BIPOLE III TRANSMISSION PROJECT:

OPERATIONAL PHASE MAMMALS MONITORING PROGRAM TECHNICAL REPORT YEAR 6 (2019-2020)

PART A

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EXECUTIVE SUMMARY

The following monitoring Part A report presents the results of winter field work conducted on mammal Valued Ecosystem Components (VEC's) identified by the Bipole III (BPIII) Transmission Project ('the Project'). This report provides analyses for data collected during the Operational phase (mid 2018 – 2020). The results of woodland caribou telemetry and human access monitoring, primarily derived from trail camera studies and supplemented with aerial multi-species survey observations, will be provided in a subsequent separate Part B report.

The following report contributes to the annual monitoring framework for annual reporting of mammal monitoring studies undertaken to assess potential impacts on mammals at both a local and landscape scale through each phase, including Construction and Operation of the Project. Project effects have been identified in the Environmental Impact Statement (EIS) and include the following (Mammals Monitoring Program Technical Reports for Years 1-5 (2016, 2017; 2018; 2019; 2020)).

Habitat alteration, population ecology and community dynamics:

1. *Effectiveness of mitigation measures and management activities; and*
2. *Progress toward achieving Project commitments and monitoring objectives.*

Ongoing evaluation of annual monitoring results are intended to inform an adaptive management process by:

1. *Providing the necessary information to allow for the implementation of adaptive mitigation measures, when and where necessary, to minimize significant effects (e.g., mortality, disturbance) to local mammal populations;*
2. *Facilitating modification of the monitoring design to improve rigor, sampling efficiency and/or duration; and*
3. *Adjusting for unforeseen Project effects encountered.*

Based on the commitments outlined by MB Hydro in the Project EIS, the overall objectives of the mammals monitoring program include:

1. *Expanding baseline knowledge of select VEC species interacting with the Project, including estimates of population distribution, population abundance, habitat use and movement patterns, and identification and fidelity of critical habitat sites;*
2. *Ensuring compliance with regulatory requirements and EIS commitments;*
3. *Monitoring and measuring VEC responses to the Project Right-of Way (ROW) creation, Construction, and Operation, including disturbance / avoidance from sensory disturbance, direct and functional habitat loss, changes in population vital rates or demographics, and/or changes in predator-prey community dynamics;*

4. *Ensuring that mitigation measures, management activities, and restoration / enhancement measures are implemented;*
5. *Monitoring the level of success or effectiveness of mitigation measures with respect to reducing ROW effects on VECs; and*
6. *Identifying, measuring, and then mitigating and monitoring any unforeseen effects.*

Reports to date have provided analyses on forest-tundra and boreal woodland caribou (Cape Churchill and Pen Island herds) and barren-ground caribou (Qamanirjuaq herd). Detailed monitoring, including aerial moose population estimates for important moose areas are also found in previous monitoring reports (Mammals Monitoring Program Technical Reports for Years 1-5 (2016, 2017; 2018; 2019; 2020)).

Effects monitoring conducted, and the associated results for the Operational phase of the Project found in this report, include the following data collected in Year 6:

- **Boreal Caribou Recruitment Surveys** in three potentially effected boreal woodland caribou ranges (P-Bog, N-Reed, and Wabowden ranges) to assess predator and ungulate overlap as a potential for increased predation risk from grey wolf, and to compare results with the remote Charron Lake Range, which has little anthropogenic disturbance.
- **Replication of Ungulate-Wolf Winter Distribution Surveys** in three potentially effected boreal woodland caribou ranges and the Charron Lake Range, to also assess and compare predator and ungulate overlap as a potential for increased predation risk from grey wolf.
- **Replication of Multi-Species Aerial Survey** along transects paralleling the BPIII segments N1, N2, N3, N4, and north half of C1. Coarse scale assessment of ungulate and grey wolf overlap to assess predation risk was undertaken through kernel density estimates. Use and/or avoidance of the ROW included the analysis of distance and density values.
- **Winter Ground Track Transect Surveys** were replicated on 39 transects as part of Operation monitoring.
- **Human Access** along Multi-Species Aerial Transects was evaluated to assess potential disturbance along the BPIII ROW during Operation.

The following is a summary of results for the Operational Phase and comparisons to previous monitoring results:

Boreal Woodland Caribou Population Demography

Trends in calf/cow ratios increased during the 2020 surveys conducted from 2015 – 2020 in the P-Bog, Wabowden, and Charron Lake caribou study areas. The largest increase occurred in the P-Bog range from an average of over 20 calves/100 cows (2015 – 2018) to 54 calves/100 cows in 2020. Similar trends were found for Wabowden (43 calves/100 cows) and Charron Lake (37 calves/100 cows). The Naosap-Reed (N-Reed) range survey results are consistent throughout years, with a slight increase in 2020 (33 calves/100 cows) from 2019 (16 calves/100 cows). The data do not illustrate any decline in calf recruitment from construction to Operation phases, and the range and variation between years is expected given annual variation resulting from various environmental factors including weather and conditions favorable for predators.

Altered Predator-Prey Dynamics – Ungulates and Wolves - Boreal Woodland Caribou Study Areas

Density kernels developed for the Operational phase using observation data from the Ungulate-Wolf Distribution Survey for each woodland caribou survey provided statistics of overlap for ungulate prey and wolf occurrence. The results illustrate similar patterns for previous years of monitoring. Predation risk between caribou survey areas are variable and when comparing risk to the Charron Lake range, there is no evidence of predator/prey overlap being influenced by the BPIII Project.

Distribution and Occurrence (Ungulates and Wolves) From Multi-Species Aerial Transects – Disturbance and Predation Risk

Linear regression analyses were performed on data pooled over the entire study area (including sensitive moose areas). Additional analyses were also conducted for the northern transects and sensitive moose areas. As part of examining potential trends in species distribution over such a large landscape, the vegetation habitat relationships for all observed species and human activity was also assessed.

Results of pooled data for the Operational phase did not show any significant effects on caribou, wolves, or elk. Moose relationship with distance to the BPIII ROW was significant with some observed avoidance near the ROW, however, this was best explained by vegetation and habitat characteristics. In the northern transects and special moose areas, there is no evidence of displacement due to the BPIII Project with all results being not significant and distribution best explained by habitat. Results are similar to previous reports and substantially support the conclusion that vegetation-habitat relationships rather than proximity to ROW explain species distributions.

Distribution and Occurrence - White-tailed Deer Ingress

Distribution and ingress of white-tailed deer and the potential effects of increased *Parelaphostrongylus tenuis* (*P. tenuis*) infection rates have been undertaken in previous years monitoring, specific to deer monitoring areas. White-tailed deer monitoring in 2020 included mapping observations from all surveys. Review of distribution and occurrence in previous years do not suggest any observable increase in numbers, or range expansion into boreal caribou ranges.

Furbearers (Winter Ground Transect Survey) – Disturbance/Displacement

The relationship between furbearer (and larger mammal) track abundance along the Winter Ground Track Transect Survey lines and distance to the BPIII alignment was analyzed using Generalized Additive Models (GAMs), and were attempted for nine most common species, but only the first four (Hare, Ermine/Weasel, Fisher/Marten, and Squirrel) had sufficient sample size to provide robust models. Linear multiple regressions were also performed, and vegetation composition assessed. Analysis indicated an edge effect (the 500 m transect in the ROW), however avoidance beyond the ROW is not significant for the four groups. Results for the Operational phase were consistent with previous construction phase monitoring and showed no relationship with distance to the BPIII ROW with vegetation contributing to distribution and occupation.

Human Access Monitoring – Disturbance/Displacement – Increased Mortality

Human activity relationship with distance for the BPIII ROW was examined using regression methods on the snowmobile tracks, as well as multiple regressions using vegetation covariates. Coefficient for distance from ROW was not significant. Analysis of vegetation classes indicate a strong association between human activity and dense deciduous cover, and this likely reflects the fact that human activity is greatest in the southern region of study area where deciduous stands are more common. Trailheads in deciduous and upland areas are also typically more accessible by existing road networks, and likely influencing the landcover-human activity relationship. There was no evidence that the BPIII ROW is influencing or attracting greater human activity; the relationship between snowmobile tracks and the alignment was not significant, instead, trends in human activity are explained by vegetation/landcover. Additional results on human access monitoring from trail camera data are presented in Part B including summaries and maps.

Monitoring and Mitigation Recommendations

- Overall monitoring and mitigation recommendations are presented in Part B in consideration that year 6 is the last year of major data collection. Combined results of Part A and B contribute to these overall recommendations.

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ARD	Manitoba Agriculture and Resource Development
BPIII	Bipole III
EIS	Environmental Impact Statement
EOSD	Earth Observatory for Sustainable Development
ESS	Environmentally Sensitive Sites
GAM	Generalized Additive Models
GHA	Game Hunting Area
MB Hydro	Manitoba Hydro
MB Gov	Government of Manitoba
NDVI	Normalized Difference Vegetation Index
N-Reed	The Reed portion of the Naosap-Reed boreal woodland caribou population
P-Bog	The Bog (The Pas North-South) portion of the Pasquia-Bog boreal woodland caribou population
PCA	Principal Component Analysis
ROW	Project Right-of-Way
WMU	Wildlife Management Unit
VEC	Valued Ecosystem Component
ZOI	Zone of Influence

1.0 INTRODUCTION

Manitoba Hydro (MB Hydro) was granted an Environment Act License by the Government of Manitoba (MB Gov 2013) on August 14, 2013 for the construction, operation, and maintenance of the Bipole III (BPIII) Transmission Project (the 'Project'). Clearing for the Project began during the winter of 2013-14, the Construction phase was completed in July 2018, and the Project is now in the Operational phase.

Terrestrial mammal Project effects focused on caribou, moose, and furbearers (CEC 2013). The regulatory review of the Environmental Impact Statement (EIS) identified various potential negative effects as a result of the Project Construction and Operation. For ungulates, concerns were related to habitat alteration, access, and human activity that could lead to displacement and higher than normal rates of mortality known as apparent competition.

The theory of 'apparent competition' was first advanced by Bergerud (1967) to explain observed and negative population response of predator and prey. Holt (1977) presented a general mathematical framework to explain how dynamic functional relationships between two prey species, that share a common food-limited predator, could lead to a shift in the equilibria density of the predator, and differentially impact the population densities of each prey species. This theory is known to explain the decline of woodland caribou populations that have been exposed to higher wolf densities arising from disturbance and human development (Bergerud and Elliot 1986). More recently, the theory has been adopted to account for several woodland caribou population declines throughout various boreal and southern mountain caribou ranges in Canada, based on the premise that widespread anthropogenic landscape disturbances (e.g. forest harvesting, energy exploration, and development) favoured higher moose and wolf population densities on the periphery of caribou ranges, thereby effecting a shift in the equilibria balance (Serrouya 2019; Holt et al. 1994).

Mammal Valued Ecosystem Components (VECs) were selected based on their ecological, cultural, and economic importance and associated potential effects related to the Project. These included boreal woodland caribou, forest-tundra woodland caribou, barren-ground caribou, moose, elk, white-tailed deer, grey wolf, black bear, and furbearers (including beaver, wolf, wolverine, and marten).

2.0 MONITORING OBJECTIVES AND FRAMEWORK

Monitoring objectives described below include those for both Part A and Part B reports. The objectives of the overall monitoring plan are to:

- Confirm the nature and magnitude of predicted environmental effects as stated in the EIS;
- Assess effectiveness of mitigation measures implemented;
- Identify unexpected environmental effects of the Project, if they occur;
- Identify mitigation measures to address unanticipated environmental effects, if required;
- Confirm compliance with regulatory requirements including approval terms and conditions; and
- Provide baseline information to evaluate long-term changes or trends.

The BPIII mammals monitoring program provides a framework to address multiple assessment objectives for each mammal VEC. These include spatial and temporal monitoring activities for each phase of the Project to assess if potential effects identified in the EIS and regulatory review are measurable and if mitigation and adaptive management actions have accomplished their objective to minimize potential effects relative to disturbance, displacement, increased mortality or negative population responses via apparent competition.

Specifically, detailed monitoring objectives for caribou, moose, deer, elk, furbearers and predators for all phases of the Project are found in Appendix 1 Table 1-Appendix 1 Table 6.

Based on the commitments outlined by MB Hydro in the Project EIS, the overall objectives of the mammals monitoring program include (Mammals Monitoring Program Technical Report Year 5 (2020):

1. *Expanding baseline knowledge of select mammal VECs interacting with the Project including estimates of population distribution, population abundance, habitat use and movement patterns, identification, and fidelity of critical habitat sites.*
2. *Ensuring compliance with regulatory requirements and EIS commitments.*
3. *Monitoring and measuring select mammal VEC responses to Project Right-of-Way (ROW) Construction and Operation including disturbance / avoidance from sensory disturbance, direct and functional habitat loss, changes in population vital rates or demographics, and/or changes in predator-prey community dynamics.*
4. *Ensuring that mitigation measures, management activities, and restoration / enhancement measures are implemented.*

5. *Monitoring the level of success or effectiveness of mitigation measures with respect to reducing ROW effects on mammal VECs.*
6. *Identifying, measuring, and then mitigating and monitoring any unforeseen effects.*

2.1.1 Boreal Woodland Caribou

Caribou monitoring plan objectives (Appendix 1 Table 1) are to:

1. Expand baseline knowledge of distribution, abundance and population characteristics of boreal woodland caribou interacting with the Project.
2. Investigate Project influence on woodland caribou at local and range (P-Bog, Wabowden, N-Reed, and Charron Lake) scales.
3. Assess effectiveness of mitigation measures.
4. Investigate the influence of Project effects on mortality (predation and/or hunting and/or vehicle collisions) on boreal woodland caribou (P-Bog, N-Reed, Wabowden, Charron Lake populations), forest-tundra woodland caribou (Penn Islands and Cape Churchill populations) and barren-ground (Qamanirjuaq) caribou populations interacting with the Project.

