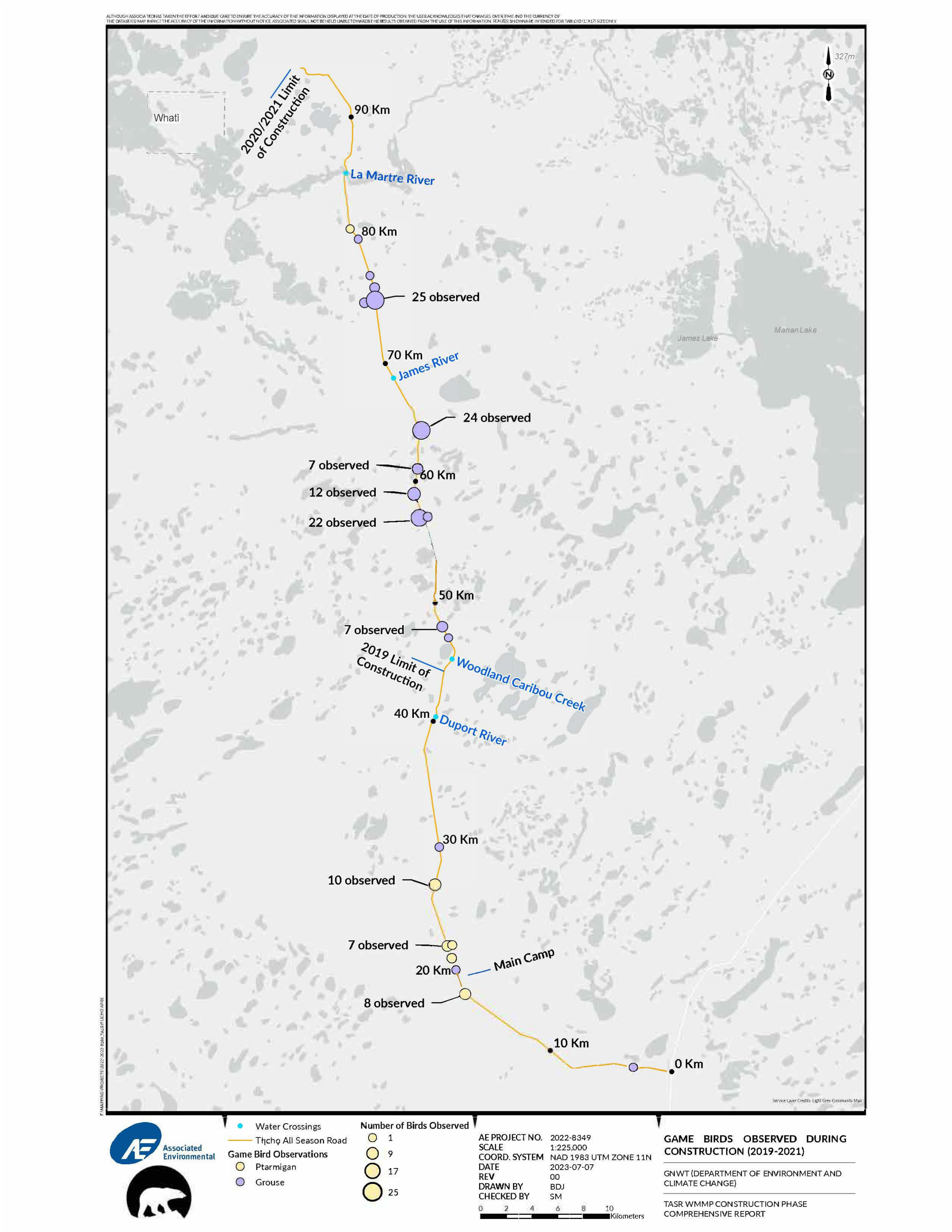

Figure 4-10. Game birds observed during project construction (2019-2021).

4.1.4.7 Observations of Furbearers and Other Species During Project Construction

Other species were also recorded, although these are not species that are being monitoring specifically for impacts. A summary of other wildlife observations, including furbearers, made during the construction phase (September 4, 2019 – November 20, 2021), is provided below (see also Table A-7 in APPENDIX A). This includes wolverine, which was included in the Adequacy Statement Response related to focal wildlife species addressed in the WMMP (section 2.8).

Twelve species of fur-bearing animals, as identified by both the Fur Harvesters Auction Inc. and the Northwest Territories Summary of Hunting and Trapping Regulations 2022-2023, were identified in the project area. These species are: American marten, grizzly bear, black bear (see Section 4.1.4.5), Canada lynx, cougar, fisher, fox species, red squirrel, river otter, weasel species, wolves and wolverine. Note that while cougars are included in this section for the purposes of this report and are considered to be fur-bearing animals, they are not defined or listed as furbearers in the NWT in trapping regulations.

Wolverine are not listed as at risk the NWT under the *Species at Risk (NWT) Act* but are ranked as sensitive in the NWT under the General Status Ranking Program (Working Group on General Status of NWT Species 2021) and listed as special concern in Canada (Government of Canada 2021). A general ranking of sensitive means that the species is not at high risk of extinction or extirpation but may require special attention or protection to prevent them from becoming at risk (Working Group on General Status of NWT Species 2021). There were a total of seven wolverine sightings during construction, but two sightings were within the same day (October 20, 2020) and at the same kilometre marking (KM 71), so may have been the same animal or may indicate the start of mating season for wolverine (Figure 4-11). Wolverine sightings spanned a total of 54 kilometres along the project route, and since a wolverine's home range easily covers several hundred square kilometres (ECC 2023), it is probable that each sighting was of the same one or two individuals.

There was one observation of a fisher on December 4, 2019, at KM 17 (Figure 4-10). Fisher are ranked as sensitive within the NWT. All other furbearing species that were observed during construction are ranked as secure in either the NWT or Canada-wide (Working Group on General Status of NWT Species 2021).

Three other species that were observed within the project area are the North American porcupine, snowshoe hare and cougar. The North American porcupine and snowshoe hare are ranked as secure within the NWT and are either not ranked Canada-wide or are ranked as secure (Figure 4-11).

There were four reports of cougar sightings (Figure 4-11). Cougars are ranked as undetermined in the NWT. This means that insufficient information, knowledge, or data is available to reliably evaluate their general status (Working Group on General Status of NWT Species 2021). Two sightings occurred between September 4 and October 15, 2019 at KM 15 and KM 10, respectively, and the other two occurred between August 22 and August 27, 2021 at KM 61 and KM 69, respectively (Table A-7 in APPENDIX A). Because the sightings in both 2019 and 2021 were within 5 to 10 kilometres of each other, it is possible that it was the same individual spotted on two separate occasions.

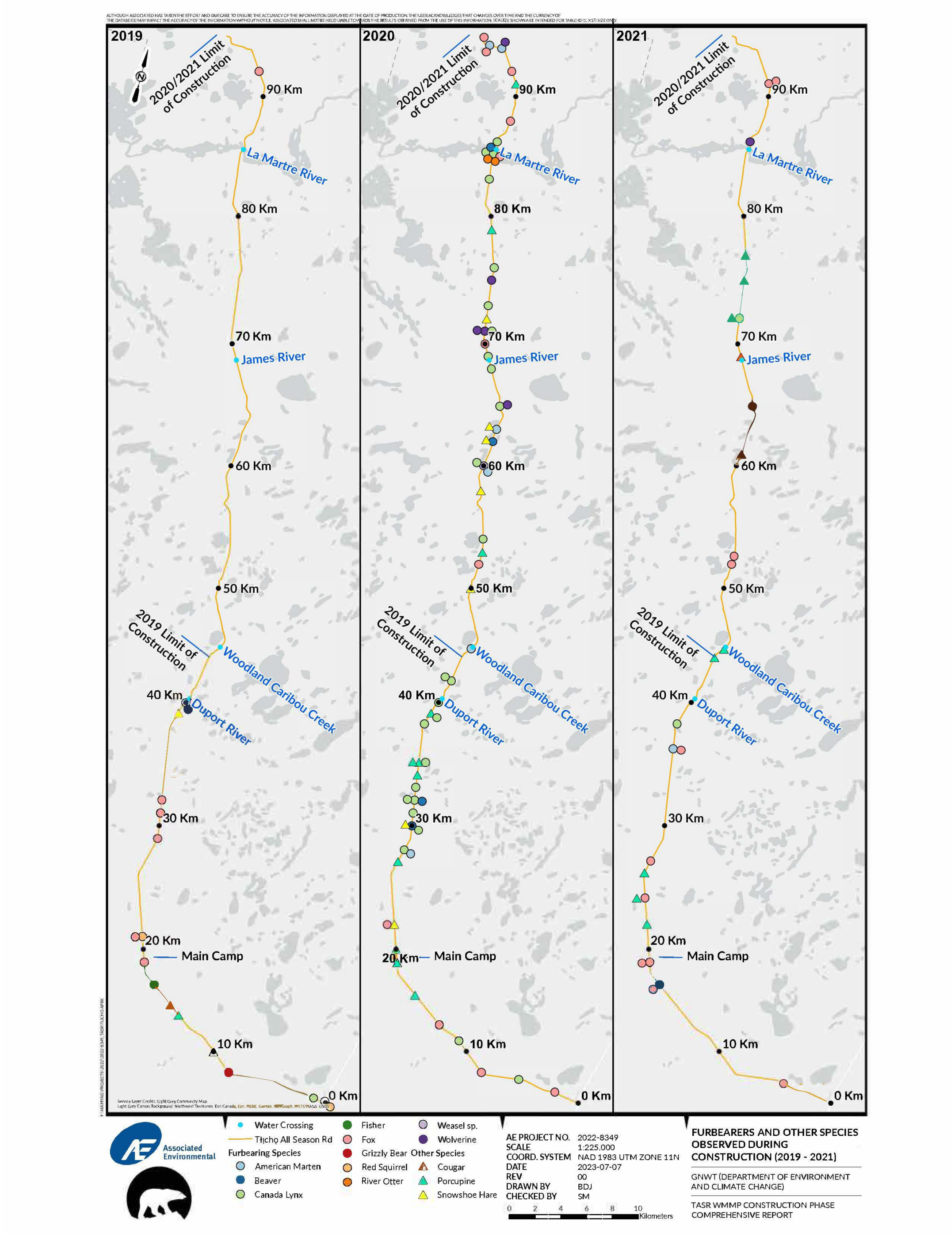

Figure 4-11. Furbearers and other species observations during project construction (2019-2021).

4.2 Pre-disturbance Wildlife Surveys

4.2.1 Bird Nesting and Bat Roosting

Observations of birds nesting were recorded as part of wildlife surveillance surveys (see section 4.1.3). In addition, specific monitoring was proposed in the WMMP (section 5.1.4 and Appendix F) to detect bird nesting or bat roosting activity and mitigate impacts to active nests and bat roosting sites. If a nest was found on project infrastructure or in hazardous areas, Environmental Monitors would work in consultation with ECCC, on a case-by-case basis, to establish buffer zones around nests to ensure adequate protection from disturbance. Clearing of vegetation was scheduled to occur outside of the migratory bird breeding season (1 May to 15 August), but if vegetation removal was required during this period due to unforeseen changes, non-intrusive bird nesting and bat roosting surveys would have been required (see section 4.2.3).

4.2.1.1 <u>Bird Nesting Results</u>

No nesting activity was observed in the vicinity of the camp nor on or in any infrastructure/equipment in 2019 or 2021. In 2020, barn swallows were observed flying over Dorm B, which led to the evaluation and regular monitoring of potential nesting locations available in the camp infrastructure such as vent pipes and overhead structures. No nesting activity was observed in the vicinity of the camp nor on or in any infrastructure/equipment. One new mitigation measure was recommended as a result of the information gathered from the bird survey, which is to create suitable alternative habitat for bank swallows if they are found to be nesting in any project stockpiles.

No pre-clearing bird nesting surveys were required due to vegetation clearing, because all vegetation clearing occurred outside of the breeding season (see section 4.2.3).

4.2.1.2 <u>Bat Roosting Results</u>

Bat roosting surveys (to be conducted as part of bird nest surveys, if needed) were not required because vegetation clearing did not occur during the breeding bird season (which generally coincides with the bat maternity roosting season). No active bat maternity roost sites were reported during the construction phase. A pre-construction aerial survey to detect bat hibernacula is described in section 4.2.3 below.

4.2.2 Pre-Blast Surveys

<u>Purpose and Methods:</u>

As part of construction activities, blasting was required both within the Tłı̨chǫ ASR RoW and in borrow pits. All blasting was preceded by a scan for large mammals to reduce the risk of injury and the impacts of sensory disturbance on wildlife. Blasting only proceeded if no large mammals (e.g., caribou, moose, bison) were detected in the 500 m blast radius or immediate blast zone. As outlined in WMMP Appendix F Pre-Blast Survey Procedure, two Environmental Monitors were required to complete a 1-hour survey, within a 500m radius of the blast zone perimeter (or as defined by the Blast Supervisor and blast plan). The survey was conducted by foot or truck and also included surveying within the immediate blast zone area to the extent that it was safe to do so. Scans for large mammals within the blast radius were completed prior to all blasts, regardless of blast size.

If large mammals were detected, they were to be given at least 15 minutes to move away from the blast area before deterrent procedures would be considered and only used if there was a risk to human or wildlife safety. Blasting was also preceded by air horn signals intended to deter wildlife from the area.

Results:
There were 140 blasting events during the construction phase of the Tłı̨chǫ ASR. During the pre-blast surveys conducted in 2020 and 2021, large mammals were never observed. In 2019, a moose was observed during a December 5, 2019, pre-blast survey. Air horns and truck horns were used to move the moose and to deter it from re-entering the blast radius. This was the only large mammal observed during a pre-blast survey in 2019.

Table 4-4. Number of pre-blast surveys completed, and number of large mammals, bird nests, or den sightings recorded for each year of the Tłı̨chǫ ASR construction phase (2019-2021).

Period	Number of pre-blast surveys completed	Number of large mammals, bird nests, or den sightings recorded
September 4 – December 31, 2019	38	1
January 1 – December 31, 2020	69	0
January 1 – November 20, 2021	34	0

4.2.3 Pre-clearing Large Mammal and Bird Nesting Surveys

Because the Tłı̨chǫ ASR generally follows a historic winter road route, clearing of vegetation was required primarily to widen the RoW. Clearing was also required at the quarries and quarry access roads. Vegetation clearing was scheduled to occur between September and April in 2019-2020 and 2020-2021 to avoid the migratory bird nesting season, however, other wildlife were anticipated be present and active in the RoW (WMMP 2022).

Two surveys were required prior to vegetation clearing:

- Pre-clearing survey to detect large mammals, no more than 48 hours prior to clearing activities, completed during clearing operations, and
- Bear den aerial survey, completed in the fall to detect possible bear denning locations before denning is initiated.

If a caribou was observed within 500 meters of clearing activities, clearing would be temporarily suspended as per the Pre-Clearing Large Mammal Survey Guidelines (see Appendix F in the WMMP). If a large mammal den was detected during pre-clearing surveys or during construction activities, the NSI Environmental Manager would temporarily suspend operations and GNWT-ECC would be consulted to determine next steps. Timing of the surveys were to be flexible to select suitable weather and snow conditions, and to account for the construction schedule (WMMP 2022).

4.2.3.1 Pre-Clearing Nest Surveys

If vegetation removal was required during the migratory bird breeding period due to unforeseen changes, non-intrusive bird nesting and bat roosting surveys would have been required (see section 4.2.3). No pre-clearing nest surveys were required because clearing activities were completed during the late fall and winter months, which fall outside of the breeding bird season.

4.2.3.2 Pre-Clearing Large Mammal Surveys

Purpose and methods:

The pre-clearing large mammal survey consisted of a ground-based survey no more than 48 hours prior to clearing and was used to sweep for bird nests and large mammals including dens sites. When encountered, recent signs of animals (tracks and scat) were also documented, which assisted in focusing sweep efforts.

Results:

There were 123 pre-clearing surveys completed during the construction phase of the Tłı̨chǫ ASR (Table 4-5). During these surveys, signs of animals such as tracks and scat were frequently observed, but individual animals were never observed around the clearing activities. Heavy equipment working in the vicinity would have elevated the noise levels and may have deterred wildlife from the area prior to pre-clearing surveys. In addition, dense forest composition that made viewing or spotting of fauna difficult even with binoculars or infrared scopes may have affected the ability of these surveys to detect large mammals.

Table 4-5. Number of pre-clearing surveys completed, and number of large mammals, bird nests, or den sightings recorded, for each year of the Tłı̨chǫ ASR construction phase (2019-2021).

Period	Number of pre-clearing surveys completed	Number of large mammals, bird nests, or den sightings recorded
September 4 – December 31, 2019	70	0
January 1 – December 31, 2020	39	0
January 1 – November 20, 2021	14	0

4.2.3.3 Bear Den Aerial Survey

Purpose

The purpose of the bear den aerial survey was to document potential or active bear dens within 800 m of the Tłı̨chǫ ASR alignment, borrow sources and borrow source access roads, and if an active den was detected, trigger mitigation and monitoring measures outlined in the WMMP. Additional requirements of this survey were to survey sites of hibernacula potential within 200 m of the RoW (WMMP, section 4.1.1), and to document any mineral licks, raptor nests, and other wildlife sightings observed during the survey. Surveys were to be flown following a recent snowfall to detect bear tracks or sign of recent excavations.

Methods

The study area for the aerial bear den survey was defined as an 800 m buffer around the Tłı̨chǫ ASR RoW and any of the proposed borrow sources. A helicopter flew at low altitude (100-200 ft above ground) and slow speed (60 km/hr) along survey transects spaced 250 m apart within the 800 m buffer. Aerial flight paths, suspected den sites, wildlife observations, and other wildlife habitat features of note were recorded with GPS waypoints and photos were taken where possible.

Results

2019-2020 Winter Season

For the 2019-2020 winter season, ECC completed a bear den aerial survey along the Tłı̨chǫ ASR alignment. A biologist from GNWT-ECC and two observers from Behchokǫ̀ completed the survey over a 3-day period between October 23-25, 2019. At the time of the survey, clearing of the RoW was advancing between KM 28.5 to 31.3, two camps were active at KM 0 and 19, and quarrying operations were occurring at Pit #2B and #13C (Kiewit-NSI Weekly Environmental Report for October 20-26, 2019).

No active bear dens were detected during the aerial survey, but two potential den sites were recorded. One potential den site was roughly 800 m from the Tłı̨chǫ ASR, and one was located within the 60 m RoW between KM 65-70. The crew landed at the den site that was 800 m from the Tłı̨chǫ ASR to investigate its occupancy status. It was determined to not be occupied, and no old or fresh bear tracks were seen around either potential den site. Old bear tracks were detected in three locations within the 800 m buffer and one set of fresh bear tracks was observed just south of KM 65, presumably within the Tłı̨chǫ ASR RoW. NSI investigated the potential den within the Tłı̨chǫ ASR RoW prior to clearing but no evidence of bear denning was observed. No raptor nests or mineral licks were recorded during the aerial survey.

Caves or potential sinkholes that may provide suitable bat hibernacula were recorded in six locations. None of these were within the Tłı̨chǫ ASR RoW or within the footprint of potential borrow sources.

A comprehensive report on the October 2019 aerial bear den survey can be found in Appendix H of the WMMP (2022).

2020-2021 Winter Season

For the 2020-2021 winter season, GNWT-ECC recommended that another aerial bear den survey be carried out in fall 2020 for any areas that remained uncleared, or within 800 m of areas where blasting would occur during the winter 2020-2021 season.

Most of the road clearing was completed in winter 2019-2020, with some clearing on the west side of the road left and completed in 2020-2021. There was no aerial bear den survey in 2020.

4.3 Wildlife Incidents and Mortalities

There were no recorded large mammal or predator mortalities during the Tłı̨chǫ ASR construction phase. There were six mortalities of smaller species recorded as wildlife incident reports during construction (Table 4-6).

Table 4-6. Wildlife mortalities reported as wildlife incidents during project construction.

Date	Species	Number	KM	Cause of death
December 10, 2019	Ptarmigan	1	24	Unknown – likely a vehicle collision with a rock truck
February 10, 2020	Unknown fish species	4-6	40+500	Deemed natural causes by DFO
March 22, 2020	Spruce grouse	1	47	Struck by light duty pickup
May 31, 2020	Longnose dace fish	30-40	46+219	Stranded in small basin that dried up
September 28, 2020	Spruce grouse	1	10	Unknown – likely struck by a transport truck
June 24, 2021	Snowshoe hare	1	19+500	Struck by road user

5.0 WILDLIFE EFFECTS MONITORING

5.0 Wildlife Effects Monitoring

The Tłı̨chǫ ASR WMMP established that wildlife monitoring would occur to evaluate impacts on wildlife and wildlife habitat during the construction and operation phases of the Tłı̨chǫ ASR. The proposed monitoring of effects of the Tłı̨chǫ ASR on wildlife and wildlife habitat focuses on boreal caribou, barren-ground caribou, moose and bison.

GNWT-ECC has a lead role in monitoring the impacts of the Tłı̨chǫ ASR on wildlife at a regional scale. The Tłı̨chǫ Government is also responsible for implementing some of the EA measures pertaining to monitoring the state of winter habitat for caribou (ʔekwǫ̀) and a non-mandatory Aboriginal harvest monitoring and reporting program.

The primary objectives of wildlife effects monitoring activities, as stated in the WMMP (section 5.2), are outlined in Table 5-1. This report focuses on reporting on monitoring activities that applied to the construction phase; however, monitoring activities completed to allow the detection of changes associated with the construction or operations phase(s) are included.

Table 5-1. Primary objectives of wildlife effects monitoring activities outlined in the Tłı̨chǫ ASR WMMP, their relevance to construction and/or operations phases of the Tłı̨chǫ ASR, and documentation in this report.

Wildlife effects monitoring activities: primary objectives	Construction phase	Operations phase	Documented in this report
Determine if improved year-round access created by the Tłı̨chǫ ASR results in a level of harvest mortality or harvest patterns of any wildlife that would suggest a conservation concern.	(√)	√	Determine sustainable levels of harvest for boreal caribou; actions taken to facilitate harvest monitoring, and harvest information available prior to operations phase (section 5.2).
Determine the distribution, habitat use, and movements of boreal woodland caribou in the Tłı̨chǫ ASR study area and adjacent areas before, during and after road construction.	√	√	Yes (section 3.3.1, maps for mitigation; section 5.0, movements and habitat use).
Measure direct habitat loss at completion of construction.	√		Yes (section 3.2.2).
Monitor and measure changes in distribution and abundance of moose, bison, and boreal caribou as borrow site activities and Tłı̨chǫ ASR RoW construction progresses.	√		Yes (sections 4.1, wildlife observations by NSI staff; section 5.0, wildlife abundance surveys by GNWT-ECC, bison distribution).
Monitor and measure changes in distribution and abundance of moose, bison, and caribou for up to five years after construction of the Tłı̨chǫ ASR is completed, and possibly longer if traffic levels increase substantially beyond predicted levels.	(√)	√	Distribution and abundance of key species documented for the pre-construction and/or construction phases, so that changes can be measured in operations phase (section 5.0).

Determine the amount and seasonality of wildlife injuries and mortality from vehicle collisions.	√	√	Yes (for construction phase - section 4.3).
Determine spatial and temporal distribution of wildlife movements, sightings, and collisions along the road to inform targeted mitigation actions.	√	√	Yes (section 4.1.4, NSI wildlife observations; section 3.3.1, collared boreal caribou locations).
Use the information from monitoring to mitigate and manage highway impacts where possible.	√	√	Actions documented in Table 6-1.
Use information from monitoring to inform best practices associated with future highway development and wildlife management in the NWT.			Section 6.0, adaptive management; Table 6-1.

5.1 Traffic Monitoring

The WMMP noted that predictions in the environmental assessment for the Tłı̨chǫ ASR are contingent on the Tłı̨chǫ ASR having relatively low traffic volumes, which were estimated in the WMMP to be 20-40 vehicles per day (WMMP section 5.2.1). Key monitoring questions are: (1) whether daily traffic levels averaged over a three-year period remained within 100% of the predicted maximum annual average daily traffic levels (i.e., within 40-80 vehicles per day) and (2) what are the average and maximum daily traffic levels during sensitive seasonal periods for boreal caribou, moose, and bison, or during periods of higher known collision risk?

The approach proposed in the WMMP to address these questions was for GNWT-INF to install a permanent traffic counting station along the Tłı̨chǫ ASR at KM 50, and two temporary traffic counters, one at the south end of the road near KM 1, and one towards the north end of the road near the La Martre River bridge at KM 85. GNWT-INF is also to develop a regular schedule of visual counts and surveys to verify the accuracy of units.

At the end of the construction phase, GNWT-INF installed two traffic counters (TRAFX Research Ltd.): one at the south end of the road at KM 18 and one towards the north end of the road at KM 60 (see Figure 2-1). These began collecting data on December 9, 2021. Three more counters provided by GNWT-ECC were installed post-road opening, which are outside the scope of this report. Traffic counters will be retrieved to download captured data on a regular schedule (spring and autumn). Another traffic counter installed near Woodland Caribou Creek is maintained by NSI. Traffic monitoring results will be addressed in the Operation Phase Comprehensive Report that is required after the road has been operational for five years.

5.2 Access and Harvest Monitoring

The WMMP noted that a specific concern in the EA associated with the Tłı̨chǫ ASR is increased wildlife mortality associated with: (a) hunting along the road, (b) greater hunter access from the road into previously difficult-to-access harvesting areas, and (c) extending seasonal access into winter harvesting areas for barren-ground caribou beyond the Tłı̨chǫ ASR study area (WMMP section 5.2.2).

The WMMP outlines objectives and key monitoring questions for addressing these concerns (Table 5-2).

There was no access or harvest monitoring specific to the Tłı̨chǫ ASR during the construction phase because the Tłı̨chǫ ASR alignment was closed to public use. However, this report focuses on steps taken during the construction phase to prepare for monitoring during the operations phase, as required by the WMMP. In addition, Measure 6-2 of the Report of EA (MVEIRB 2018), required that GNWT-ECC, in collaboration with Aboriginal groups and in accordance with the requirements of the Tłı̨cho Agreement, determine sustainable harvest levels for boreal caribou in the North Slave portion of the NT1 range prior to the road being opened to the public (see section 5.2.5).

Table 5-2. Monitoring questions posed in the WMMP to address concerns about increased wildlife harvesting associated with the Tłı̨chǫ ASR, their relevance to construction and/or operations phases of the Tłı̨chǫ ASR, and documentation in this report.

Wildlife effects monitoring activities: primary objectives	Construction phase	Operations phase	Documented in this report
Determine if the Tłı̨chǫ ASR is resulting in a pattern or level of harvest mortality for moose and caribou that would suggest a conservation concern or need for additional harvest management actions.		√	No.
Identify who is using the road to access harvest opportunities.		√	No.
Determine the sex and age structure of the harvested population of moose in the North Slave Region.	√	√	Methods reported in section 5.2.4.
Determine if and where moose are being harvested near the Tłı̨chǫ ASR.		√	No.
Determine if improved year-round access from the Tłı̨chǫ ASR results in the proliferation of new trails leading off of the Tłı̨chǫ ASR RoW.		√	Current extent of trails mapped as of end of construction phase (section 3.2.2).

The proposed approaches to addressing access and harvest monitoring in the WMMP (section 5.2.2) are summarized in Table 5-3, with more information in the following sections.

Table 5-3. Proposed approaches and temporal scope outlined in the Tłı̨chǫ ASR WMMP to address access and harvest monitoring, their relevance to construction and/or operations phases of the Tłı̨chǫ ASR, and documentation in this report.

Proposed approach	Construction phase	Operations phase	Documented in this report
Create a new GNWT-ECC Renewable Resource Officer position in Whatì (permanent, starting in 2021-22).		√	Yes, section 5.2.1.
Once the Tłı̨chǫ ASR is operational, establish regular [ECC] patrols along the Tłı̨chǫ ASR throughout the year, particularly during fall		√	No.

resident moose harvest seasons and fall/winter caribou harvest seasons.			
Once the Tłı̨chǫ ASR is operational, GNWT will establish a checkpoint station during the barren-ground caribou winter harvest season on the Tłı̨chǫ ASR south of Whatì and extend the period the checkpoint is open by one month on either end of the current winter road season, if there is evidence that barren-ground caribou are wintering in the region north of Whatì and if there is evidence that hunters are using the Tłı̨chǫ ASR to reach barren-ground caribou in that area.		√	No.
GNWT-ECC will work together with the Tłı̨chǫ Government and WRRB to develop and implement a non-mandatory Aboriginal harvest monitoring and reporting program, with a target to implement for the opening of the Tłı̨chǫ ASR.	√	√	Yes, section 5.2.4 below.
Increased number of aerial surveys to monitor harvesting activities on either end of the winter barren-ground caribou harvest season.		√	No.
Map the pre-construction trail network leading off of the existing Lac la Martre winter road using satellite imagery and update annually starting at the end of the construction phase, and for the first five years of operation of the road.	√	√	Yes, pre-construction trail network mapped (sections 5.2.2 and 3.2.2).
Continue GNWT-ECC North Slave Region's moose jaw collection program.	√	√	Yes, section 5.2.3 below.

Work completed on these proposed approaches during the construction phase is detailed below.

5.2.1 Create a New GNWT-ECC Renewable Resource Officer (RRO) Position in Whatì

A new GNWT-ECC Renewable Resource Officer (RRO) position in Whatì was established and the RRO began work in summer 2021, before the end of the Tłı̨chǫ ASR construction phase.

5.2.2 Map Trail Network and New Trails

Mapping of the pre-construction trail network from the existing Lac la Martre winter road, and mapping of trails from the Tłı̨chǫ ASR at the end of construction, was completed as a baseline to update annually for the first five years of operation of the road. Mapping is described in section 3.2 of this report.

5.2.3 Continue GNWT-ECC's North Slave Region Moose Jaw Collection Program

The GNWT-ECC North Slave Region's moose jaw collection program can help to provide information on the sex and age structure of moose harvested in the North Slave Region, and areas of higher harvest pressure using a 10 km by 10 km grid. This voluntary program has been ongoing since 2013. Moose harvesters in the North Slave Region are provided an incentive of $50 and a ball cap to provide

GNWT-ECC with the lower jaws of harvested moose and the general location of harvest. Locations of moose harvests before 2021 can provide baseline information, and data from 2021 and later may provide a sense of the extent to which harvest areas near the Tłı̨chǫ ASR or in previously difficult to access areas are being used when the Tłı̨chǫ ASR is open to the public. Data from the moose jaw collection program has not yet been spatially referenced to assess patterns of harvest along the Tłı̨chǫ ASR corridor. This information will be summarized in the comprehensive WMMP report for the operations phase.

5.2.4 Collaborative Access and Harvest Monitoring

The approach proposed in the WMMP was for GNWT-ECC to work together with the Tłı̨chǫ Government and WRRB to develop and implement a non-mandatory Aboriginal harvest monitoring and reporting program, with a target to implement for the opening of the Tłı̨chǫ ASR.

The Tłı̨chǫ Government developed a proposal for a monitoring program to address this requirement, as well as to address Measures 7-1 and 9-1 of the Report of EA. In August 2020, GNWT-INF committed funds to support the Tłı̨chǫ Government to undertake this program. As required by Measure 9-1, the harvest monitoring and reporting program will: (a) focus on boreal caribou, barren-ground caribou and moose population trends in areas accessed by winter roads and trails from the project, (b) be community-based and involve collaboration between the Tłı̨chǫ Government and the developer, (c) involve traditional knowledge holders and harvesters in monitoring wildlife harvesting trends and (d) report wildlife harvesting numbers and trends from checkpoints or other methods annually to the Tłı̨chǫ Government, WRRB, GNWT-ECC and other wildlife co-management partners. The information from this program will provide information that will also support the implementation of Measures 6-2 and 7-2, as well as inclusion of traditional knowledge as required by Measures 9-3 and 10-2.

The resulting Tłı̨chǫ ASR Wildlife Monitoring Program is detailed in Appendix I of the WMMP 5.2 (2022). Work conducted under this program during the construction phase is outlined in section 5.2.4.1 below, as well as in section 5.4.2 (caribou winter habitat monitoring).

5.2.4.1 <u>Tłı̨chǫ Government Tłı̨chǫ Highway Wildlife Monitoring Program</u>

Work was conducted in 2020-21 by the Tłı̨chǫ Government's Department of Culture and Lands Protection (DCLP), with support from the Firelight Group, to establish a Tłı̨chǫ Highway Wildlife Monitoring Program (the Monitoring Program). The Monitoring Program was developed in response to measures identified by MVEIRB in their 2018 Report of EA and Reasons for Decision for the GNWT's proposed Tłı̨chǫ ASR, and will provide important data to understand increases in harvesting pressure and impacts to wildlife, particularly woodland caribou (tǫdzı), barren-ground caribou (hozìı ekwǫ), and moose (dedìı) living in the vicinity of the Tłı̨chǫ Highway (Tłı̨chǫ Government 2021a). In relation to Measure 7-1, the project will focus on improving and informing mitigation of significant adverse impacts to ʔekwǫ̀ through the inclusion of Tłı̨chǫ traditional knowledge in Tłı̨chǫ Highway monitoring and management.

During the construction phase of the Tłı̨chǫ ASR, the following work was done:

In 2020, the Tłı̨chǫ Government developed a proposal and workplan for the Monitoring Program. The Monitoring Program will provide data to be used by the Tłı̨chǫ Government in considering and negotiating mitigations related to the Tłı̨chǫ Highway. The proposal was funded through a contribution agreement with GNWT-ECC in August 2020 for project work between 2020 and March 2023. As one of the first workplan tasks, the Tłı̨chǫ ASR Wildlife Monitoring Coordinator position was filled in December 2020 within the DCLP. The Coordinator leads the establishment of the Tłı̨chǫ Tı̨lıì Deè Committee (described below) and the development of the harvest pressure and habitat monitoring program, including assisting monitors with data collection on the Tłı̨chǫ Highway.

The Tłı̨chǫ Tı̨lıì Deè Committee consists of elders and knowledge holders with expertise related to caribou, monitoring, and/or the Tłı̨chǫ ASR area. The Tłı̨chǫ Tı̨lıì Deè Committee's role is to provide advice and guidance to the Monitoring Program. In 2020, the foundation for the Committee was created, including drafting the terms of reference, selecting Committee members, and scheduling the first Committee meeting for January 14-15, 2021.

In 2021, the following key actions were undertaken by the Tłı̨chǫ Government:

To guide the Monitoring Program, the Tłı̨chǫ Tı̨lıı` Deè Committee was established in January 2021 and had its first meeting on January 14-15, 2021.

Data Collection for Baseline Conditions Report – The Tłı̨chǫ Tı̨lıı̨̀ Deè Committee provided guidance on interview participants and reviewed draft questions for the baseline conditions report at the January 14-15, 2021, Committee meeting. Semi-directive and open-ended interviews were held with thirteen key knowledge holders in February-March 2021. Interviews focused on woodland caribou and moose harvesting, barren-ground caribou and woodland caribou habitat, suggested monitoring approaches, existing harvest levels prior to the Tłı̨chǫ Highway opening, and key concerns related to harvest and habitat in the Tłı̨chǫ ASR area. Existing Tłı̨cho use of the Tłı̨cho ASR was also documented, including use of the area for camping, fishing, trapping, and visiting culturally important and sacred sites.

Between February 9-11, 2021, a track survey was conducted by skidoo along the entire length of the Tłı̨chǫ ASR alignment (see section 5.4.2.2).

The baseline analysis was completed, including guidance and input from the Tłı̨chǫ Tı̨lıı̨̀ Deè Committee, knowledge holder interviews, existing information from the K'àgòò Tı̨ lıı̨̀ Deè: Traditional Knowledge Study for the Proposed All-Season Road to Whatì (2014) and other sources, as well as Tłı̨chǫ Highway track surveys and observations from February 2021. The baseline conditions report was completed in April 2021, and was verified and revised following the April 14-15, 2021, Tłı̨chǫ Tı̨lıı̨̀ Deè Committee meeting.

Tłı̨chǫ Tılıı̨ Deè Committee Meetings – Meetings were held on January 14-15, April 14-15, and November 24-25, 2021, to provide guidance to the development of the Monitoring Program, including review of key plans, materials and methods. The January 14-15 Committee meeting focused on setting the purpose and terms of reference of the Committee, setting the monitoring needs, and working through the methodology to complete the baseline conditions report. The April 14-15 Committee meeting focused on work done to date, upcoming plans, issues and concerns, reviewed signage and confirmed finalization of the baseline report. The November 24-25 Committee and harvest monitors meeting discussed work done to date, upcoming plans, issues and concerns, and the harvest monitors working on the highway. Field books were reviewed and edited based on committee and monitor feedback.

Monitor training and program launch – On November 8-12, 2021, wildlife monitor training was held in Behchokǫ, Whatì, and Wekweètì via Zoom. From December 1-15, 2021, the wildlife monitoring training consultant worked with the harvest monitors on the Tłı̨chǫ Highway when the voluntary harvest reporting program launched. Information posters were distributed in Behchokǫ̀ and Whatì, and on Facebook. Preparation for fieldwork included purchasing safety equipment. The Tłı̨chǫ Government also supplied a truck for ongoing harvest monitoring. Wildlife monitors began daily monitoring of the Tłı̨chǫ ASR on December 1, 2021.

5.2.5 Sustainable Boreal Caribou Harvest Assessments

As required by Measure 6-2 of the Report of EA (MVEIRB 2018), GNWT-ECC undertook a study in 2019 to develop population and harvest models for boreal caribou to evaluate potential sustainable harvest levels for boreal caribou in the southern NWT, including the North Slave (Wek’èezhìı) portion of boreal caribou range in the NWT (Rettie 2020). The report from this study was released in October 2021 prior to the road being opened to the public and was presented to Indigenous governments and Indigenous organizations for feedback in fall 2021 and winter 2022. This section provides a summary of that report, focussing on the findings specific to the North Slave (Wek’èezhìı). Further details about the methods, results and recommendations from the study can be found in the full report[3].

Population and harvest models were developed for six study areas in the southern NWT where boreal caribou population trends are monitored – Dehcho North, Dehcho South, North Slave (Tłı̨chǫ ASR), Mackenzie, Hay River Lowlands, and Pine Point/Buffalo Lake (see Figure 1 in ENR 2020b). Two NWT wildlife management zones (WMZs), Zone D and Zone R (which encompass the Wek’èezhìı and North Slave Region) were also included in the study. The models used survival rates of cows and bulls at different ages, calf to cow ratios, bull to cow ratios, and reproduction rates, based on monitoring data from the six study areas. This information was used to forecast the population growth rate over time, based on how many adult cows and bulls survive from one year to the next, how many calves are born each year, and how many of those calves will survive to become reproducing adults.

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3 https://www.gov.nt.ca/sites/ecc/files/resources/gnwt_boreal_caribou_population_model_report_final_bil_1.pdf

Because precise population estimates for boreal caribou in the NWT are difficult to obtain, population density (how many caribou are in a particular area) was used to estimate the number of caribou in each of the different study areas. Six different population densities of caribou (of 1 - 6 caribou per 100 km^2) were used for each study area based on density estimates found across Canada. The densities were multiplied by the size of each study area to estimate a starting population size. The average annual growth rate, without hunting included, was calculated for each population using 10 years of data (2008-2018). Because the boreal caribou monitoring program for the Tłı̨chǫ ASR study area only started in 2017, data from this study area was combined with data from the Dehcho North monitoring area to estimate the 10-yr average population growth rate. The average population growth rates for each area are shown in Table 5-4.

Table 5-4. Population growth rate [lambda (λ)] values determined for each modelled NWT boreal caribou population, exclusive of hunter kill.

Model population	Average annual population growth rate (λ)	Population trend
Dehcho North	1.021	Increasing
North Slave (Tłı̨chǫ ASR)	1.021	Increasing
Dehcho South	0.989	Decreasing
Mackenzie	1.094	Increasing
Hay River Lowlands	1.000	Stable
Pine Point/Buffalo Lake	1.000	Stable
Zone D	1.011	Increasing
Zone R	1.038	Increasing

Population models were then used to predict what would likely happen to each group of boreal caribou at different levels of hunting. Three scenarios were modelled for all populations: no harvesting; harvest of 10 animals a year (for mixed sex harvest, 6 cows and 4 bulls); and harvest of 20 animals a year (for mixed sex harvest, 13 cows and 7 bulls).

For areas with an estimated annual average growth rate greater than 1 (Dehcho North, North Slave (Tłı̨chǫ ASR), Mackenzie, Zone D and Zone R) the model was used to calculate how many animals could be harvested before the population begins to decline under a bull-only, cow-only, and mixed-sex harvest.

Each model was run 1,000 times for a ten-year period to see what would happen over that length of time.

The study found that:

- In the North Slave (Tłı̨chǫ ASR) area, the mixed-sex harvest model predicted that 2 cows and 1 bull could be harvested at the lowest population density (1 caribou / 100 km^2) and 13 cows and 7 bulls could be harvested at the highest population density (6 caribou / 100 km^2) before the number of caribou in this area begins to decline (Table 5-5).
- Wildlife Management Zone R includes the North Slave (Tłı̨chǫ ASR) area and part of the Mackenzie study area. It also has a growing number of boreal caribou that could support

some level of hunting. At the lowest population density, 9 cows and 5 bulls could be harvested before the population begins to decline. At the highest population density, 50 cows and 30 bulls could be harvested (Table 5-5).

- In all areas, hunting had a greater effect when the initial population density was lower, the harvest level was higher, or the proportion of cows harvested was higher. More animals could be harvested under a bull only harvest before the population declines, and fewer animals could be harvested under a theoretical cow-only harvest.

The 2020 boreal caribou abundance survey in the Tłı̨chǫ ASR estimated the density of boreal caribou in the study area to be 4.6 – 8.2 caribou / 100 km^2 (see section 5.3.3), which suggests the sustainable harvest amount is closer to the higher model estimates.

The sustainable harvest report noted that the most important missing information for management decision-making is an accurate estimate of total boreal caribou harvest that includes both Indigenous and non-Indigenous harvest. The estimated resident harvest of boreal caribou harvest is small (21 animals a year across the NWT) and not likely to have a big impact on the entire NWT boreal caribou population on its own. Little is known about the Indigenous harvest. Accurate estimates of total harvest would allow for a better understanding of population growth rates and the potential effects of hunting. Harvest location information from all harvesters would allow the GNWT to assess risk to caribou in specific areas, especially those with fewer boreal caribou.

The report recommends that data on NWT boreal caribou survival and recruitment should continue to be collected, and sustainable harvest models should be developed every three to five years with updated 10-year data sets.

Table 5-5. Upper limits of annual sustainable harvests for all modeling scenarios. Only managed study areas with baseline population growth rates (lambda λ) >1.00 are included.

	Caribou / 100 km²	**1**		**2**		**3**		**4**		**5**		**6**	
Management area	**Licensed hunting model scenario**	**Cow**	**Bull**	**Cow**	**Bull**	**Cow**	**Bull**	**Cow**	**Bull**	**Cow**	**Bull**	**Cow**	**Bull**
Dehcho North	Non-selective	5	3	9	5	13	8	18	11	23	14	27	17
	Cow-only	5		10		15		20		26		31	
	Bull-only		16		33		49		67		85		102
North Slave (Tłı̨chǫ ASR)	Non-selective	2	1	4	2	6	4	9	5	11	6	13	7
	Cow-only	2		5		8		10		13		15	
	Bull-only		7		16		24		32		40		49
Mackenzie	Non-selective	5	3	9	6	14	8	19	11	24	14	29	17
	Cow-only	6		11		16		22		27		33	
	Bull-only		8		16		25		33		41		50
Zone D	Non-selective	8	5	16	10	24	15	32	20	40	24	50	30
	Cow-only	9		19		27		36		46		57	
	Bull-only		40		81		121		163		206		248
Zone R	Non-selective	9	5	17	10	25	15	34	20	42	25	50	30
	Cow-only	9		18		28		37		47		57	
	Bull-only		22		45		69		92		115		137

5.3 Boreal Caribou

Boreal caribou are a focal wildlife species in the WMMP (section 2.8.1). Both traditional knowledge and science-based studies identified the Tłı̨chǫ ASR corridor as habitat used by boreal caribou. Boreal caribou are listed as "Threatened" under the federal *Species at Risk Act* and as "Threatened" under the *Species at Risk (NWT) Act*. While the NWT population identified in the federal Boreal Caribou Recovery Strategy is considered to be "likely self-sustaining" based on habitat conditions, population trends likely vary among NWT regions. While GNWT-ECC had conducted boreal caribou population monitoring in the South Slave, Dehcho and Inuvik regions, boreal caribou had only been once formally surveyed in the North Slave Region in 2005, and no long-term population monitoring had ever been conducted in this region prior to 2017.

In other jurisdictions, linear features including roads have been shown to contribute to the loss of functional habitat for boreal caribou and to population declines associated with increased predation by wolves that use those features (Environment Canada 2012). Although the Tłı̨chǫ ASR is not predicted to change the population status of boreal caribou at the NWT range-wide scale, its impact on boreal caribou within the North Slave (Wek'èezhìı) portion of the NWT range is less certain given that the region is currently close to the minimum 65% undisturbed habitat management threshold identified in the national recovery strategy as required for self-sustaining caribou populations.

To monitor for and mitigate impacts to boreal caribou, the WMMP proposed: (a) a collar-based monitoring program to provide data on caribou distribution, population trend, and movements including in relation to the Tłı̨chǫ ASR alignment, and in response to road construction and operations, (b) a boreal caribou abundance survey, required by Measure 6-1, Part 2 of the Report of EA, and using collared caribou to provide sightability metrics for these surveys, and (c) the use of traditional knowledge methods to monitor the state of caribou habitat during and after the completion of the Tłı̨chǫ ASR project. Information on habitat selection and areas where collared caribou frequently cross the Tłı̨chǫ ASR alignment can also be used to target mitigations for preventing collisions. In addition, the WMMP required that specific monitoring questions be addressed in comprehensive reports prepared after the final year of construction (this report) and five years after monitoring during operations starts (Table 5-6).

To complement the collaring program with information from traditional knowledge, GNWT supported the Tłı̨chǫ Government in the design and implementation of a program that uses Tłı̨chǫ harvesters' traditional knowledge and methods to monitor the state of boreal caribou (tǫdzı) habitat, during and after the completion of the Tłı̨chǫ ASR Project. The details of this program, which will be implemented by the Tłı̨chǫ Government and includes harvest monitoring and other efforts, are described in section 5.2.4 and Appendix I of the WMMP 5.2 (2022). Monitoring of caribou habitat under this program for both boreal and barren-ground caribou is included in section 5.4.2.

This section begins with an overview of the collar-based monitoring program and results of that program (section 5.3.1). Next, it provides results from the boreal caribou abundance survey (section 5.3.2). Finally, it provides analyses and results to address the remaining monitoring questions for boreal caribou outlined in the WMMP and in Table 5-6 below (section 5.3.3).

Table 5-6. Monitoring questions for boreal caribou as outlined in the Tłı̨chǫ ASR WMMP, their relevance to the construction and/or operations phase of the Tłı̨chǫ ASR, and documentation in this report.

Monitoring questions for boreal caribou to address using a collaring program	Construction phase	Operations phase	Documented in this report
Where collared boreal caribou are located in relation to construction activities.	√		Yes, section 3.3.1 (maps of collared boreal caribou provided to NSI).
If boreal caribou avoid the road during and after construction.	√	√	Yes, section 5.3.3.
If and where boreal caribou cross the road.	√	√	Yes, section 5.3.3.
If the rate of boreal caribou movements changes in proximity to the road and, if sample sizes allow, the potential zone of influence of the road on boreal caribou habitat use.	√	√	Yes, section 5.3.3.
If rates of caribou mortality increase within the study area during and after Tłı̨chǫ ASR construction.	√	√	Yes, section 4.3, section 5.3.1.
The population trend of boreal caribou in the regional Tłı̨chǫ ASR study area.	√	√	Yes, section 5.3.1.

5.3.1 Boreal Caribou Population Monitoring

The Tłı̨chǫ All-Season Road – North Slave Region boreal caribou monitoring program (Tłı̨chǫ ASR-NSR) began in 2017 in anticipation of the construction of the Tłı̨chǫ ASR. The objective of this program was to collect baseline boreal caribou data prior to construction and to monitor the boreal caribou population in relation to the construction and operation of the new highway.

The boreal caribou monitoring program activities include deploying collars on adult female caribou, conducting a late-winter recruitment survey each year, investigating any mortalities of collared caribou, retrieving collars that release from animals as scheduled (typically after four years), submitting biological samples for pregnancy, health, and cause of death information, and analyzing the biological and movement data. A caribou abundance survey completed in 2020 used collared caribou to help estimate sightability metrics for the survey.

The boreal caribou monitoring program is scheduled to continue for the first five years after the Tłı̨chǫ ASR opens and will be re-evaluated at that time.

Using GPS collars to monitor caribou

Global Positioning System (GPS) collar-based monitoring was chosen for this program because boreal caribou are difficult to detect using other aerial survey methods due to their habitat use, coloration, behavior, and low density. GPS collars provide information about boreal caribou survival rates that is used, along with other data, to estimate population trends in the study area. GPS collars also transmit location data via satellite, which provides information about the movements and habitat use of the collared caribou, and can be evaluated to detect responses to landscape features including the Tłı̨chǫ ASR alignment. Collared caribou are also used to locate caribou for calf recruitment surveys and to estimate sightability of caribou during population surveys.

Between 20 and 30 collars are required to monitor adult female survival rates to provide sufficient statistical power to detect population trends over a minimum five-year period (Rettie 2017). The objective in the Tłı̨chǫ ASR-NSR monitoring program is to have a minimum of 30 collars on adult females at the beginning of each monitoring year (April 1 – March 31). The survival of collared females is used to represent the mean adult female survival of caribou in the study area.

The GPS Iridium collars used in this study (Telonics model TGW-4677-4, Mesa, Arizona) are programmed with a geofence that encompasses the area within 10 km of the Tłı̨chǫ ASR alignment and Highway 3. When collars are within the geofence area they collect a GPS location every hour. Outside of the geofence, collars collect a GPS location every four hours. Collars are fitted with release mechanisms that are programmed to release the collar four years after deployment.

Boreal caribou population monitoring study area

In 2017, the Tłı̨chǫ ASR-NSR caribou study area was defined using the GNWT-ECC North Slave Region administrative border as the southern boundary (see Figure 5-1). In 2018, this population monitoring study area was revised to exclude the area east of Highway 3, and the area east of

Highway 3 that occurs within the North Slave Region was added on to the Mackenzie boreal caribou study area (see Figure 5-2), which was initiated in 2015. This change was made due to the low number of occurrences of collared caribou crossing Highway 3, suggesting it made sense to treat groups of caribou on either side of Highway 3 as separate for the purpose of population trend monitoring. Two collars deployed southeast of Highway 3 that were initially considered part of the Tłı̨chǫ ASR-NSR program were reassigned to the Mackenzie study area. The boreal caribou monitoring program in the Mackenzie study area is led by the South Slave GNWT-ECC office. Some collared caribou in the Mackenzie study area move back and forth between the GNWT-ECC North Slave and South Slave administrative regions on an annual basis. The revised (2018) study areas are shown in Figure 5-2.

Collar deployments

To deploy collars, caribou are captured using a net that is fired from a helicopter. Capture and handling methods are reviewed and approved each year by the NWT Wildlife Care Committee and follow standards set by the Canadian Council for Animal Care. The helicopter lands near the caribou as soon as it is restrained by the net. The caribou is blindfolded and hobbled, and the crew assesses body condition, removes the net, places the collar on the caribou, collects biological samples (blood, hair, feces, and measurements) and releases the caribou. The animal is monitored throughout this process, which typically lasts about 15 minutes.

In 2017, caribou collar deployments were preceded by a fixed wing aerial reconnaissance survey from March 7 to 12, 2017, to establish where the collars should be deployed in the study area, based on the relative abundance and distribution of caribou observed. This survey consisted of transects spaced 4 km apart with a pilot, navigator and two observers, and recorded all wildlife observations (Figure 5-1).

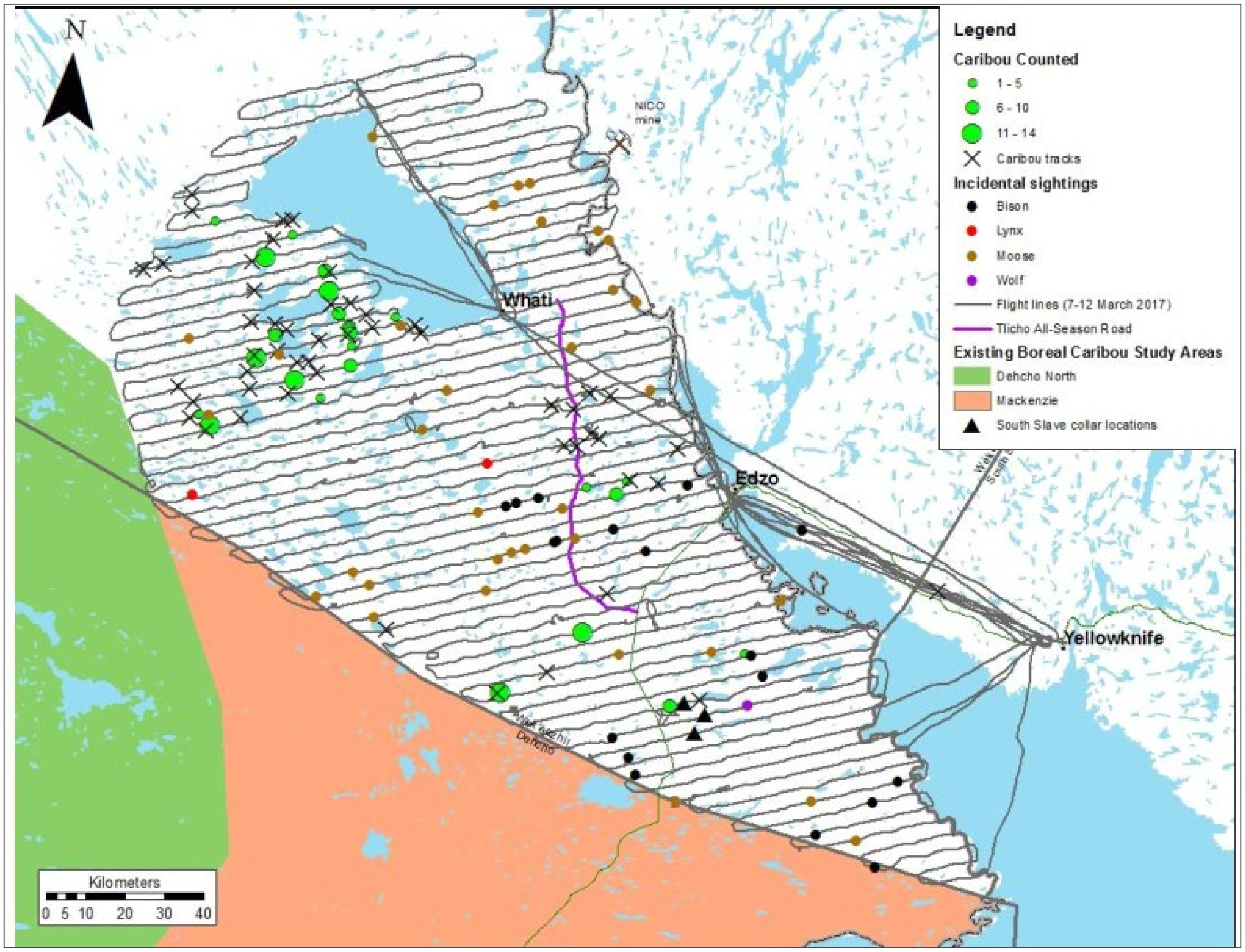

Figure 5-1. Results of the 2017 caribou collar deployment reconnaissance flight (Williams 2017).

The initial collar deployments for the Tłı̨chǫ ASR-NSR study area occurred immediately following the reconnaissance survey. Twenty collars were deployed between March 14 and March 22, 2017. Ten were deployed west of Lac la Martre, three were deployed immediately adjacent to the Tłı̨chǫ ASR alignment, and seven were deployed in the southern portion of the study area (Figure 5-2). During the 2017 collaring deployment, a fixed wing aircraft was used alongside a helicopter. The role of the fixed wing was to relocate groups of caribou, while the role of the helicopter was to identify an individual female for collaring. This two-aircraft approach reduced helicopter flight time and reduced the overall financial commitment of the project.

Additional collars were deployed in subsequent years to replace collars scheduled to drop off, mortalities, and to bring the target sample size up to 30 collars. Five collars were deployed in March 2018, seven were deployed in March 2019, there were no deployments in 2020, and 23 were deployed in March 2021. The 2021 deployment was larger than typical because the collars deployed in 2017 were scheduled to drop off in March 2021. From 2018-2021, collared caribou were used as sentinel animals to help locate groups of caribou to deploy additional collars. All collar deployment locations as of 2021 are shown in Figure 5-2.

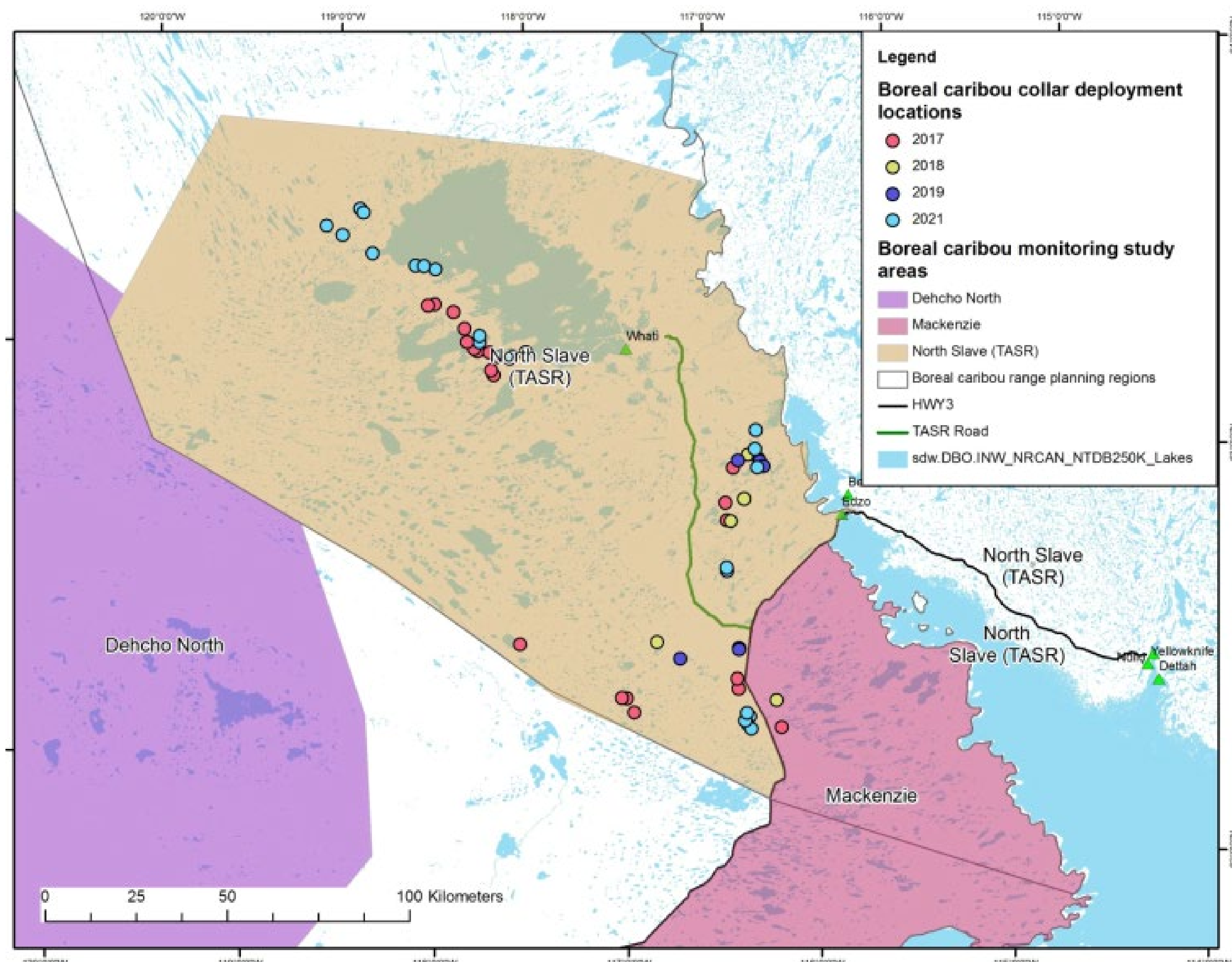

Figure 5-2. GPS collar deployments on adult female boreal caribou in the Tłįchǫ ASR-NSR study area between 2017 and 2021.

Investigating stationary GPS collars

When a collar is stationary (i.e., no movement is detected by an accelerometer) for six hours, a mortality alert is triggered. Stationary collars are investigated as soon as possible to determine the cause of death of the caribou. Cause of death is determined by the evidence at the mortality site, and is categorized as predation (either by bear, wolf, wolverine, or unknown predator), non-predation (i.e., carcass found intact with no signs of predation; death likely from starvation, disease, old age, or other non-predator causes), harvest, accidental (i.e., entrapment, vehicle collision) and unknown.

The official cause of death is considered unknown if there is not enough evidence to conclusively determine the caribou died of harvest, predation, non-predation (i.e., intact carcass), or accidental causes. This occurs most commonly when evidence does not distinguish between a predation event versus scavenging of a caribou that died of natural causes (i.e., likely starvation, disease, or old age). Results of investigating seven stationary collars in the Tłı̨chǫ ASR-NSR study area between 2017 and March 31, 2022, are described in Table 5-7.

Table 5-7. Cause of death assessments resulting from investigations of stationary collar sites in the Tłı̨chǫ ASR-NSR study area from March 14, 2017, to March 31, 2022.

Animal ID	Date of mortality	Date of site investigation	Official cause of death	Suspected cause of death (if official cause "unknown")
BWCA17603	April 16, 2020	NA	Harvest	
BWCA17612	April 27, 2021	April 30, 2021	Unknown	Predation, bear
BWCA17613	November 30, 2017	May 1, 2018	Unknown	Predation, likely wolf
BWCA17620	January 12, 2020	January 15, 2020	Non-predation	
BWCA18600	May 2, 2021	May 10, 2021	Predation	Both wolf and bear sign at site
BWCA19604	April 30, 2021	May 10, 2021	Predation, wolf	
BWCA21601	August 19, 2021	August 27, 2021	Unknown	Predation, unknown species

Boreal caribou adult female survival

Survival data is derived from collared cows that contribute data from when they are collared until a mortality event or until the collar releases or is otherwise censored. 'Censored' means the animal's status is no longer monitored and its fate is not known. Between March 2017 and March 2022, 63 adult females were collared (10 deployed in February 2022), seven collared caribou died (Table 5-7), 17 collars released on schedule after three years, and one caribou had to be recaptured to remove a collar that did not release on schedule. There were 28 collared caribou alive in the study area at the end of 2021 (Figure 5-3).

Adult female survival is calculated each year (measured from April 1 of one year to March 31 of the following year) with Pollock et al.'s (1989) staggered-entry modification of Kaplan and Meier's (1958) survivorship model. Adult female survival data from 2017-2022 is shown in Table 5-8 and Figure 5-4. Adult female survival rates ≥0.85 are typically associated with a stable to increasing population. Adult female survival was consistently high in the study area from 2017 to 2021 with the lowest survival value of 0.89 recorded in 2021 (Table 5-8).

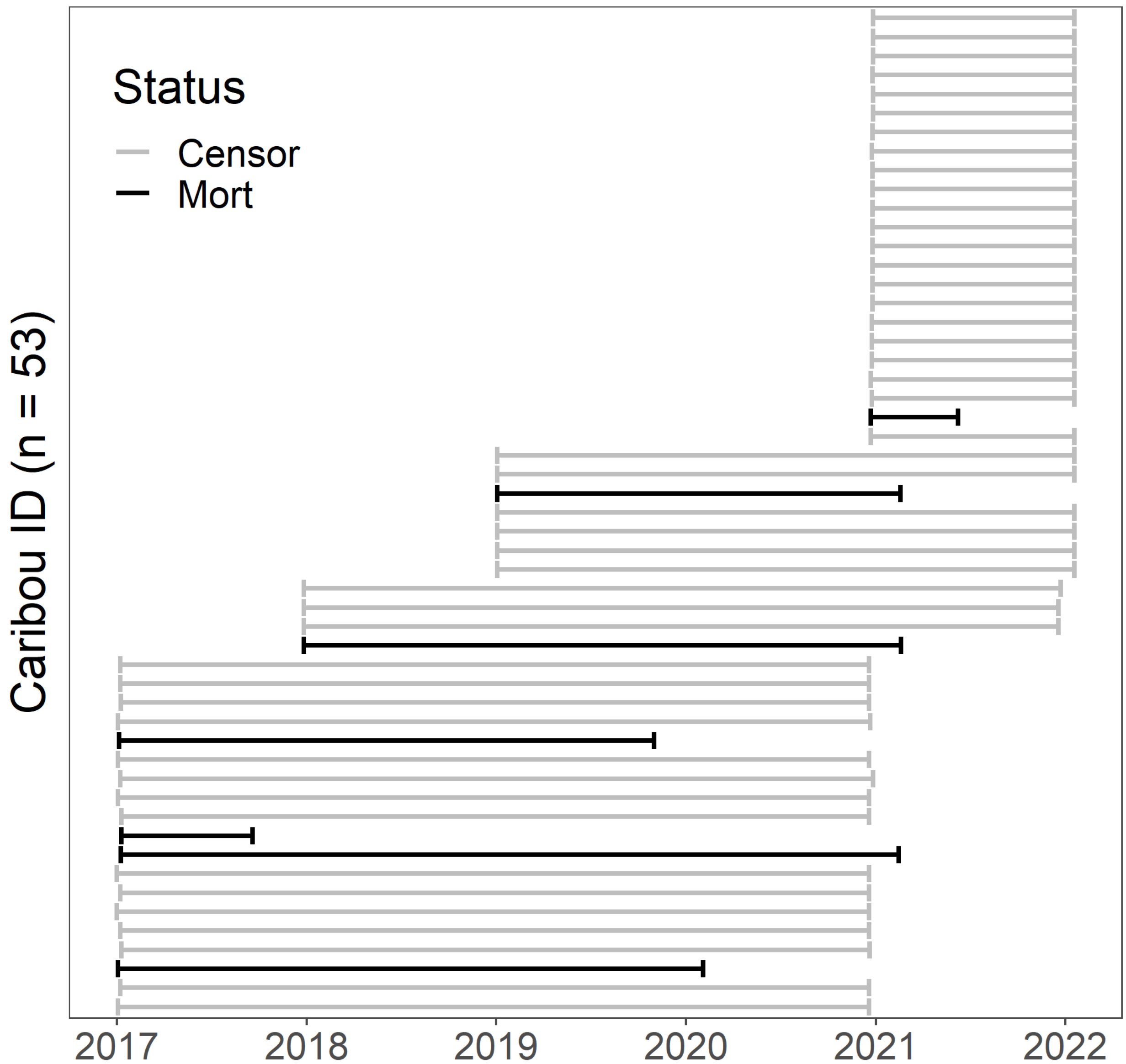

Figure 5-3. Collared caribou data used to estimate survival from 2017-2018 to 2021-2202 in the Tłįchǫ ASR-NSR study area.

Table 5-8. Population monitoring data for the Tłı̨chǫ ASR-NSR boreal caribou study area for monitoring periods (April 1 – March 31) of 2017-2018 to 2021-2022.

Year	n	Survival	SE_s	N (comp survey)	Calf: cow ratio	SE_c	Lambda (λ) (mean)	LCL	UCL
2017-2018	23	0.957	0.044	155	0.326	0.050	1.088	0.985	1.190
2018-2019	29	1.000	0.000	189	0.375	0.048	1.156	1.150	1.163
2019-2020	29	0.966	0.035	445*	0.263	0.028	1.077	0.999	1.155
2020-2021	51	0.980	0.020	295	0.312	0.036	1.112	1.067	1.157
2021-2022	45	0.911	0.047	314	0.274	0.032	1.019	0.914	1.125

*In February/March 2020, the boreal caribou abundance survey [see section 5.3.2] also served as the late-winter composition survey, which resulted in a larger number of caribou classified than in other years.

Late-winter calf recruitment surveys

A late-winter recruitment survey is completed each February or March. The purpose of this survey is to classify caribou into age and sex classes and count the number of calves per 100 cows observed. Because caribou mortality is highest during the first year of life, calves that survive until the time of survey (when calves are approximately 10 months old) are assumed to be "recruited" into the adult population with an associated higher survival rate. The ratio of female calves to total females is used together with the adult female survival to estimate the annual population trend.