2.1.2 Moose

Moose monitoring plan objectives were updated in MB Hydro 2019 and are presented in Appendix 1 Table 2. Note that results related to moose monitoring objectives are included to some extent in Section 5.0 of this report however subsequent Part B report will include additional moose monitoring analysis and results.

1. Determine changes (pre- vs. post-construction) to the quantity of potential moose browse along the ROW within the three sensitive moose ranges (Tom Lamb Wildlife Management Unit (WMU)/Game Hunting Area (GHA) 8, Moose Meadows (Bellsite Swamp in GHA 14) and Pine River GHA 14A/19A) using remote sensing (Normalized Difference Vegetation Index or NDVI data).
2. Expand baseline knowledge of distribution (relative to the ROW).
3. Investigate changes in population abundance trend over time of populations intersected by the Project (i.e., the three sensitive moose ranges and Split Lake population) relative to adjacent populations.
4. Investigate the Project influence of the ROW as a wolf travel corridor.
5. Investigate human presence along the ROW.
6. Determine changes in the Project related to vehicle-moose collisions.

2.1.3 Deer and Elk

Deer and Elk monitoring plan objectives (Appendix 1 Table 3) are to:

1. Monitor presence of *Parelaphostrongylus.tenuis* (*P. tenuis*) and thereby change in risk to ungulates in relation to Project-related change in white-tailed deer distribution (i.e., potential deer ingress into woodland caribou local population ranges).
2. Assess Project-related change in mortality risk (harvest, predation, vehicle collisions) to elk because of altered Project access, sensory disturbance and/or habitat alteration.

2.1.4 Wolf and Black Bear

Wolf and black bear monitoring plan objective (Appendix 1 Table 4) is to assess changes in predation-risk to woodland caribou and moose due to the Project effects on predator occurrence and distribution.

2.1.5 Furbearers

Furbearer monitoring plan objective (Appendix 1 Table 5) is to assess Project-related changes in furbearer harvest statistics, furbearer occurrence and distribution relative to changes in the Project access and associated habitat disturbance, with particular attention to beaver, marten, wolf, wolverine, and Environmentally Sensitive Sites (ESS; black bear dens, wolverine dens, wolf dens and rendezvous sites).

2.1.6 Human Access

Human access monitoring plan objective (Appendix 1 Table 6) is to assess changes in access to the Project area by humans.

2.1.7 Adaptive Management Framework

Adaptive Management was originally developed in the late 1970's as a formal, rigorous stepwise scientific tool to assist managers in the design, implementation and testing of management prescriptions that have a degree of uncertainty and risk (Holling 1978). Adaptive Management, by definition, is the process of defining management problems, hypothesizing how ecosystems work, identifying affordable paths to reduce uncertainty and risk, comparing results with predicted outcomes. The identification of information gaps, adapting with refined approaches to monitoring is a basic principle of Adaptive Management (Lancia et al. 1996).

There are constraints including sufficient time and resources to reduce ecological uncertainties and risks, and equally to reach out to stakeholders in meaningful ways at each and every step from problem identification to the refinement of future actions to maximize both support and acceptance (Walters 1986). Adaptive Management in the context of the BPIII monitoring program has involved annual review of monitoring results with regulators to determine efficiencies in data collection and analysis to provide direction or modification to the monitoring program.

The BPIII Biophysical Monitoring Plan (MB Hydro 2018) includes the implementation of adaptive management strategies that have guided and informed Project mitigation activities (habitat management and timing of Construction phase activities) and modifications to monitoring to minimize potential Project effects and create efficiencies relative to survey designs and effort throughout the various phases of the Project. Adaptive Management principles and objectives for the BPIII Monitoring Project have been outlined in previous reports and include:

1. *Baseline monitoring is intended to identify temporal and spatial variability within an ecosystem, biological community, or population to understand the historical range of variability prior to disturbance by BPIII. Baseline monitoring will continue in areas prior to Construction phase and clearing the ROW. After Construction, baseline monitoring will be focused in reference areas outside of the Project ZOI (Zone of Influence).*
2. *Effects monitoring investigates the influence (extent and magnitude) of disturbance-related Project effects on the habitat, population and/or community level components for each mammal VEC. Reference or control sites will be used where feasible to allow for effects of the Project to be disseminated from natural variation. Assessment of pre-disturbance condition to post-disturbance is used to assess the Project effects and mitigation effectiveness.*
3. *Effectiveness monitoring is conducted by measuring or estimating the effectiveness of mitigation measures, management activities, habitat restoration and enhancement measures. Where mitigation measures are not providing adequate protection for mammal VECs or their habitat, monitoring results will be used through a passive adaptive management framework to modify or identify new strategies to employ.*
4. *Implementation monitoring will be undertaken to ensure that mitigation measures were implemented as specified in the EIS, technical reports and EA License and that activities are compliant with applicable provincial and federal environmental legislation. Implementation monitoring is used to track the implementation of mitigation measures, management activities, and ecological restoration and enhancement measures identified in the EIS commitments. This inspection is largely completed by environmental inspectors overseeing the Construction of the ROW.*

2.2 Study Design

The Operational monitoring conducted in year 6 are based on the commitments described in the BPIII Biophysical Monitoring Plan (2018). As outlined above, emphasis includes monitoring on boreal woodland caribou, moose, predation (apparent competition), loss of functional habitat due to disturbance and effects on furbearers on three main components: (1) Habitat Effects; (2) Population Effects; and (3) Community Effects.

The following Section describes the details of monitoring activities for the components of this report. Additional analysis of trail camera data and caribou telemetry is planned and will be incorporated into this report and/or a part B.

3.0 MONITORING ACTIVITIES

Operational monitoring activities and analysis have replicated, and augmented previous surveys conducted within the Boreal Shield and Boreal Lowlands Ecozones (Map 1). Monitoring activities conducted through the life of the Project to date:

- **Pre-monitoring (2013/14)** - conducted by MB Hydro in 2013/14 including review of existing information and acquisition of baseline datasets from the Project EIS regulatory review, associated technical reports and the BPIII Transmission Project Biophysical Monitoring Plan (MB Hydro 2018).
- **Construction Phase (2014 to 2018)** - Annual mammals monitoring reports were prepared and submitted to regulating authorities for all years of construction (Mammals Monitoring Program Technical Report Years 1-5 (2015, 2016; 2017; 2018; 2019).
- **Operation Phase (mid 2018 – winter 2020)** - data from caribou recruitment surveys, multi-species aerial transects along selected portions of the BPIII ROW and ground snowshoe track transects.

3.1 Field Activities – Year 6 (2019/20)

The following is a summary of field activities conducted for year 6 and the associated data analysis for the Operational phase monitoring 2019/2020 reported on the selected components found in this report.

1. **Woodland Caribou Recruitment Surveys** aided by GPS telemetry collar relocations, to obtain winter calf recruitment estimates and population structure in four boreal woodland caribou ranges (P-Bog, N-Reed, Wabowden, and Charron Lake).
2. **Ungulate-Wolf Winter Distribution Survey** of each boreal woodland caribou study area (P-Bog, Wabowden, N-Reed, and Charron Lake) to collect information on ungulate, wolf, and wolverine relative landscape distribution, and to assess changes in predator-prey relationships.
3. **Multi-species Aerial Survey** provides coarse local scale information to assess large mammal winter distribution proximate to the BPIII ROW, and to assess *P. tenuis* risk to woodland caribou during winter in relation to changes in deer and elk distribution along the BPIII ROW. The survey was conducted January 12 to 20 and February 11 to 14, 2020 by MB Hydro.
4. **Winter Mammal Ground Tracking Transect Surveys** to assess fine scale occurrence of furbearer VECs relative to the ROW during the Project Construction and Operation phases. All 40 camera transects in construction segments N1-N4 were sampled February 5 to 11, 2020.

5. **Human Access Monitoring** involved assessment of snowmobile and trail observations from the multi-species aerial transect surveys. Assessment of trail camera data from ground transects is included in Part B report.

4.0 METHODS

The following section summarizes field and analytical methods used to quantify and compare results from the Pre-construction phase (2010 to November 2014), the Construction phase (December 2014 to July 2018), and first and second year of the Operational phase (August 2018 to July 2019 and winter 2020).

4.1 Boreal Woodland Caribou

Three woodland caribou ranges (P-Bog, N-Reed, and Wabowden) have been identified as potentially interacting with the BPIII Project. In addition, Charron Lake is used as a reference for comparisons of population demography and predator risk to an undisturbed woodland caribou range. Map 2 provides an overview of the study areas for these ranges where aerial recruitment surveys and ungulate/predator distribution surveys have been conducted. Results of telemetry studies will augment the findings in this report and will be reported on separately.

4.1.1 Aerial Surveys

Woodland Caribou Recruitment Survey - Annual winter calf recruitment, population structure and distribution were assessed throughout the Construction and Operation phase (year 5 and 6). The survey involved replication of previously identified transects spaced at 3 km intervals oriented in an east-west direction (Map 2). All transects were flown by helicopter at ±200 m ground height and approximately 90 km/hr to identify caribou and caribou sign (tracks and cratering), and moose and wolf observations and tracks. Guidelines for surveys require a minimum of 20 cm snow cover and minimal overcast to provide contrast to identify fresh tracks and maximum detectability. Using last locations from collared caribou downloaded the previous day, telemetry tracking was used to locate caribou and classify all individuals into sex and to determine number of calves per cow within the group. Standard protocols to reduce stress on animals included requirement for experienced observers, short observation times, and flying as high as possible. Animals were categorized into age and sex classes based on vulva patch / penis sheath, and size in proximity to adult cows (calves). Number of calves, adult females, adult males, and un-classified individuals were documented.

4.1.2 Ungulate-Wolf Distribution Surveys in Woodland Caribou Survey Areas

Landscape scale predation risk was assessed from caribou, moose, and wolf observations obtained during the recruitment surveys along the previously designated transects for each Woodland Caribou Recruitment Survey area as shown on Map 2. These data included the pooled Operational phase surveys (2019 and 2020) and both sightings and track identification to assess potential predation risk. Surveys were conducted during the first 4 years of the Construction phase in winter (between January and February 2014-2018), followed by the next 2 years of Operational phase in winter (between January and February 2018-2020). These results were compared to Construction phase results to determine any measurable change in predation risk during the Operation phase.

Predation risk was based on utilization densities derived from kernel analysis and visual assessment using violin plots and non-parametric tests of distance to wolves for ungulate species. Kernel analysis of all fresh tracks and observations for caribou, moose, and wolves were derived utilizing the R package adeabitatHR (Calenge, 2006). This package was also used to assess different components of overlap in the utilization distributions (following Fieberg and Kochanny 2005). These included: volume (volume of the intersection between the utilization distributions); area (the area of the intersection between the utilization distributions), and probability (the probability of finding another species in the utilization distribution of the first). Predation risk and transmission corridor effect were also assessed by examining distance to wolves for ungulate species. Predator-prey distances were visually examined using violin plots (R Package vioplot, Adler and Kelly, 2020), which are a are refinement of the boxplot methods used in previous reports. These plots provide similar statistical summaries as boxplots, but unlike boxplots, the width of the violin is proportional to the number of observations for values along the vertical axis (Hintze and Nelson, 1998). For predator-prey distances, if the widest portion of the violin is close to the bottom of the vertical axis, the majority of distances are short (i.e. wolves are close to prey) and conversely if the widest portion is near the top of the vertical axis, most distances are long (i.e. wolves are far from prey). Wilcoxon rank sum tests with continuity correction (R Core Team, 2020) were also performed on these data to determine if distances to wolves differed significantly for prey species. In combination, these analyses and graphs can provide evidence of relative predation risk for these species at the time of survey.

In assessing landscape scale predation risk, kernels were also developed using data collected for the multi-species distribution surveys. The methods and software used in performing the kernel and statistical analysis for these data are identical as those described above, with the exception that for areas where more than two ungulate species were present, Kruskal-Wallis rank sum tests were performed instead of the Wilcoxon tests. To facilitate comparisons given that different flight-line spacing was used in the north compared with the south survey areas (with additional strips in sensitive moose areas), the aerial surveys were stratified into northern transects (largely associated with coastal caribou ranges), The Pas North-South (P-Bog and sensitive moose area by The Pas), and south mountain transects (sensitive moose areas adjacent to the Porcupine and Duck Mountains and agricultural corridor between them. This stratification also corresponds with the major changes in land-use, geomorphology, ecosystems and climate that occur over the length of the surveyed transects.

4.2 Multi-species Distribution Surveys for Ungulates and Wolves (Transects Parallel to the Bipole III ROW)

These surveys provide coarse scale winter and local distribution data on medium and large furbearer species (i.e. wolf and wolverine) species in proximity to the ROW, and predator-prey distribution (i.e., ungulates and wolf). These data were also utilized to inform potential *P. tenuis* risk to woodland caribou in relation to changes in deer and elk distribution along the ROW (Section 4.5). Surveys for pre-construction (2013-2014), were conducted by fixed-wing aircraft. In the first year of Construction (2014/15), no aerial survey was conducted. Winter surveys using helicopters were conducted in years 2-4 of Construction phase (between January and February 2015-2018) and the next 2 years of the Operational phase (between January and February 2018-2020). Map 3 provides a summary of the for BPIII 2014 – 2020 multi-species aerial transect survey design.