For this survey, a helicopter is used to locate and classify observed caribou into cows, calves, bulls, and yearlings. Groups of caribou are located by radio-tracking collared cows, and any incidental groups of caribou observed are also classified. Animals are classified as calves or adults (greater than or equal to 10 months) based on body size. Females are identified by the presence of a black vulva patch and males by lack thereof. Recruitment is expressed as the ratio of calves per 100 adult cows. Recruitment survey data from 2017-2022 is shown in Table 5-8 and Figure 5-4. Late winter cow: calf ratios of ≥ 100 cows: 28 calves (of both sexes) are typically associated with a stable to increasing population. 2017-2022 calf: cow ratios in the Tłı̨chǫ ASR-NSR study area have ranged from 26.3 – 37.5 calves: 100 cows.

Calculating population trend (lambda)

For each year, the annual population trend (also known as the finite rate of population increase, or lambda (λ)) is estimated using the adult female survival data obtained from collared cows, and the calf recruitment data obtained from late-winter surveys. A female: male calf sex ratio of 50:50 is used to estimate the ratio of female calves to total females used to calculate the annual population trend. Lambda is determined using a stochastic version of Hatter and Bergerud's (1991) equation (λ = adult female survival/[1-female calf recruitment]) following Latham et al. (2011). The mean λ is the mean of 10,000 iterations calculating λ. A lambda value >1.0 represents an increasing annual population trend (where the number of female calves reaching one year of age, or "recruited" into the adult population, exceeds the adult female mortality rate). A lambda value <1.0 represents a declining annual population trend, and a value = 1.0 represents a stable annual population trend.

In the Tłı̨chǫ ASR-NSR study area, lambda values have been >1.0 in each monitoring year, with confidence intervals suggesting a stable or increasing population trend from 2017-2018 to 2021-2022 (Figure 5-4). This is consistent with population trends in most other ECC monitoring areas in the southern NWT during the same period and may reflect favorable conditions for boreal caribou during this time period.

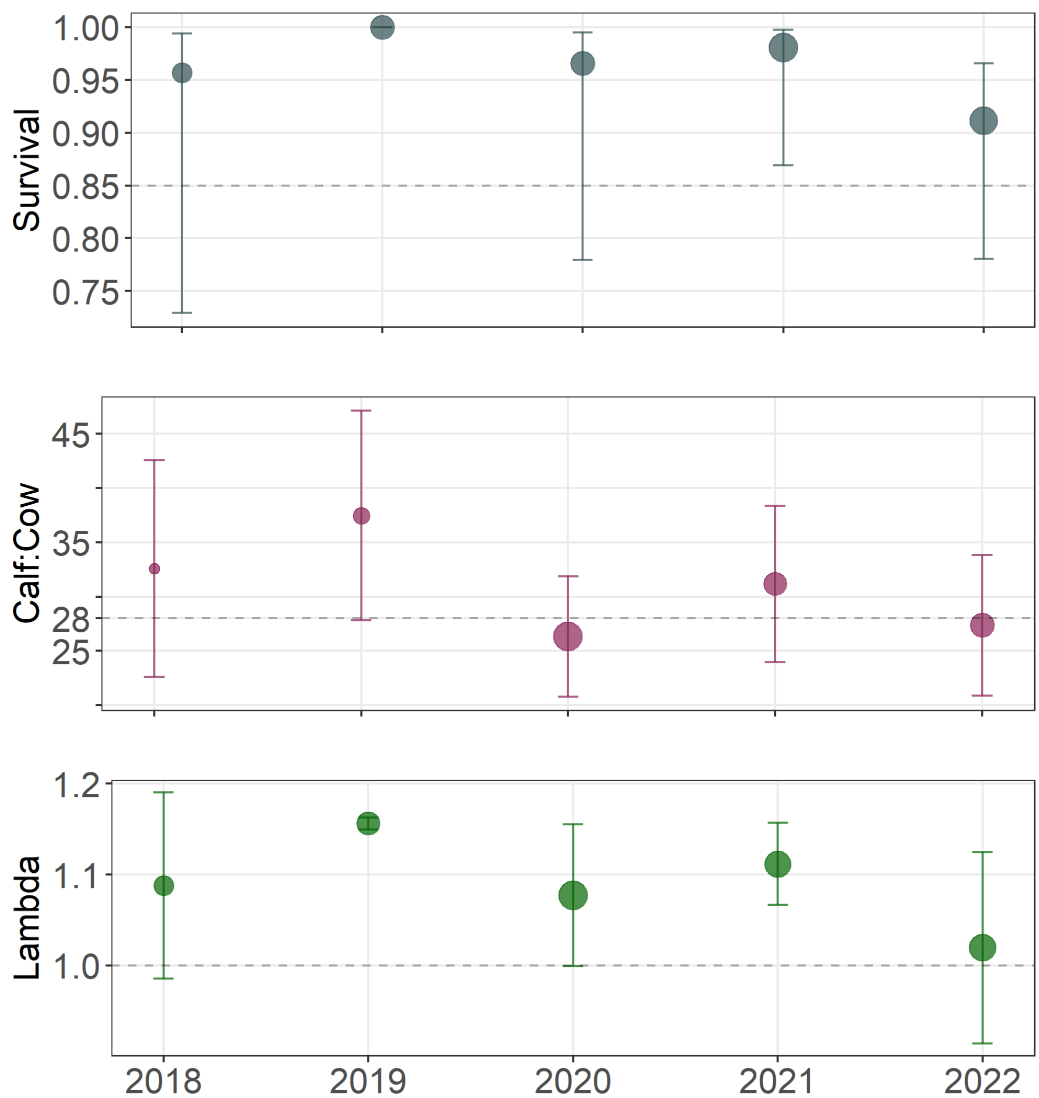

Figure 5-4. Top to bottom: (a) adult female survival, (b) calf: cow ratios, and (c) boreal caribou population trend (lambda) for the Tłı̨chǫ ASR-NSR caribou study area, 2017-2018 to 2021-2022.

5.3.2 Boreal Caribou 2020 Population Abundance Survey

GNWT-ECC conducted an aerial survey to estimate the population abundance of boreal caribou within the Tłı̨chǫ ASR-NSR study area between February 19 and March 2, 2020. This survey was a requirement of the WMMP and was timed to occur during the construction phase of the road. A detailed report on this survey is in APPENDIX B and a summary is provided here.

The survey was designed following boreal caribou survey methods used in Quebec (Courtois et al. 2003). The two-phase survey method used a fixed-wing aircraft and equally spaced transects to locate caribou and caribou tracks (phase 1) and followed up with a helicopter to count and classify (cow, calf, bull) caribou associated with those track networks (phase 2). During phase 2, collared boreal caribou that were not detected via the survey methods were radio-tracked to include in the classification survey.

The planned study area was divided into five survey blocks to facilitate the survey using two fixed-wing planes and to reduce observer fatigue by dividing long transects up between the two aircraft (Figure 5.5). Note that aircraft and weather issues resulted in the intended 26,300 km^2 study area being reduced to 21,071 km^2 (Figure 5.6).

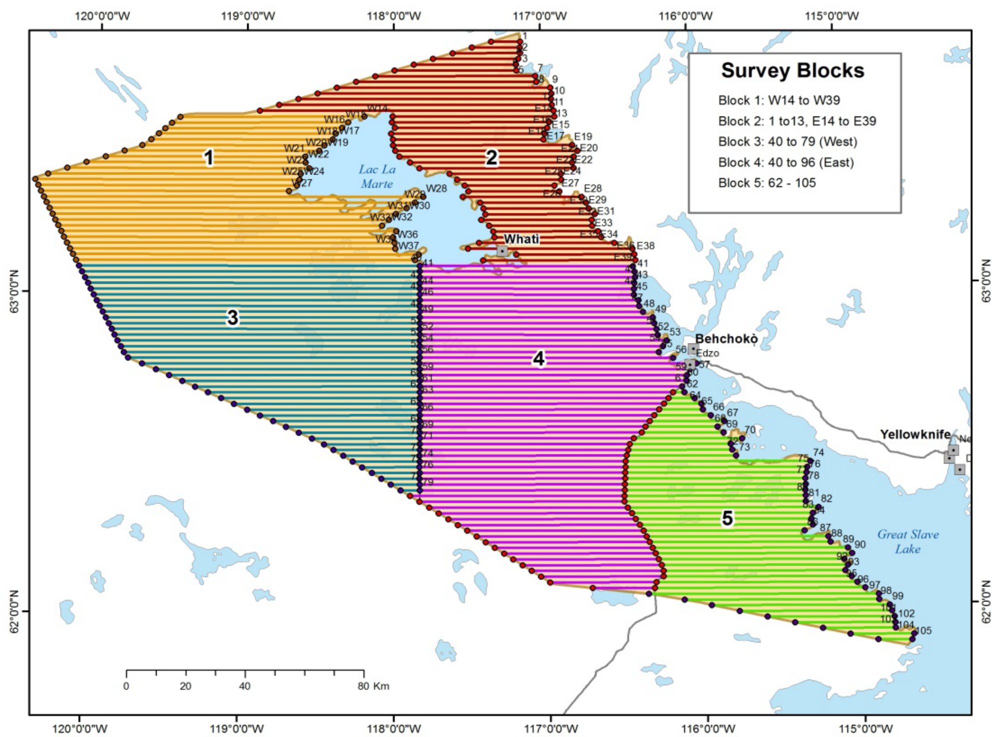

Figure 5-5. Original Tłı̨chǫ ASR-NSR study area with survey blocks 1-5.

The survey was conducted between February 19 and March 2, 2020. An incident with of one of the fixed-wing aircraft just prior the start of the survey and limited availability of a replacement aircraft resulted in the study area being reduced to 21,071 km^2 (Figure 5.6). Areas eliminated from the survey were block 2 in the northeast portion of the study area (east of Lac la Martre) where a relatively recent fire had occurred and based on previous surveys and radio-collar data, the likelihood of finding caribou was considered to be low. There were also portions of some survey transects that could not be completed due to poor weather and visibility associated with ice fog (in blocks 1 and 3, Figure 5.5), and due to time constraints for completing the survey (southern portion of block 5; Figure 5.5). Fourteen transects in the northern part of survey block 5 were completed by the helicopter, and only visual sightings of wildlife (not tracks) were recorded in this area.

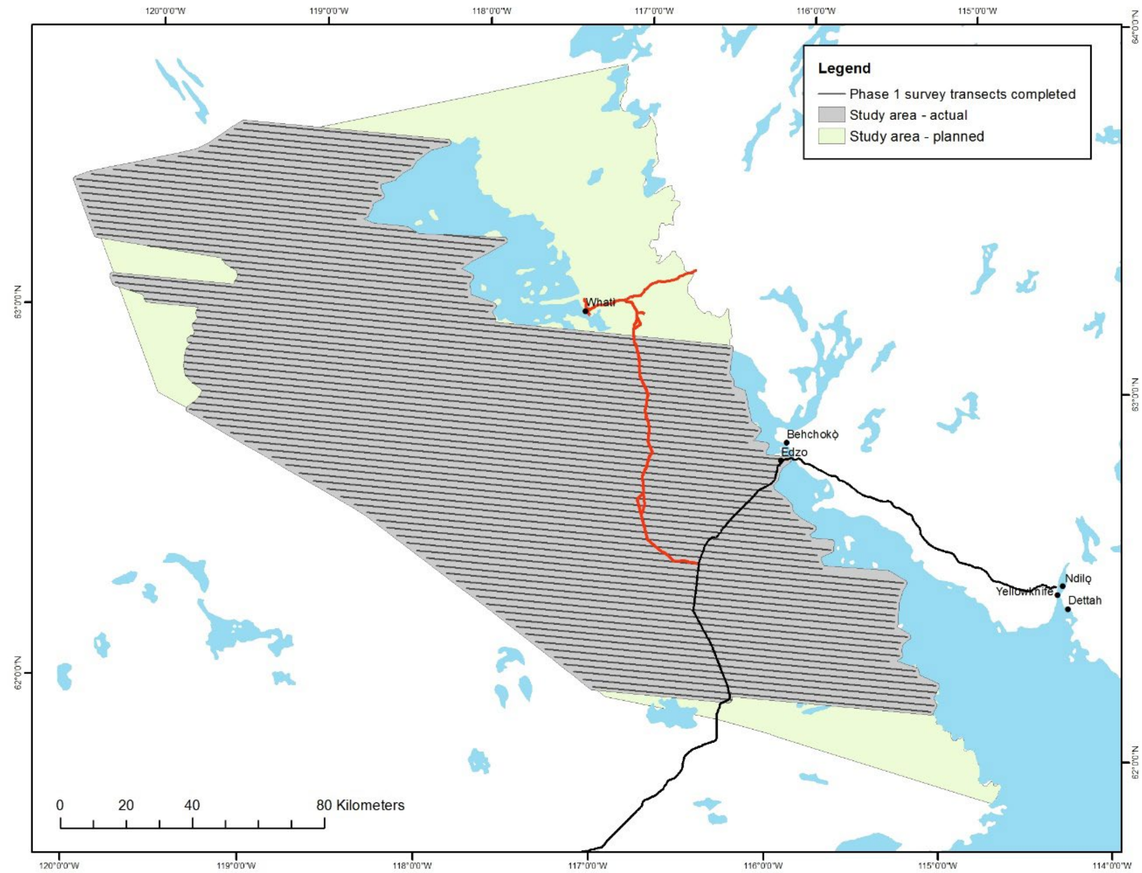

Figure 5-6. Actual study area (grey polygon) and transects (lines) surveyed between February 19-28, 2020, by two fixed-wing aircraft for sightings and tracks of boreal caribou, other ungulate and carnivore species.

Phase 1

The phase 1 survey was flown with a Bush Hawk and DHC-2 Beaver (when available) along survey lines spaced 2 km apart, at altitudes ranging from 97 to 172 m and a speed of approximately 90 knots (167 km/hr; ranging from 124 to 212 km/hr). Community observers included Tłı̨chǫ community members from Whatì and Behchokǫ̀, and members of the Yellowknives Dene First Nation and North Slave Métis Alliance. The survey was flown over nine days and took 82.6 hrs total to complete. Weather and observing conditions ranged from fair to excellent and were considered adequate for detecting wildlife and tracks.

A total of 10,109 kms were flown along 154 transects that ranged from 1 km to 122 km in length (including those transects flown by helicopter, not shown in Figure 5.7). In phase 1, crews observed 172 caribou in 39 groups ranging in size from 1-12 individuals and recorded a total of 910 tracks/sightings (Table 5-9, Figure 5-7). In addition, 189 wood bison in 25 groups (1-23 individuals/group), and 58 moose in 41 groups (1-3 individuals/group) were recorded. Seven grey wolves were observed in five groups of 1-2 individuals/group, and wolves were the most common carnivore species in the area based on tracks. Fox, lynx, and wolverine tracks were also recorded (Table 5-9). Forty-three unidentified tracks were mainly ungulate, however, two unidentified predator tracks may have been cougar. All tracks were counted, regardless of proximity to another set, so tracks of one individual/group may have been counted several times. It should be noted that during phase 2, where the helicopter could fly slower, lower and could follow the tracks, it became evident that some of the tracks had been misidentified during phase 1. However, it is difficult to determine the degree of this error, as the phase 2 helicopter did not visit all observation locations for species other than caribou. Other wildlife or signs noted during the survey included snowshoe hare, spruce grouse, ptarmigan, and great grey owl.

Most phase 1 observations (where estimated distance was recorded) were within 200 and 400 m horizontal distance from the aircraft, although some ungulates were observed up to approximately 1 km away. Qualitatively, the vast majority of actual sightings/tracks of caribou and other wildlife were in open to semi-open areas; relatively few observations were associated with densely forested habitat.

Table 5-9. Wildlife observations recorded during the boreal caribou abundance phase 1 survey in the Tłı̨chǫ ASR-NSR study area, February 19-28, 2020.

Species	Number of observations tracks/visuals	Number of individuals observed	Number of groups	Group size range
Boreal caribou	910	172	39	1-12
Wood bison	288	189	25	1-23
Moose	467	58	41	1-3
Wolf	281	7	5	1-2
Fox	6			
Lynx	5			
Wolverine	6			
Unidentified tracks	43			

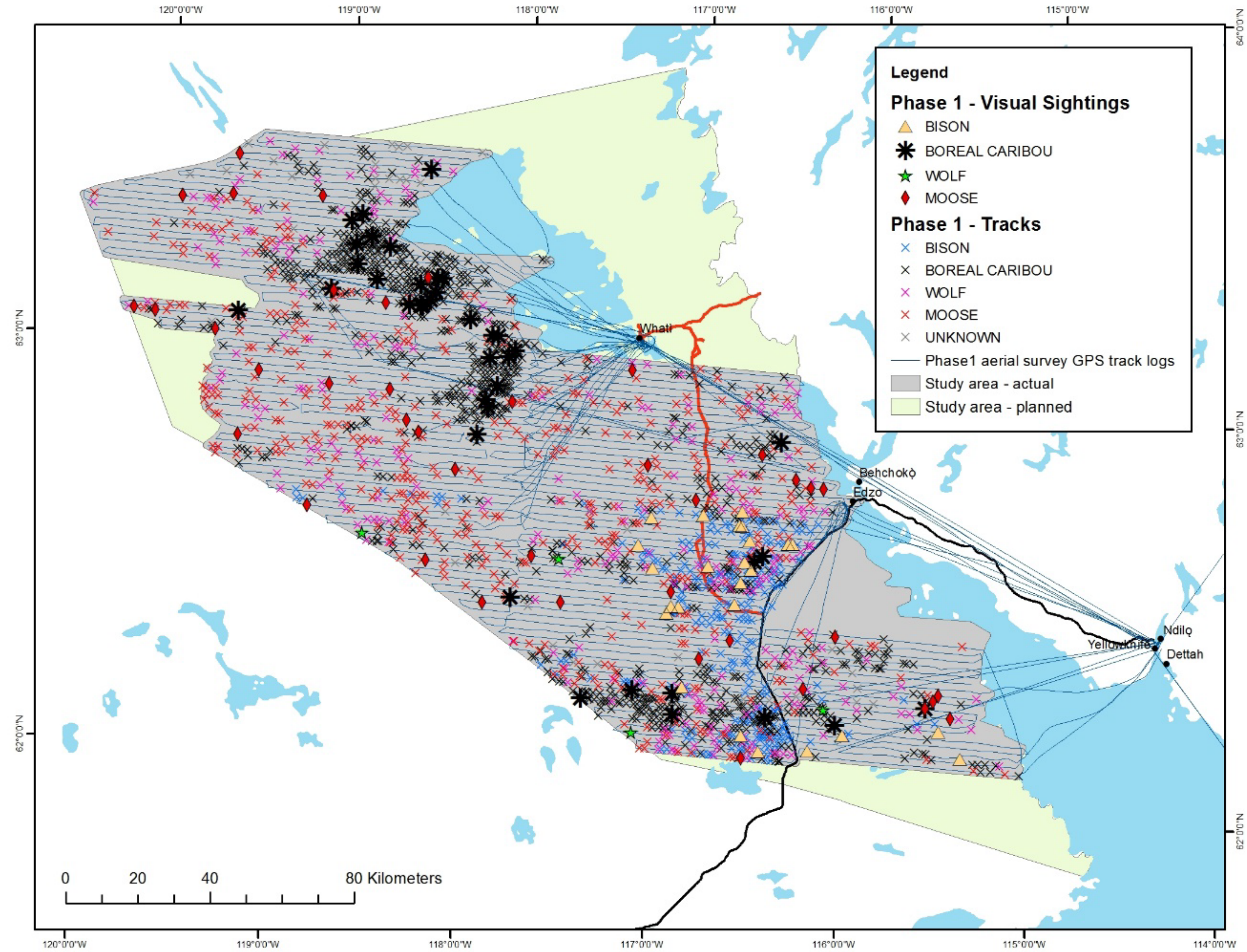

Figure 5-7. Species observations (tracks and visual sightings made during phase 1 (fixed-wing) of the boreal caribou abundance survey between February 19-28, 2020.

<u>Phase 2</u>

Phase 2 surveys were conducted between February 20, 2020, and March 02, 2020, with no survey on February 26 due to poor weather. A total of 414 boreal caribou (218 cows, 122 bulls, and 66 calves) in 73 different groups were recorded visually by flying to the location of boreal caribou sightings and tracks recorded by the phase 1 survey crew and intensively searching the area (Table 5-10, Figure 5-8). Eight collared boreal caribou were located visually within these groups without the aid of telemetry. An additional 163 boreal caribou (97 cows, 37 bulls, and 26 calves) were counted inside the study area by locating groups with collared boreal caribou (n=26) by telemetry as well as other groups (n=5) found incidentally while searching for the collars that would have otherwise been missed by the visual surveys. The total number of boreal caribou counted within the study area was 577, resulting in a minimum density estimate of 2.74 caribou/100 km^2. Fifteen additional caribou were counted in three groups, each containing one collared female, which were located by telemetry just outside of the western study area boundary, in an area that was not covered by the phase 1 surveys (Figure 5.8). These caribou were not included in the minimum density estimate.

Based on all of the boreal caribou counted and classified, the calf: cow ratio was 28:100, and the bull: cow ratio was 49:100. Group sizes of caribou varied between 1 and 16, with a mean group size of 5.5. The phase 2 survey crew also recorded 219 bison in 28 groups, 61 moose in 43 groups, one wolverine, and nine wolves in two packs (two and seven individuals), one of which was on a moose kill site (Figure 5.8). One lynx and one great grey owl were also recorded, as were numerous spruce grouse (not counted).

Table 5-10. Summary of phase 2 aerial survey results for boreal caribou conducted within the Tłı̨chǫ ASR-NSR study area between February 20 - March 2, 2020.

	Boreal caribou observations					
	Total number of groups	**Total number of individuals**	**Cows**	**Bulls**	**Calves**	**Number of collared adult females**
Detected visually	73	414	218	122	66	8 (7 groups)
Detected by telemetry	31*	163	97	37	26	26 (23 groups)
Total	**104**	**577**	**315**	**159**	**92**	**34 (30 groups)**

*Includes 5 groups without collared caribou found incidentally while searching for the collars

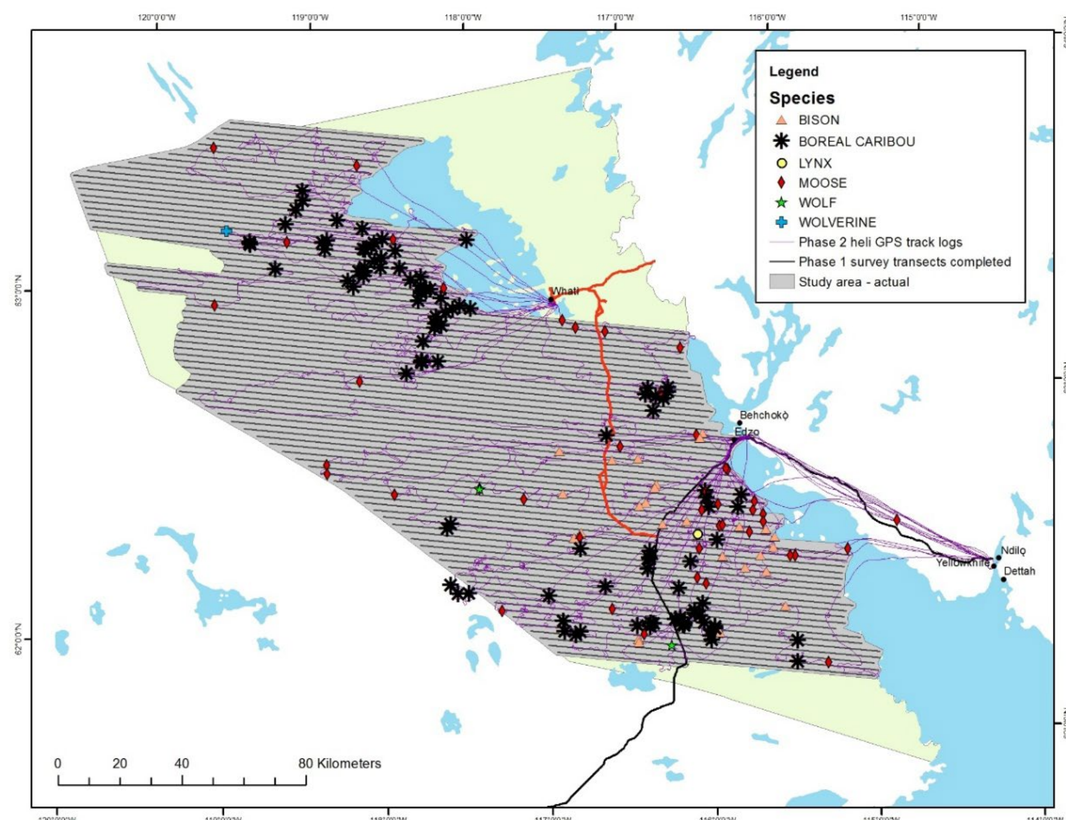

Figure 5-8. Species observations made during phase 2 (helicopter) of the boreal caribou abundance survey between February 20-March 2, 2020.

Data analysis: estimating sightability

Accounting for animals that were not observed during a wildlife survey is critical for estimating abundance based on survey observations. For this survey, sightability correction factors were estimated for both phase 1 and phase 2 and were multiplied to provide a global sightability rate. The purpose of the global sightability rate is to correct for imperfect detection of occupation sites (in phase 1) and imperfect detection of individuals within the detected occupation sites (in phase 2).

The phase 1 sightability rate estimated the detection rate of the "occupation sites" that occurred during the survey. An occupation site was defined as a location along the survey transect corresponding to the movement path of one or more collared caribou that either crossed or was within 1 km of a survey transect within one day prior to or on the same day the transect was surveyed. The purpose of calculating the phase 1 sightability rate is to determine how effective the fixed-wing observers were at detecting these collared caribou and/or their tracks as they flew transect lines spaced 2 km apart. During the phase 1 survey, 21 of the 35 occupation sites that had the potential to be found were located by the survey crew. This provided a 60% detection rate for phase 1, which was used in global sightability estimates for both phase 2 methods.

For phase 2, sightability rates were calculated using two methods: the Lincoln Peterson estimate used in Courtois et al. (2003), and a modified Horvitz-Thompson (HT) estimator of abundance used in sightability models to estimate abundance while accounting for covariances between logistic regression parameters (Fieberg 2012). We also estimated the variance around these estimates (see APPENDIX B). Before creating sightability models for the HT method in phase 2, we partially tested the assumption that collared caribou detectability rates are representative of the entire population of caribou in the sampling area. We also assessed what factors might influence sightability, including percent of closed canopy land cover classes within different sized buffers around observations, group size, log group size, and mid-winter resource selection function (RSF) scores that indicated habitat caribou were more or less likely to select at that time of year (see APPENDIX B for more information). We then developed sightability models to describe likely variation in sightability and produce an alternative abundance estimate to the Courtois et al. (2003) method.

Assessment of the distribution of collared groups by land cover class suggested there were more observations in areas with higher percentages of open canopy land cover classes, and the proportion of caribou detected was low, suggesting low probability of detecting collared caribou even when canopy cover was low. Further results indicated that collared caribou groups were more likely to occur in areas of higher tree cover than observations of non-collared caribou groups. This difference could not be attributed to differential habitat selection. This result could be due to differential sightability of collared vs non-collared groups (i.e., collared caribou were radio-tracked and thus detected and recorded even when they were in areas with higher tree cover) but also could be due to collared caribou selecting areas of higher cover. It is difficult to assess this issue completely given the relatively low sample size of collars. Regardless, estimates using a mean sightability based on collars could be biased if the distribution of collared groups relative to tree cover differed from non-collared groups. We therefore pursued sightability models to model variation in sightability due to differences in tree cover class to control for this potential source of bias and variation.

Using only collared caribou groups (n = 34), there was no significant relationship between frequency of detection and percent tree cover. We then did a second analysis that included additional groups that were not sighted (i.e., not observed independently of radio-tracking) to boost sample sizes. The non-sighted groups included collared groups (23), and groups seen while looking for collars or groups seen based on tracks (8 groups total). In addition, groups sighted without collars were included, which amounted to 66 groups. We note this approach assumes that the sample of detection/non-detections still represents sightability; in other words, the non-detected caribou groups were adequately represented so that the relationship between percent cover or other covariates and sightability represents the larger population of caribou. A plot of percent cover with detection type for this data set had higher frequencies in the open cover class in comparison to the collar-only data set.

Logistic regression was then used to assess dominant factors influencing sightability. The most supported model had percent closed canopy cover classes (using a 1,000 m buffer) as a significant predictor. Parameter estimates for the percent cover model were significant at $\alpha = 0.05$. The receiver operating characteristic (ROC) curve score for the percent cover model was 0.65, which suggests satisfactory but not optimal predictive ability of the logistic model. This was likely due to a lack of data points in areas with higher percentages of closed canopy land cover classes.

Overall, these results indicated that caribou were more likely to be sighted in open habitat than in habitat with higher tree cover. Each observation was then assigned a sighting probability based on the percent of closed canopy land cover classes surrounding the location. The dataset used to model sightability included some observations where caribou were located using radiotelemetry or other methods, however, only the observations made independently by the phase 2 survey crew (“sighted”) are used for abundance estimates (Figure 5-9).

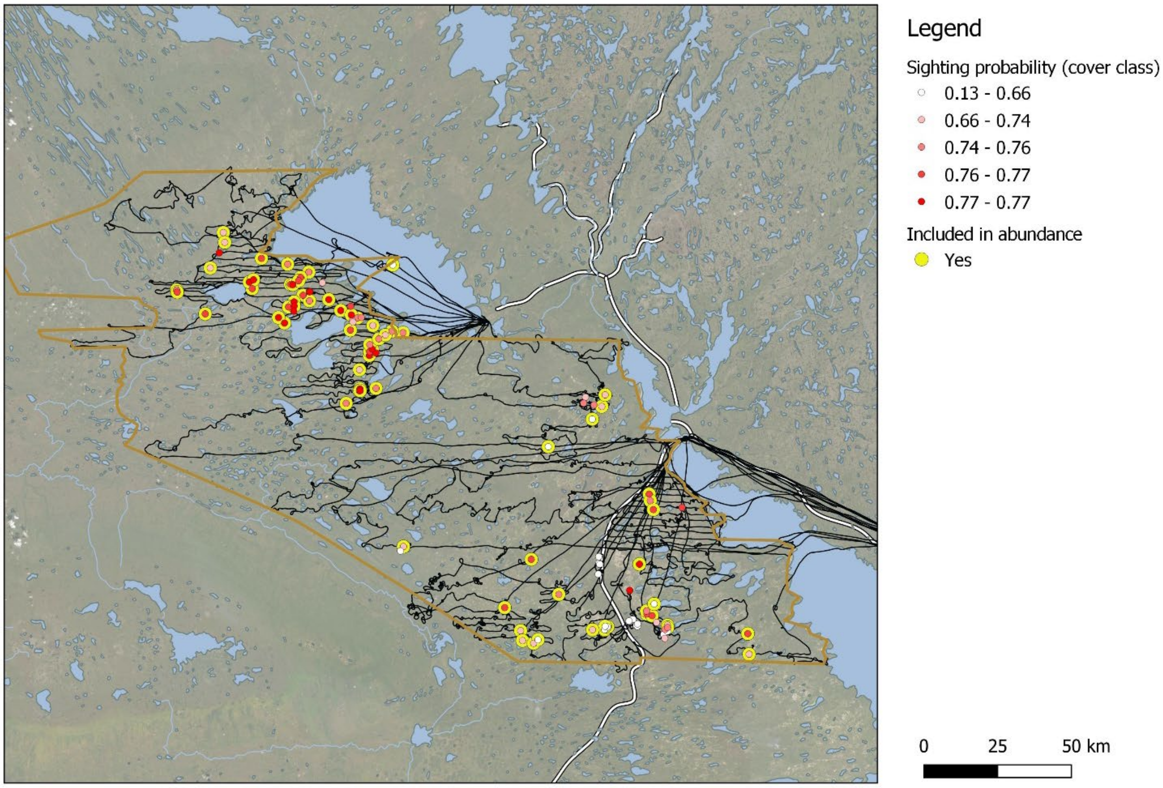

Figure 5-9. Predicted sighting probabilities for each observation during phase 2. Aircraft flight paths are shown with black lines.

<u>Abundance estimates</u>
Table 5-11 provides total estimates using the Courtois and sightability model approach. In each case, the final estimate was the phase 2 abundance estimate divided by phase 1 sightability (0.6). The main reason for the large difference in estimates is that the Courtois method estimates a single detection probability for phase 2 (of 0.4) based on the collar-only data set that was distributed in areas of higher tree cover compared to the visually detected caribou. In contrast, the sightability method used a broader dataset to estimate sightability based on tree cover. However, the sightability estimate is based upon supplemental data sources, which may not be completely indicative of the range of sightability in the survey area.

The total number of boreal caribou counted within the study area was 577, resulting in a minimum density estimate of 2.74 caribou/100 km^2. After accounting for sightability using these methods, the estimated caribou abundance is 965-1,725 caribou, or a mean density estimate of 4.6 – 8.2 caribou/100 km^2 within the 21,071 km^2 study area, depending on the method used (Table 5-11).

Table 5-11. 2020 boreal caribou abundance survey in the Tłı̨chǫ ASR-NSR study area.

Method	Phase 2 estimates			Phase 1 and 2 estimates (N_{phase2}/p_{phase1})				
	Caribou sighted	N_{phase2}	CV	N	SE	Conf. limits		CV
Sightability model	414	579	0.31	**965**	326.7	506	1,842	0.34
Courtois/LP	414	1035	0.23	**1,725**	467.4	1,023	2,908	0.27

The boreal caribou abundance survey methods and analyses are discussed in greater detail in APPENDIX B.

The WMMP recommends that a second boreal caribou abundance survey be completed during the first five years of operation of the Tłı̨chǫ ASR. In recent years, DNA-based methods to estimate population abundance have improved as technologies have improved. Planning for an operations-phase boreal caribou abundance survey in the Tłı̨chǫ ASR region will include an assessment of the best methods to obtain an estimate with reasonable precision.

5.3.3 Boreal Caribou Road Crossings and Movement Behaviour in Proximity to the Road

The WMMP required an evaluation of the impact of construction of the Tłı̨chǫ ASR on boreal caribou movements (Table 5-6), including: (1) whether boreal caribou avoid the road during and after construction, (2) if and where boreal caribou cross the road, (3) if the rate of boreal caribou movements changes in proximity to the road, and (4) if sample sizes allow, the potential zone of influence of the road on boreal caribou habitat use.

GPS collars were deployed on boreal caribou in the vicinity of the Tłı̨chǫ ASR alignment 2.5 years prior to the start of construction and provided a baseline of caribou movements in the proposed area before construction. To understand if construction of the Tłı̨chǫ ASR affected boreal caribou movements, we compared boreal caribou movements near the Tłı̨chǫ ASR alignment before construction to caribou movements in the same area during the construction period.

We also compared boreal caribou movements near Highway 3 to caribou movements near the Tłı̨chǫ ASR alignment during the pre-construction and construction periods. Existing collar data suggested that Highway 3 did affect boreal caribou movements, with few collared caribou crossing Highway 3 despite many locations on each side of the highway. We included Highway 3 in some analyses to verify that the methods used would be able to detect impacts of a linear feature on boreal caribou, even if no impacts of the Tłı̨chǫ ASR were detected during the construction period.

First, we looked at if and where boreal caribou crossed the Tłı̨chǫ ASR alignment. We mapped road crossings of the Tłı̨chǫ ASR by collared boreal caribou broken down by 1-km road segment and summarized by time period. We also examined whether road crossing rates differed seasonally and by construction phase, taking into account the different number of GPS-collared cows in different time periods.

Second, we looked at whether boreal caribou movement behaviours (e.g., speed, distance, changes in direction) changed in proximity to roads. We used several approaches to investigate the effect of 'distance from road' on boreal caribou movement characteristics, with the understanding that obtaining similar results through differing methods would increase the confidence in those results.

Third, we looked further into caribou behaviours when they encountered the Tłı̨chǫ ASR, and whether responses like crossing the road or turning back from the road were different during the pre-construction period compared to the construction period and compared to when caribou encountered Highway 3.

The following sections provides a summary of the methods and key results from analyses that are described in greater detail in Appendix C. Appendix C includes some additional analyses and results that are not summarized below.

5.3.3.1 Boreal caribou road crossings

Movement paths of GPS collared caribou were used to assess where they crossed the Tłı̨chǫ ASR alignment before construction (March 15, 2017 – September 2, 2019) and during construction (September 3, 2019 – November 30, 2021). GPS collars included a 10 km wide geofence along either side of the Tłı̨chǫ ASR and Highway 3, within which collar locations were recorded every hour. This provided relatively high temporal resolution movement data to evaluate where boreal caribou crossed each road alignment. During the period before construction started, 20 collared caribou had GPS locations within the geofence, and 29 collared caribou had collar locations within the geofence during construction. Figure 5-10. Number of collared boreal caribou movement tracks (grey lines) that crossed each 1-km long segment of the Tłı̨chǫ ASR before (March 15, 2017 – September 2, 2019; left panel) and during (September 3, 2019 – November 30, 2021; right panel) construction. Figure 5-10 shows the number times boreal caribou crossed the Tłı̨chǫ ASR alignment, broken down into 1 km segments, before and during construction. The map shows several locations along the alignment where boreal caribou appear to often cross the road, suggesting that the road alignment may bisect some important movement corridors.

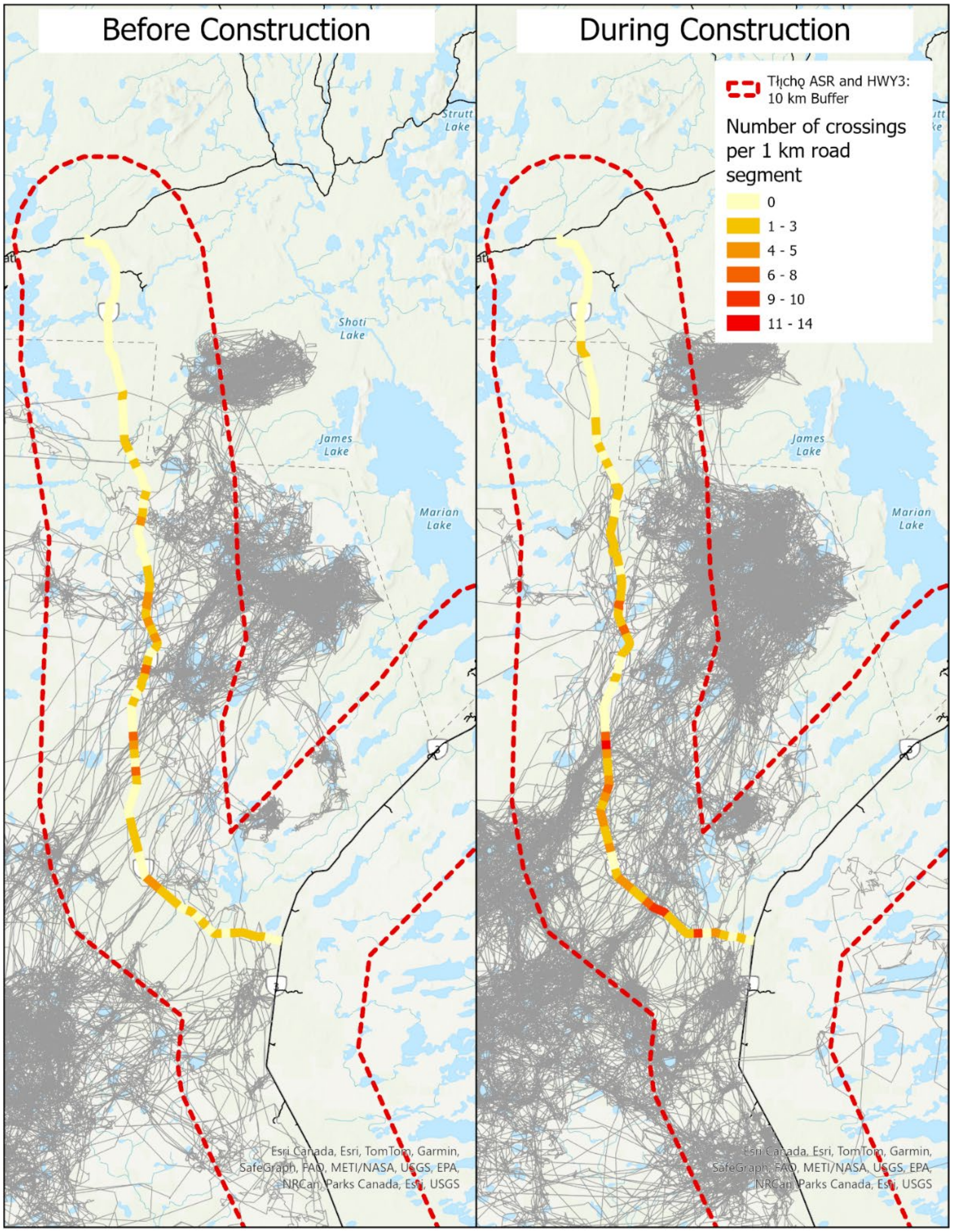

Figure 5-10. Number of collared boreal caribou movement tracks (grey lines) that crossed each 1-km long segment of the Tłı̨chǫ ASR before (March 15, 2017 – September 2, 2019; left panel) and during (September 3, 2019 – November 30, 2021; right panel) construction.

To statistically compare whether boreal caribou road crossing frequency differed before vs. during construction it was first necessary to standardize the data to account for differences in monitoring effort during each phase. There were fewer caribou collared during the "before construction" phase, and this phase covered a shorter time period than the construction phase, meaning there were less opportunities to observe collared caribou crossings. Three standardized metrics were used to evaluate differences in crossings rates during the different project phases (before vs. during) and during different behavioural seasons (pre-calving, calving, summer, early fall, late fall, and winter). For each collared caribou in each season-phase combination (e.g. "Pre-calving - Before"), the number of steps recorded for each caribou and the number of days ('Time') that each caribou was tracked during that period was measured. A 'step' represents the line connecting two sequential GPS locations from an individual collared caribou. The number of steps and number of days tracked were then summed across individuals during each season-phase combination. Crossing rates were measured as # Crossings per 1000 days, Crossings per 1000 steps, and # Crossings per 1000 steps that occurred inside the 10 km geofence. Crossing rates of HWY 3 were also measured for the entire period between March 15, 2017, and November 30, 2021, to provide a comparison to an active road with much higher traffic levels.

Crossing rates in the pre-calving season were higher during pre-construction than during the construction phase (Table 5-12, Figure 5-11; *p*-value = 0.002). No significant differences in crossing rates (before versus during construction) were detected for the other seasons. Crossing rates of the Tłı̨chǫ ASR were an order of magnitude larger than that of Highway 3 (Table 5-12 and Table 5-13)

In summary, crossing rates of the Tłı̨chǫ ASR were an order of magnitude larger than that of Highway 3. There was a reduction in the number of crossings of the Tłı̨chǫ ASR in the pre-calving period during the construction phase, but crossing rates in other seasons remained similar during construction to those observed before the road was built.

Table 5-12. Number of times individuals crossed the Tłı̨chǫ ASR, broken down by season and construction phase, along with different measures of monitoring effort.

Season	Phase	# Crossings	Time (# days tracked)	# steps	# steps within 10 km	Crossings / 1,000 days	Crossings / 1,000 steps	Crossings / 1,000 steps within 10 km
Pre-calving	Before	30	1,154	11,162	4,655	25.99	2.69	6.44
Pre-calving	During	7	1,760	15,138	2,770	3.98	0.46	2.53
Calving	Before	26	3,034	25,426	6,854	8.57	1.02	3.79
Calving	During	18	2,751	26,287	10,359	6.54	0.68	1.74
Summer	Before	2	2,163	15,990	2,745	0.92	0.13	0.73
Summer	During	5	2,280	21,128	7,393	2.19	0.24	0.68
Early fall	Before	3	795	5,692	1,266	3.77	0.53	2.37
Early fall	During	9	1,978	14,505	3,034	4.55	0.62	2.97
Late fall	Before	12	857	7,768	3,133	14.00	1.54	3.83
Late fall	During	50	2,080	20,508	10,454	24.04	2.44	4.78
Winter	Before	35	2,741	27,939	13,723	12.77	1.25	2.55
Winter	During	55	7,293	51,647	21,532	7.54	1.06	2.55

Table 5-13. Number of times individuals crossed Highway 3, along with different measures of monitoring effort.

# crossings	Time (# days tracked)	# steps	# steps within 10 km	Crossings / 1,000 days	Crossings / 1,000 steps	Crossings / 1,000 steps within 10 km
10	23,177	224,002	52,326	0.43	0.04	0.19

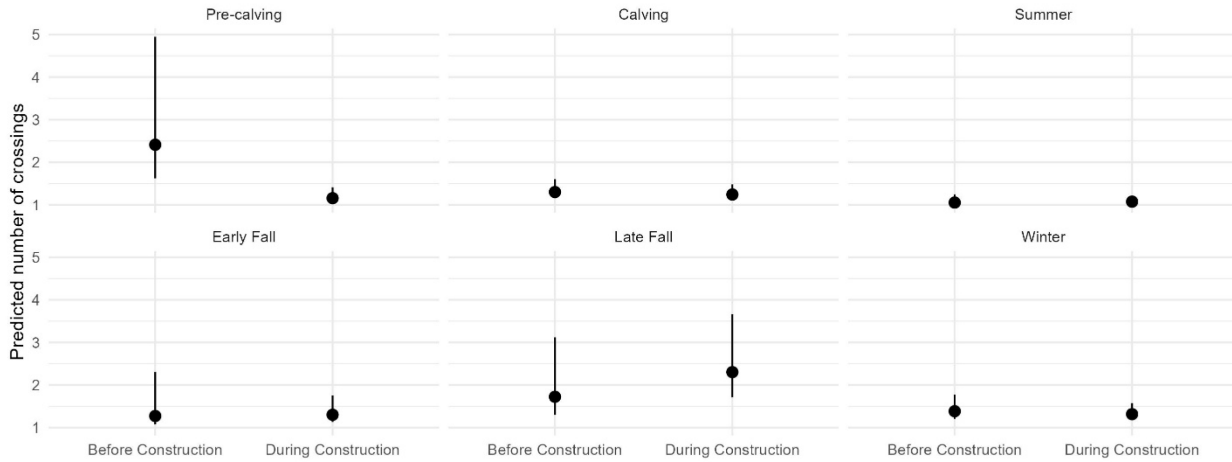

Figure 5-11. Estimated number of crossings during each season and construction period for a "typical" individual (i.e., one with random intercept = 0; Fieberg et al. (2009)).

5.3.3.2 <u>Effect of Distance from Road on Caribou Movement Characteristics</u>

Three different methods were used to assess whether boreal caribou movement characteristics (step lengths and turning angles) changed in proximity to the road alignment before and during the construction phase: piecewise regression models, generalized additive models, and integrated step-selection analysis. These analyses only considered GPS locations from within the 10km geofence that had location intervals of 1 hour. For each step connecting two successive GPS locations from the same individual, step length (sl = the straight-line distance between pairs of sequential GPS observations) and turn angle (ta = the change in direction between two consecutive steps (Figure 5-12) were calculated. The log of step length ('log(sl)') and the cosine of turning angle ('cos(ta)') were used in analyses. The cosine of turning angle serves as a measure of directional persistence; cos(ta) will reach its maximum value of 1 when the animal continues to move in the same direction as the previous step and will take on its minimum value of -1 when the animal turns around and moves in the exact opposite direction as the previous step (Prokopenko et al. 2017).

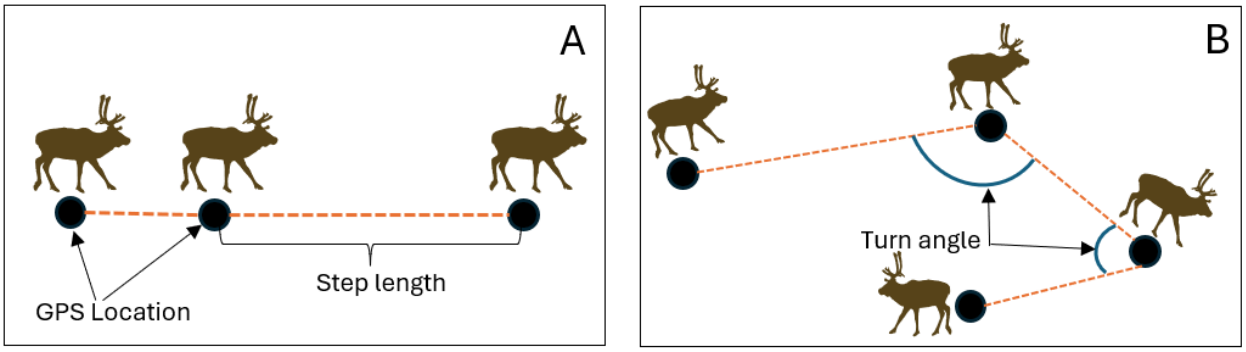

Figure 5-12. Illustration of step length (the straight-line distance an animal moves between two consecutive GPS points) and turn angle (the change in direction an animal makes between two consecutive step lengths).

Zone of Influence – Piecewise Regression

Piecewise regression models were used to estimate a zone of influence of the Tłįchǫ ASR both before and during construction, and of Highway 3. The 'zone of influence' can be defined as the distance from infrastructure where the effect of disturbance on habitat selection, or movement behaviour, is no longer discernable from natural background variation (Boulanger et al. 2012). Piecewise regression models estimate a single breakpoint that allows the effect of 'distance to road' to change before and after the breakpoint. Separate models were fit to log(step length) and cos(turn angle) as a function of distance to road. The models included predicted values from an all-year resource selection function model (a habitat selection model; DeMars et al. 2020) as an additional explanatory variable to control for other environmental factors known to influence caribou habitat selection.

Estimated breakpoints for distance to road in the log(step length) models were 1.425 km (SE = 0.218) (Tłįchǫ ASR during pre-construction), 2.494 km (SE = 0.102) (Tłįchǫ ASR during construction), and 0.882 km (SE =0.103) (Highway 3), with higher mean log(step length) values occurring when caribou were close to the road (Figure 5-13).

Estimated breakpoints for distance to road in the cos(turn angle) models were 1.445 km (SE = 0.3) (Tłįchǫ ASR during pre-construction), 2.464 km (SE = 0.326) (Tłįchǫ ASR during construction), and 5.28 km (SE = 0.449) (Highway 3), with caribou exhibiting more directed movements when close to the Tłįchǫ ASR and less directed movements when close to Highway 3 (Figure 5-13).

There was considerable variation in step lengths and turning angles at different distances from the road, and overall, the piecewise regression models explained <2% of the variation in step lengths, and <1% of the variation in turn angles. This suggests that there are other important factors influencing step lengths and turning angles that are not accounted for in the models.

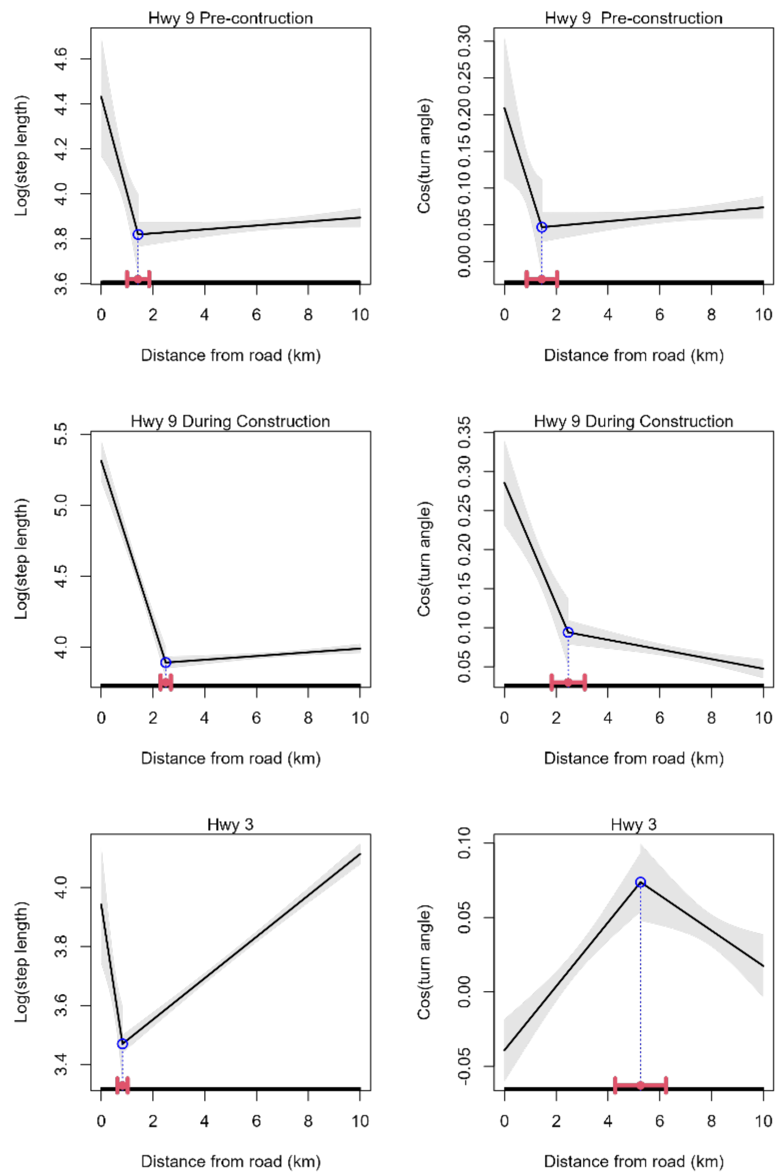

Figure 5-13. Estimated mean log(sl) (left column) and cos(ta) (right column) as a function of distance from road for the Tłı̨chǫ ASR during the pre (top row) and during (middle row) construction phases of the study and for Highway 3 (bottom row) from fitted piecewise linear regression models.

Generalized Additive Models

Generalized additive models (GAMs) were fit to estimate non-linear (smooth) effects of distance from road on log(step length) and cos(turn angle). These models revealed similar trends in step lengths and turning angles as the piecewise regression models with respect to distance from the road (Figure 5-14), but similar to the piecewise regressions, these models also explained very little of the variation in step lengths and turning angles.

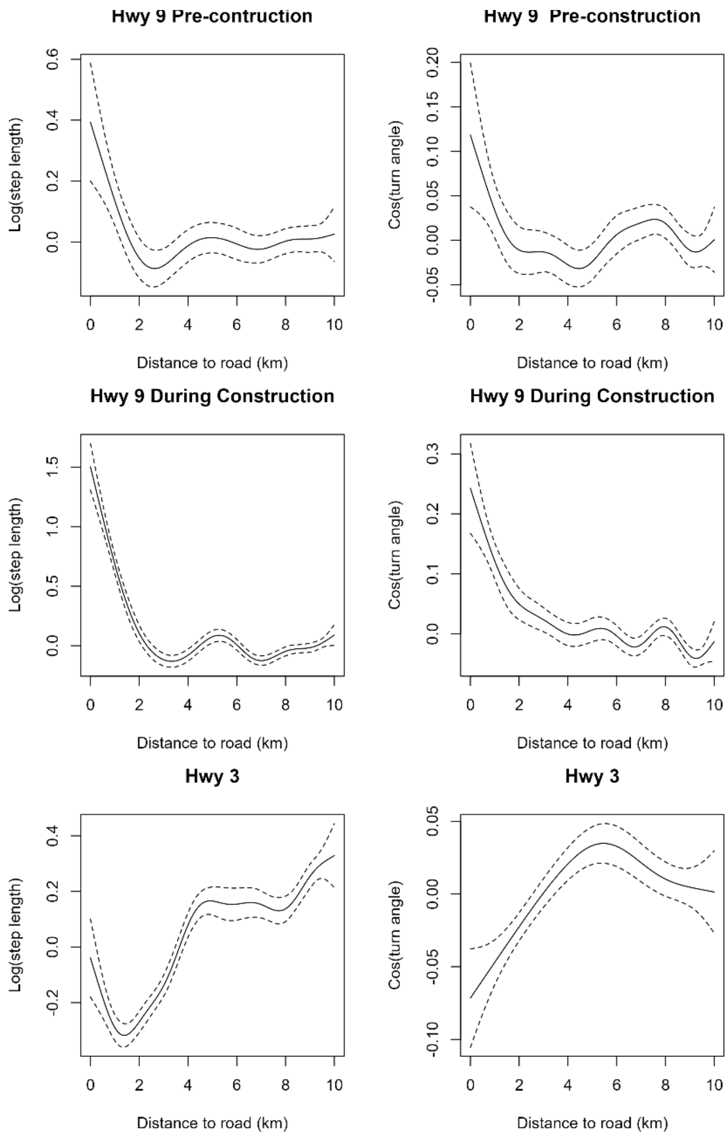

Figure 5-14. Estimates of the effect of distance from road on mean log(sl) (left column) and cos(ta) (right column) for the Tłı̨chǫ ASR during the pre (top row) and during (middle row) construction phases of the study and for Highway 3 (bottom row) from fitted generalized additive models. Dotted lines represent 95% confidence intervals.

Summary

A behavioural change in movement characteristics was detected as animals approached the Tłı̨chǫ ASR. Specifically, longer step lengths and more directed movements (cos(ta) closer to 1) were observed when animals were within approximately 2 km of the road alignment. Caribou also moved faster when crossing the road alignment than when they were not crossing a road (see Appendix C – Figure C-4). A change in movement behaviors when individuals approached Highway

3 was also detected, but the relationships between log(step length), cos(turn angle) and distance to road was more complicated (Figure 5-13) and challenging to interpret. Overall, step lengths and turn angles were highly variable over the range of distances from road measured (0-10 km), and distance to road explained very little of this variation in both piecewise regression and GAM models.

Integrated step-selection functions

Integrated step-selection analyses (Avgar et al. 2016; Fieberg et al. 2021) were conducted to quantify how caribou select habitat and change their movements when near Highway 3 and the Tłįchǫ ASR. Integrated step-selection analyses assume that animal space use is captured by the product of two kernels, a selection-free movement kernel, $\phi(.)$, that quantifies how the animal would move in the absence of habitat selection and a movement-free selection kernel, $w(.)$, representing habitat preferences (Fieberg et al. 2021). The analysis involves matching observed steps taken by collared caribou with sets of random steps used to describe habitat available to a caribou at each step. Step lengths and turning angles for determining random steps are drawn from statistical distributions of observed steps and turning angles. Habitat covariates are measured at the start and end of each step, and the analysis compares attributes of habitat where caribou chose to go (observed steps) to available habitat that they could have chosen (random steps). Covariates in the analysis included the distance to each road at the end of each movement step, and predicted habitat values (at the end of the movement step) from a fitted resource selection function from DeMars et al. (2020) to control for other environmental factors known to influence caribou movements. Observed and random steps were combined into strata and analyzed by fitting a generalized linear mixed effects model.

Although estimated mean step lengths were slightly larger when caribou were near the Tłįchǫ ASR during the pre-construction phase of the study (Figure 5-15), this effect was small and estimated median step lengths were similar for all quantiles of distance from road. Similarly, distance from road had very little effect on the distribution of turn angles during the pre-construction phase of the study (Figure 5-16). The effect of distance from road on step lengths was statistically significant (p-values for the interaction terms between distance from road and sl and log(sl) were both < 0.001) but the effect on turn angles was not (p-value = 0.632).

The effect of distance from road was more pronounced during the construction phase of the study, with higher mean and median step lengths estimated when caribou were close to the Tłįchǫ ASR (Figure 5-15). The estimated distribution of turn angles also became more concentrated on 0, indicating more directed movements when caribou were close to the road (Figure 5-16). The effects of distance from road on step lengths and turn angles were statistically significant (p-values for all interaction terms were < 0.001).

In contrast to the results for the Tłįchǫ ASR, estimated mean and median step length decreased and turn angles were estimated to be less concentrated on values near 0 as caribou approached Highway 3 (Figure 5-15 and Figure 5-16). Again, these effects were statistically significant (p-values for the interaction terms with sl and log(sl) were < 0.001, and the p-value for the interaction term with cos(ta) was 0.0023).

Summary

These contrasting results likely reflect differences in how caribou view Highway 3 and the Tłı̨chǫ ASR. Caribou were much more likely to cross the Tłı̨chǫ ASR than Highway 3. When approaching the Tłı̨chǫ ASR, they often crossed quickly, resulting in longer and more directed steps, and this behaviour became more pronounced during the construction phase. By contrast, caribou rarely crossed Highway 3 and often changed their direction and moved less in its vicinity.

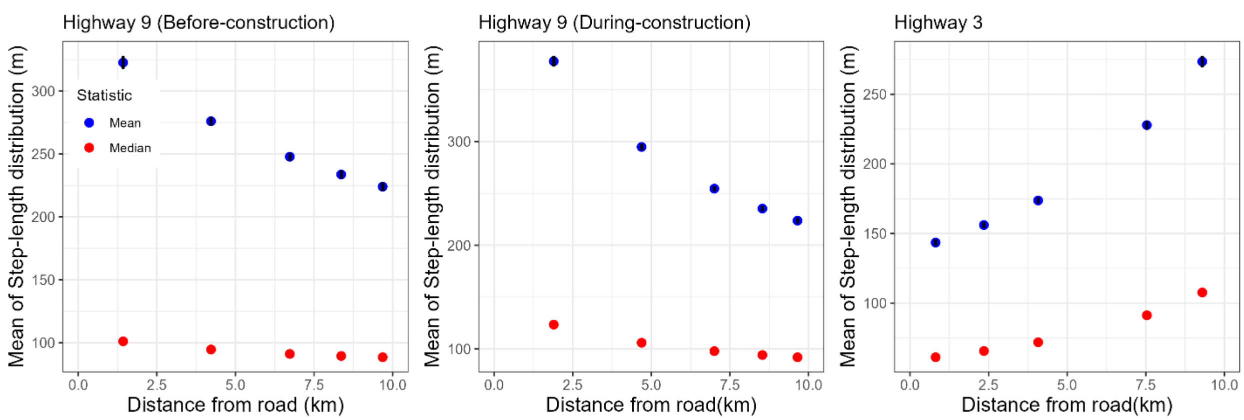

Figure 5-15. Estimated mean and median step lengths for different quantiles of distance from road (5%, 25% 50% 75% and 95%) for a "typical individual" (i.e., one with coefficients set to their mean values in the population; Fieberg et al. (2009)) during the pre (left panel) and (middle panel) construction phases of the Tłı̨chǫ ASR [Highway 9] and for Highway 3 (right panel) from fitted integrated step-selection models.

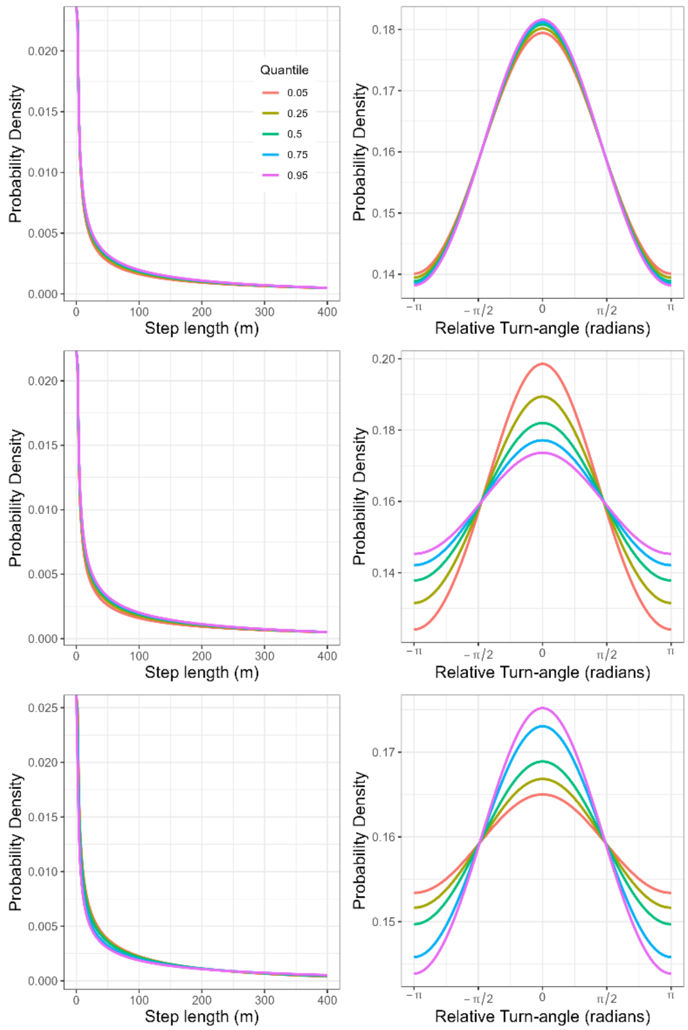

Figure 5-16. Estimated distributions of step length (left column) and turn angle (right column) for different quantiles of distance (see Figure 5-15 for the distances used) from road during the pre (top row) and during (middle row) construction phases of the Tłı̨chǫ ASR and for Highway 3 (bottom row) from fitted integrated step-selection models.

5.3.3.3 <u>Effect of Road Encounters on Caribou Movement Behaviours</u>

Animal responses to linear features like roads can be more complex than changes in step length and turn angles and can include changes in behaviours like 'patrolling' or tracing alongside the road, deflecting away from the road, or continuing to move normally near the road. The barrier behaviour analysis (BaBA) developed by Xu et al. (2021) provides a useful tool for detecting and categorizing these behavioural changes. In this framework, animal movements that occur within a specified distance from the road are considered encounter events and are classified into one of six barrier behaviour types across three movement types: normal movements, altered movements, and trapped movements. Normal movement includes 'average' movement, when the barrier does not obviously influence animals' movements, and 'quick cross', when an animal quickly crosses the barrier after it is encountered. These 'normal' movements may be affected by the linear feature in other ways that are not considered here; for example, movement speed (i.e., crossing faster to avoid being close to the road). Altered movements include 'bounce', when the animal quickly moves away from the barrier; 'back-and-forth', when the animal stays close to the barrier by going back and forth; and 'trace', where the animal stays close to the barrier and moves alongside it. Back-and-forth and trace movements may ultimately lead to a crossing event, but because there was a delay in crossing the road after encountering the barrier, it is considered an altered movement. 'Trapped' movements are when animals' movements are constantly near a barrier, suggesting an animal is constrained by the barrier (Figure 5-17).

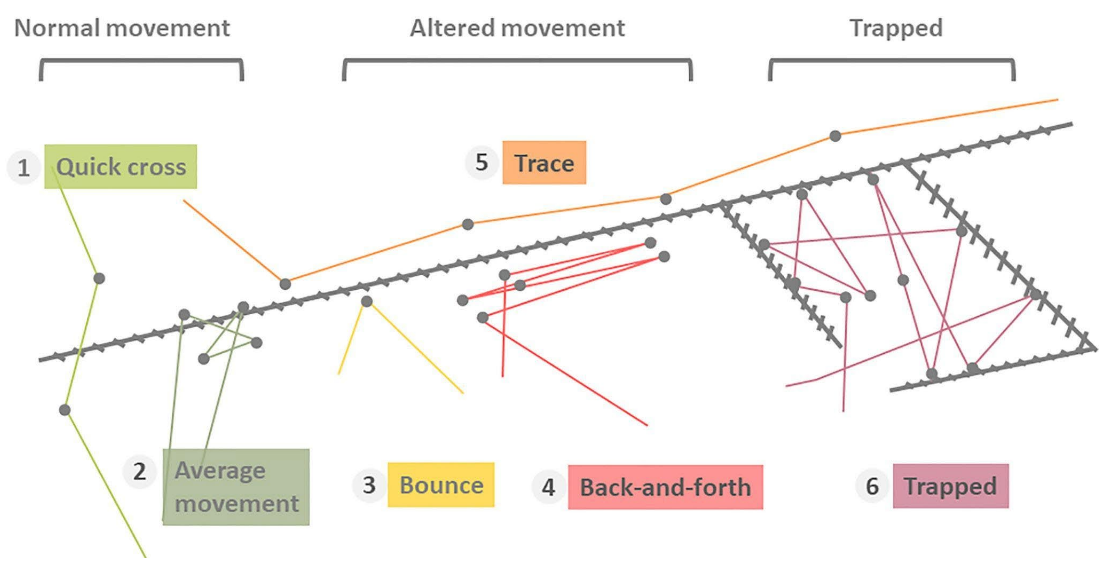

Figure 5-17. Schematic diagram of the different behaviour types identified using the barrier behaviour analysis (BaBA) (from Xu et al. 2021).