The replicated surveys were conducted based on 500 m wide transect strips parallel to the ROW centered on distances of 0.25 km, 1.25 km, 3.25 km, 5.25 km along construction segments N1, N2, N3, N4 and north half of C1 construction segments. Additional strip transects were flown at 10.25 km from the ROW in the sensitive moose areas (Pine River/GHA 14A/19A, Moose Meadows, and Tom Lamb WMU/GHA 8) and along the ROW from Thompson (northern portion of N2 construction segment) to the Keewatinohk Converter Station (N1 construction segment) (Maps 4-5). Along these transects species occurrences and human activity (mainly snowmobile trails) were recorded based on tracks or sightings of individual animals. Final values were expressed as number of observations per 10 km and log transformed to meet parametric assumptions for normality in subsequent analyses.

In addition to species distributional data, vegetation-habitat condition was also assessed for the transects using Principal Component Analysis (PCA; Legendre and Legendre, 2012). Vegetation-habitat characteristics were based on the Canada-wide Earth Observatory for Sustainable Development (EOSD) dataset as in used previous reports. Vegetation condition was expressed as percent cover within a 250 m radius disk centered on each observation (500 m diameter). PCA was performed in CRAN R on the log-transformed percent cover data using centered and z-standardized values (R Core Team 2020). These results were summarized using a biplot displaying the major trends in vegetation trends relative to species and human activity observations. To facilitate a refinement of the visual assessment of the PCA results in previous reports, the observations were color-coded by observation type.
To provide an analysis that was robust with respect to sample size, analyses were performed on data pooled over the entire study area. However, to account for different flight-line spacing used in the north and to provide a more focused analysis for the sensitive moose areas, the aerial surveys were stratified into northern transects (largely associated with coastal caribou ranges),

and sensitive moose areas transects. As with the stratification used to assess wolve predation risk, this stratification also corresponds with major changes in land-use, geomorphology, ecosystems and climate occurring over the length of the surveyed transects.

Aerial transects were analyzed to determine the relationship between species occurrence and distance to the BPIII alignment including human activity. To examine the potential influence of the BPIII alignment, linear regression of species abundance with distance to the ROW was performed. To incorporate the influence of vegetation, multiple linear regression was also performed by including percentage cover of all EOSD vegetation classes in addition to distance to the ROW. To reduce model bias for species with few observations relative to the number of vegetation classes, composite vegetation axes derived from PCA were developed (following Legendre and Legendre 2012).variables as added For all regression models, residuals (using the Base and MASS packages), outlier analysis (Car Package), Cook's distance (Base and MASS Packages), and k-fold cross-validations (DAAG Package) were performed or examined in CRAN R (R Core Team 2020) to determine if the data met the assumptions of the modelling framework.

4.3 White-tailed Deer Ingress

Deer ingress and elk occurrence along the ROW were assessed through mapping and assessment from the following methods compiled in this report and include:

1. Winter Ground Track Transect Survey of N1, N2, N3 and N4 construction segments;
2. Ungulate-Wolf Distribution Survey of woodland caribou study areas concurrent with the annual Woodland Caribou Winter Calf Recruitment Survey;
3. Multi-species Aerial Surveys, and;
4. Incidental observations of deer and deer sign by the Project Environmental Monitors.

4.4 Furbearers - Winter Ground Track Transect Surveys (Distribution)

Annual winter ground transect intercept sampling was undertaken to compare furbearer occurrence (by species) as a function of the distance to the Project during the Construction and Operation phase to quantify local behaviour relative to the Project installation. Sampling is focused on those furbearer species that are active in winter on terrestrial habitat (excludes black bear, beaver, muskrat). The data are used to determine whether there is evidence of local displacement of furbearer species relative to the Project location. Analysis is focused on quantifying patterns over time starting in the Construction phase as local furbearer track data relative to the Project footprint during the Pre-disturbance phase is not available for locations where the Project ended up being installed on the landscape. This analysis assesses local furbearer responses to the Project installation; quantifying furbearer species distribution along the ROW was undertaken through the multispecies aerial survey.

Winter ground transect intercept sampling was conducted in the construction segments (N1-N4) during the first 4 years of the Construction phase (February or March 2014-2018), followed by the next 2 years of the Operational phase (February 2019-2020). It included concurrent deployments of remote cameras, or servicing of deployed cameras with new memory cards and batteries (One placed near the ROW at the start of the 1,000 m segment and a second placed at the far end of the 1,000 m segment). The cameras are intended to collect supplementary data on mammal VECs and human access across seasons.

The initial ground transect intercept sampling design (Construction) was undertaken on 80 transects that utilized L-shaped design spaced at approximately 10 km intervals along construction segments N1 - N4 of the ROW. Operational monitoring was conducted on 39 replicate transects based on review of previous year's results and constraints resulting from weather, staff resources and budget (Map 6). Each L-shaped transect includes a 500 m segment placed diagonally along the ROW, and a 1,000 m segment place perpendicular to the ROW; with the direction from the ROW initially selected at random.

The relationship between track abundance and distance to the BPIII alignment was examined by summarizing the observations along each transect expressed as number of tracks per 200 m transect segment as done in previous reports. These values were log transformed to meet parametric assumptions of normality in subsequent analyses. Abundance relationships were modelled using regression analyses with presence-only data similar to previous reports. These included linear regression as well as multiple linear regression and Generalized Additive Models or GAM (Yee and Mitchell 1991), using the GAM package in R for species with a sufficient sample size to provide a robust model. Multiple regressions were based on the use of site vegetation composition as covariates. Vegetation condition was determined using the Canada-wide EOSD dataset as in previous reports. Rather than creating binary dummy-variables, vegetation condition was expressed as percent cover along each 200 m segment. This permitted the incorporation of all cover types within a multiple regression-based framework for species with a large sample size. To include vegetation covariates for species with few observations, composite constructed axes were generated by first calculating scores on the top two PCA axes for each site based following Legendre and Legendre (2012). These composite axes were also utilized in calculation of GAMs for common furbearer species. For all regression models residuals (Base and MASS packages), outlier analysis (car Package), Cook's distance (Base and Mass Packages), and k-fold cross-validations (DAAG Package) were performed in CRAN R (R Core Team 2020) and examined to determine if the data met the assumptions of the modelling framework.

4.5 Human Access Monitoring

Annual winter ground transect intercept sampling undertaken to collect furbearer data also provided opportunity to collect human access and activity data across seasons through trail camera deployments. Analysis of trail camera data will follow in in part B report.

For this report, human access monitoring data was supplemented with aerial multi-species survey observations. Human access data collected via aerial multi-species survey analysis primarily considered the snowmobile tracks that were measured during the aerial transect surveys. Distance to the nearest snowmobile track for every mammal track (or animal) location was calculated, and the distributions were examined using violin plots. Summary statistics were calculated, and the Kruskal-Wallis rank sum test was performed to determine if distance by species was significantly different. A Pairwise comparisons using Conover's all-pairs test was then performed to determine any pairs of species that might have significantly different distributions. To examine the effect of distance to the BPIII alignment on human activity, linear and multiple linear regressions similar to the approach used to examine species trends were performed. Results are also illustrated using Violin Plots as described above. Further analysis of human activity from trail camera data are provided in Part B as well as overall summaries and conclusions and monitoring recommendations.

5.0 RESULTS AND DISCUSSION

5.1 Ungulates

This section focuses primarily on boreal woodland caribou monitoring results. Note that results related to moose monitoring objectives are included to some extent however Part B report will include additional moose monitoring analysis and results.

5.1.1 Boreal Woodland Caribou Population Demography

Trends in calf/cow ratios increased during the 2020 surveys conducted from 2015 – 2020 in the P-Bog, Wabowden, and Charron Lake caribou study areas. The largest increase occurred in the P-Bog range from an average of over 20 calves/100 cows (2015 – 2018) to 54 calves/100 cows in 2020. Similar trends were found for Wabowden (43 calves/100 cows) and Charron Lake (37 calves/100 cows). The N-Reed range survey results are consistent throughout years, with a slight increase in 2020 (33 calves/100 cows) from 2019 (16 calves/100 cows), however overall counts were down in 2020 (from 117 in 2019 to 40 in 2020). There was track based evidence that caribou were occupying areas south of the N-Reed survey block. Time since new snow in this block was longer than other survey areas and search times following tracks was extended to ensure an accurate count within the block. The data do not illustrate any decline in calf recruitment from Construction to Operation phases, and the range and variation between years is expected given annual variation resulting from various environmental factors, including weather and conditions favorable for predators.

Table 1 provides a summary of recruitment survey results. Adult female survival is not included as mortality data will be included in future assessments.

Table 1: Summary of annual population structure and winter calf recruitment for Boreal Woodland Caribou from mid-winter aerial surveys and telemetry study

Caribou Range	Year	Number of Caribou Observed					Bulls/100 Cows	Calves/100 Cows	Calves/100 Adults	% Calves
		Bulls	Cows	Calves	Unknown	Total				
P-Bog	2015	12	53	13	4	82	22.6	24.5	20.0	16.7
	2016	5	49	11	1	66	10.2	22.4	20.4	16.9
	2017	6	49	11	0	67	12.2	22.4	20.0	16.7
	2018	22	55	14	1	92	40.0	25.5	18.2	15.4
	2019	4	29	5	0	37	13.8	17.2	15.2	13.2
	2020	19	37	20	4	80	51.4	54.1	35.7	26.3
N-Reed	2015	15	52	11	5	81	28.8	21.2	16.4	14.1
	2016	1	25	11	0	37	4.0	44.0	42.3	29.7
	2017	13	50	13	0	76	26.0	26.0	20.6	17.1
	2018	23	35	13	0	71	65.7	37.1	22.4	18.3
	2019	42	56	9	0	107	75.0	16.1	9.2	8.4
	2020	15	18	6	1	40	83.3	33.3	18.2	15.4
Wabowden	2015	17	61	15	7	100	27.9	24.6	19.2	16.1
	2016	24	68	14	1	2.7	35.3	20.6	15.2	13.2
	2017	10	44	9	0	63	22.7	20.5	16.7	14.3
	2018	18	55	11	1	85	32.7	20.0	15.1	13.1
	2019	12	46	8	0	66	26.1	17.4	13.8	12.1
	2020	19	56	24	0	99	33.9	42.9	32.0	24.2
Charron Lake	2015	19	50	16	2	87	38.0	32.0	22.5	18.8
	2016	58	131	23	0	212	44.3	17.6	12.2	10.8
	2017	39	108	17	11	175	36.1	15.7	10.8	10.4
	2018	55	114	20	1	190	48.2	17.5	11.8	10.6
	2019	54	109	34	11	207	49.5	31.2	20.9	17.3
	2020	66	142	53	16	277	46.5	37.3	25.5	20.3

5.1.2 Altered Predator-Prey Dynamics – Ungulates and Wolves

5.1.2.1 Wolf Predation-risk – Boreal Woodland Caribou Study Areas

Landscape Scale – For Operation Phase

Density kernels were developed using observation data from the Ungulate-Wolf Distribution Survey for each woodland caribou survey area and the overlap of ungulate prey and wolf occurrence was measured (following Fieberg and Kochanny 2005). Volume (volume of the intersection between the utilization distributions), area (the area of the intersection between the two home ranges), and probability (the probability of finding another species in the home range of the first) were calculated. Additionally, the distance to wolf was tested using non-parametric tests to determine if distances differed for prey species. In combination, these can provide evidence of relative predation risk for these species at the time of survey.

- **Charron Lake Survey Area** (Figure 1; Table 2, Map 7) – Similar patterns in abundance and distribution as in previous years: moose occurrence was minimal compared to woodland caribou. Caribou were distributed throughout study range, resulting in higher core area overlap and greater volume intersection with wolves than moose. However, probability of moose occurring in wolf core areas was greater. This is supported by the results of the distance analysis, where there is evidence that the distance to wolves differ between prey species, with moose having a lower median distance. Caribou distance from wolves had a greater range than moose as evident in the violin plots. Results suggest that wolves are distributed on the landscape to predate both species, with some evidence that moose were at greater predation risk during the period of the survey.
- **P-Bog Survey Area** (Figure 1; Table 3, Map 8) – As in previous years, distribution and occurrence of moose was minimal within the study area. Kernel overlap had similar trend as found in the Charron Lake study area. Caribou are well distributed across the range resulting in larger volume and area overlap with wolves than moose, but lower probability of encounter. This is supported by the analysis of distance to wolves for caribou and moose. Additionally, caribou distance from wolves had a greater range than moose as evident in the violin plots. There is evidence that the species differ in terms of distance to wolves, with moose having a lower median value. Wolves are distributed on the landscape along the moraine to provide access to both species, with moose at a higher overall risk during the time of the survey. Overlap of moose, wolves, and caribou near the transmission corridor was not observed, and indicated no evidence of increased predation risk.
- **N-Reed Survey Area** (Figure 1; Table 4, Map 9) – More caribou than moose were observed in the study area, as with previous years, although moose abundances were higher than the other study sites. Trends in encounter probabilities are the opposite of what was found in Charron and P-Bog, with moose having a lower probability but the difference is small (0.26 compared to 0.28). Analysis of distance to wolves found no significant difference. This is further supported by the distributions of caribou and moose distances from wolves having similar shape in the violin plots, although moose have a longer tail. Wolves are well-distributed across the landscape with access to both prey species. No evidence of increased predator and prey overlap, resulting from the transmission corridor, was observed.
- **Wabowden Survey Area** (Figure 1; Table 5; Map 10) – Total number of animals/tracks observed in Wabowden was lower than the other ranges during the study period. Most caribou were clustered in the north-east of the study area. This resulted in some of the lowest values for overlap statistics. However, because of wolf proximity to the caribou

cluster, encounter probabilities were higher for caribou than moose. This is also supported by the analysis of distance to wolves. There is evidence that moose and caribou distances differ with caribou having a lower median value compared to moose. Clustering of caribou is also evident in the violin plots with the distribution of distance tightly clustered close to the median. Although wolves are dispersed across the landscape to maximize access to prey, the proximity of wolf activity close to the large cluster of caribou potentially resulted in a greater risk of predation for caribou during the sample period. In Wabowden, a large cluster of caribou proximate to wolves likely increased predation risk during the sampling period, although conversely the actual kernel overlap and absolute probabilities were lower than other ranges. The BPIII alignment does not divide these ranges symmetrically (or at all in the case of Charron Lake), but there is no evidence that areas of predator and prey overlap are influenced by the location of the transmission corridor.