Appendix C describes sensitivity analyses that were undertaken to determine the optimal parameters to use to differentiate between different barrier behaviour types described in Figure 5-17. As with the other analyses described above, collar locations were filtered to those occurring within the 10-km geofence around the roads and with a 1-hour location interval. For a given barrier and a dataset of animal locations (consisting of regular location fixes over time), any set of consecutive animal locations that fall within a user-defined buffer radius of this barrier are considered "encounter events". Three buffer sizes (500 m, 1000 m, and 1500 m) were used to define encounter events and to compare the frequency and proportion of behaviours among three road categories: Tłı̨chǫ ASR pre-construction, the Tłı̨chǫ ASR during construction, and Highway 3. The frequency of key behaviours (e.g., quick cross and bounce behaviours) between each road category, was compared using a Pearson's Chi-squared test. A test was run for each buffer (500, 1,000, and

1,500 m) and for each pair of road categories (Tłı̨chǫ ASR before construction to Highway 3, Tłı̨chǫ ASR during construction to Highway 3, and Tłı̨chǫ ASR before construction to Tłı̨chǫ ASR during construction) to compare the observed counts for each behaviour.

Across buffer distances, there was largely a difference found in the proportion of quick cross and bounce behaviours categories for the Tłı̨chǫ ASR categories versus Highway 3 (Figure 5-18 and Table 5-14). For Highway 3, there was a much larger proportion of bounce behaviors detected (~50-70%) and a low proportion of quick cross behaviours (~1-2%), compared to the Tłı̨chǫ ASR before construction (~16-19% bounce, ~50-65% quick cross) (Figure 5-18 and Table 5-14). For the Tłı̨chǫ ASR during construction, a relatively equal proportion of quick cross (~36-47%) and bounce behaviours (~37-45%) was found (Figure 5-18 and Table 5-14). These differences were consistent across the three buffer distances.

Further, Pearson's Chi-square tests showed that the frequency of quick cross behaviours were significantly different, regardless of buffer size, between the Tłı̨chǫ ASR (both before and during construction) and Highway 3 (Table 5-14). The frequency of quick cross behaviours was not statistically different for the Tłı̨chǫ ASR before versus during construction with the 500 m buffer but was with the 1,000 and 1,500 m buffer (Table 5-14). For bounce behaviour, results of the Pearson's Chi-square test showed that all road category comparisons (Tłı̨chǫ ASR before construction to Highway 3, Tłı̨chǫ ASR during construction to Highway 3, and Tłı̨chǫ ASR before construction to Tłı̨chǫ ASR during construction) were significantly different, even with different buffer widths (Table 5-14).

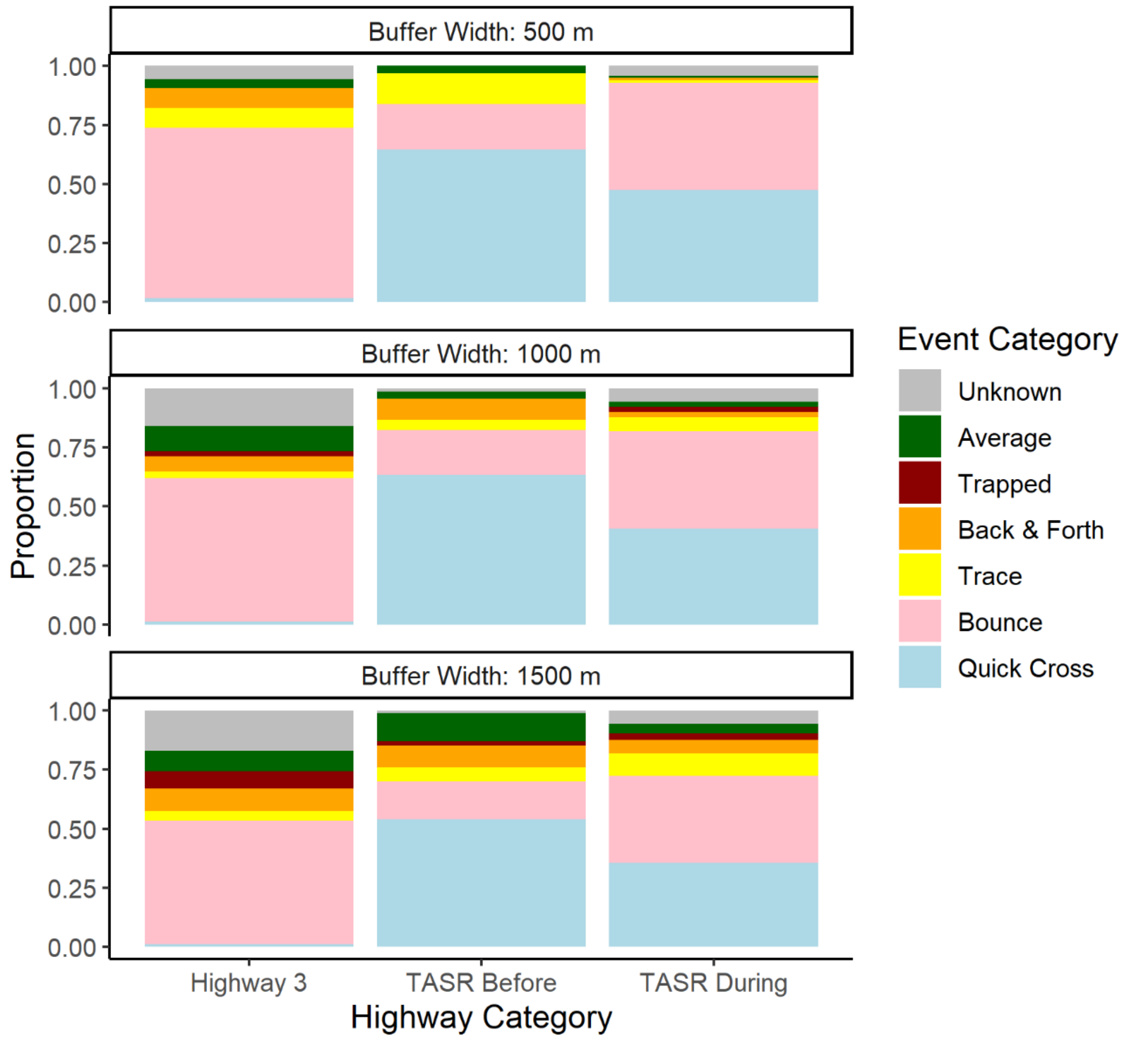

Figure 5-18. Barplots of the proportion of various behaviour types for three buffer distances (500, 1,000, and 1,500 m) and comparing the different highway categories of interest (Highway 3, TASR before construction, and TASR during construction).

Table 5-14. Results of Pearson's Chi-square tests, applied on each buffer (500, 1,000, and 1,500 m), for the frequency of each behaviour (quick cross versus non-quick cross, bounce versus non-bounce) for each unique pair of road categories (Tłı̨chǫ ASR before construction to Highway 3, Tłı̨chǫ ASR during construction to Highway 3, and Tłı̨chǫ ASR before construction to Tłı̨chǫ ASR during construction.

Quick cross versus non-quick cross behaviour (500 m buffer)			
Road categories	**df**	**Test statistic**	**P-value**
Tłı̨chǫ ASR before construction and Highway 3	1	65.8	5.0e-16
Tłı̨chǫ ASR during construction and Highway 3	1	56.2	6.6e-14
Tłı̨chǫ ASR before construction and Tłı̨chǫ ASR during construction	1	2.1	0.15
Quick cross versus non-quick cross behaviour (1,000 m buffer)			
Road categories	**df**	**Test statistic**	**P-value**
Tłı̨chǫ ASR before construction and Highway 3	1	105.7	2.2e-16
Tłı̨chǫ ASR during construction and Highway 3	1	66.4	3.7e-16
Tłı̨chǫ ASR before construction and Tłı̨chǫ ASR during construction	1	8.5	0.0036
Quick cross versus non-quick cross behaviour (1,500 m buffer)			
Road categories	**df**	**Test statistic**	**P-value**
Tłı̨chǫ ASR before construction and Highway 3	1	106.9	2.2e-16
Tłı̨chǫ ASR during construction and Highway 3	1	67.5	2.2e-16
Tłı̨chǫ ASR before construction and Tłı̨chǫ ASR during construction	1	8.1	0.0043
Bounce versus non-bounce behaviour (500 m buffer)			
Road categories	**df**	**Test statistic**	**P-value**
Tłı̨chǫ ASR before construction and Highway 3	1	25.6	4.2e-07
Tłı̨chǫ ASR during construction and Highway 3	1	13.8	0.00020
Tłı̨chǫ ASR before construction and Tłı̨chǫ ASR during construction	1	5.6	0.018
Bounce versus non-bounce behaviour (1,000 m buffer)			
Road categories	**df**	**Test statistic**	**P-value**
Tłı̨chǫ ASR before construction and Highway 3	1	30.7	3.0e-08
Tłı̨chǫ ASR during construction and Highway 3	1	10.0	0.0015
Tłı̨chǫ ASR before construction and Tłı̨chǫ ASR during construction	1	9.0	0.0027
Bounce versus non-bounce behaviour (1,500 m buffer)			
Road categories	**df**	**Test statistic**	**P-value**
Tłı̨chǫ ASR before construction and Highway 3	1	33.7	6.4e-09
Tłı̨chǫ ASR during construction and Highway 3	1	8.02	0.0046
Tłı̨chǫ ASR before construction and Tłı̨chǫ ASR during construction	1	12.3	0.00046

Summary

Highway 3, which is an established highway with vehicle traffic, had a significantly higher amount of "altered" behaviours, mainly in the form of "bounce" behaviours, with reduced crossings. For the Tłı̨chǫ ASR, the comparison between caribou movements before construction started, and caribou movements during the construction period, shows that constructing the highway impacted caribou behaviour, mainly with a significant increase in altered (bounce) behaviours and a decrease in quick cross behaviours during construction.

5.4 Barren-ground Caribou

Barren-ground caribou are a highly valued species in the NWT and have been assessed as "Threatened" under the *Species at Risk (NWT) Act*. Several herds in the NWT have experienced substantial population declines. While barren-ground caribou have not been detected in the vicinity of the Tłı̨chǫ ASR in recent years of low population levels, the historic annual range of the Bathurst herd as determined by traditional knowledge, aerial survey data and collaring data has overlapped the northern section of the Tłı̨chǫ ASR corridor. It is possible that barren-ground caribou may re-occupy the area of the Tłı̨chǫ ASR corridor in the future, likely in winter. There is concern that if they do return to this area, the Tłı̨chǫ ASR could act as a barrier to their movements or facilitate access for hunting. In the event that collared barren-ground caribou locations indicate overlap with the 10-km buffer around the Tłı̨chǫ ASR, or if groups of barren-ground caribou are observed along the road, this could trigger further management actions, such as increased monitoring and patrols by GNWT, temporary signage, speed reductions or road closures. Thus, wildlife effects monitoring for barren-ground caribou focused on determining whether barren-ground caribou approached the area of the Tłı̨chǫ ASR corridor (Table 5-15).

To complement the barren-ground caribou collaring program and as required by Measure 7-1, GNWT supported the Tłı̨chǫ Government in the design and implementation of a program that uses Tłı̨chǫ harvesters' traditional knowledge and methods to monitor the state of barren-ground caribou (ʔekwǫ̀) winter habitat, during and after the completion of the Tłı̨chǫ ASR Project. The details of this program, which will be implemented by the Tłı̨chǫ Government and includes harvest monitoring and other efforts, are described in section 5.2.1 and Appendix I of the WMMP 5.2 (2022). Monitoring the state of both boreal caribou (tǫdzı) and barren-ground caribou (ʔekwǫ̀) winter habitat under this program is included in section 5.4.2.

Table 5-15. Monitoring questions for barren-ground caribou as outlined in the Tłı̨chǫ ASR WMMP, their relevance to the construction and/or operations phase of the Tłı̨chǫ ASR, and documentation in this report.

Monitoring questions for barren-ground caribou to address using a collaring program	Construction phase	Operations phase	Documented in this report
Determine whether barren-ground caribou are approaching the area of the Tłı̨chǫ ASR corridor.	√	√	Yes, section 5.4.1.

5.4.1 Monitor Whether Barren-ground Caribou are Approaching the Tłı̨chǫ ASR Corridor

GNWT-ECC maintains GPS collars on barren-ground caribou herds as part of well-established, on-going programs. The WMMP proposed approach was to monitor these collars to detect the approach of barren-ground caribou into the Tłı̨chǫ ASR area. Weekly maps of the Core Bathurst Caribou Management Zone could be used to evaluate overlap of the Mobile Zone with a 10 km buffer around the Tłı̨chǫ ASR alignment, and any overlap between the two polygons would be used as a trigger to initiate patrols.

<u>Methods and Results:</u>

Data from ECC's existing barren-ground caribou collaring program was used to determine whether barren-ground caribou approached the area of the Tłı̨chǫ ASR corridor during the construction phase. GNWT-ECC attempts to maintain 70 GPS collars annually on the Bathurst caribou herd: 50 on cows and 20 on bulls. Collars are generally programmed to generate three locations per day. ECC staff responsible for circulating the Core Bathurst Caribou Management Zone maps (aka "Mobile Zone" maps), which have been generated weekly every winter since 2015, were asked to notify those involved in wildlife effects monitoring programs for the Tłı̨chǫ ASR in the event that the Mobile Zone approached the Tłı̨chǫ ASR during the construction phase. However, collared barren-ground caribou were always found much further to the east than this buffer throughout the construction period. To illustrate this, movement paths of collared female and male barren-ground caribou from both the Bathurst and Bluenose-East herds were mapped using collar locations recorded during the construction phase of the Tłı̨chǫ ASR alignment (Figure 5-19). Figure 5-10 shows that during the construction phase collared individuals from both herds were using areas greater than 100 km away from the Tłı̨chǫ ASR. There were no collar locations during this period that fell within the 10 km buffer around the Tłı̨chǫ ASR, and therefore no further management actions for barren-ground caribou were triggered during the construction phase.

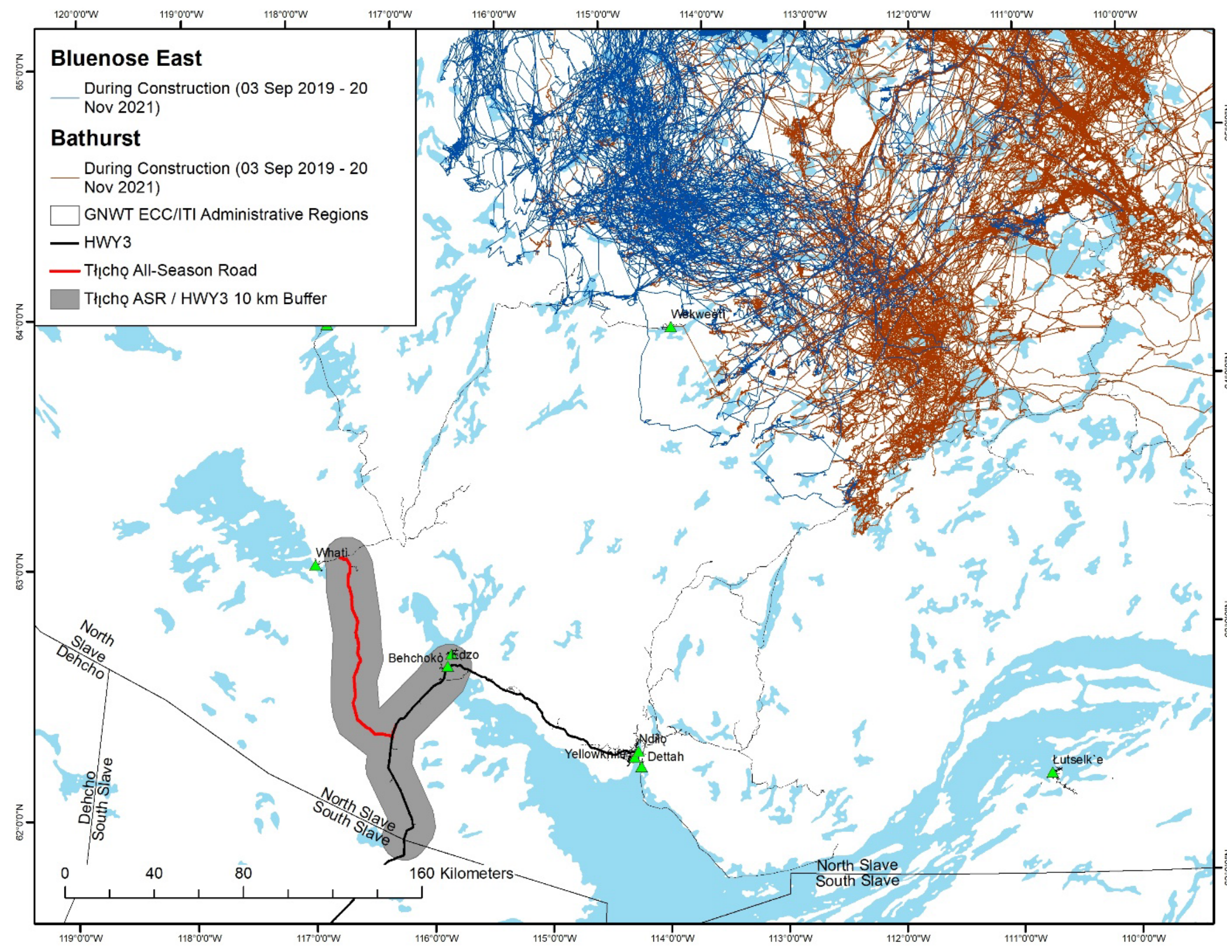

Figure 5-19. Movement paths of collared female and male barren-ground caribou from the Bathurst (brown lines) and Bluenose-East (blue lines) herds during the construction phase of the Tłı̨chǫ ASR.

5.4.2 Monitoring Barren-ground Caribou Winter Habitat

The Tłı̨chǫ Government's Department of Culture and Lands Protection collected and analysed boreal caribou and barren-ground caribou habitat data as part of the Tłı̨cho Highway Wildlife Monitoring Program. In addition to the vegetation survey and winter track surveys detailed below, the Monitoring Program completed a baseline conditions analysis that included information on caribou habitat and in the Tłı̨chǫ ASR area (see Section 5.2.4.1 and Tłı̨chǫ Government reports in Section 6.1 for more information).

5.4.2.1 <u>Vegetation Surveys</u>

Based on direction from the Tłı̨chǫ Tłı̨lıı̨ Deè Committee that more baseline habitat information was needed prior to the official opening of the road, vegetation surveys were completed along the Tłı̨chǫ ASR on August 23-27, 2021.

These vegetation surveys were conducted to collect habitat data prior to the Tłı̨cho Highway opening, to be able to monitor changes in caribou habitat over time and make decisions about additional mitigation measures if needed. Data collection in 2021 focused on surveying for vegetation at a variety of distances from the road. These vegetation surveys focused primarily on species abundance and composition, as well as ground cover composition, general site health, and arboreal lichen loads. Data analysis for the surveys was presented in a September 2021 report (Tłı̨chǫ Government 2021a).

Survey Methods

Assuming greater vegetation disturbance will occur closer to the Tłı̨chǫ ASR, a distance gradient approach was used with vegetation sampling occurring at specific distances (5, 50, 100, 150, 200 m) from the edge of the road in perpendicular transects running on both the east and west sides of the road. Distances were selected based on the assumption that most of the fugitive dust is deposited within 152.4 m (500ft) on either side of an unpaved roadway (Sanders and Addo 1993 in Tłı̨chǫ Government 2021b).

General transect locations were selected in advance by identifying areas of barren-ground and boreal (woodland) caribou habitat and movement corridors from existing data (TRTI 2014 in Tłı̨chǫ Government 2021b and ENR 2020a), as well as from survey work conducted by members of the Tłı̨chǫ Tı̨lıı`Deè Committee in February 2021. During field work, transect locations were modified to accommodate Tłı̨chǫ ASR construction activities and visual identification of suitable caribou habitat. The two transects completed in the summer 2021 surveys are shown in Figure 5-20.

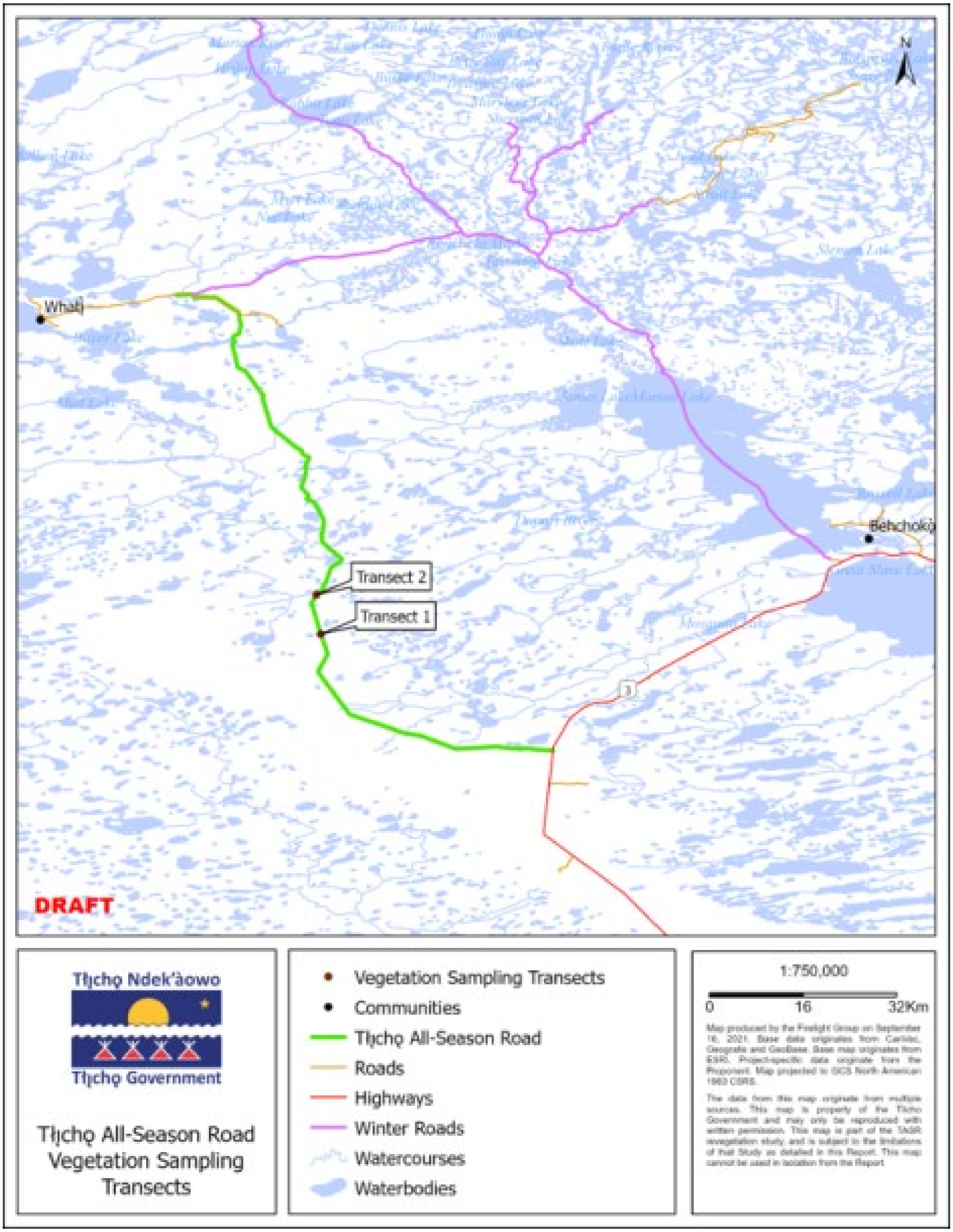

Figure 5-20. Vegetation transect surveys from August 24-27, 2021 (Tłı̨chǫ Government 2021b).

On each side of a transect location (east and west of the road), plots were sampled at 5, 50, 100, 150, and 200 m. Monitoring plots were sampled using the point-intercept method via 100 fixed measurement locations in a 1 x 1 m quadrat. The first plant species that were touched in the vegetation and ground layers were tallied using the point-intercept field form. The point-intercept method was selected based on sampling objectivity and reproducibility for future survey efforts. At minimum, species were identified to their plant group: tree, shrub, forb, graminoid, bryophyte, and lichen. Each plot was marked with the GPS and a pigtail marker in the northeast corner of the quadrat. Observations related to habitat health and existing impacts were opportunistically discussed with the monitoring team at each plot and recorded in the field data form when applicable.

Once point-intercept data collection was complete, from the center of each quadrat, the field team marked four 5 m transects running north, south, east, and west. Tree and shrub species along each transect were recorded on the data form. For each tree, the estimated lichen load below the 4.5 m mark and estimated height were recorded. For each shrub, the field team recorded the estimated height and browsing pressure. Once all four 5 m transects were complete, the field team estimated the percentage of crown closure for the plot area (10 m x 10 m).

Data from the 2021 vegetation surveys were limited by access to the Tłı̨chǫ ASR due to construction, timing (late August; timing was dictated by travel allowances due to COVID-19), and the number of plots that could be completed within the available timeframe (Tłı̨chǫ Government 2021b).

Results Summary

The following section provides a summary of comparisons between transects and distance classes observed during the summer 2021 field activities.

Transect 1 consisted of a new growth area recovering from wildfire, whereas transect 2 is in an old-growth area. Key observations between these two transects included:

- Transect 1 had noticeably more dust across all distance classes, as transect 2 was more protected from current dust impacts. As monitoring continues, there may need to be different mitigations along the new growth areas on the southern portion of the Tłı̨chǫ ASR to further reduce dust accumulation (e.g., slower speeds, more frequent watering).
- Transect 1 had nearly no active shrub browsing and had zero arboreal lichen compared to transect 2.

For each transect section, plots were surveyed at 5, 50, 100, 150, and 200 m from the edge of the Tłı̨chǫ ASR (excluding D200 at transect 1-west due to the presence of a waterbody). Key observations between distance classes included:

- All D5 plots were entirely soil/rock resulting from the road construction. As the roadway is not going to be actively revegetated, overtime it will be useful to monitor these plots to determine changes in species composition and to track any invasive species.
- For transect 2, D150 and D200 plots had no dust present and were determined to be sites that could be used for harvesting. As mentioned above, transect 1 had dust present

throughout. In particular, the D200 plots for transect 2 were consistently observed to be healthy and useable sites and will be good markers to compare to future work.

- In transect 2, it was observed that there was higher browsing pressure in D50 and D100 plots, compared to those farther from the road (D150 and D200). This could mean wildlife travelling along the road from the north-south are not travelling as far into the forest; additional monitoring overtime is needed to draw any conclusions regarding browsing.

A second vegetation survey was conducted in the summer of 2022, after the road opened, the results of which will be reported on in the Operations Phase Comprehensive Monitoring Report. Vegetation work in 2022 focused on dust accumulation and impacts from road operation. Improved accessibility to the road in the future may allow for increased sampling, including sampling on the north portion of the Tłı̨chǫ ASR.

5.4.2.2 Winter Track Survey

The Tłı̨chǫ Government's DCLP completed a winter track survey in February 2021. A 4-person crew snowmobiled the length of the Tłı̨chǫ ASR and recorded all wildlife interactions with the Tłı̨chǫ Highway. Tracks were recorded from tǫdzı (boreal caribou), dedìı (moose), nǫ̀da (lynx), dechı̨ta gojıe (bison) and nǫhwhe (marten), and a group of 30 dechı̨ta gojıe (bison) were observed (Tłı̨chǫ Government 2021b).

5.5 Wood Bison

Wood bison are listed as Threatened under the federal *Species at Risk Act* and *Species at Risk (NWT) Act*, and are a species of management concern in the NWT. With construction of the Tłı̨chǫ ASR, it is possible that the Mackenzie bison herd will use the road corridor to expand its range northward, possibly entering the community of Whatì. This has raised the concern among community members that bison may begin to exclude moose and caribou in the region. Hunting of the Mackenzie bison population was closed following an anthrax outbreak in 2012, but a new road will increase hunters' access into bison habitat and may increase hunting pressure when hunting is reinstated. At the end of the construction phase, the most recent Mackenzie bison population estimate (2019) exceeded 1,000 individuals, and the Mackenzie Bison Working Group subsequently recommended that a limited harvest of the herd be re-opened. Traffic on a new road will also increase the number of bison-vehicle collisions, which is already a substantial cause of bison mortality on Highway 3. Collisions are also a risk to human safety.

The WMMP required that specific monitoring questions be addressed in comprehensive reports prepared after the final year of construction (this report) and five years after monitoring during operations starts (Table 5-16).

Table 5-16. Monitoring questions for wood bison as outlined in the Tłı̨chǫ ASR WMMP, their relevance to the construction and/or operations phase of the Tłı̨chǫ ASR, and documentation in this report.

Monitoring questions for wood bison to address from population monitoring conducted in the regional Tłı̨chǫ study area	Construction phase	Operations phase	Documented in this report
If, and at what rate bison expand their range northward along the road corridor.	√	√	Yes, section 5.5.1.
If the relative abundance of bison in the Tłı̨chǫ ASR regional study area changes over time.	√	√	Yes, section 5.5.2.

5.5.1 Wood Bison Observations to Detect Changes in Range Distribution

5.5.1.1 Mackenzie Bison Population Monitoring and Range Expansion

The effect of the Tłı̨chǫ ASR on bison should be considered in the context of changes to the larger bison population. Wood bison in the vicinity of the Tłı̨chǫ ASR are from the Mackenzie population and its population trend is monitored by GNWT-ECC. Although wood bison were historically present throughout the Mackenzie Valley (Stephenson et al. 2001), the Mackenize bison population was reintroduced north of the Mackenzie River in 1963 and has expanded its size and range use since that time. The population expanded from an initial 18 bison in 1963 to an estimated 2,400 animals in 1989, remaining stable at around 2,000 animals until approximately the year 2000 and then around 1,500 animals from 2008-2012. In the summer of 2012, a large anthrax outbreak killed at least 451 bison (GNWT-ENR 2018). The population has increased in size since 2013 to around 1,500 animals in 2019 (Table 5-17). Figure 5-21 shows the population size estimated from aerial surveys from 1964 to 2019 (Armstrong and Schwarz 2019).

Table 5-17. Density and abundance of bison in the Mackenzie population estimated on aerial surveys using distance sampling methods since 2012.

Year	Density of individual bison	Standard Error	Lower 95% Confidence Limit	Upper 95% confidence limit
2012	7.0	1.1	5.0	9.6
2013	3.2	0.7	2.1	4.8
2016	3.8	0.9	2.4	5.9
2019	6.1	1.5	3.8	9.7

Year	Estimated number of bison	Standard Error	Lower 95% Confidence Limit	Upper 95% confidence limit
2012	1525	241	1118	2079
2013	706	160	453	1100
2016	851	209	528	1371
2019	1468	357	914	2359

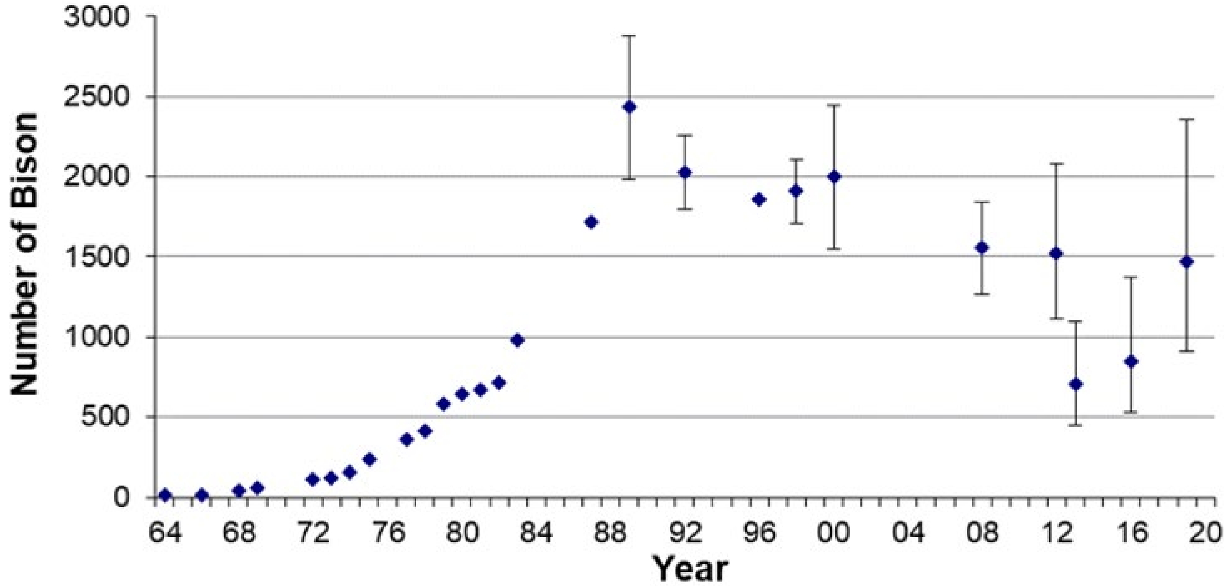

Figure 5-21. Mackenzie wood bison population size estimated from aerial surveys, 1964-2019.

The Mackenzie bison population has expanded its range use since the late 1990s (Figure 5-22). In 2014, wildfires (Birch Lake fire complex, fires 2014ZF-020 and farther north, 2014ZF-046) burned a large proportion of the bison range, and subsequent post-fire regeneration has further affected the distribution of bison with increased use of areas north of 62.5° and smaller groups dispersed across a larger area (A. Kelly, T. Armstrong, pers. comm. 2023).