Table 2: Charron Lake kernel overlap, descriptive statistics, and non-parametric test of distance from wolves

CHARRON			
Kernel Overlap Statistics			
	Caribou	**Moose**	**Wolf**
Volume			
Caribou	0.9998733	0.4357196	0.3541235
Moose	0.4357196	0.9998733	0.311228
Wolf	0.3541235	0.311228	0.9998733
Area			
Caribou	1	0.2987014	0.179107
Moose	0.6054406	1	0.2126692
Wolf	0.4012758	0.2350719	1
Probability			
Caribou	0.6999965	0.6046023	0.449224
Moose	0.2474104	0.6999991	0.2149664
Wolf	0.1623267	0.2474237	0.6999959

Descriptive statistics by group and distance to wolf													
	vars	**n**	**mean**	**sd**	**median**	**trimmed**	**mad**	**min**	**max**	**range**	**skew**	**kurtosis**	**se**
Caribou	1	1028	8861.96	6429.54	6936.92	8047.35	4607.98	331.62	28668.86	28337.24	1.07	0	200.53
Moose	1	19	6017.34	4633.48	5124.34	5697.36	2875.84	834.56	16639.7	15805.13	1.22	0.28	1062.99

Wilcoxon rank sum test with continuity correction
Distance to wolf by caribou and moose
W = 12747, p-value = 0.02248
Alternative hypothesis: true location shift is not equal to 0
Evidence moose closer than caribou to wolves

Table 3: P-Bog kernel overlap, descriptive statistics, and non-parametric test of distance from wolves.

BOG			
Kernel Overlap Statistics			
	Caribou	**Moose**	**Wolf**
Volume			
Caribou	0.9998733	0.4898735	0.5158589
Moose	0.4898735	0.9998733	0.4753076
Wolf	0.5158589	0.4753076	0.9998733
Area			
Caribou	1	0.4513954	0.548073
Moose	0.4656411	1	0.5146613
Wolf	0.4862064	0.4425981	1
Probability			
Caribou	0.6999986	0.4202973	0.4072965
Moose	0.374081	0.6999951	0.3406531
Wolf	0.4189914	0.464105	0.6999992

Descriptive statistics by group and distance to wolf													
	vars	**n**	**mean**	**sd**	**median**	**trimmed**	**mad**	**min**	**max**	**range**	**skew**	**kurtosis**	**se**
Caribou	1	464	7082.9	4263.93	6146.81	6829.14	4293.5	398.4	16447.12	16048.71	0.49	-0.92	197.95
Moose	1	59	4986.66	2697.88	3778.51	4715.35	1403.85	1480.15	14664.4	13184.24	1.21	1.45	351.23

Wilcoxon rank sum test with continuity correction
Distance to wolf by caribou and moose
W = 17441, p-value = 0.0005984
Alternative hypothesis: true location shift is not equal to 0
Evidence moose closer than caribou to wolves

Table 4: N-Reed kernel overlap, descriptive statistics, and non-parametric test of distance from wolves.

N-REED			
Kernel Overlap Statistics			
	Caribou	**Moose**	**Wolf**
Volume			
Caribou	0.9998733	0.5064651	0.4280083
Moose	0.5064651	0.9998733	0.4777251
Wolf	0.4280083	0.4777251	0.9998733
Area			
Caribou	1	0.4483988	0.2805246
Moose	0.3212658	1	0.2408351
Wolf	0.2694926	0.3229206	1
Probability			
Caribou	0.6999976	0.2771007	0.2245911
Moose	0.4356594	0.6999972	0.3356469
Wolf	0.2858964	0.267988	0.6999967

Descriptive statistics by group and distance to wolf

	vars	n	mean	sd	median	trimmed	mad	min	max	range	skew	kurtosis	se
Caribou	1	477	3590.16	1487.67	3413.11	3608.66	1346.63	206.88	6791.14	6584.26	0.03	-0.5	68.12
Moose	1	91	3534.15	2400.32	3133.85	3285.12	1942.82	173.72	10446.9	10273.17	1.03	0.96	251.62

Wilcoxon rank sum test with continuity correction

Distance to wolf by caribou and moose

W = 23559, p-value = 0.196

Alternative hypothesis: true location shift is not equal to 0

No evidence moose or caribou are closer to wolves

Table 5: Wabowden kernel overlap, descriptive statistics, and non-parametric test of distance from wolves.

WABOWDEN			
Kernel Overlap Statistics			
	Caribou	**Moose**	**Wolf**
Volume			
Caribou	0.9998733	0.1710755	0.2181311
Moose	0.1710755	0.9998733	0.2844675
Wolf	0.2181311	0.2844675	0.9998733
Area			
Caribou	1	0.02770827	0.2332621
Moose	0.007180817	1	0.1301879
Wolf	0.067713132	0.14582595	1
Probability			
Caribou	0.69999035	0.02196578	0.08022578
Moose	0.08963498	0.69999545	0.11585945
Wolf	0.24805576	0.15250228	0.69999533

Descriptive statistics by group and distance to wolf

	vars	n	mean	sd	median	trimmed	mad	min	max	range	skew	kurtosis	se
Caribou	1	383	4192.62	2086.09	4261.79	4133.91	1838.54	283.67	10267.68	9984.01	0.41	0.4	106.59
Moose	1	77	7502.7	4503.44	6118.07	7271.37	4592.53	495.03	16718.36	16223.33	0.42	-0.88	513.22

Wilcoxon rank sum test with continuity correction
Distance to wolf by caribou and moose
W = 8321, p-value < 0.0001
Alternative hypothesis: true location shift is not equal to 0
Evidence caribou closer than moose to wolves

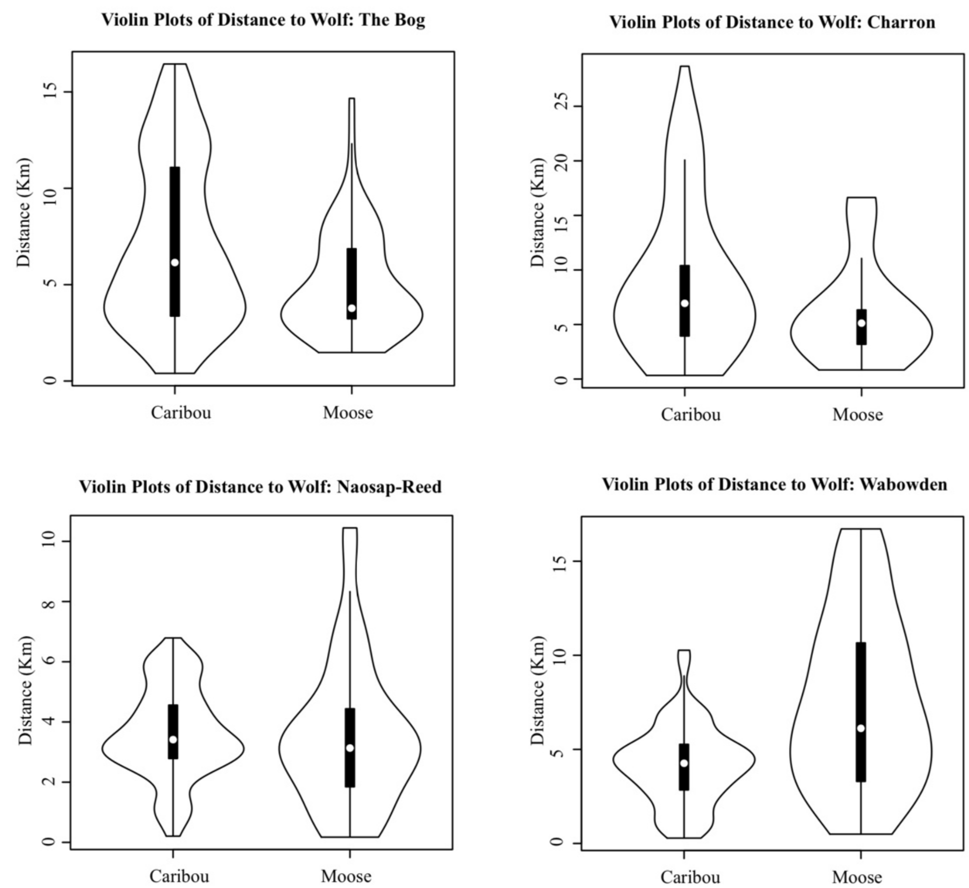


Figure 1: Violin plots distance to wolves for caribou and moose.
White dot represents medians, black bars the interquartile ranges, lines are drawn to 1.5 times the interquartile range or truncated to the minimum and maximum values if larger, and violin shape is drawn based on the observed distribution of distance values. At most sites caribou are further from wolves except for Wabowden (although for N-Reed the distributions are not significantly different).

5.1.2.2 Wolf Predation-risk and Ungulate distribution from Multi Species Surveys

Local Scale

Transect results are provided below. Previous reports pooled all aerial multispecies transects, however, to augment analysis of potential ROW effects, the analysis here are stratified (as describe in section 4.2). Comparisons between Construction and Operational phases in the spatial distributions of species overlap did not yield any indication of project effects and are consistent with previous reports.

- **Northern Transects** (Figure 2; Table 6; Map 11) – Kernel overlap between wolves, caribou, and moose had nearly equal probabilities of encounter. Caribou observed in this area are primarily the coastal subspecies and were well distributed across the surveyed flight lines. This is likely due to the behavioral characteristics of coastal caribou movement across large areas, during migration into the area where the northern transects were surveyed. Moose and wolves are similarly well-dispersed, resulting in shorter distances to wolves for both species, with a log-normal distribution as evident in the violin plots. This is supported by the analysis of distance to wolves for caribou and moose, which finds no significant differences in the distribution of distances. Wolves were widely distributed on the landscape, which provides access to both species. There was no evidence to suggest differences in overall predation risk, or increased risk to caribou or moose associated with the transmission corridor, during the time of the survey.

- **The Pas North-South Transects** (Figure 2; Table 7 and Table 8; Map 12) – In the analysis of kernel overlap, caribou typically had lower observed overlap compared with moose and deer. Deer, followed by moose and caribou, had the highest probability for encounter with wolves. Part of this pattern is the result of few caribou occurring in the sensitive moose area near The Pas, while deer were clustered in this area. The pattern is evident in the violin plots for the species (e.g. large interquartile range for caribou, long-tailed distribution, narrow distribution for deer). Moose and wolves are well-dispersed resulting in shorter distances to wolves for most species. This is supported by the analysis of distance to wolves for these species, which found significant differences in the distribution of distances for all comparisons. Wolves are generally more widely distributed on the landscape to provide access to all species, with a cluster of deer in close proximity to wolves increasing the observed risk of predation for deer, followed by moose and caribou, during the timing of the survey. The low overlap between caribou, wolves, and moose did not illustrate any suggested effects of increased predation risk to caribou or moose because of the transmission corridor.
- **South Mountain Transects** (Figure 2; Table 9 and Table 10) – This area does not contain caribou populations, but does have deer, elk, moose, and wolves. In the analysis of kernel overlap, elk had lower observed overlap compared with moose and deer. Moose, followed by deer, had the highest probability for encounter with wolves. Part of this pattern is the result of elk occurring in the open agricultural corridor between the Porcupine and Duck mountains, deer occurring in the open corridor and more heavily vegetated areas, and moose and wolves strongly associated with heavily vegetated areas. This pattern is well-represented and supported by the violin plots, with elk having a large positive skew, moose a negative skew and log-normal distribution of shorter distances to wolves, and deer are slightly bi-modal (reflecting the concentration in both heavily vegetated and agricultural landscape) and are also widely distributed (large interquartile range). This is supported by the analysis of distance to wolves for these species, which found significant differences in the distribution of distances for all comparisons. Wolves are distributed across the survey area and have access to moose, deer, and elk while avoiding open agriculture, with a cluster of elk in the open greatly reducing interactions with wolves. Deer overlap with wolves occurs in heavily

forested area, but not on the open agricultural landscape, resulting in an increased predation risk for some individuals. Moose, because of similar habitat use to wolves, are likely to have greater predation risk during the timing of the survey. There was no evidence that potential predation effects would be related to the transmission corridor, rather, habitat selection would explain predator overlap.

Table 6: Northern aerial transects kernel overlap, descriptive statistics, and non-parametric test of distance from wolves.