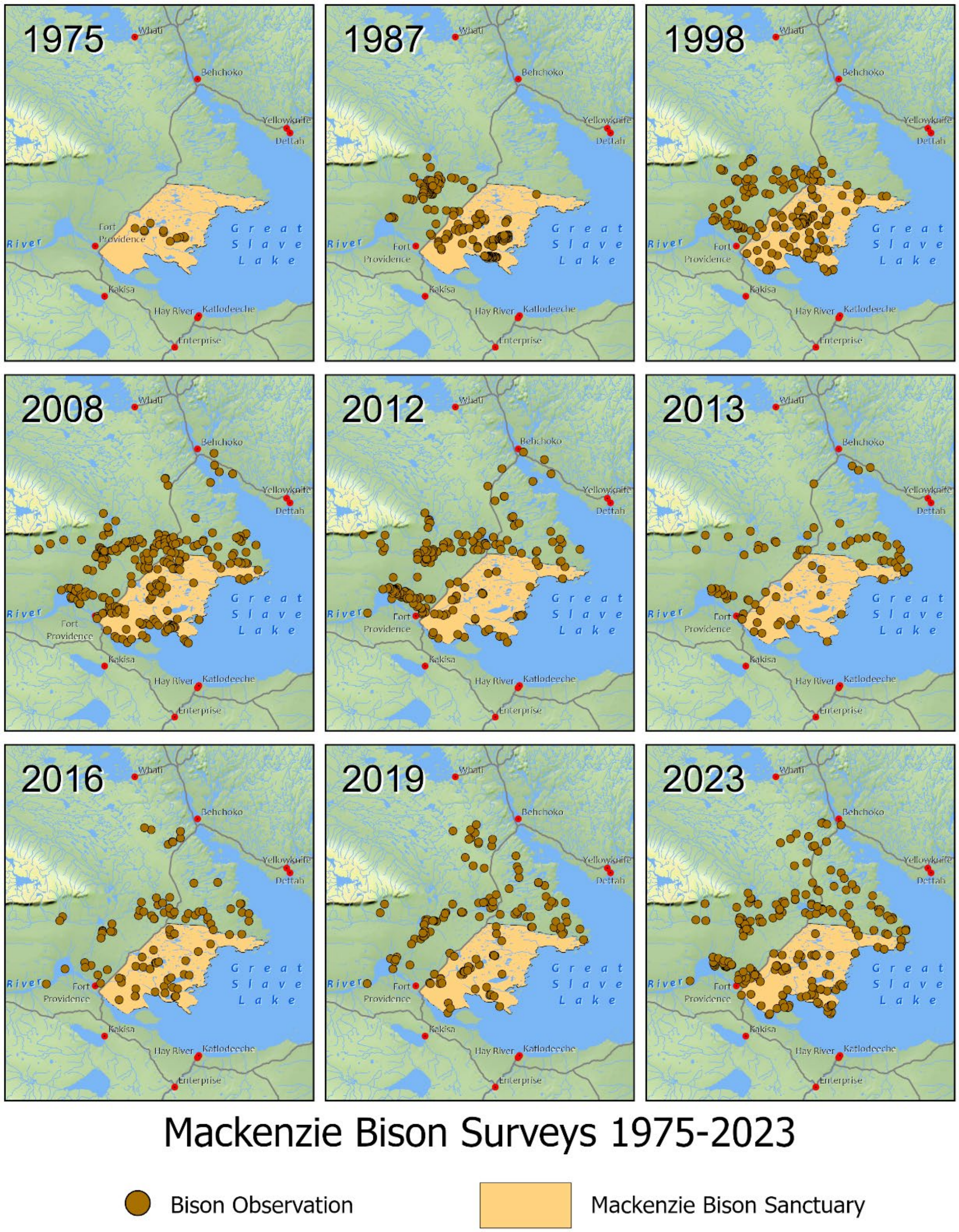

Figure 5-22. Observations of bison during Mackenzie bison population surveys, 1975-2023, showing range use of the Mackenzie bison population.

5.5.1.2 Mapping Bison Observations from Aerial Surveys to Detect Northward Expansion of Bison

To detect northward expansion of bison along the Tłı̨chǫ ASR RoW, if it occurs, the WMMP (section 5.2.5) suggested that other ongoing programs such as regular road surveys and wildlife sightings recorded by NSI project staff, as well as annual boreal caribou spring composition surveys, will continue to provide sufficient bison sighting data to detect northward expansion of bison along the Tłı̨chǫ ASR RoW if it occurs.

Methods and Results

During GNWT-ECC aerial wildlife surveys, bison observations are recorded as an incidental wildlife sighting. Observations of bison during aerial wildlife surveys by GNWT-ECC from 2017 to 2021 were mapped to provide baseline data and to evaluate whether bison expanded their range northward along the Tłı̨chǫ ASR road corridor during the construction phase (Figure 5-23). Bison observations were included from the following boreal caribou surveys: the 2017 boreal caribou reconnaissance survey (Figure 5-1), the 2020 boreal caribou abundance and classification survey (Figure 5-7), and the 2018, 2019, and 2021 boreal caribou classification surveys (see section 5.3.2). The 2017 and 2020 surveys provided systematic coverage over a large study area, whereas the boreal caribou classification surveys only provided incidental observations on flight paths that focused on locating the collared boreal caribou in the study area. Bison observations from the 2019 Tłı̨chǫ ASR alignment bear den survey are included (see section 4.2.3, and WMMP section 5.2 Appendix H for that survey extent). Bison data from the 2018 Tłı̨chǫ ASR bison and moose abundance survey and the 2019 ECC Mackenzie bison survey (see section 5.5.2) are also included in Figure 5-14. Both surveys used distance sampling methods and flew systematic transects across their survey extents.

The most northerly bison observation from these surveys occurred in 2018 between KM 46 and 48 along the Tłı̨chǫ ASR alignment. Given that bison observations near the northern edge of the Mackenzie bison range along the Tłı̨chǫ ASR alignment were made in all survey years (2017-2021; both before and during construction) it does not appear as though construction of the Tłı̨chǫ ASR resulted in a northern expansion of their range. This finding will be assessed again after the first five years of operation of the road, considering bison observations from surveys occurring between 2022-2026.

NSI construction staff observations of bison during the construction phase also occurred south of KM 48, except for two bison observed at KM 76 on September 21, 2021 (see Figure 4-3). Observations of bison by NSI staff (section 4.1.4) were biased by where NSI staff travelled and where crews were working on the road during the construction phase; for example, southern sections of the road were accessible longer than northern sections due to the progression of construction.

Since the Tłı̨chǫ ASR opened to the public, Highway Monitors have systematically recorded wildlife observations along the entire Tłı̨chǫ ASR as part of the Tłı̨chǫ Highway Monitoring Program (see section 5.2.4.1). For the operations phase comprehensive report, there will likely be a more systematic record of bison observations along the road corridor. Additionally, at the end of the construction phase, the sides of the Tłı̨chǫ ASR RoW were not yet revegetated or only beginning to revegetate. The Tłı̨chǫ ASR alignment may become more attractive to bison if vegetation that bison like to eat establishes along the road corridor.

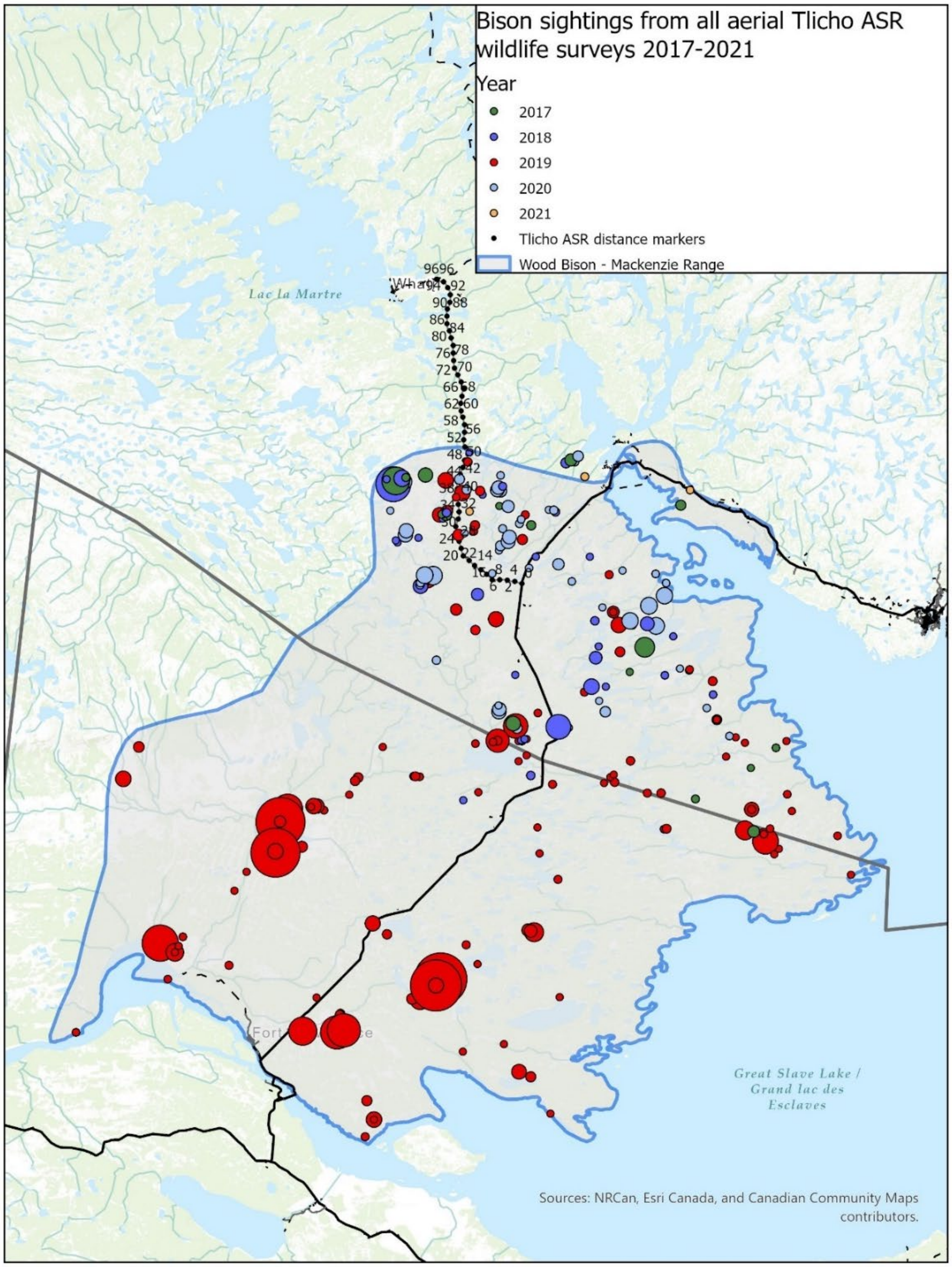

Figure 5-23. Observations of bison during aerial wildlife surveys by GNWT-ECC from 2017 to 2021**.**

5.5.2 Wood Bison Abundance Surveys in the Tłı̨chǫ ASR Area

To address changes in the relative abundance of bison, the WMMP originally proposed late winter aerial surveys every three years to generate density estimates in the Tłı̨chǫ ASR: once before construction, once during construction, and every 3-5 years after the road opens. A combined bison and moose survey specific to the Tłı̨chǫ ASR was conducted in 2018 (see section 5.5.2.1).

5.5.2.1 2018 Tłı̨chǫ ASR Bison Abundance Survey (Pre-construction Phase)

The first aerial bison abundance survey occurred in February 2018, before road construction, to obtain a baseline estimate of bison density (see APPENDIX D for a detailed report of this survey). The 11,005 km^2 study area was centered on the proposed Tłı̨chǫ ASR alignment and surveyed between February 23 and March 2, 2018 (Figure 5-24). The survey used distance sampling methods to estimate the abundance of bison and moose in the study area. When animals were spotted, the aircraft left the survey line to take a GPS location directly overhead of the animal or where it was first spotted if it moved before the aircraft arrived, and to make an accurate count. The crew also recorded information about group size (number of animals), canopy cover, and vegetation type at the GPS location.

The survey was flown in a DHC-2 Beaver aircraft at a planned altitude of 150 m above ground level (AGL) and a planned speed of 90 knots (167 km/hr). The survey crew consisted of two observers, a navigator and the pilot. The survey took 47 hours and was flown over seven days with a total of 82 transects flown. The survey recorded 174 bison in 27 groups (group sizes 1-54 bison) (Figure 5-24).

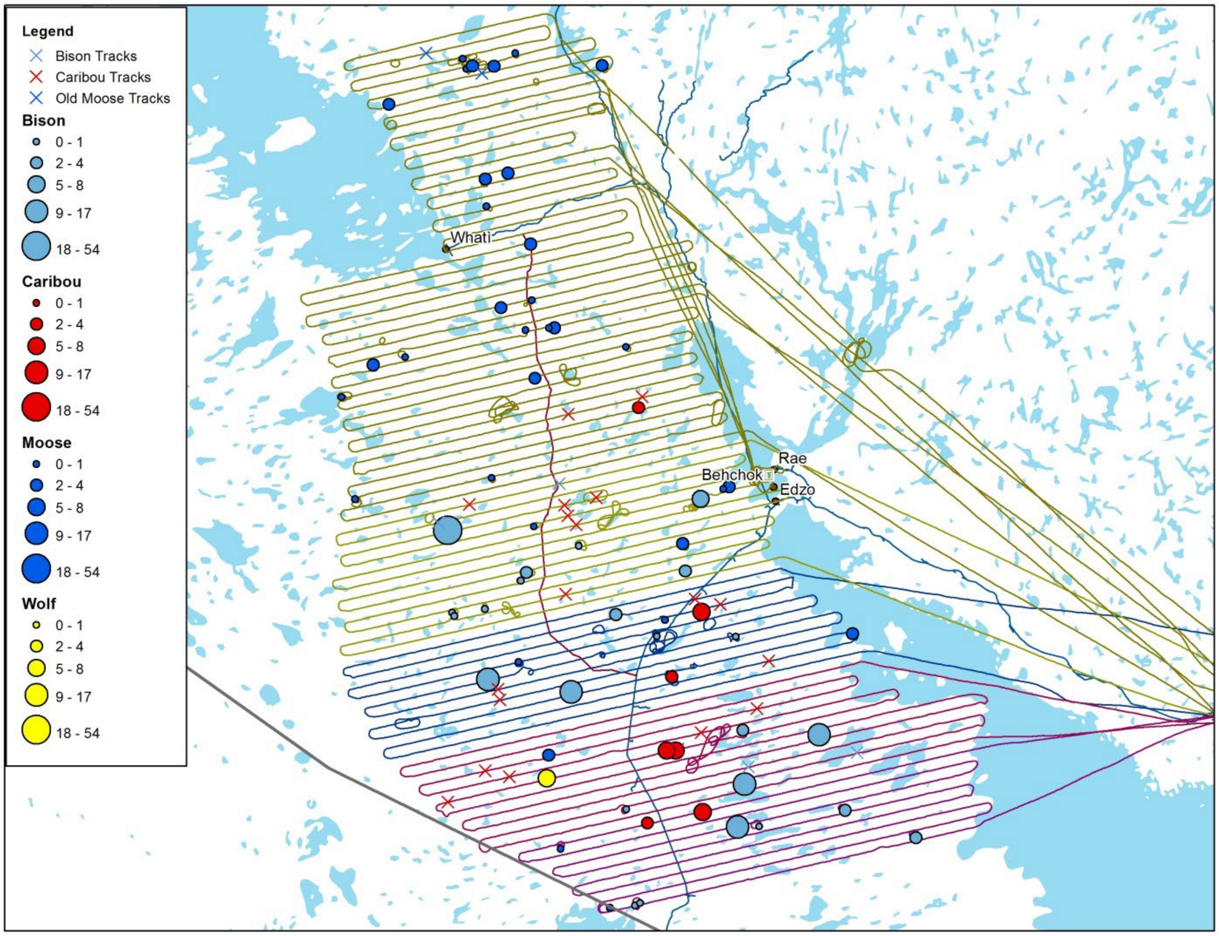

Figure 5-24. Wildlife observations recorded during an aerial survey conducted within a ~10,000 km^2 study area centered on the proposed Tłįchǫ ASR alignment between February 23 and March 2, 2018.

In the distance sampling method, the distribution of the number of observations made at different distances to survey transects is used to estimate a detection function to model how the probability of recording observations decreases as a function of distance from the line. The detection function is then used to estimate the density of bison in the study area while accounting for decreasing likelihood of recording animals that are farther from the transect. The bison observations from this survey alone (27 groups) were insufficient to estimate a detection function, as Buckland et al. (2001: 240) recommend at least 60 to 80 independent observations of a species to estimate a reliable detection function. To obtain a sufficient sample size to estimate a detection function for bison, the 2018 Tłįchǫ ASR survey data was combined with data from the same area collected during a 2019 abundance survey of the entire Mackenzie bison population that also used distance sampling (Figure 5-25).

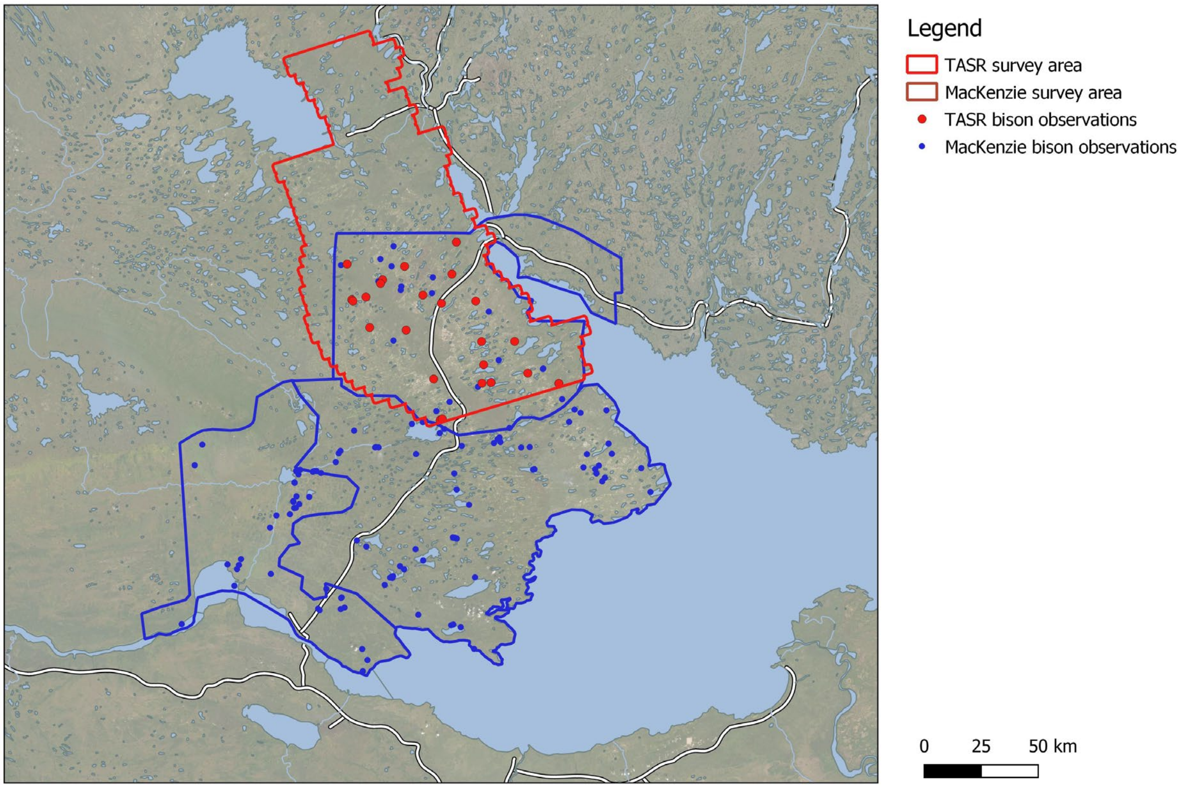

Figure 5-25. Bison observations from the 2018 Tłı̨chǫ ASR moose/bison survey (red) and 2019 Mackenzie bison survey (blue) used for the distance sampling analysis.

Different factors can affect sightability and these were accounted for by including them as covariates in models, and testing which covariates contributed to the best performing model(s). These covariates were aircraft type, canopy class, zone, project, and group size. Aircraft type was included because it can affect the probability of observers detecting animals close to the aircraft due to window placement, seat height, and other factors. A DHC-2 Beaver aircraft was used for the Tłı̨chǫ ASR survey whereas a Cessna 185 and Beaver aircraft were used for the 2019 Mackenzie bison survey. Canopy class referred to observations in the none (0% canopy cover) or closed-open (10% - >50% canopy cover) canopy cover class. Zone pertained to observations in the Tłı̨chǫ ASR or Mackenzie (not overlapping with Tłı̨chǫ ASR) area, regardless of what year they were surveyed. Project (Tłı̨chǫ ASR or Mackenzie) was used to define the group (crew, aircraft, etc.) that did the actual survey. Group size was the number of individual animals recorded in a group.

The survey data from both surveys were screened and left- and right-truncated as appropriate to meet assumptions of sightability (refer to APPENDIX D for an explanation of left- and right-truncation of the data). Detection function models were then fit to the data, and covariates that could affect sightability (aircraft type, canopy class, zone, project, and group size) were included in models. We ranked models based on Akaike's Information Criterion adjusted for small sample sizes [AIC_c]) and used information theoretic methods to select the best candidate models (Burnham and Anderson 2002).

Of the detection functions and covariates considered, canopy class was most supported with a half-normal detection function. No other covariates were more supported than the hazard rate model with a constant detection function. Estimates of abundance increased when project was added as a covariate.

Many models were supported by the data as indicated by delta AICc values of less than two, so a model averaged approach was used to estimate bison abundance. A model-averaged abundance estimate for the Tłįchǫ ASR survey based on all the models (APPENDIX D, Table 3) was 197 bison (SE = 79.2, CI = 91-423, CV = 40%).

There were no bison observed in the northern portion of the Tłįchǫ ASR survey area during the 2018 survey (Figure 5-16). Thus, the survey extent over which bison abundance was estimated was truncated by the northwest boundary of the Mackenzie survey. Density of bison was estimated across this smaller area (5,998 km^2), which is a more accurate delineation of the northern extent of the Mackenzie bison range as of 2018 (Figure 5-17). The estimated density of bison in 2018 in the southern portion of the Tłįchǫ ASR area, using the model-averaged estimate of 197 bison (SE = 79.2, CI = 91-423, CV = 40%), is 3.28 bison per 100 km^2 (SE = 1.32, CI = 1.52-7.05) (APPENDIX D).

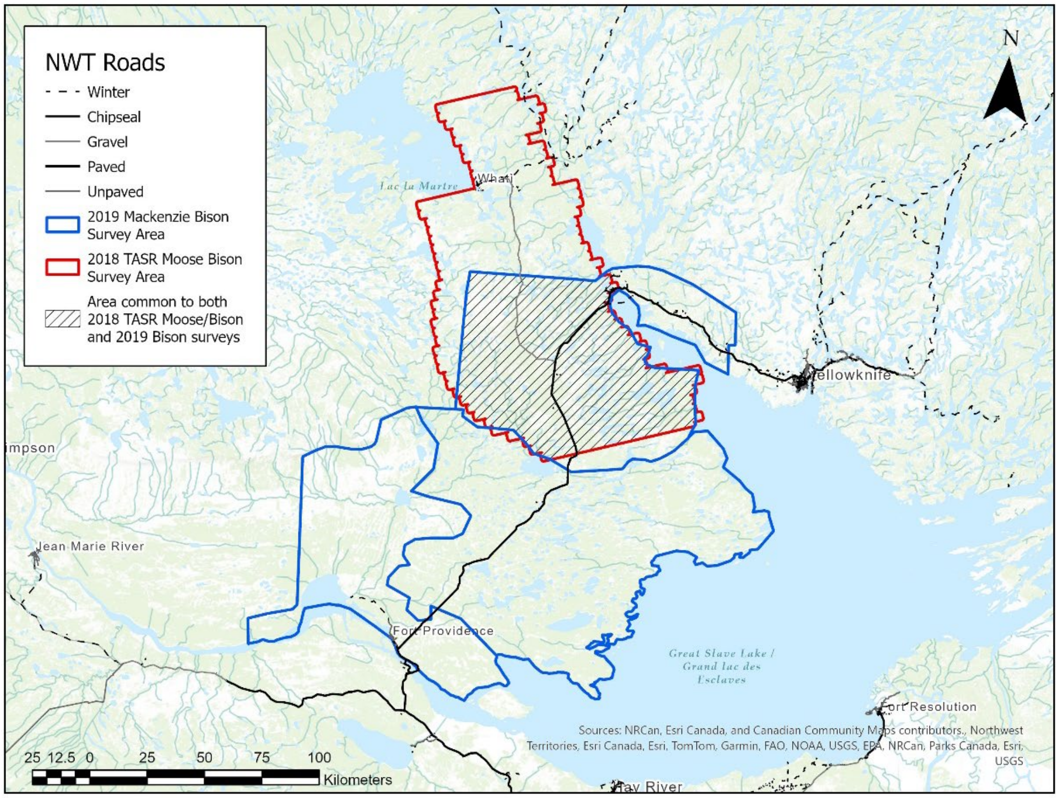

Figure 5-26. Area for which bison density in the Tłı̨chǫ ASR survey area was estimated using bison abundance surveys.

5.5.2.2 <u>Revision of Bison Abundance Survey Methods and Methods to Assess Changes in Range Use</u>

In a review of the wildlife effects monitoring programs (Rettie 2019), it was recommended that surveys of bison abundance be combined with the larger Mackenze bison population surveys, which would produce more bison observations and thus be more likely to provide population estimates with an acceptable level of precision to detect changes in population size. Boulanger et al. (2015) recommended a target coefficient of variation (CV) of 15% for monitoring bison populations, which would provide 80% power to detect a decline of a population to ~54% of its initial value (*in* Rettie 2019). The clumped distribution of bison across small groups and large herds creates challenges for abundance surveys to provide results with enough precision to detect changes in population over short periods of time.

Bison in the southern portion of the Tłı̨chǫ ASR area were surveyed again in 2019 and 2023 as part of the larger Mackenzie bison population abundance surveys. The next survey is expected to occur in 2027. The Tłı̨chǫ ASR study area will continue to be treated as a sub-area within the broader Mackenize population survey areas to estimate bison densities specific to the Tłı̨chǫ ASR area.

The main factor limiting precision of bison surveys is the aggregated distribution of groups, which leads to a large degree of variation in encounter rate. Density surface modelling (Miller et al. 2013) is an approach to address aggregation as well as learn more about factors influencing density of bison. This approach could be used to assess if density changes as a function of distance from the road in successive surveys.

In addition to bison abundance surveys and mapping bison incidental observations during other aerial ECC surveys, bison observations made along the Tłįchǫ ASR corridor will be important to understanding the role of the Tłįchǫ ASR in facilitating bison use of the highway corridor. Under the Tłįchǫ Highway Wildlife Monitoring Program (see section 5.2.4.1), Tłįchǫ Highway Monitors regularly drive the road and record wildlife observations. This consistent data collection will be important in understanding whether and how bison use the Tłįchǫ road corridor and if that use facilitates range expansion in the future.

5.6 Moose

Moose are an important big game species in the North Slave Region, comprising a substantial portion of the Tłįchǫ subsistence harvest and supporting a resident fall harvest. While GNWT-ECC conducts moose population surveys approximately every five years throughout the North Slave Region, these studies have not historically focused on the Tłįchǫ ASR regional study area and are not designed to detect changes in a small-targeted area. Moose occur in low densities throughout the NWT, and a population survey in the North Slave Region conducted in 2012 identified densities of roughly 2.9 moose/100 km^2 in the Taiga Plains (Cluff 2013). A North Slave Region moose survey took place in 2016, but the area of the Tłįchǫ ASR could not be surveyed due to poor weather (Cluff 2016).

There are several factors affecting moose in the Tłįchǫ ASR study region that, in addition to the road itself, warrant tracking moose populations. Given harvest restrictions on barren-ground caribou, moose may be targeted more frequently by hunters, which will be further facilitated by the road. This could lead to the potential for localized over-hunting. In addition, community members have expressed concerns that the potential expansion of Mackenzie bison northward towards Whatì will negatively impact moose and caribou in areas where they overlap. While the extensive recent burns in the vicinity of the Tłįchǫ ASR might be expected to increase moose habitat over time, the interaction of these factors introduces sufficient uncertainty to warrant more targeted regional monitoring. Understanding how the population is changing in the regional study area is essential to placing the information generated by harvest and collision monitoring into context for making decisions about the need for management actions.

Table 5-18. Monitoring questions for moose as outlined in the Tłįchǫ ASR WMMP, their relevance to the construction and/or operations phase of the Tłįchǫ ASR, and documentation in this report.

Monitoring questions for moose to address using population monitoring conducted in the regional Tłįchǫ study area	Construction phase	Operations phase	Documented in this report
If the relative abundance of moose in the Tłįchǫ ASR regional study area changes over time. This	√	√	Yes, section 5.6.1.

will help to identify potential conservation concerns related to the road and hunter access.			
Whether changes in the abundance of moose in the Tłı̨chǫ ASR regional study area are qualitatively similar to what is observed in North Slave regional surveys.	√	√	Yes, section 5.6.2.

5.6.1 Moose Abundance Surveys in the Tłı̨chǫ ASR Area

To address changes in the relative abundance of moose, the WMMP originally proposed late winter aerial surveys every three years to generate density estimates in the Tłı̨chǫ ASR: once before construction, once during construction, and every 3-5 years after the road opens. A combined bison and moose survey specific to the Tłı̨chǫ ASR was conducted in 2018 (see sections 5.5.2.1 and 5.6.1.1).

Following a review of the wildlife effects monitoring programs (Rettie 2019), it was recommended that surveys of moose abundance be combined with North Slave Region moose population surveys, which would produce more moose observations and thus be more likely to provide population estimates with an acceptable level of precision to detect changes in population size. Moose abundance in the Tłı̨chǫ ASR area was surveyed again in 2021 as part of a larger North Slave Region moose survey (section 5.6.1.2).

5.6.1.1 2018 Tłı̨chǫ ASR Moose Abundance Survey (Pre-construction Phase)

The first aerial moose abundance survey occurred in February 2018, before construction of the Tłı̨chǫ ASR, to obtain a baseline estimate of moose density. The combined moose and bison survey is described in section 5.5.2.1 above with a full report of the survey results in APPENDIX D.

The survey recorded 53 moose in 34 groups (group sizes 1-3 moose) (Figure 5-15)). As with bison, the number of moose observations from this survey alone were insufficient to estimate a detection function, as Buckland et al. (2001: 240) recommend at least 60 to 80 independent observations of a species to estimate a reliable detection function. To obtain a sufficient sample size to estimate a detection function for moose, the 2018 Tłı̨chǫ ASR survey data was combined with data from the 2019 Mackenzie bison (and moose) survey, which also surveyed moose using distance sampling methods, and from the Tłı̨chǫ ASR sub-area of the 2021 North Slave moose survey that also used distance sampling methods. Figure 5-18 shows the overlap of these survey extents with the 2018 survey, and the moose observations used in the analysis.

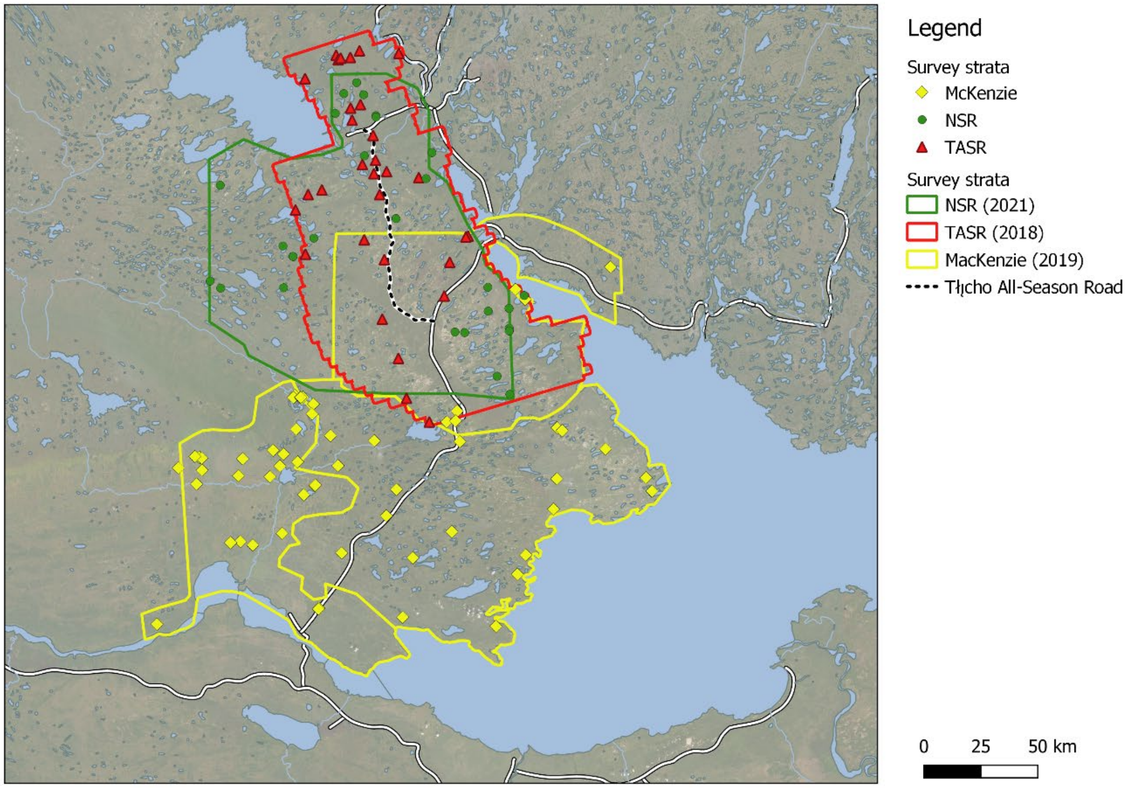

Figure 5-27. Survey areas and moose observations from the 2018 Tłı̨chǫ ASR bison and moose survey (red), the 2021 Tłı̨chǫ ASR sub-area of the North Slave Region moose survey (green), and the 2019 Mackenzie bison and moose survey (yellow) used in estimating moose abundance for the 2018 Tłı̨chǫ ASR area and the 2021 Tłı̨chǫ ASR sub-area of the larger North Slave moose survey.

We used distance sampling methods to estimate the density and abundance of moose (APPENDIX D). This method first involved screening the data to determine proper right and left truncation distances for the distance sampling data. Once data screening was completed, detection function models were fit to the data. Distance sampling models were considered with a base half-normal and a hazard rate detection function first applied to the dataset with the hazard rate detection function being most supported.

Different factors can affect sightability and these were accounted for by including them as covariates in models, and testing which covariates contributed to the best performing model(s). Covariates considered in moose models included canopy cover class (0%, 10-50%, or >50% cover), group size, survey area, and an NSR covariate that accounted for the different detection function shape of the NSR survey (no left-truncation, due to a different aircraft without a 'blind spot' near the transect line). Of the covariates considered, canopy class was most supported with a half-normal detection function, however, no other covariates were more supported than the hazard rate model with a constant detection function. Therefore, the constant hazard rate model was used to provide estimates of moose abundance and density for the 2018 Tłı̨chǫ ASR survey and the 2021 Tłı̨chǫ ASR-NSR sub-area (section 5.6.1.2).

The 2018 moose abundance estimate for the Tłı̨chǫ ASR area was 113 moose (SE = 28.7, CI = 69-185, CV = 0.25). The estimated density of moose across the 11,005 km^2 survey area was 1.03 moose / 100 km^2 (SE = 0.26, CI= 0.63-1.70) (APPENDIX D).