NORTH AERIAL TRANSECTS			
Kernel Overlap Statistics			
	Caribou	**Moose**	**Wolf**
Volume			
Caribou	0.9998733	0.5551045	0.4518872
Moose	0.5551045	0.9998733	0.5578781
Wolf	0.4518872	0.5578781	0.9998733
Area			
Caribou	1	0.8474488	0.6152139
Moose	0.704105	1	0.6042432
Wolf	0.7617025	0.9004239	1
Probability			
Caribou	0.9499994	0.7229815	0.8143096
Moose	0.9075722	0.9499999	0.9378132
Wolf	0.7056106	0.704128	0.9499992

Descriptive statistics by group and distance to wolf													
	vars	**n**	**mean**	**sd**	**median**	**trimmed**	**mad**	**min**	**max**	**range**	**skew**	**kurtosis**	**se**
Caribou	1	362	4425.28	3202.61	3669.82	3858.41	1970.36	126.46	18820.31	18693.85	1.88	3.82	168.33
Moose	1	1070	4387.2	3759.01	3292.22	3703.82	2144.73	16.52	26509.47	26492.96	2.46	8.2	114.92

Wilcoxon rank sum test with continuity correction
Distance to wolf by caribou and moose
W = 205343, p-value = 0.08611
Alternative hypothesis: true location shift is not equal to 0
No evidence moose or caribou are closer to wolves

Table 7: The Pas North-South aerial transects kernel overlap, descriptive statistics, and non-parametric test of distance from wolves.

THE PAS NORTH-SOUTH AERIAL TRANSECTS				
Kernel Overlap Statistics				
	Caribou	**Deer**	**Moose**	**Wolf**
Volume				
Caribou	0.99987332	0.03554696	0.3096125	0.2177359
Deer	0.03554696	0.99987332	0.3309788	0.3434867
Moose	0.30961247	0.33097883	0.9998733	0.480357
Wolf	0.21773586	0.34348666	0.480357	0.9998733
Area				
Caribou	1	0	0.4327139	0.2048121
Deer	0	1	0.7408385	0.6659627
Moose	0.2177475	0.1664701	1	0.4249855
Wolf	0.1095404	0.1590483	0.4516899	1
Probability				
Caribou	0.699996407	0.008713767	0.1883748	0.09671397
Deer	0.003055366	0.699998181	0.1745179	0.17461847
Moose	0.423499264	0.739672249	0.6999997	0.39970765
Wolf	0.202765056	0.688822787	0.4225257	0.69999955

Table 8: The Pas North-South (Cont'd.) aerial transects kernel overlap, descriptive statistics, and non-parametric test of distance from wolves.

Descriptive statistics by group and distance to wolf													
	vars	**n**	**mean**	**sd**	**median**	**trimmed**	**mad**	**min**	**max**	**range**	**skew**	**kurtosis**	**se**
Caribou	1	144	11498.02	14403.09	3075.32	9267.39	2008.8	125.29	42887.79	42762.5	1.17	-0.31	1200.26
Deer	1	199	1876.34	1296.55	1563.62	1752.95	1223.69	72.18	6007.31	5935.12	0.97	0.78	91.91
Moose	1	640	7294.25	12185.76	2385.93	3998.8	2235.67	35.71	56511.24	56475.53	2.26	3.86	481.68

Kruskal-Wallis rank sum test
Distance to wolf by species
Kruskal-Wallis chi-squared = 76.105, df = 2, p-value < 2.2e-16
Evidence that the difference between distance to wolves for some species is significant

Pairwise comparisons using Conover's all-pairs test
Distance to wolf by species
All pairwise comparisons significant (p-value << 0.0001, p-value adjustment method: Bonferroni).
Evidence that the true location shift is not equal to zero for all pairs of species (based on medians deer are closest to wolves, moose are second, followed by caribou with the largest median distance).

Table 9: South Mountain aerial transects kernel overlap, descriptive statistics, and non-parametric test of distance from wolves.

SOUTH MOUNTAIN				
Kernel Overlap Statistics				
	Deer	**Elk**	**Moose**	**Wolf**
Volume				
Deer	0.9998733	0.30741037	0.5342604	0.39686704
Elk	0.3074104	0.99987332	0.090174	0.03023261
Moose	0.5342604	0.090174	0.9998733	0.41405284
Wolf	0.396867	0.03023261	0.4140528	0.99987331
Area				
Deer	1	0.1111208	0.481655	0.282511
Elk	0.6157585	1	0	0.000001
Moose	0.6267043	0.0000001	1	0.348937
Wolf	0.5318886	0.0000001	0.5049004	1
Probability				
Deer	0.6999975	0.61649932	0.56358947	0.470846
Elk	0.1466612	0.69998153	0.02064248	0.0000009
Moose	0.3584348	0.01987749	0.6999969	0.50609
Wolf	0.2146352	0.01983523	0.27843398	0.6999953

Table 10: South Mountain (Cont'd.) aerial transects kernel overlap, descriptive statistics, and non-parametric test of distance from wolves.

Descriptive statistics by group and distance to wolf													
	vars	**n**	**mean**	**sd**	**median**	**trimmed**	**mad**	**min**	**max**	**range**	**skew**	**kurtosis**	**se**
Deer	1	296	7786.62	6969.08	4753.49	7090.38	5817.09	112.19	22880.71	22768.52	0.72	-0.91	405.07
Elk	1	244	19124.26	4730.44	21623.43	20043.58	782.87	1496.54	23379.68	21883.14	-2.04	4.14	302.84
Moose	1	997	3887.24	3945.32	2536.86	3181.26	2156.72	21.86	22623.14	22601.28	2.28	6.36	124.95

Kruskal-Wallis rank sum test
Distance to wolf by species
Kruskal-Wallis chi-squared = 540.67, df = 2, p-value < 2.2e-16

Pairwise comparisons using Conover's all-pairs test
Distance to wolf by species
All pairwise comparisons significant (p-value << 0.0001, p-value adjustment method: Bonferroni). Evidence that the true location shift is not equal to zero for all pairs of species. Based on medians, moose are closest to wolves, deer second followed by elk with the largest median distance.

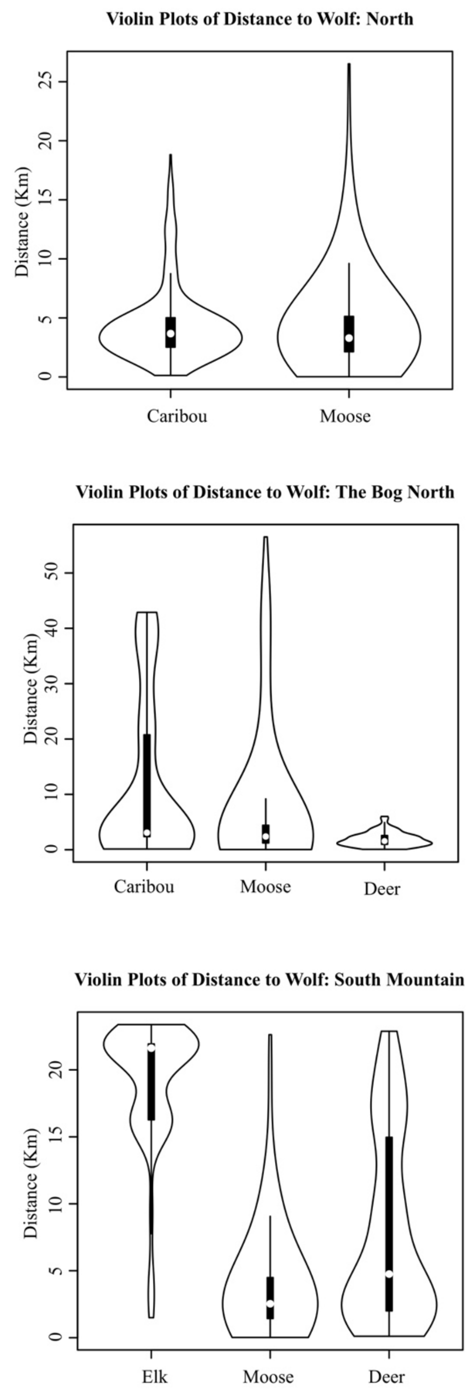


Figure 2: Violin plots distance to wolves for caribou, moose, deer and elk.
White dot represents medians, black bars the interquartile ranges, lines are drawn to 1.5 times the interquartile range or truncated to the minimum and maximum values if larger, and violin shape is drawn based on the observed distribution of distance values. At most sites caribou are further from wolves except for Wabowden (although for N-Reed the distributions are not significantly different).

5.1.3 Distribution and Occurrence (Ungulates and Wolves) From Multi-Species Aerial Transects

These analyses focus on the relationship between species occurrence and distance to the BPIII alignment. To provide an analysis that was robust with respect to sample size, analyses were performed on data pooled over the entire study area (including sensitive moose areas). However, to better capture trends in the northern transects and sensitive moose areas, these transects are also presented using separate analyses. As part of examining potential trends in species distribution over such a large landscape, the vegetation habitat relationships for all observed species and human activity were first investigated using PCA.

5.1.3.1 Vegetation-Habitat Trends

The PCA of EOSD vegetation classes for the aerial survey observations is presented in Figure 3. The first two axes account for 29.3% of the overall variation in EOSD vegetation classes on the landscape. To facilitate interpretation of trends each point in Figure 3 is symbolized by a colour corresponding to observation type. Caribou observations are strongly associated with conifer cover types and wet treed landscapes, while elk and deer are associated with open deciduous landscapes (parkland cover types). Moose are ubiquitous but the highest concentration of observations are in dense stands (particularly deciduous) and tall shrub (in the EOSD these are largely post-fire cover types). Wolves are also ubiquitous with denser observations in cover types associated with dense concentrations of prey species. The highest concentration of wolves is found in vegetation classes that are simultaneously also associated with moose, deer, and elk (deciduous classes primarily). These are also cover types associated with human activity. Although PCA does not include observation as a factor in analysis, the trends between vegetation and observation are strong and reflect the ecology of this system. These strong relationships also suggest that PCA can be used to construct composite vegetation axes for species with a sample size that would otherwise not support multiple regression analysis. These results are similar to previous reports and substantially support the conclusion that vegetation-habitat relationships rather than proximity to ROW explain species distributions.

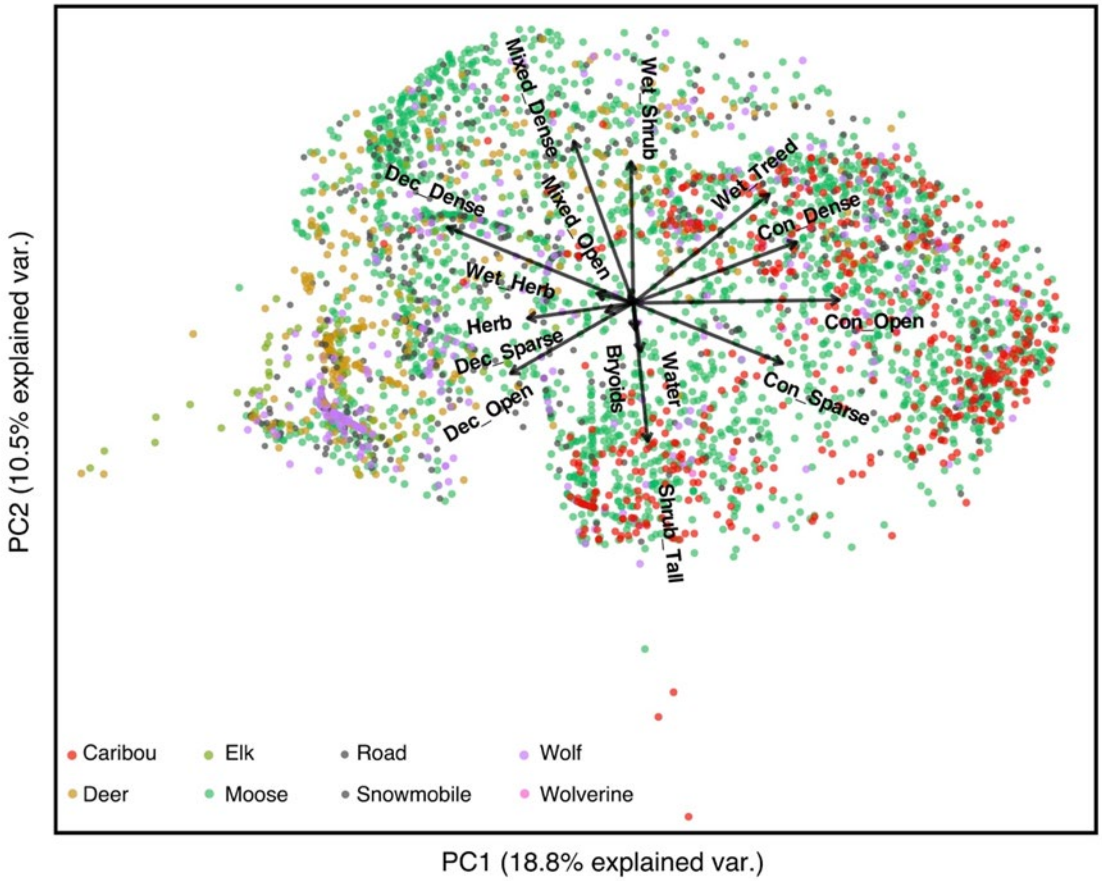


Figure 3: Principle Component Analysis of EOSD classes within a 250 m radius of each observation made during the aerial multispecies survey.
Points are coloured based on observation type, which is not a factor used in construction of the axes.