5.6.1.2 2021 Tłı̨chǫ ASR Moose Abundance from the North Slave Region Moose Survey (Construction Phase)

In 2020-2021, during the construction phase, a North Slave Region regional moose survey was completed in fall 2020 and spring 2021 (Figure 5-28), that overlapped with the 2018 Tłı̨chǫ ASR survey area (Figure 5-27). A moose composition survey was conducted in November 2020 to estimate sex ratios prior to bull moose shedding their antlers, followed by the moose abundance survey in March 2021. The survey used a distance-based sampling approach, with survey transects spaced 8 km apart, and covered a much larger area (~44,000 km^2), which mostly encompassed the Tłı̨chǫ ASR area surveyed in 2018 (Figure 5-27). Transect spacing was decreased to 4 km within the Tłı̨chǫ ASR area to obtain a more precise density estimate.

The 2021 moose abundance estimate for the Tłı̨chǫ ASR sub-area was obtained using the same methods and analysis as for the 2018 Tłı̨chǫ ASR moose survey. As noted, the data was analyzed together to increase the sample size to estimate a detection function for moose (APPENDIX D).

The 2021 moose abundance estimate for the Tłı̨chǫ ASR sub-area was 183 moose (SE = 50.6, CI = 106-316, CV = 0.28). The estimated density of moose across the 11,830 km^2 survey area was 1.55 moose / 100 km^2 (SE = 0.43, CI= 0.89-2.67). Although the 2021 moose estimate is higher than the 2018 estimate, there was no significant difference in the two estimates, given the moderate precision of the surveys (i.e., overlapping confidence intervals).

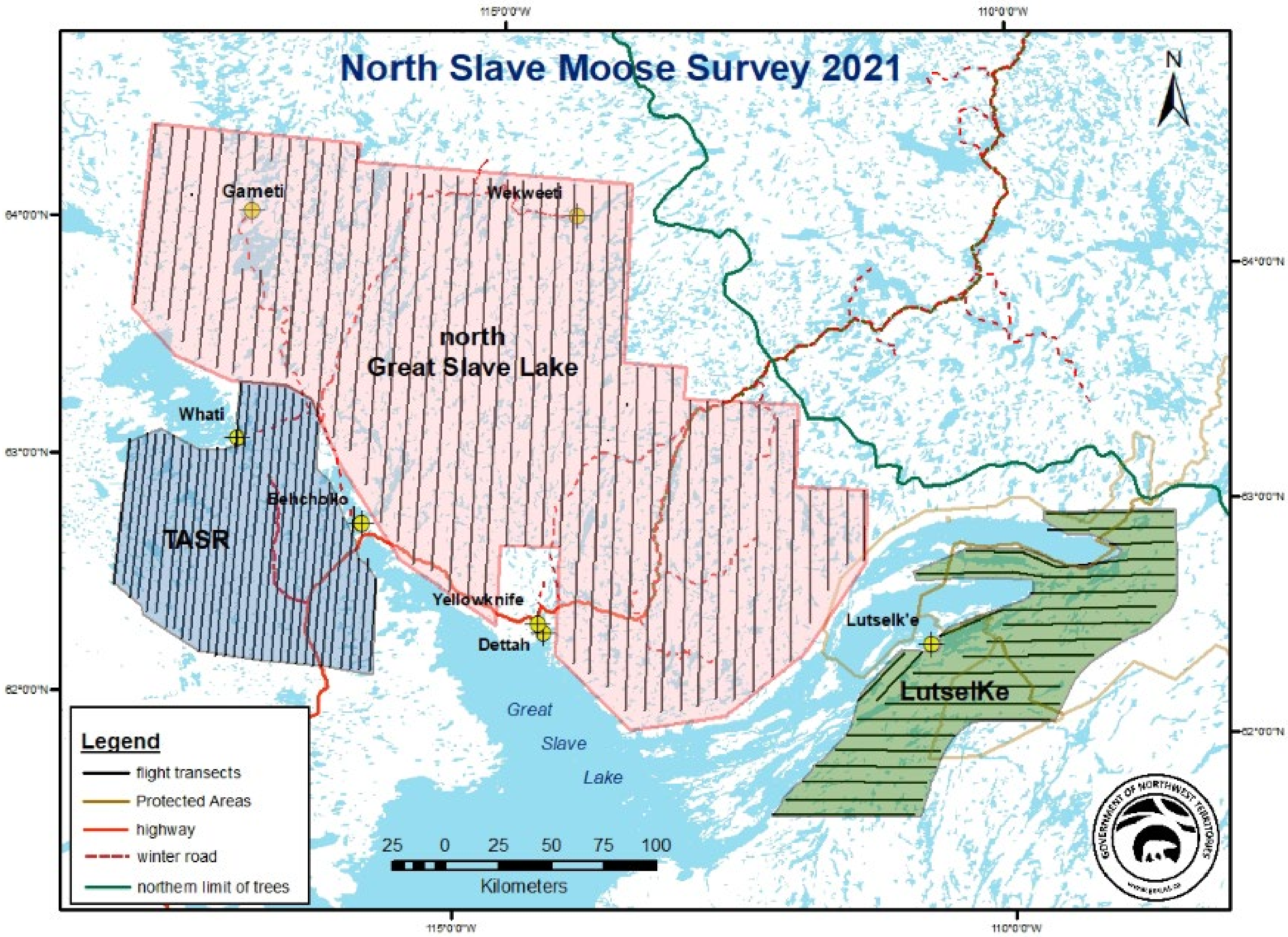

Figure 5-28. Moose abundance survey areas surveyed in March 2021. Results are reported for the area encompassing the Tłı̨chǫ ASR alignment, shown in blue.

In a 2019 review of the wildlife effects monitoring programs in the Tłı̨chǫ ASR WMMP, it was recommended that future aerial surveys for moose for the Tłı̨chǫ ASR be combined with the larger regional North Slave moose aerial survey, which also uses a distance-based sampling approach (Rettie 2019). The Tłı̨chǫ ASR area will continue to be treated as a strata within the broader North Slave regional moose surveys in order to estimate moose densities specific to this area. The next North Slave moose survey is anticipated in 2026.

5.6.2 Moose Abundance Surveys in the North Slave Region

The WMMP (section 5.2.5) noted that changes in the abundance of moose in the Tłı̨chǫ ASR regional study area should be compared to changes in moose abundance observed in larger North Slave regional surveys. Moose in the North Slave Region have been surveyed in both the Taiga Plains and Taiga Shield ecological regions.

The Taiga Plains is the ecological region that encompasses the Tłı̨chǫ ASR area (Ecosystem Classification Group 2007 (rev. 2009)). In 2004, 2007, and 2012, a North Slave Region Taiga Plains moose survey was conducted across an area that included most of the Tłįchǫ ASR alignment (Figure 5-29). These surveys used a geospatial survey method (ver Hoef 2001, 2008). Based on these survey estimates (Table 5-19), moose abundance in the North Slave Taiga Plains survey area decreased slightly between the 2004 and 2012 surveys (ECC 2023).

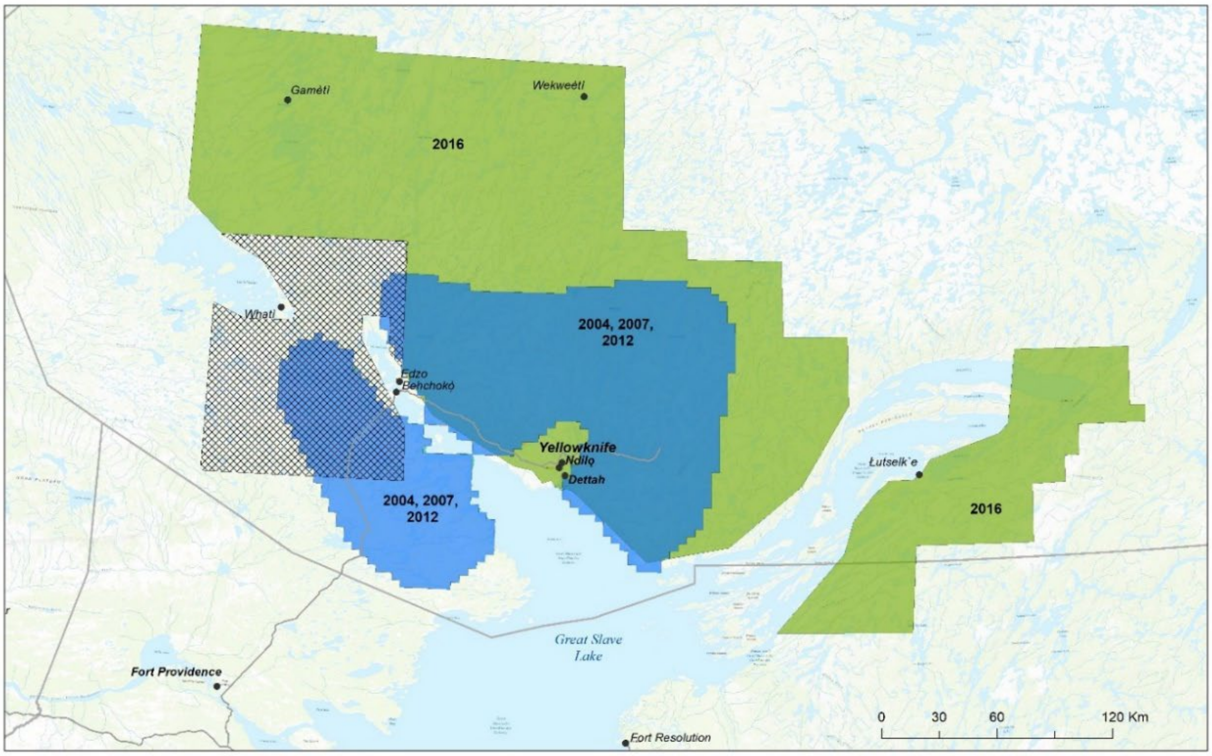

Figure 5-29. Locations of moose surveys in the North Slave Region, 2004-2019. Blue blocks were surveyed in 2004, 2007, and 2012; the Taiga Plains study area is the block to the west of Great Slave Lake and the Taiga Shield is north and east of the lake. The 2016 survey area is shown in green except the hatched area was not surveyed due to inclement weather (Cluff 2016, ECC 2023).

Since 2016, moose surveys in the North Slave Region have used distance sampling methods. A 2016 moose survey was completed on the Taiga Shield east of Great Slave Lake, but poor weather prevented the Taiga Plains portion of the survey from being flown as planned. The 2018 and 2021 moose surveys in the Taiga Plains ecological region were designed to survey the Tłįchǫ ASR area and are reported in section 5.6.1 above.

Comparing moose surveys of the Taiga Plains and Taiga Shield in 2004, 2007, and 2012 shows that moose densities and population trends were different in the two ecological regions during this period (stable or decreasing trend in the Taiga Plains and increasing trend in the Taiga Shield) (ECC 2023). A better comparison of moose abundance across a broader geographic area will be from surveys within the same ecological region.

Based on the moose surveys completed in the North Slave Region within the Taiga Plains ecological region, moose densities were higher in 2004-2012 compared to 2018-2021 (Table 5-19), although differences in survey methods and the area surveyed could affect these results.

Table 5-19. Moose densities recorded from aerial moose surveys conducted in the Taiga Plains ecoregion within the North Slave Region of the NWT between 2004 and 2021.

Year	Density Estimate (moose / 100 km^2)	Survey Method
2004	3.6	Geospatial
2007	3.2	Geospatial
2012	2.9	Geospatial
2018	1.03	Distance sampling
2021	1.55	Distance sampling

5.6.3 Moose Abundance Surveys in the Larger Taiga Plains Ecological Region

Changes in the abundance of moose in the Tłı̨chǫ ASR regional study area should also be compared to changes of moose abundance observed across the broader ecological region instead of focusing on the North Slave administrative area.

Moose abundance has also been estimated using distance sampling methods during Mackenzie bison population surveys. These moose abundance estimates include the entire Mackenzie population range (see Figure 5-18), which spans the GNWT-ECC North Slave and South Slave administrative regions.

Across the entire Mackenzie bison range area, moose abundance declined from a density of 5.2 moose per 100 km^2 in 2012 to 0.7 moose per 100 km^2 in 2013. This has remained lower in 2016 and 2019 (1.5 and 1.7 moose per 100 km^2 in 2016 and 2019, respectively) (Table 5-20). Bison also declined between 2012 and 2013 due to a large anthrax outbreak that occurred during the summer of 2012.

Table 5-20. Density of moose in the Mackenzie bison range. Densities were estimated during bison surveys using distance sampling (ECC 2023).

Year	Density Estimate (moose/100 km^2)	95% confidence interval	Source
2012	5.2	3.6-7.3	Armstrong and Boulanger 2016
2013	0.7	0.4-1.2	Armstrong and Boulanger 2016
2016	1.5	0.8-2.7	Armstrong and Boulanger 2016
2019	1.7	1.1-2.7	Armstrong and Schwarz 2019

Moose abundance has been higher in the southern portion of this larger Mackenzie bison range survey area compared to the northern area, based on geospatial surveys of the southern extent only (Figure 5-30). Moose density in the southern Fort Providence survey area was estimated to be 4.8 moose / 100 km^2 in 2016 and 6.3 moose / 100 km^2 in 2019 (geospatial method; Kelly and Cox 2017).

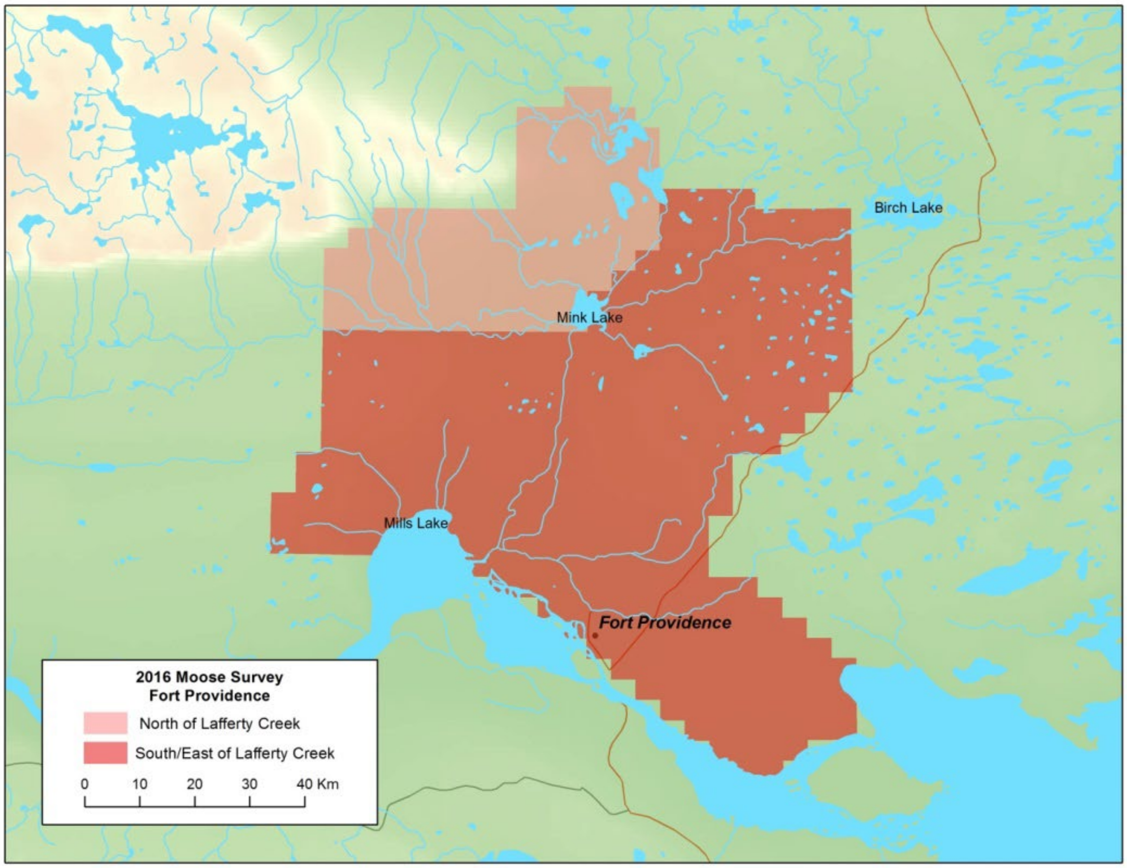

Figure 5-30. Location of moose geospatial surveys in the Fort Providence area in 2016 and 2019.

Recent moose density estimates in the Tłı̨chǫ ASR area of 1.03 moose per 100 km^2 in 2018, and 1.55 moose per 100 km^2 in 2021, are similar to moose density estimates averaged across the entire Mackenize bison range area surveyed in 2013, 2016, and 2019 (Table 5-20). Changes in moose abundance in the Tłı̨chǫ ASR should be interpreted in the context of moose abundance across the broader ecological region.

5.7 Wildlife Sightings and Collisions

As documented in the WMMP, increased risk of wildlife injury and mortality due to vehicle collisions is one of the main concerns with the Tłı̨chǫ ASR. Currently, there is no consistent, accurate, geo-referenced system in place for tracking wildlife-vehicle collisions or wildlife observations along the road to determine where potential hotspots may be that warrant dedicated mitigation efforts, such as increased signage or heightened speed limit enforcement.

Under the WMMP, ECC and INF committed to work together to pursue the development of a wildlife collisions and reporting system similar to the Alberta Wildlife Watch System. During the construction phase of the Tłı̨chǫ ASR, ECC and INF undertook preliminary work to scope out the requirements for this system and to enter into an agreement with the Government of Alberta to obtain access to the Alberta Wildlife Watch software to adapt it to the NWT. Work towards the development of an NWT Wildlife Watch system was ongoing when construction of the Tłı̨chǫ ASR was completed. Further information on the status of this component of the WMMP will be provide in the comprehensive report for the operations phase of the Tłı̨chǫ ASR.

Table 5-21. Monitoring questions related to wildlife sightings and collisions, as outlined in the Tłı̨chǫ ASR WMMP, their relevance to the construction and/or operations phases of the Tłı̨chǫ ASR, and documentation in this report.

Monitoring questions related to wildlife sighting and collisions	Construction phase	Operations phase	Documented in this report
How many wildlife-vehicle collisions are occurring along NWT highways, and how will the Tłı̨chǫ ASR contribute to that?		√	No.
Where are wildlife-vehicle collisions occurring most frequently along the Tłı̨chǫ ASR, if they occur, and other NWT highways?		√	No.
Where are wildlife being observed most frequently along the Tłı̨chǫ ASR?	(√)	√	See section 4.1.4 for observations during construction phase.
Are Mackenzie bison expanding their range further north along the road?	(√)	√	See section 5.5.1 for construction phase.
Is snow cleared from the Tłı̨chǫ ASR making it difficult for wildlife to cross the right of way?		√	No.

5.8 Predator Monitoring

Measure 6-1, Part 2 required the GNWT to undertake monitoring to assess predator population densities, movements, and predation rates. Predation rates on boreal caribou will be assessed by investigating mortalities of collared boreal caribou to determine cause of death. Although the sample size of annual mortalities and known cause of death of collared boreal caribou from the Tłı̨chǫ ASR study area is likely to be too low to analyze statistically on its own (Rettie 2019), mortality data from this program will be pooled with data from other NWT boreal caribou study areas in order to contribute to a broadscale long-term dataset that can be used to assess mortality patterns (e.g., Kelly 2020).

To assess predator population densities, wolf abundance surveys were completed in 2020 to provide baseline information from the construction phase (section 5.8.1). The WMMP recommended that wolf abundance surveys be repeated once more towards the end of the first five years of road operations.

5.8.1 Wolf Abundance Surveys

To assess the abundance of wolves in the Tłįchǫ ASR study area, aerial wolf population surveys were conducted in two 5,000 km^2 blocks in February and March 2020. One survey block was centered along the Tłįchǫ ASR alignment, and a second reference block was placed within the Mackenzie boreal caribou monitoring study area southeast of Highway 3 (Figure 5-31). Survey methods followed those used in previous wolf surveys conducted in the South Slave and Dehcho regions (Serrouya et. al. 2016). The survey was flown using a fixed-wing aircraft (Scout), and a crew consisting of the pilot and professional tracker. Flight paths were flown to ensure coverage in each 3 km^2 grid cell within the survey extent, and when wolf tracks were encountered, they were followed to locate the wolf pack and determine pack size. Where packs could not be located, numbers were estimated based on track characteristics (e.g., amount of activity, track splitting, individual tracks). Observations of other large ungulates and carnivores were also recorded by GPS.

The Mackenzie block was surveyed from February 7-12, 2020, with no flights on February 10-11 due to poor weather conditions. One pack estimated at 3-4 wolves based on tracks was recorded on February 7, and a second pack estimated at 5-6 wolves based on tracks was recorded on February 8 (Figure 5-31). Wolf density was estimated to be 1.6-2.0 wolves / 1,000 km^2.

The Tłįchǫ ASR survey block was flown on March 9-10, 2020. One pack of five wolves was observed on March 9, 2020, as well as two wolves on a bison kill (Figure 5-31). Wolf density was estimated to be 1.4 wolves / 1,000 km^2.

A second set of wolf abundance surveys was in 2022, post-highway opening, and will be included in Operations phase comprehensive WMMP report. Wolf collaring to assess wolf movement rates was begun in 2022 after the road opened, and will be summarized in the next comprehensive report.

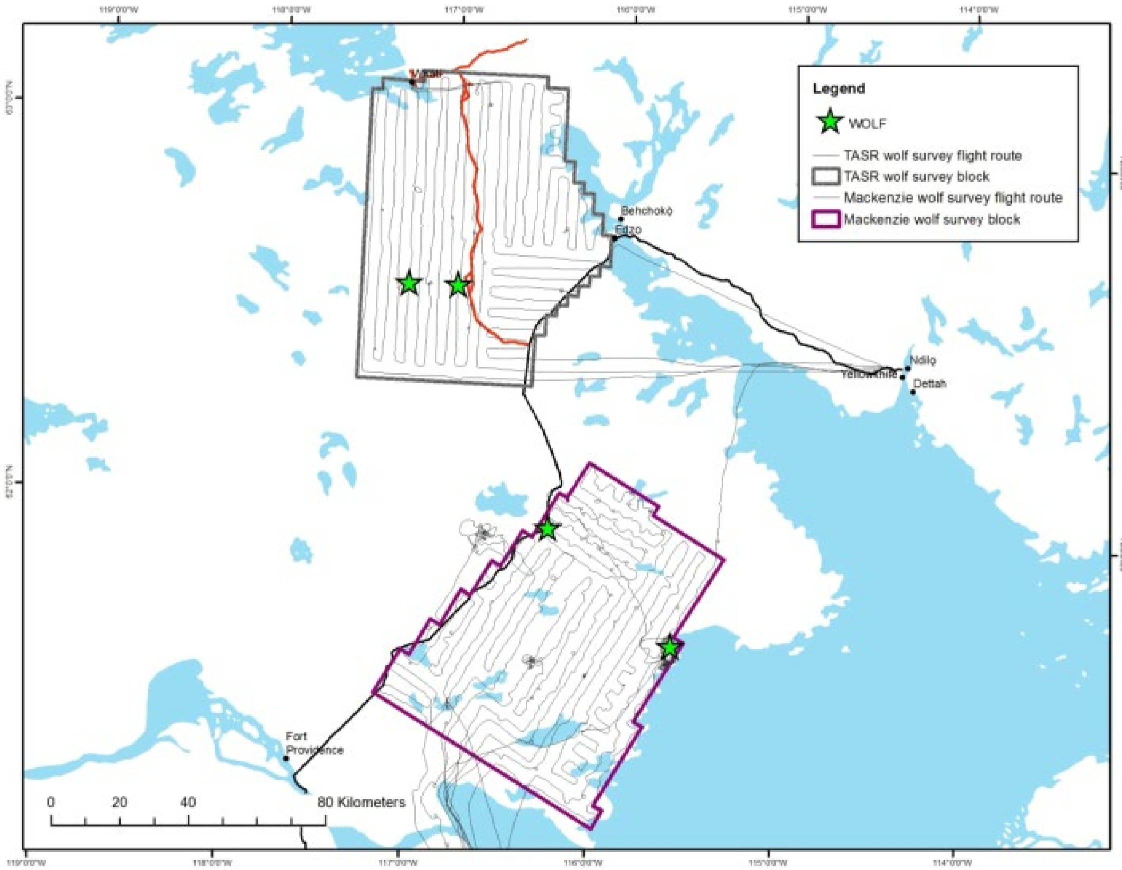

Figure 5-31. Observations of wolves or wolf track networks recorded during aerial wolf abundance surveys conducted within two ~5,000 km² blocks in February/March 2020.

6.0 REPORTING AND ADAPTIVE MANAGEMENT

6.0 Reporting and Adaptive Management

There were three levels of reporting required under the WMMP: (1) During road construction, weekly reports were required from NSI. These reports are available at https://wlwb.ca/registry/w2016e0004?page=1). (2) Annual reporting on the WMMP was required as part of water license reports. Water license annual reports for the Tłı̨chǫ ASR are available on GNWT-ECC's website at https://www.gov.nt.ca/ecc/en/services/wildlife-management-and-monitoring-plans/wmmp-resources. (3) Finally, the WMMP required comprehensive reports for the construction phase of the Tlicho ASR (this report) and the operations phase of the Tłı̨chǫ ASR (to be completed after the road has been open for five years).

Further to the requirement for a comprehensive report of the construction phase (as noted above, this report), compilation of scientific and traditional knowledge references relevant to this phase are presented in section 6.1, below, in compliance with the WMMP. An evaluation of the effectiveness of mitigation measures are presented in section 6.2 (Table 6-1 and Table 6-2) as well, and notes on adaptive management are presented in section 6.3.

6.1 Reports Relevant to the Tłı̨chǫ ASR Construction Phase

The WMMP required that this report provide a list of scientific or traditional knowledge reports from the Tłı̨chǫ ASR area relevant to the construction phase (see Table 1-1). Reports are listed below.

In addition to the written reports below, GNWT-ECC staff regularly presented updates on scientific monitoring work to the Tłı̨chǫ ASR Corridor Working Group (CWG) and, after its formation, the Tłı̨chǫ Tı̨lıı` Deè Monitoring Committee. CWG meetings were held on June 24, 2019, December 12, 2019, July 7, 2020, December 1, 2020, June 16, 2021, and December 15, 2021.

Scientific Knowledge Reports

Boulanger, J.B., Armstrong, T., Hodson, J., Cluff, D., and Kelly, A.P. 2024. Results of the 2018 bison and moose abundance survey for the proposed Tłı̨chǫ all-season road. Department of Environment and Climate Change, Government of the Northwest Territories, Yellowknife, NT. [See APPENDIX D of this report.]

Boulanger, J.B., Hodson, J., Kelly, A.P., Greenblat, A., and Nietfeld, M. 2025. Results of the 2020 boreal caribou abundance survey in the North Slave Region – Tłı̨chǫ all-season road study area. Department of Environment and Climate Change, Government of the Northwest Territories, Yellowknife, NT. [See APPENDIX B of this report.]

Environment and Natural Resources. 2020. Northwest Territories boreal caribou population and harvest models. Available online: https://www.enr.gov.nt.ca/sites/enr/files/resources/gnwt_boreal_caribou_population_model_report_final_bil_1.pdf.

Golder Associates Ltd. 2019. Tłı̨chǫ all-season road remote camera analysis – 2019. Submitted to Department of Infrastructure, Government of the Northwest Territories, Yellowknife, NT.

Golder Associates Ltd. 2019. Exotic and rare plant field survey, Tłı̨chǫ all-season road. Prepared for Department of Infrastructure. Government of the Northwest Territories, Yellowknife, NT.

Hodson, J. 2019. Summary of winter 2019 field work carried out under Wildlife Research Permit WL500580 – Wildlife effects monitoring for the proposed Tłı̨chǫ all-season road. Department of Environment and Natural Resources, Wildlife Division, Government of the Northwest Territories, Yellowknife, NT.

Hodson, J. 2019. Tłı̨chǫ all-season road project aerial bear den survey results (Wildlife Research Permit #WL500763). Department of Environment and Natural Resources, Wildlife Division, Government of the Northwest Territories, Yellowknife, NT. [See also Appendix H of WMMP 5.2 for the Tłı̨chǫ ASR.]

Hodson, J. and Greenblat, A. 2021. Summary of winter 2021 field work carried out under Wildlife Research Permit WL500585 – Wildlife effects monitoring for the Tłı̨chǫ all-season road". Department of Environment and Natural Resources, Wildlife Division, Government of the Northwest Territories, Yellowknife, NT.

Hodson, J. and Patenaude, A. 2018. Summary of winter 2018 field work carried out under Wildlife Research Permit WL500580 - Wildlife effects monitoring for the proposed Tłı̨chǫ all-season road. Department of Environment and Natural Resources, Wildlife Division, Government of the Northwest Territories, Yellowknife, NT.

Kelly, A.P., Fieberg, J., Barbour, N., Chatterjee, N. and Hodson, J. 2024. Evaluating the effect of the construction of the Tłı̨chǫ all-season road on boreal caribou movements. Department of Environment and Climate Change, Government of the Northwest Territories, Yellowknife, NT. [See APPENDIX C of this report.]

Nietfeld, M. and Hodson, J. 2020. Summary of winter 2019-2020 field work carried out under Wildlife Research Permit WL500813 – Boreal caribou abundance surveys, boreal caribou collaring and wolf surveys: Tłı̨chǫ all-season road project. Department of Environment and Natural Resources, Wildlife Division, Government of the Northwest Territories, Yellowknife, NT.

Rettie, W.J. 2019. Review of wildlife effects monitoring programs in the Wildlife Management and Monitoring Plan for the Tłı̨chǫ All-Season Road. Paragon Wildlife Research and Analysis Ltd., Winnipeg, MN. [See also Appendix J of WMMP 5.2 for the Tłı̨chǫ ASR.]

Williams, J. 2017. Summary of the capture and collaring of boreal caribou along the proposed Tłı̨chǫ all-season road to Whatì, NT, March 2017. Department of Environment and Natural Resources, Wildlife Division, Government of the Northwest Territories, Yellowknife, NT.

Traditional Knowledge Reports

North Slave Métis Alliance. 2018. Report of traditional knowledge study for the proposed Tłı̨chǫ all-season road project. North Slave Métis Alliance, Yellowknife, NT.

Tłı̨chǫ Government. 2014. Traditional knowledge study for the proposed all-season road to Whatì. Tłı̨chǫ Research and Training Institute, Behchokǫ̀, NT.

Tłı̨chǫ Research and Training Institute. 2021. Tłı̨chǫ highway wildlife monitoring program baseline conditions report. Dedats'eetsaa: Tłı̨chǫ Research and Training Institute, Behchokǫ̀, NT.

Tłı̨chǫ Research and Training Institute. 2022. Tłı̨chǫ highway wildlife monitoring program 2021 vegetation surveys report. Dedats'eetsaa: Tłı̨chǫ Research and Training Institute, Behchokǫ̀, NT.

Tłı̨chǫ Research and Training Institute. 2022. Tłı̨chǫ highway wildlife monitoring program 2022 vegetation surveys report. Dedats'eetsaa: Tłı̨chǫ Research and Training Institute, Behchokǫ̀, NT.

Yellowknives Dene First Nation. 2018. Traditional knowledge report summary, Tłı̨chǫ all-season road. Prepared for the Yellowknives Dene First Nation Land and Environment Department by Trailmark Systems and DownNorth Consulting, Yellowknife, NT.

6.2 Effectiveness of Mitigation Measures

Table 6-1 and Table 6-2, below, evaluate all the mitigation measures outlined in the WMMP for effectiveness. Comments on where mitigation may be improved are also noted. Out of the 82 mitigation measures reviewed, 67 were implemented as planned, 11 were not implemented (because they weren't triggered), and 4 will be applied during the operations phase of the road. Of those mitigation measures that applied to the construction phase, fifty-seven (57) were deemed to be effective and 21 could not be assessed for their effectiveness. No mitigation measures were assessed as ineffective. Of those mitigation measures that were implemented, 7 were identified as having potential for improvements. Recommended improvements included:

- the use of drones to conduct pre-disturbance surveys for large mammals,
- more detailed methodology and reporting for pre-disturbance bird nesting surveys, dedicated bat roosting/hibernacula surveys, and
- better two-way communication and adding details on boreal caribou movement rates to improve the utility of collar data maps and ability to track compliance with required mitigation measures in response to collared caribou proximity to construction activity.

Table 6-1. Efficacy of mitigation measures during the construction phase of the Tłı̨chǫ ASR.