5.1.3.2 Species Abundance Distributions in Relation to Bipole III

The following sections describe the results of the regressions analyses for species abundance in relation to the ROW. The full set of regression and multiple regression analyses were performed for all species with a sufficiently large sample size. For each regression, the r^2 value is provided, which indicates the proportion of variance explained by relationship. This value ranges from -1 (strong negative relationship) to +1 (strong positive relationship), with values close to 0 indicating no relationship. P-values based on the t-distribution are also given. These measure the statistical significance of the overall regression relationship. Values between 0.1 and 0.05 are considered not significant, but suggestive, while values less than 0.05 are considered significant. Each regression variable was assessed to verify linearity, outlier analysis was performed, and residuals examined to ensure that models were statistically robust. Overall, the results presented are similar to those reported previously. For most species there is weak or no relationship between abundance and distance to the ROW, although the addition of vegetation and vegetation classes in general tends to improve this relationship. This suggests that distribution and abundance is largely driven by habitat, rather than ROW effects.

Pooled Transects

Caribou abundance and distribution do not appear to be influenced by distance to the BPIII ROW (Figure 4). The results were not significant (r^2 = 0.003 and a p-value = 0.82). Further assessment indicated the log-transformed observation data used in the regression were normally distributed. One point had high leverage and a Cook's distance of greater than 1, but it was not detected as an outlier (Bonferroni p-value = 0.06). The data conform to normal assumptions and are robust, although not significant. Multiple regression using vegetation covariates derived from PCA was also performed. Inclusion of vegetation does not explain caribou abundance and distribution (p-value = 0.07 and an r^2 = 0.23), although the analysis suggests that vegetation-habitat relationships are more likely to explain distribution than distance to ROW. This is further supported by multiple regression using composite vegetation axes from PCA (PCA axis 1 was significant; p-value = 0.03). Given that distance to ROW was not significant in the multiple regression, vegetation may better explain trends in caribou observations (although only weakly given the overall test was not significant).

Moose abundance increases with distance from the BPIII ROW (Figure 4; r^2 = 0.1 and a p-value = 0.01). The log-transformed observation data were normally distributed, and no points had high leverage (no Cook's distance exceeding 0.5), and thus no outliers were detected. The data conform to normal assumptions and are robust. Multiple regression using vegetation covariates derived from PCA was also performed. Inclusion of vegetation in the multiple regression greatly increased the strength of the overall relationship for moose (r^2 = 0.16; p-value = 0.005), and both distance (p-value = 0.003) and vegetation (PCA 2 composite axis) were considered significant (p-value = 0.01). Vegetation and distance to ROW explain the trends in moose distribution and given the coefficient for distance from ROW is positive in both analyses, there is a tendency for moose abundance to increase with distance.

Deer abundance and distribution is not influenced by BPIII ROW (Figure 4; r^2 = 0.02 and a p-value of 0.45). The distance to ROW coefficient was negative, but not significant (p-value = 0.45). The log-transformed observation data departed slightly from normality, but no points had high leverage (no Cook's distance exceeding 0.5, although one observation was close to this threshold), and no outliers were detected (Bonferroni p-value = 0.67). The data mostly conform to normal assumptions and are robust. Multiple regression using vegetation covariates derived from PCA was also performed. The overall multiple regression was not significant, with a p-value = 0.59 and an r^2 = -0.03. No coefficients were significant; however, a test using EOSD cover types did find that areas with high herb cover (the cover type that many agricultural crops are classified) was significant, although the overall test was not. Vegetation only very weakly explains deer observations, with no significant relationship detected for distance from ROW.

Elk distribution does not appear to be influenced by the BPIII ROW (Figure 4; r^2 = 0.008 and a p-value of 0.84). The distance to ROW coefficient was negative, but not significant (p-value =

0.85). The log-transformed observation data departed slightly from normality, but no points had high leverage (no Cook's distance exceeding 0.5, although several observations were close to this threshold), and no outliers were detected. The data mostly conform to normal assumptions and are robust. Multiple regression using vegetation covariates derived from PCA was also performed. The overall multiple regression was not significant, with a p-value = 0.89 and an r^2 = -0.52. No coefficients were significant. No relationship with distance to ROW was detected. Map 13 provides an overview of elk observations from all surveys.

Wolf distribution and abundance is not influenced by the BPIII ROW (Figure 4; r^2 = 0.05 and a p-value = 0.17). The distance to ROW coefficient was positive, but not significant (p-value = 0.17). The log-transformed observation data were normally distributed, and no points had high leverage (no Cook's distance exceeding 0.5), and no outliers were detected. The data conform to normal assumptions and are robust. Wolf distribution is influenced by vegetation; the overall multiple regression was significant (p-value = 0.01 and an r^2 = 0.19). The PCA 1 surrogate vegetation axis coefficients were significant (p = 0.004), however distance to ROW was not (p-value = 0.46). Tests performed using individual EOSD cover types found that deciduous dense, deciduous open, conifer dense, and wet treed cover type were significant. These are all vegetation types strongly associated with prey species, which may explain why vegetation influences wolf distribution. None of the analyses found that distance to ROW had any effect on wolf distribution.

Except for moose, none of the species in the pooled transects showed any relationships with distance to ROW. Addition of vegetation covariates often did result in stronger overall trends, and (as in the case of wolves) were significant in predicting occurrence. This suggests that habitat in most instances is important in determining species abundance patterns, rather than the ROW.

Northern Transects

Caribou relationship with distance from the BPIII ROW were examined using regression methods in the northern aerial survey region and the results of the linear regression are presented in Figure 5. The primary caribou subspecies in this area is coastal rather than boreal whereas the pooled analysis contained both subspecies. As in the pooled analysis, results were not significant with an r^2 = 0.05 and a p-value = 0.60. The log-transformed observation data were normally distributed. One point had high leverage and a Cook distance between 0.5 and 1, but no outliers were detected (Bonferroni p-value 0.93). The data conform to normal assumptions and are robust although not significant. Multiple regression using vegetation covariates derived from PCA was also performed. The overall multiple regression was not significant with a p-value = 0.83 and an r^2 = -0.44. Low sample size did not permit multiple regression against individual EOSD classes.

Moose observations in the northern transects do not appear to be influenced by distance to the BPIII ROW (Figure 5; $r^2 = 0.04$ and a p-value = 0.63). The log-transformed observation data were weakly normally distributed, and no points had high leverage (no Cook distances exceeding 0.5 although two values were close to that value) and no outliers were detected. The data mostly conform to normal assumptions and linear regression is reasonable. Multiple regression using vegetation covariates derived from PCA was also performed. The overall multiple regression was not significant with a (p-value = 0.38) and an $r^2 = 0.13$. Sample size was not large enough to examine individual EOSD cover types using multiple regression.

Wolf relationship with distance from the BPIII ROW were examined using regression methods and the results of the linear regression are presented in Figure 5. The results were not significant ($r^2 = 0.08$ and a p-value = 0.49) and it does not appear that distance to ROW influences wolf distribution. The log-transformed observation data were normally distributed and with some point having higher leverage (one observation with a Cook distances exceeding 0.5 but less than one and two others marginal at 0.5), but no outliers were detected. The data mostly conforms to normal assumptions and are robust. Multiple regression using vegetation covariates derived from PCA was also performed. The overall multiple regression was not significant with a p-value = 0.11 and an $r^2 = 0.55$. Although this result is beyond the margin of a suggestive relationship, it is the strongest of all species ROW distance relationships for the northern transects. Despite the overall test not being significant, the coefficient for PCA 1 (surrogate vegetation axis) was significant (p = 0.04), however distance to ROW as not p-value = 0.42. Sample size was not large enough to examine individual EOSD cover types within a multiple regression framework.

None of the species had a significant relationship with distance from the BPIII line in the northern study area. Addition of vegetation covariate by and large did not improve any of the models, although when included in the wolf analysis, vegetation covariates (using the constructed axis) did show the strongest trends (although not significant).

Sensitive Moose Areas Transects

Deer observations do not appear to be influenced by distance to the BPIII ROW within the sensitive moose areas (Figure 6; $r^2 = -0.05$ and a p-value = 0.23). The distance to ROW coefficient was negative, but not significant. The log-transformed observation data departed slightly from normality, but no points had high leverage (although one had a Cook’s distance close to 0.5), and no outliers were detected (Bonferroni p-value = 0.21). The data mostly conform to normal assumptions and are robust. Multiple regression using vegetation covariates derived from PCA was also performed. The overall multiple regression was not significant, but suggestive, with a p-value = 0.07 and an $r^2 = 0.15$. The coefficient for distance from ROW was not significant, but the PCA 2 composite vegetation axis was (p-value = 0.05). Sample size was relatively low, and multiple linear regression tests using EOSD cover types were not performed.

Overall, deer distribution has a weak relationship with vegetation and is not influenced by the ROW.

Moose relationship with distance to the BPIII ROW in the sensitive moose areas was examined using regression methods, and the results of the linear regression are presented in Figure 6. The results were not significant, with an $r^2 = 0.02$ and a p-value = 0.39 (more than 0.05) and illustrate no effect. The log-transformed observation data were normally distributed, and no points had high leverage (no Cook's distance exceeding 0.5), and no outliers were detected. The data conform to normal assumptions and are robust.

However, using multiple regression with vegetation covariates derived from PCA, the result was slightly significant with a low p-value (< .0001 and an $r^2 = 0.48$). This suggests that when considering vegetation and not distance to ROW, there is a slight trend in moose avoidance of the ROW within the sensitive moose areas. Overall, the potential effect should be considered minimal given the two separate tests.

Wolf abundance and distribution do not seem to be influenced by distance to the BPIII ROW in the sensitive moose areas (Figure 6; $r^2 = 0.06$ and a p-value = 0.24). The log-transformed observation data were normally distributed, and no points had high leverage (no Cook's distance exceeding 0.5), and no outliers were detected. The data conform to normal assumptions and are robust. Multiple regression using vegetation covariates derived from PCA was also performed. The overall multiple regression was significant, with a p-value = 0.02 and an $r^2 = 0.26$. The PCA 2 surrogate vegetation axis coefficient was significant (p = 0.006), however distance to ROW was not (p-value = 0.18). Sample size was relatively low and multiple linear regression tests using EOSD cover types were not performed. Vegetation condition, and not distance to the ROW, explains wolf distribution.

The distance to the BPIII ROW was not significant for the species in the sensitive moose areas. When vegetation was included as a covariate for moose and wolf, the overall regressions were significant, but only for coefficients associated with vegetation (constructed axes). As was found for the northern and pooled datasets, vegetation/habitat relationships seem to primarily drive the observed abundances of large mammal species in the multispecies surveys, rather than the presence of the ROW.

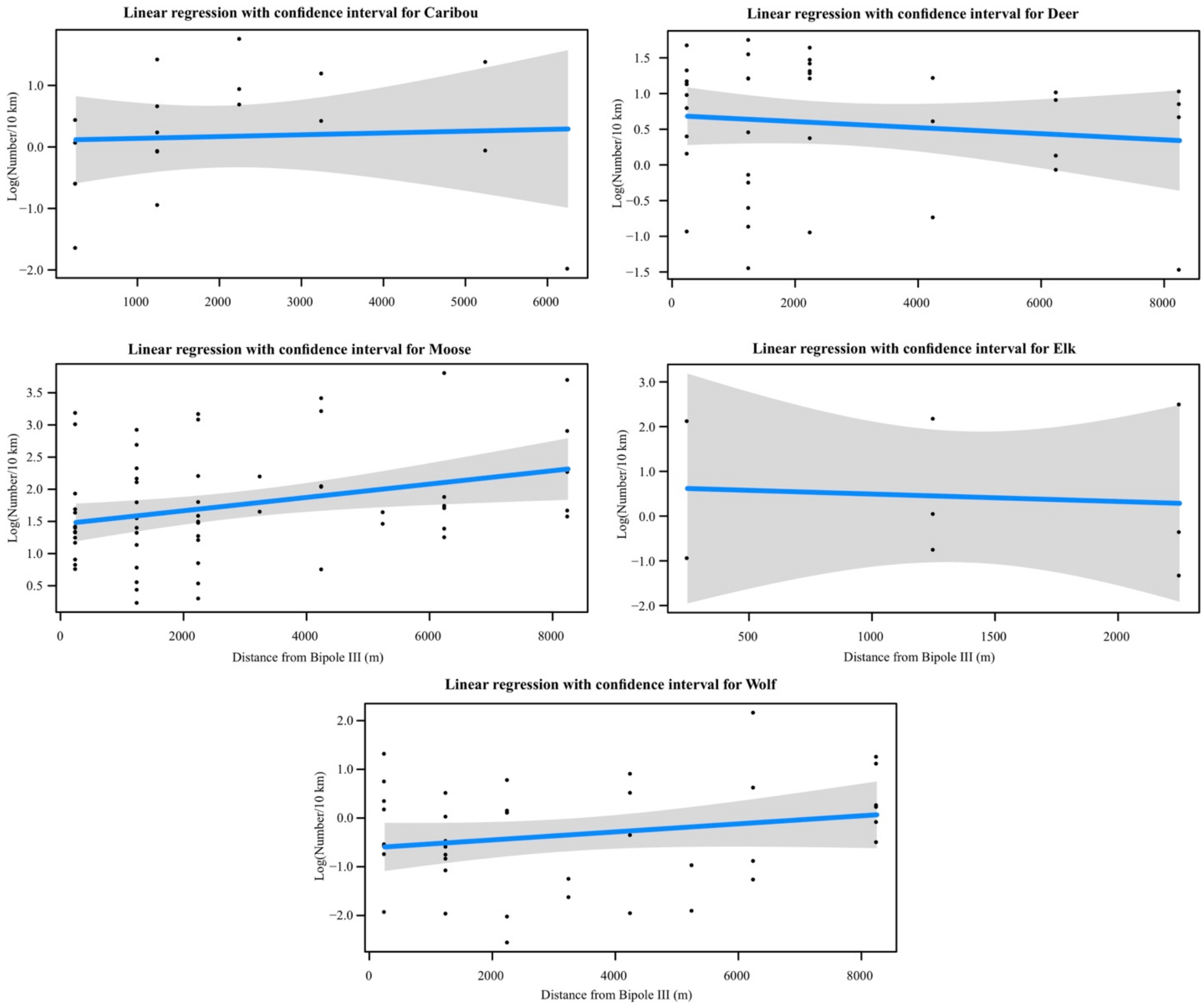


Figure 4: Linear regressions of pooled multi-species aerial transect data by species.
Regression line is indicated in blue and grey bands represent 95% confidence interval. All are not significant with the exception of moose which is slightly significant.