Mitigation measure	Implemented?	Was this mitigation measure effective?	Could this mitigation be improved?
WMMP section 4.1.1 (construction) - direct			
The current layout of the project footprint will minimize the amount of new disturbance by following the existing Old Airport Road route to Whatì and intersecting areas previously burned where feasible.	Yes. The Tłı̨chǫ ASR followed much of the Old Airport Road route and 55.96 ha of the new 550 ha as-built footprint avoided new habitat disturbance.	Yes. The as-built footprint of the project (550 ha) was less than the predicted footprint in the Report of EA (564 ha for the road corridor + 220 ha estimated for the borrow sources and access roads).	No. This was an opportunity specific to the Tłı̨chǫ ASR construction and every reasonable opportunity was taken to minimize disturbance.
Limit the cleared Tłı̨chǫ ASR corridor to 60 m wide (not including the borrow sites and access corridors).	Yes.	Yes.	No. Refinement to the "actual" RoW cleared limits varied due to suitable road building material but effort was dedicated to reduce RoW cleared widths wherever possible.
Borrow source areas will be minimized and will be located close to the Tłı̨chǫ ASR right of way so that access roads are short. Most of the borrow sources also overlap the Tłı̨chǫ ASR alignment so additional disturbance to access these areas will be limited.	Yes. Only six borrow sources were developed outside of the Tłı̨chǫ ASR RoW.	Yes.	No. Selection of borrow sources to be used and to what extent they would be developed was evaluated throughout the construction to maximize project efficiencies.
If borrow pits and quarries are no longer required during the operations phase, reclamation will be conducted in consideration of the Northern Land Use Guidelines for Pits and Quarries. Once reclamation activities are complete, access will be blocked to quarries and borrow sources that are no longer required.	Yes.	Yes.	No.
Avoid disturbance or destruction of bird nests and eggs by clearing land outside of the bird nesting and fledging season (May to mid-August); however, if vegetation clearing is required within this time, non-intrusive pre-clearing nest surveys will be	Yes. The clearing activities were completed during the late fall and winter months, which fall outside of the breeding bird season. Pre-clearing and blast surveys were conducted before	Perhaps. No nests were identified during construction. This may indicate ineffectiveness of nest surveys or that no nests were present at the time of clearing.	Yes. Where nest surveys are required during the nesting season, having nest survey reports where methodology, effort, and experience of surveyor was provided would

Mitigation measure	Implemented?	Was this mitigation measure effective?	Could this mitigation be improved?
completed, and no-work zones will be observed where there is evidence of nesting. Through consultation with GNWT-ECC and ECCC, bird nests will be protected by a buffer that protects the nest while allowing construction to continue and will be monitored. Details of nests identified, and the mitigation, will be included in the weekly wildlife monitoring reports.	all operations of vegetation clearing and blasting on the RoW to sweep for bird nests.		aid in determining effectiveness of these surveys.
Birds will be deterred from nesting on infrastructure by placing covers/screens on vents, holes, and crevices where birds could potentially nest, and if necessary, through active (but non-lethal) disturbance of birds to discourage them from establishing a nest on a construction site. Physical deterrents will not be applied during the nesting season. If bird nesting occurs, the nest will not be disturbed until after the birds have left the area, with clearance to be discussed in consultation with GNWT-ECC and ECCC.	No report of bird deterrents being used. No nesting activity reported. Prior to and during the bird nesting season, mitigation measures were taken including the regular movements of equipment, daily visual inspections of all equipment prior to use and the Environmental Department conducted and reported on any needed interventions in the weekly reporting.	Unclear as mitigation was not triggered.	No.
Destruction of bat roosts will be avoided by managing, to the extent possible, the incremental removal of vegetation so that it occurs outside of spring through fall. If vegetation clearing is required within this time, pre-clearing nest surveys and no-work zones for identified active maternity roost sites will be implemented to avoid disturbance.	Yes. The clearing activities were completed during the late fall and winter months, which fall outside of the breeding bird season. Pre-clearing and blast surveys were conducted before all operations of vegetation clearing and blasting on the RoW. Bat hibernacula surveys were conducted alongside bear den surveys during project construction.	Unclear as no bat roost sites were identified within the RoW.	Yes. Bat hibernacula surveys were conducted alongside bear den surveys. If bats are a concern in a future project area, a more dedicated/tailored assessment may be warranted in advance of the construction phase.
Avoid disturbance of hibernating bats by surveying for sites of hibernacula potential	Yes. Potential bat hibernacula habitat (i.e., caves) were noted	Unclear as no features that could provide potential bat	

Mitigation measure	Implemented?	Was this mitigation measure effective?	Could this mitigation be improved?
(i.e., abandoned buildings and mines and caves) within 200 m of the RoW during the bear den aerial survey.	during aerial bear den surveys conducted by GNWT-ECC during project construction.	hibernacula sites were identified within 200 m of the RoW during the survey.	
If any reclamation activities are planned for the terrestrial portions of the existing Tłı̨chǫ winter road, it will be managed and addressed jointly by the Tłı̨chǫ Government and the GNWT by way of a bilateral agreement.	Not yet. This mitigation measure will be addressed as part of the Caribou Habitat Offset Plan for the Tłı̨chǫ ASR project.	Cannot be determined yet.	Cannot be determined yet.
Operating machinery on highly saturated soil (primarily during freshet) outside of the highway alignment, borrow sources and borrow source access roads will be avoided, where practical. Where it is unavoidable, suitable ground equipment will be used to prevent unnecessary soil damage through rutting.	Yes.	Yes. This was a condition of the land use permit. Highly saturated soils were not encountered outside of the alignment.	No.
Herbaceous plant surveys of the project footprint were completed in August 2018 by a qualified botanist and a Tłı̨chǫ assistant (Golder 2019). Further surveys will be completed at one year, five years and ten years following completion of construction. If rare plants and/or invasive species are found, GNWT-ECC will be consulted to determine next steps.	Yes.	Yes. The survey found eight exotic species at 27 locations, and no observations of 'rare' plants. This provides valuable baseline data to compare to future surveys.	Unclear.
Rare and exotic plant survey has been completed (Golder 2019) and the results posted on the WLWB's public registry.	Yes. See APPENDIX E for the full report. The report was not posted to the WLWB public registry.	Yes.	No.
Management and control plan for rare and exotic plant species will be prepared in consultation with ECC prior to the next scheduled surveys; one year after construction and five years thereafter.	N/A. Will be implemented in the operations phase.	N/A.	N/A.

Mitigation measure	Implemented?	Was this mitigation measure effective?	Could this mitigation be improved?
Any required reseeding will be done with an approved native, non-invasive seed mix to avoid the introduction of noxious and invasive plants.	Yes. The localized application of seed to minimize erosion was conducted utilizing an approved native seed mixture. Details on this have been provided in annual reports.	Yes.	No.
WMMP section 4.2.1 (construction) - indirect			
Dust suppression techniques (as per the GNWT Guideline for Dust Suppression and the GNWT-INF Erosion and Sediment Control Manual) will be utilized as required and feasible to reduce dust emissions onto vegetation outside of the RoW.	Yes.	Yes.	No.
Layout and location of quarries will consider the Northern Land Use Guidelines for Pits and Quarries.	Yes.	Yes.	No.
Reduced speed limits (50 km/h) during construction will reduce dust production.	Yes. Primarily during heavy haul operations with cycling rock trucks and in the areas of construction activity.	Yes. Dust was managed both for safety during construction as well as environmental benefits.	No.
Clean and inspect project vehicles and equipment prior to entering the NWT to avoid introducing noxious and invasive plants.	Yes. All equipment arrived and left site completely cleaned. Each piece of equipment was inspected and accepted by Kiewit Maintenance.	Yes.	No.
Re-cleaning project vehicles and equipment if an area of weed infestation is encountered, prior to advancing to a weed-free area to minimize the spread of noxious and invasive plants.	No. No weed infestation area was ever identified.	Uncertain.	Uncertain.
Locating and managing cleaning locations on the project site to avoid the spread of noxious and invasive plants (see the pamphlet “Invaders in the Northwest Territories” for more information on invasive plants in the NWT).	Yes.	Yes.	No.

Mitigation measure	Implemented?	Was this mitigation measure effective?	Could this mitigation be improved?
Domestic and recyclable waste and dangerous goods will be stored on site in appropriate containers, as per the Waste Management Plan, to avoid exposure until they are shipped off site to an approved facility, and to prevent spills or leakage into the surrounding environment that would cause habitat degradation.	Yes.	Yes.	No.
Hazardous materials and fuel will be stored according to regulatory requirements to avoid contamination to the environment and workers.	Yes.	Yes. Where encountered spills were identified, they were cleaned up and reported in weekly, monthly and annual reports. The project was inspected by government agencies routinely to ensure compliance. No major infractions ever noted.	No. Standard for all construction.
Individuals working on-site and handling hazardous materials will be trained in the Workplace Hazardous Materials Information System and the Transportation of Dangerous Goods to avoid accidental spills.	Yes.	Yes.	No. Standard for all construction.
An approved Spill Contingency Plan will be followed by project staff to prevent spills and if spills occur as a result of an accident, they will be controlled to minimize the area impacted.	Yes.	Yes. Spills were immediately identified, cleaned up and reported. More importantly, pre-operation inspections and pro-active maintenance programs for equipment contributed significantly to project success.	No. Standard for all construction.
Emergency spill kits will be available wherever toxic materials or fuel are stored and transferred during construction to minimize effects to vegetation and wildlife habitat.	Yes.	Yes. Spill response products were actively positioned in sensitive work areas, all active work fronts, fluid storage and transfer locations as well as on	No. Standard for all construction.

Mitigation measure	Implemented?	Was this mitigation measure effective?	Could this mitigation be improved?
		each piece of equipment used on the project.	
Spill response and containment will be completed expeditiously in accordance with the approved site-specific Spill Contingency Plan to reduce the area impacted. Spills will be reported in a timely manner.	Yes.	Yes.	No. Standard for all construction and a regulatory requirement.
Construction equipment, machinery, and vehicles will be regularly maintained to avoid accidental spills.	Yes.	Yes. Kiewit/NSI pre-operation inspections and pro-active maintenance programs for equipment contributed significantly to project success.	No.
Fuel storage areas will be equipped with spill kits and will be located at least 100 m away from water bodies. Large fuel storage tanks (2,000 to less than 80,000 litres) will be double walled as per the regulations.	Yes.	Yes.	No. Standard for all construction.
Construction and maintenance vehicles will be equipped with spill kits and fuelled at least 30 m away from water bodies.	Yes.	Yes.	No. Standard for all construction.
The GNWT-INF Erosion and Sediment Control Manual, in conjunction with a suitable road design, will be utilized for erosion and sediment control and slope stabilization, which should minimize damage to riparian, stream, wetland, and lake habitat from altered hydrology.	Yes.	Yes.	No. Standard for all construction.
Workers will not travel off the project site unless there is a specific requirement.	Yes.	Yes.	No.
Riparian areas will be maintained whenever possible to minimize erosion, with vegetation removal limited to the width of the RoW. At watercourse crossings, a riparian buffer will be maintained along the width of the RoW except at the actual crossing location.	Yes.	Yes. Where possible, riparian vegetation was left in place and if removals were required, it was all done by hand cutting.	No.

Mitigation measure	Implemented?	Was this mitigation measure effective?	Could this mitigation be improved?
Removed vegetation/debris will be removed from site to prevent them entering the watercourse.	Yes.	Yes.	No.
Impacts to riparian vegetation at temporary crossings will be minimized by using structures such as snow fills and single-span bridges instead of fording, especially where banks are susceptible to erosion.	Yes.	Yes. Early road construction progress was realized using temporary crossings.	No.
Disturbed areas along the stream banks will be stabilized upon completion of work to minimize erosion.	Yes.	Yes.	No. Standard for all construction.
Culverts will be embedded as appropriate to maintain species and habitat present and will be installed parallel to the existing channel to minimize changes to channel morphology.	Yes.	Yes.	No.
WMMP section 4.3.1 (construction) – sensory disturbance			
Project staff will be provided with awareness training prior to working on the site as outlined in section 4.7.1 of the WMMP. This training will include the various procedures and protocols that are included in this section.	Yes.	Yes. Annual training was provided by the Environmental Department as well as season specific training such as fisheries restricted construction periods, bird nesting periods, bear awareness training, sensitive wildlife and species at risk were shared as toolbox talks and training sessions.	No.
Harassment, feeding or approaching wildlife by project staff will be prohibited.	Yes.	Yes.	No.
Project staff will communicate, via radio, relevant observations of wildlife to the NSI Environmental Manager or designate. The NSI Environmental Manager will then relay this information to Site Supervisors and equipment operators working in the area.	Yes.	Yes. Environmental Manager was always made aware of active work fronts and any wildlife observations. This information was reported weekly, monthly and annually.	No.

Mitigation measure	Implemented?	Was this mitigation measure effective?	Could this mitigation be improved?
Any such observations should be included in the wildlife sightings log.			
Construction will be temporarily suspended by the NSI Environmental Manager, or speed limits on the road temporarily reduced, when moose, caribou, bison, or any other wildlife that may be at imminent risk of injury or mortality, are known to be near the active construction site. An incident report will be prepared for each such occurrence.	Yes.	No injury or mortality of ungulates or large mammals was reported so it appears to have been effective.	No.
Blasting may only proceed if no large mammals (e.g., caribou, moose, and bison) are detected in the 500 m blast radius or immediate blast zone (as determined by the Blast Supervisor). As outlined in WMMP - Appendix F Pre-Blast Survey Procedure, two environmental monitors will complete a 1-hour survey, within a 500 m radius of the blast zone perimeter (or as defined by the Blast Supervisor). The survey will be conducted by foot or truck and will also include surveying within the immediate blast zone area to the extent that it is safe to do so. The Environmental Monitors will conduct a visual scan of the blast radius using both binoculars and thermal imaging device prior to blasting to ensure no large mammals are present. All blasting will be preceded by air horn signals, which should deter wildlife from the area. Specific mitigation measures that apply to blasting during the late-winter and calving season for collared boreal caribou are included in APPENDIX D.	Yes.	Unclear. During these surveys, from 2019 to 2021, large mammals were rarely or never observed around the blasting or clearing activities. Because there were no incidents where NSI needed to implement buffers or delay blasting; it is unclear if this mitigation or preventative measure was effective because it was not tested.	Yes. It is recommended that drones be permitted for these sweeps moving forward as this would be a far superior way to detect wildlife in the vicinity of blasting.

Mitigation measure	Implemented?	Was this mitigation measure effective?	Could this mitigation be improved?
Construction activities will consider sensitive periods. For example, vegetation clearing is planned to occur outside of the nesting season for migratory birds.	Yes.	Yes. Construction was well timed to allow clearing to proceed largely outside of the bird nesting season.	No.
Boreal caribou collar locations will be used to notify construction crews of their proximity to active construction areas during the late-winter and calving season, and increased mitigation measures will be triggered as described in APPENDIX D.	Yes. Implemented mitigations included reduced traffic speed (in most instances) and site wide notifications (in one instance).	Maybe. Collar data maps indicated where caribou were recently located relative to different segments/cautionary buffer zones. None of the collar data maps ever resulted in a suspension or delay of activities such as clearing or blasting, so increased mitigation measures (beyond reduced traffic speeds or site wide notifications) were never triggered. There were no reported incidents of caribou injury or mortality during the construction phase.	Yes. GNWT-ECC provided collar data maps to NSI at the beginning of each week but didn't find out where construction activities actually occurred that week until the following week (based on the weekly reports). To improve GNWT-ECC's ability to track compliance with the mitigation measures tied to collar data maps, proponents should provide details about where they are and will be operating in the coming week at the start of each week. Movement rates of caribou could also be included with the collar data maps to indicate potential calving events.
If any big game species are observed within the cleared RoW adjacent to active construction areas, speed limits will be reduced to 30 km/h within 1 km on either side of the sighting. If bison are present on roads, Environmental Monitors will be contacted. Environmental Monitors should be aware that groups of bison with more than five individuals are likely to be nursery groups containing calves and juveniles. Any such observations should be included in the wildlife sightings log.	Yes.	Yes. Notifications and speed reductions were routinely provided to operational fronts and any travelling personnel based on wildlife (bison observations).	No.

Mitigation measure	Implemented?	Was this mitigation measure effective?	Could this mitigation be improved?
The NSI Environmental Manager will communicate, via radio, the requirements for a reduced speed limit to supervisors and equipment operators working in the area. The Manager will monitor equipment operations to ensure the reduced speed limit is followed.	Yes.	Yes. Notifications and speed reductions were routinely provided to operational fronts and any travelling personnel based on wildlife (bison observations).	No.
In the event that an active mammal den, bird nest (active or inactive) or young are discovered during construction, disruptive construction activities will be halted and GNWT-ECC and ECCC (for migratory birds) will be consulted to determine an appropriate strategy to avoid or minimize disturbance. APPENDIX C provides the appropriate contact information for ECCC personnel.	No.	No active mammal den, bird nest (active or inactive) or young were reported during construction. Efficacy of mitigation cannot be assessed.	Uncertain.
Pre-clearing surveys will detect the presence of large mammals prior to vegetation clearing.	Yes.	Yes. No animals were ever observed during pre-clearing sweeps. It is also suggested that the disturbance from mulching operations is a sufficient deterrent to large active mammals.	Yes. It is recommended that drones be permitted for these sweeps moving forward as this would be a far superior way to detect wildlife in the vicinity of blasting.
Observations of caribou, moose, bison, and other big game and species at risk will be reported to Environmental Monitors. Observations of species at risk will be reported to GNWT-ECC through weekly reports.	Yes.	Yes, but where wildlife was not identified to species, determination if it was a species at risk could not be made (e.g., owl species, duck species).	No. Wildlife observations were contributed by all project staff, but it would not be feasible or reasonable to expect that all staff would be trained to identify all species at risk potentially occurring in the project area. Environmental staff were trained in species at risk identification and did report them when observed.

Mitigation measure	Implemented?	Was this mitigation measure effective?	Could this mitigation be improved?
Fixed wing and helicopter flights associated with highway construction will consider the minimum altitude guidelines outlined in the brochure "Flying Low? Think Again.", and Appendix D of the WMMP, where safety permits. Flight paths will follow the cleared highway RoW to the extent feasible. Observations of big game should be documented in the wildlife sightings log.	No.	Uncertain. No flights occurred that were associated with construction activities; it never needed to be implemented.	Uncertain since no flights occurred.
If available, generalized calving locations of collared boreal caribou will be provided to pilots indicating areas to avoid during the calving season. Pilots will be expected to complete a visual scan for large mammals prior to landing.	No.	Uncertain. No flights occurred that were associated with construction activities; it never needed to be implemented.	Uncertain.
If caribou, bison, or moose are observed during helicopter flights, they will not be approached, followed, hovered above, or circled around.	No.	Uncertain. No flights occurred that were associated with construction activities; it never needed to be implemented.	Uncertain.
Pilots will increase altitude and follow flight paths that veer away from caribou, bison, and moose if the animals are observed running, panicking, or exhibiting other startled response.	No.	Uncertain. No flights occurred that were associated with construction activities; it never needed to be implemented.	Uncertain.
Road embankments will be gently sloped and use fine-grain materials.	Yes and no. Road embankments had gentle slopes and used fine grain materials along most of the alignment, but there were three sections of the road that required steep cuts/ embankments (km 34, 59 and 79), ranging in length from 500 m to 1 km. KM 34 coincides with a general area where collared boreal caribou frequently cross the road.	Uncertain. The boreal caribou collar data is not at a fine enough resolution (even with hourly locations within the 10 km geofence along the road) to assess whether the steeper cut between KM 34-35 has affected their ability to cross the road along that section.	No.

Mitigation measure	Implemented?	Was this mitigation measure effective?	Could this mitigation be improved?
WMMP section 4.4.1 (construction) – wildlife mortality			
Project staff will be provided with awareness training prior to start of work on the site as outlined in WMMP section 4.7.1. This training will include the various procedures and protocols that are included in this section.	Yes.	Yes.	No.
Quarry stockpiles, overburden, or exposed soil banks will be maintained with slopes of less than 70 degrees to prevent bank swallow nesting, following ECCC (2017a) guidance. Regular activity in the quarries will also help to deter nesting (ECCC 2017a). If a nesting colony is found, a buffer zone of at least 50 m will be established, and excavation of the nest area will not continue (ECCC 2017a).	No.	No swallow colony was found nor any suitable nesting habitats observed.	Unclear.
Awareness training provided to personnel, as outlined in WMMP section 4.7.1, will include information on yielding the RoW to wildlife during construction. If wildlife are crossing or attempting to cross a road or active construction area, traffic and mobile equipment will stop and wait for the animal to cross unless they are posing a risk to personnel or themselves as noted in the following bullet point. The presence of large mammals (e.g., caribou, moose, and bison) and other wildlife will be communicated to construction workers, which will minimize risks of physical hazards through site-wide awareness.	Yes.	Yes. Regular toolbox talks and environmental presentations as well as environmental presence on site were effective.	No.
Project staff will communicate, via radio, relevant observations of wildlife to the NSI Environmental Manager or designate. The NSI Environmental Manager will then relay	Yes.	Yes. Regular communication occurred between environmental staff and the operational work fronts.	No.

Mitigation measure	Implemented?	Was this mitigation measure effective?	Could this mitigation be improved?
this information to Site Supervisors and equipment operators working in the area.			
If bison, caribou or moose are observed in areas where there are hazards, operations at that particular work site will be temporarily suspended by the NSI Environmental Manager to allow wildlife to move away from the area of their own accord. If they do not leave the area within 15 minutes, they may be gently encouraged to move away from construction activities. This will involve the slow approach of Environmental Monitors by vehicle towards the caribou/moose/bison or making their presence known by calling out and waving their arms to encourage them to move. This is to be done from behind a vehicle or piece of equipment to prevent personnel from going too close to the animal. An incident report will be completed for all deterrent actions. It is possible that females may be unwilling to leave the area if they have a calf hiding nearby. In these cases, operations in the area may be suspended by the NSI Environmental Manager.	No. There are no incident reports of deterrent actions taken so this mitigation was likely not required.	Unknown as was not required.	Uncertain.
Bear-banger type deterrents are only to be used if there is an immediate need to mitigate risk to personnel or wildlife safety.	Yes.	Yes. Used one time to effectively deter a bear from entering the camp perimeter.	No.
Speed limits for construction vehicles will be limited to 50 km/h.	Yes. Where possible	Yes. No wildlife collisions reported except for ptarmigan and snowshoe hare.	No.
If any big game species are observed within the cleared RoW adjacent to active construction areas, speed limits will be reduced to 30 km/h within 1 km on either side of the sighting. The NSI Environmental	Yes. Where practical.	Yes. For effective construction, bison herds were routinely in the cleared RoW but speed of traffic permitted to remain at 50 km/hr where good visibility	No.

Mitigation measure	Implemented?	Was this mitigation measure effective?	Could this mitigation be improved?
Manager will communicate, via radio, the requirements for a reduced speed limit to supervisors and equipment operators working in the area. The manager will monitor equipment operations to ensure the reduced speed limit is followed.		was present and Environmental Manager permitted.	
Blasting may only proceed if no large mammals (e.g., caribou, moose, and bison) are detected in the 500 m blast radius or immediate blast zone. As outlined in WMMP -Appendix F Pre-Blast Survey Procedure, two Environmental Monitors will complete a 1-hour survey within a 500 m radius of the blast zone perimeter (or radius as defined by the Blast Supervisor and Blast Plan). The survey will be conducted by foot or truck and will also include surveying within the immediate blast zone area to the extent that it is safe to do so. The Environmental Monitors will conduct a visual scan of the blast radius using binoculars and thermal imaging device prior to blasting to ensure no large mammals are present. All blasting will be preceded by air horn blasts, which will deter wildlife from the area. Specific mitigation measures that apply to blasting during the late-winter and calving season for collared boreal caribou are included in APPENDIX D.	Yes.	During these surveys from 2019 to 2021, large mammals were rarely or never observed around the blasting or clearing activities. Because there were no incidents where NSI needed to implement buffers or delay blasting; it is unclear if this mitigation or preventative measure was effective because it was not tested.	When completing pre-blast and pre-clearing walks the forest composition was often dense tree cover with areas lacking active fauna, thus the ability to see wildlife was limited. It is recommended that drones be permitted for these sweeps moving forward as this would be a far superior way to detect wildlife in the vicinity of blasting.
Pre-clearing den surveys will be completed. In the event that an active mammal den is identified during pre-clearing surveys, or during construction activities, GNWT-ECC will be consulted to determine next steps. Operations near the den will be temporarily	Yes.	No active dens identified.	No.

Mitigation measure	Implemented?	Was this mitigation measure effective?	Could this mitigation be improved?
suspended by the NSI Environmental Manager, and GNWT-ECC will be consulted.			
Project staff will be provided with environmental awareness training.	Yes.	Yes.	No.
An appropriately designated supervisor will provide field workers with Bear Aware training (see WMMP-Appendix E) and general wildlife awareness.	Yes.	Yes. Awareness training provided annually.	No.
Environmental Monitors will document wildlife and manage and minimize risks to wildlife and workers.	Yes.	Yes.	No.
Harassment, feeding or approaching wildlife by project staff will be prohibited.	Yes.	Yes.	No. Standard for all construction.
No hunting or fishing by project staff will be permitted.	Yes.	Yes.	No.
To avoid wildlife harvest, firearms will not be allowed on-site during construction except for firearms in the possession and control of authorized Environmental Monitors or law enforcement officers.	Yes.	Yes.	No.
Camps and buildings will be designed to prevent wildlife interactions, including appropriate storage of non-waste wildlife attractants (e.g., food and petroleum products) and use of adequate lighting will be installed in areas where it is essential to detect bears that may be in the vicinity.	Yes.	Yes. The only intrusion into the camp perimeter was two wolves over the period of two evenings and one black bear observed outside the berm.	No.
Development and implementation of a Waste Management Plan to avoid access to food waste by wildlife.	Yes.	Yes.	No.
Exposure of wildlife to contaminants will be avoided by use of appropriate deterrents (e.g., temporary fencing and noise makers) to discourage wildlife from entering an affected area.	N/A. Mitigation was not required to be implemented.	N/A.	N/A.

Mitigation measure	Implemented?	Was this mitigation measure effective?	Could this mitigation be improved?
In case of wildlife exposure to contaminants, territorial (GNWT-ECC) or federal (ECCC) authorities will be contacted immediately to determine appropriate course of action, which may include capturing, relocating or treating contaminated wildlife	N/A. Mitigation was not required to be implemented.	N/A.	N/A.
WMMP section 5.5.1 (construction) – access and harvesting			
Firearms will not be allowed on-site except for firearms in the possession and control of authorized Environmental Monitors or law enforcement officers.	Yes.	Yes.	No.
No hunting or fishing by project staff will be permitted.	Yes.	Yes.	No.
WMMP section 4.6 (construction) – caribou mitigation			
See Table 6-2 below for caribou-specific mitigation and monitoring during the construction phase.			
WMMP section 4.7.1 – education and training			
Contractor(s) hired for road construction, and maintenance activities during the operational phase of the road will be responsible for educating and training project staff on applicable practices contained within the WMMP. All training will be documented and recorded in the WMMP annual report.	Yes.	Yes.	No.
WMMP section 4.7.2 – public awareness			
The public will be restricted from accessing the active construction areas, unless authorized and accompanied by NSI representatives.	Yes.	Yes. The road was closed to the public and only one local resident was able to access regularly at the very south end of the project.	No.

Table 6-2. Construction phase mitigation and monitoring for boreal and barren-ground caribou.

Threshold	Caribou-specific mitigation	Caribou-specific monitoring	Was this mitigation measure implemented?	Was this mitigation effective?	Could this mitigation be improved?
Collared barren-ground caribou are present within 10 km of the Tłı̨chǫ ASR.	GNWT-ECC will advise the NSI Environmental Manager if a collared caribou is within 10 km of the project, and provide updates based on collar data as required. GNWT-ECC will also notify GNWT-INF, the Tłı̨chǫ Government, and WRRB. NSI Environmental Manager to notify all project staff working in the area.	Wildlife road surveys along the Tłı̨chǫ ASR by Environmental Monitors or patrols by GNWT-ECC wildlife officers to document caribou presence near the road and group size.	No. Barren-ground caribou were never present within 10 km of the Tłı̨chǫ ASR during construction.	Cannot assess as mitigation measure was never triggered.	Cannot assess as mitigation measure was never triggered.
Caribou (barren-ground or boreal) observed on or adjacent to the Tłı̨chǫ ASR RoW.	Caribou have the right of way on the road. Communicate location of caribou sightings to other project staff working in the area via radio. Notify GNWT-ECC of the location and number of individuals. Decrease speed limits within 1 km on either side of the area to 30 km/h. NSI Environmental Manager may temporarily suspend construction traffic and other activities if caribou are on the road or within an active construction area (e.g., borrow source).	Environmental Monitors will be informed of general location and time of caribou sighting and will initiate active monitoring of the area. Continue monitoring the road within 1 km on either side of where caribou were sighted for 30 minutes after they leave the RoW, before increasing speed limits to 50 km/h again.	Yes, but only occasionally as caribou were rarely observed. In one case, an individual caribou was seen in one of the borrow pits and access to the pit was restricted and a no-work zone was set up until the caribou left.	Yes. Observations of wildlife sightings were provided to all interested parties and regulatory agencies involved with the Tłı̨chǫ Highway on a weekly and monthly basis.	No.
Collared boreal caribou within 0.5-3 km of the Tłı̨chǫ ASR RoW, borrow sources or borrow		Boreal caribou collar-based monitoring; maps of collar locations will be provided on a more frequent basis if caribou occur within cautionary	Yes. Frequency for providing collar data maps was increased to every 2-3 days during the late-winter and calving season.	Unclear. Collar data maps never resulted in a delay or suspension of activities, just speed limit reductions and	Yes. To improve GNWT-ECC's ability to track compliance with the mitigation measures tied to collar data maps,

source access roads.		zones during late winter and calving periods.		site-wide notifications. It was difficult for GNWT-ECC to assess whether any additional mitigations should have been triggered. No injuries or mortalities of boreal caribou were ever reported.	proponents should provide details about where they are and will be operating in the coming week at the start of each week. Movement rates of caribou could also be included with the collar data maps to indicate potential calving events.

6.3 Adaptive Management

An Adaptive Management Framework for the Tłı̨chǫ ASR was prepared for the WLWB as part of the EA process (https://registry.mvlwb.ca/Documents/W2016L8-0001/W2016L8-0001%20-%20TASR%20-%20Adaptive%20Management%20Framework%20-%20Jan%208_19.pdf). It described active adaptive management, passive adaptive management, adaptive co-management, and impromptu adaptive management. These guidelines clarified that the best available information and new learning would be incorporated in approaches to building the road and monitoring and mitigating potential impacts to wildlife. The Tłı̨chǫ ASR CWG was identified as a venue for adaptive co-management, with concerns raised at the CWG described further in section 7.0 of this report.

In 2019, the GNWT contracted a technical review of the wildlife effects monitoring program components of the WMMP (Rettie 2019). This report discussed road-focused monitoring and wildlife-focused monitoring. Recommendations from this report were used to determine whether modifications should be made in an adaptive management framework. The methods described in the WMMP to survey moose and bison abundance were adapted following the recommendations in this review (see sections 5.6 and 5.7 of this report).

As part of adaptive management, the WMMP (section 6.2.2) identified specific thresholds and actions during the construction phase that would trigger an immediate review of the WMMP mitigation:

- One caribou, moose or bison killed or injured as a result of construction operations.
- Destruction or disturbance of one bird nest, one bat roost site or hibernaculum, or one mammal den.
- One bear or other carnivore killed in defense of life and property as a result of attraction to camp facilities or other work areas.
- Initiate more frequent bird nesting surveys if nests or nesting activity is observed.
- Boreal caribou harvest levels that exceed sustainable levels will initiate management actions to reduce harvest levels in conjunction with Tłı̨chǫ Government.

None of these thresholds or actions occurred during the construction phase. Therefore, no associated reviews were triggered.

7.0 WILDLIFE CONSERVATION CONCERNS RELATED TO THE TŁĮCHO ALL-SEASON ROAD

7.0 Wildlife Conservation Concerns related to the Tłı̨chǫ All-Season Road

7.1 WMMP Development and Revisions

The Tłı̨chǫ ASR WMMP addresses wildlife conservation concerns that were raised during the EA process and describes how issues related to those concerns would be monitored and mitigated. Reporting on this process is the basis for many sections of this comprehensive report.

During the development of the Tłı̨chǫ ASR WMMP, there were opportunities for collaborators to include their wildlife conservation concerns related to the Tłı̨chǫ ASR. During the permitting process for the Tłı̨chǫ ASR, the developer worked collaboratively with ECCC, GNWT-ECC, WRRB, the Tłı̨chǫ Government, and Indigenous groups and harvesters to update the WMMP to version 3.3, which was approved by the WRRB and GNWT-ECC (Aug 30, 2019) after a period of public review. The WMMP is reviewed annually. Subsequent revisions were submitted first to the WRRB for review and approval, and then to the WLWB and GNWT-ECC, for their reviews and approvals. Prior to approvals, the revised drafts were posted to the WLWB's online review system for public comments, and to the WRRB website for public comments.

These annual reviews provided additional opportunity for individuals and groups to raise concerns. Annual revisions also incorporated available results from monitoring programs. During the review of WMMP version 4.1 in 2020-21, ECCC, the NSMA, and the WRRB each made submissions. These concerns resulted in changes to the approved WMMP version 4.2 approved in February and March 2021 (by WLWB and GNWT-ECC, respectively). Changes to the WMMP included:

- Direction to monitor the proliferation of new trails leading off the road once open for public use.
- A section on a non-mandatory harvest monitoring program (Tłı̨chǫ Government program proposal).
- Use traditional knowledge to monitor the state of boreal caribou habitat, and to monitor the state of barren-ground caribou winter habitat.
- Direction to use Bathurst Caribou Mobile Zone maps to monitor potential overlap of barren-ground caribou with a buffer around the Tłı̨chǫ ASR.
- Inclusion of recommendations from a technical review of the wildlife effects monitoring program components of the WMMP (GNWT 2020), including to monitor moose and bison abundance in combination with larger area regional surveys.
- Recommendation to repeat boreal caribou and wolf abundance surveys towards the end of the first five years of road operation, to compare against surveys completed during the road construction phase.

The WMMP version 5.2 was first submitted in November 2021 and approved in February and March 2022. It included minor changes related to updated statuses of species at risk, updated contact information, and to make some actions more explicit (e.g., collecting data on wildlife-vehicle collisions, ensuring culverts do not impede fish movement). ECCC had concerns about the analysis of baseline data collected for migratory birds. GNWT-INF shared raw migratory bird survey data with ECCC and requested that any further analytical results be shared with them to help with future decision-making on similar projects.

7.2 Corridor Working Group Meetings

A second avenue to raise concerns about wildlife conservation related to the Tłı̨chǫ ASR was at meetings held twice a year by the CWG. These meetings were required under EA Measure 14-3 and provided an opportunity for members to present updates on road construction, regulatory requirements, and results from various departments, and to ask questions, share information, and raise concerns related to the Tłı̨chǫ ASR. Membership of the CWG as listed in the CWG Terms of Reference are in Table 7-1. Information about wildlife mitigation measures and wildlife monitoring results were regularly shared.

Table 7-1. Membership of the Tłı̨chǫ ASR CWG, as listed in the CWG Terms of Reference.

Member groups
Community Government of Whatì
Community Government of Behchokǫ
Tłı̨chǫ Government
North Slave Métis Alliance (NSMA)
Yellowknives Dene First Nation (YKDFN)
Wek'èezhìı Renewable Resources Board (WRRB)
Wek'èezhìı Land and Water Board (WLWB)
GNWT – Department of Infrastructure (INF)
GNWT – Department of Lands (Inspector)
GNWT – Department of Environment and Climate Change (GNWT-ECC)
Fisheries and Oceans Canada (DFO)
Environment and Climate Change Canada (ECCC)
North Star Infrastructure (NSI)

Meeting minutes from the first meeting on June 24, 2019, to the December 15, 2021, meeting were reviewed (June 24, 2019, December 12, 2019, July 7, 2020, December 1, 2020, June 16, 2021, and December 15, 2021). Concerns discussed at CWG meetings throughout the construction phase that related to wildlife included blasting protocols and air horn use related to deterring wildlife from blast areas, dust suppression on the road, the impact of the road alignment on wetlands and moose, and the likelihood of bison reaching the community of Whatì. Members reiterated that traditional knowledge should be used in understanding impacts to wildlife and habitat.

Concerns were addressed and reported on at subsequent meetings; for example, the road alignment was mapped alongside wetlands to show the lack of encroachment on wetland areas and alleviate concerns about moose habitat. Many concerns were relevant to the operational phase of the road, for example, how bison movement might be facilitated by the completed road RoW. In general, most of the wildlife conservation concerns raised during the EA process were addressed in the WMMP, and most are directed to the operational phase of the road.

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