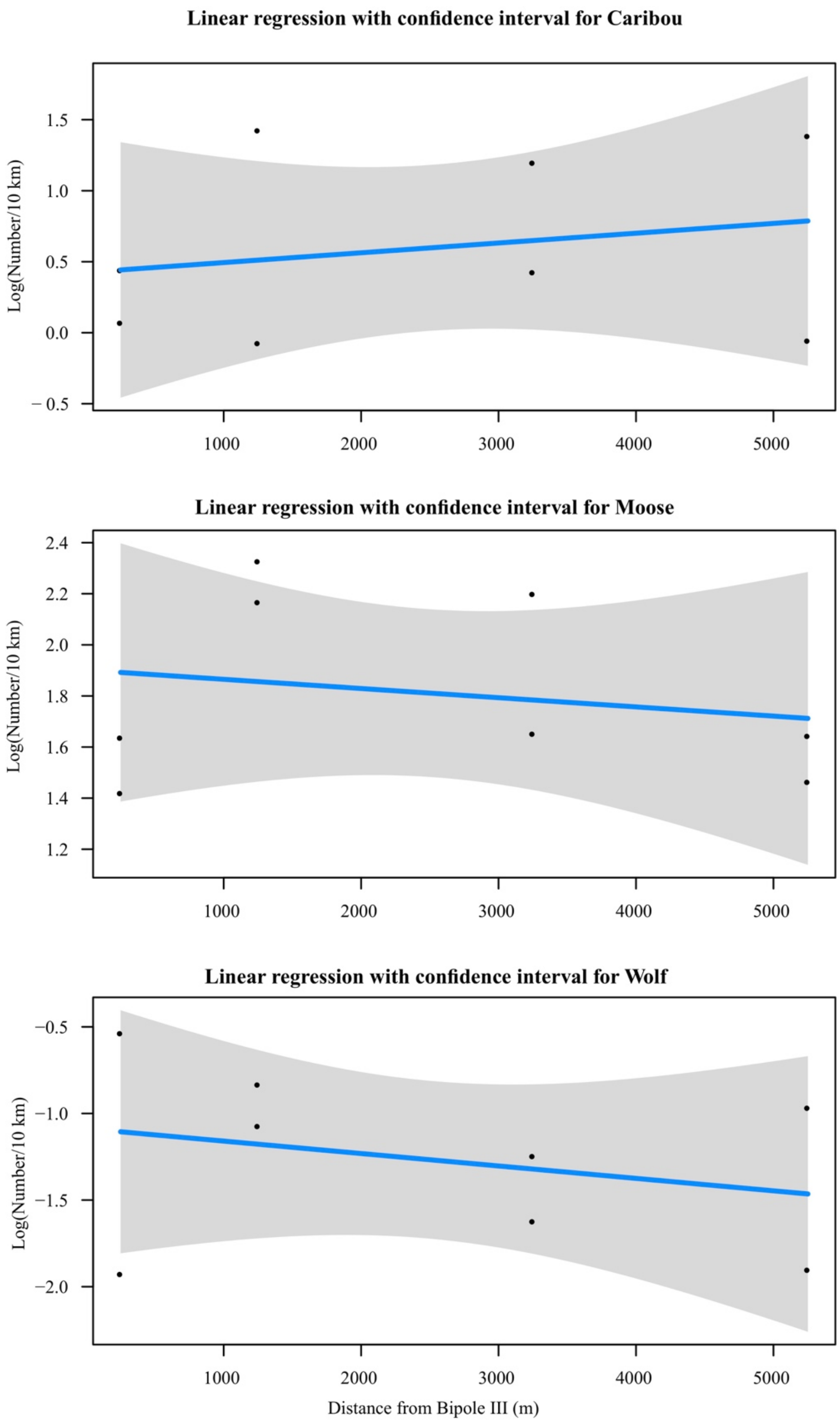


Figure 5: Linear regressions of multi-species aerial transect data for northern sampled transects.

Caribou included in this figure are principally individuals from the coastal sub-species. Regression line is indicated in blue and grey bands represent 95% confidence interval.

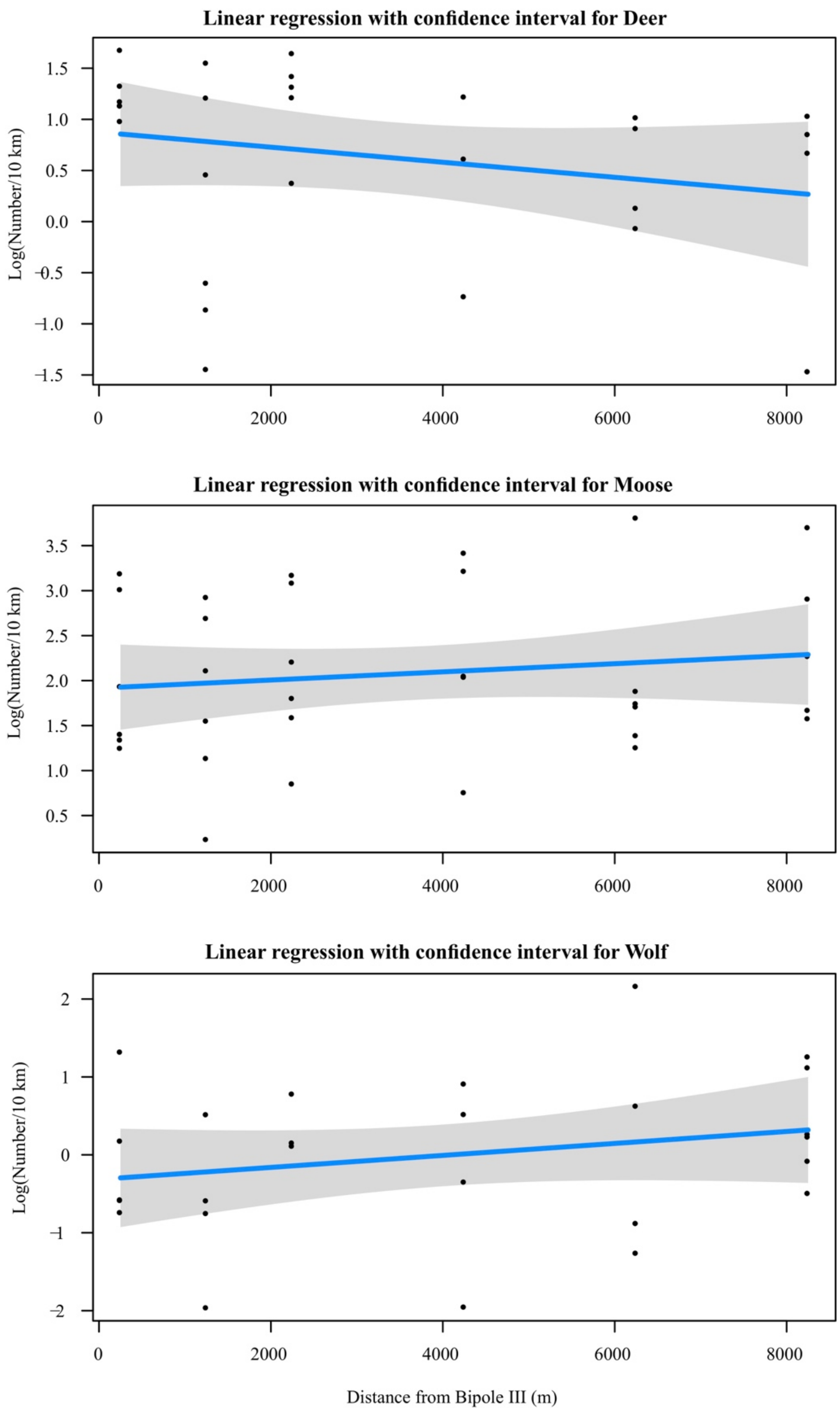


Figure 6: Linear regressions of multi-species aerial transect data for sensitive moose area transects.
Regression line is indicated in blue and grey bands represent 95% confidence interval.

5.1.4 Distribution and Occurrence - White-tailed Deer Ingress

Distribution and ingress of white-tailed deer and the potential effects of increased *P. tenuis* infection rates has been undertaken in previous years monitoring specific to deer monitoring areas. White-tailed deer monitoring in 2020 included mapping of all observations from all surveys. Map 14 provides an overview of white-tailed deer sightings. Review of previous years distribution and occurrence do not suggest any observable increase in numbers or range expansion into boreal caribou ranges.

5.2 Furbearers (Winter Ground Transect Survey)

The relationship between furbearer (and other species) track abundance along the Winter Ground Track Transect Survey lines and distance to the BPIII alignment is presented. The number of recorded tracks post-construction (2019-2020) for all species are provided in Table 11. Generalized Additive Models (GAMs) were attempted on nine most common species, but only the first four had sufficient sample size to provide robust models. Linear multiple regressions were performed on the other five species. Vegetation composition based on the EOSD dataset was performed using composite variables derived from PCA. To reduce the number of independent variables for GAMs and for species with low sample size, the composite axes were used. Where analysis of untransformed EOSD classes was possible, results will be presented or indicated in tables or text. For all regression models residuals, outlier's analysis, Cook's distance, and k-fold cross-validations were performed or examined to determine if the data met the assumptions of the modelling framework. These will also be presented or described as appropriate for the model being presented. As shown in Table 11, hare accounted for 65% of all unique tracks (unique tracks are those tracks where appearance and gait suggest different individuals) and 50% of all track sets (groups of tracks located at the same sample point without considering if they are from different individuals). Mustelids species (excluding mink) account for 21% of unique tracks and 32% of track sets, and squirrels are 7% and 10 % of tracks, respectively. Thus, the top four species (or species groups in the case of mustelids) account for more than 92% of all tracks observed on the furbearer transects. To facilitate presentation, the results will be summarized by the top four common furbearers (defined as common with respect to sample size) and remaining five infrequent species for which regression was possible (this category is primarily ungulate species). Regressions and other analyses were not performed on the final eight rare fur-bearer species (rare with respect to sample size along study transects), as listed in Table 11, because of small sample size.

Common Furbearers

Hare relationship with distance for the BPIII ROW suggests avoidance (Figure 7). Although GAMs relax parametric assumptions, the data were still tested for normality and for leverage effects. The log-transformed observation data for hare departed from normality at the tails, but no points had high leverage (no Cook distances exceeding 0.5, although there was a pattern with residuals and leverage), and no outliers were detected. The data mostly conform to normal assumptions and linear regression is reasonable, however, given the patterns observed in leverage, GAM is more appropriate. Multiple-linear regression was still performed, in addition to GAM, for consistency with the analysis of infrequent species. For hare, multiple linear regression of observation based on distance from the ROW and vegetation covariates was significant (p-value = 0.02), but explained variance was low $r^2 = 0.03$. The coefficient for distance from ROW was significant (p-value = 0.007) and the coefficient for the PCA 2 composite vegetation axis is suggestive (p-value = 0.09). The fit for the GAM was improved over the linear model. Overall, explained deviance was 21.1% and the coefficients for the smoothed parameters for distance from the ROW and the PCA 2 vegetation axis were significant (p-values = 0.0003 and 0.01 respectively). The mean shape of the effect curve increases from the ROW and rapidly plateaus, potentially indicating a short-distance effect on abundance from the ROW. Part of this trend is likely accounted for by correction for sample effort and some may be biological, as hare typically seek security cover which is not available on the ROW. These results are similar to findings in previous Construction and Operational phase monitoring and substantially support the conclusion that there is an indication of edge effect (the 500 m transect in the ROW), however avoidance beyond the ROW is not significant for hare throughout Construction and Operational phase monitoring.

The mustelid species' (ermine/weasel and fisher/martin) relationship with distance for the BPIII ROW was examined and results suggest both groups avoid the ROW although not significantly for ermine/weasel. Results of the partial effects plots for the GAMs are presented in Figure 7. Parametric tests for normality were performed and the data were normal; no observations had high leverage (no Cook distances exceeding 0.5) and no outliers were detected for either of the mustelid groups. The data mostly conform to normal assumptions, and linear regression is reasonable for both. Multiple-linear regression was performed, in addition to GAMs, for consistency with the analysis of infrequent species. For ermine/weasel, multiple linear regression of observation based on distance from the ROW and vegetation covariates was not significant (p-value = 0.13), and the r^2 was low = 0.02. None of the coefficients were significant, although the coefficient for the PCA 2 composite vegetation axis is suggestive (p-value = 0.09). For fisher/martin, results of the multiple linear regression were significant (p-value = 0.01), but the r^2 was low = 0.06. The coefficient for distance from the ROW was positive and suggestive of a relationship (p-value = 0.06), and the composite PCA 1 vegetation axis was significant (p = 0.008). The fit for the GAM for ermine/weasel was much improved over the linear model.

Overall, explained deviance was 15.7% and the coefficients for the smoothed parameters for distance from the ROW was significant (p-value = 0.007). Deviance explained for the fisher/martin GAM was 28.1% and both the distance from ROW and PCA 1 variables were significant (p-values << 0.0001 and 0.03, respectively). The mean shape of the effect curve increases from the ROW for both mustelid groups, potentially indicating a short-distance effect on abundance from the ROW. Part of this trend is likely accounted for by correction for sample effort, and some may be biological, as small mammals do seek security cover, which is not available on the ROW. To conclude, as with previous Construction and Operational phase monitoring, fisher/martin are detected more frequently at greater distances from the ROW and avoidance beyond the ROW is significant throughout Construction and Operational phase monitoring. In contrast ermine/weasel were also detected more frequently at greater distances from the ROW however avoidance beyond the ROW not significant throughout Construction and Operational phase monitoring.

Squirrel show avoidance of the ROW although not significant, and the GAM results (Figure 7) show a possible edge effect. Multiple linear regression of observations based on distance from the ROW and vegetation covariates was not significant (p-value = 0.54), and the r^2 was low = -0.01. None of the coefficients were significant. The fit for the GAM had an explained deviance of 31.7% and the coefficients for the smoothed parameters for distance from the ROW was significant (p-value = 0.0003). Vegetation covariates were not significant. The mean shape of the effect curve greatly increases from the ROW, peaks within the first 400 m, drops, and then remains constant, indicating a short-distance effect on abundance from the ROW with a possible compensatory effect. Part of this trend is likely accounted for by correction for sample effort, but also biological given that squirrels are arboreal and there are few suitable sites on the ROW and the peak may be the result of ecotonal effects. These results are similar to previous Construction and Operational phase monitoring and substantially support the conclusion that squirrel are detected more frequently at greater distances from the ROW and avoidance beyond the ROW is significant throughout Construction and Operational phase monitoring.

Infrequent Furbearers

Results of the analysis of infrequent species will be discussed collectively, since most are not furbearer, and many (e.g., caribou, moose, and deer) are included in the multispecies aerial survey. Because of the small sample size, GAMs were not performed, but multiple linear regression was, and the results are presented in Figure 8. Of these species, caribou and fox multiple linear regressions were not significant or suggestive (p-value = 0.18 and 0.70, respectively) with respect to distance to ROW or any of the vegetation covariates and will not be further discussed. For the remaining three species, all had slight departures from normality for the log distance to ROW, but no outliers were detected, and no excessive leverage on residuals was observed (Cook's distance of 0.5 was only exceeded for one lynx observation). For the remaining three species, the multiple linear regression for lynx was the only one that had a significant coefficient with respect to distance from the ROW (p-value = 0.04). However, the p-value on the overall model was only suggestive and not significant (p-value = 0.07). For white-tailed deer and moose, the overall regressions were significant (p-value= 0.005 and 0.04, respectively), but only the vegetation coefficients were significant.

Furbearer Assessment Summary

Similar to previous monitoring findings, the overall assessment indicates that disturbance during the Operation and Construction phases displays a similar furbearer avoidance patterns but with slightly more significance in the trends for the linear regressions. The GAMS were all typically much more significant, including avoidance trends for all, but these analyses are likely detecting edge effects. It is clear in all graphs that abundance trends in the first few meters, although designed to detect, likely explain the significance for GAMS. This result is partially biological (i.e. squirrels require trees) and partially from the correction for sample effort.

Table 11: Summary of furbearer tracks 2019-2020 giving the number of track sets and total number of unique tracks pooled for all sampled transects.

Species	Unique Tracks	Track Sets	Unique Tracks %	Track Sets %
Hare	1658	805	64.69	49.51
Ermine/Weasel	289	267	11.28	16.42
Fisher/Marten	260	254	10.14	15.62
Squirrel	174	162	6.79	9.96
Caribou	57	21	2.22	1.29
Moose	29	25	1.13	1.54
Lynx	27	25	1.05	1.54
White-Tailed Deer	27	27	1.05	1.66
Fox	24	23	0.94	1.41
Gray Wolf	4	4	0.16	0.25
Mink	4	3	0.16	0.18
Coyote	3	3	0.12	0.18
Elk	2	2	0.08	0.12
Otter	2	2	0.08	0.12
Grouse	1	1	0.04	0.06
Ptarmigan	1	1	0.04	0.06
Shrew/Vole	1	1	0.04	0.06
Total	2563	1626	100	100

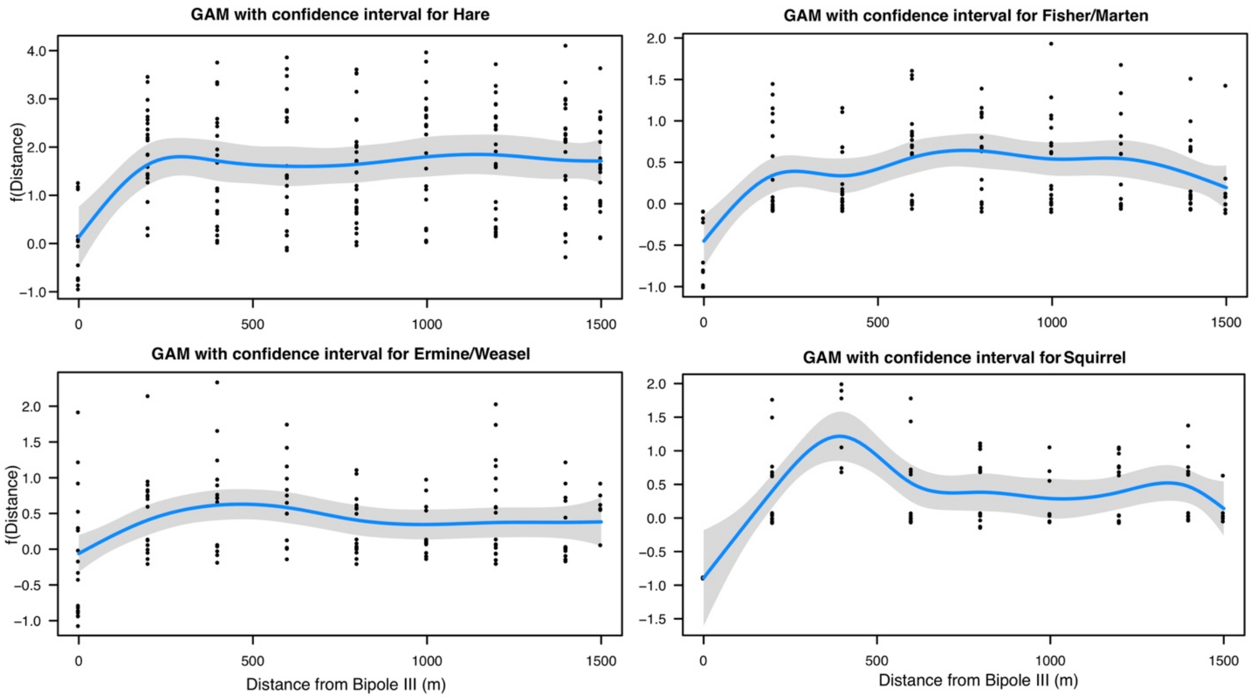


Figure 7: Summary of furbearer tracks 2019-2020 giving the number of track sets and total number of unique tracks pooled for all sampled transects.

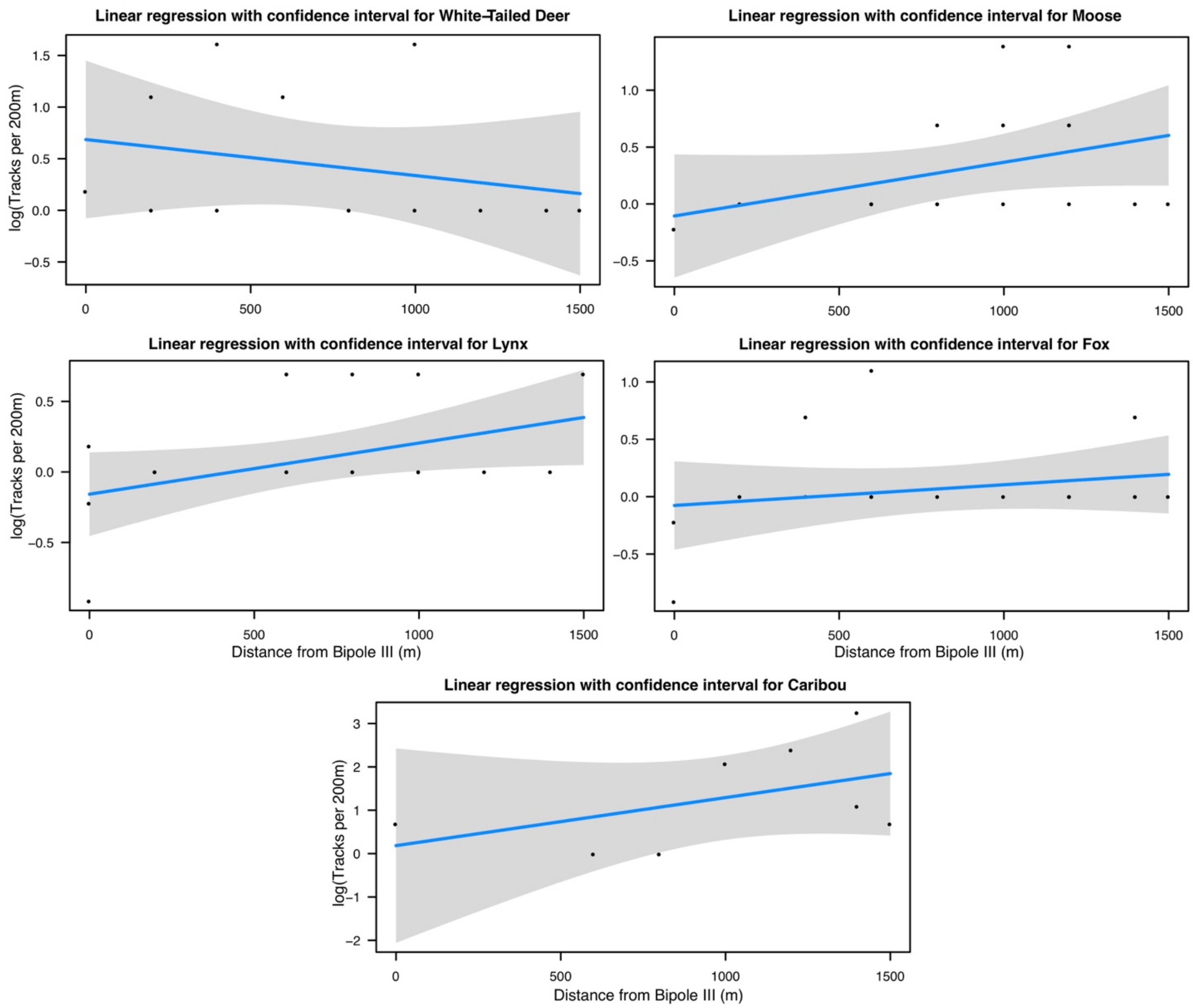


Figure 8: Summary of furbearer tracks 2019-2020 giving the number of track sets and total number of unique tracks pooled for all sampled transects.

5.3 Human Access Monitoring

Human activity is found throughout the study area with more intensive use focused in the south. To assess and monitor human activity, two analyses were done. One to determine if human activity is related to distance from the BPIII ROW, and the other to examine how human activity near the ROW may impact large mammals.

The violin plots are presented in Figure 9 and Figure 10, and the summary statistics, Kruskal-Wallis rank sum test, and Conover's all-pairs test are given in Table 12. With respect to the distance to snowmobile tracks, most species have significantly different distributions. However, elk and white-tailed deer have substantial overlap with a p-value of essentially 1. These species have a median distance from snowmobiles of just greater than one kilometer and most observations are within 5 km from human activity. Moose and wolf distributions relative to human activity are also not significantly different with a p-value = 0.77. Median distances from human activity for these species was just over 2 km, however, the distributions have long tails with some observations over 20 km from the activity. Caribou had the longest median distance from human activity over 5 km.

Human activity relationship with distance for the BPIII ROW was examined using regression methods on the snowmobile tracks and the results of the linear regression are presented in Figure 10. The log-transformed observation data were normally distributed, but one outlier was detected. The data conform to normal assumptions with the one outlier which was removed. Multiple regression using vegetation covariates derived from PCA was performed. The results were significant with an $r^2 << 0.53$ and a p-value << 0.0001. However, the coefficient for distance from ROW was not significant (p-value = 0.61) and all explanatory power of the model was partitioned on the PCA constructed vegetation variables (p-value << 0.0001 and 0.01 for PCA 1 and 2, respectively). Analysis of EOSD vegetation classes indicate a strong association between human activity and dense deciduous cover, and this likely reflects the fact that human activity is greatest in the southern region of study area where deciduous stands are more common. Trailheads in deciduous and upland areas are also typically more accessible by existing road networks also likely influencing the landcover-human activity relationship.

Human activity was recorded throughout the study area, although with greater land use in the southern region. For elk and deer this results in close proximity and access by humans, with most observations of these species within a kilometer of activity. However, there is no evidence that the BPIII ROW is influencing or attracting greater human activity, the relationship between snowmobile tracks and the alignment were not significant, instead trends in human activity are explained by vegetation/landcover. Additional human access monitoring results are found in Part B based on trail camera data from ground transect locations

Table 12: Snowmobile activity around the Bipole III ROW and impacts on wildlife

Descriptive statistics by group and distance to snowmobile												
	vars	n	mean	sd	median	trimmed	mad		min	max	range	skew
Caribou	506	6350.61	5098.23	5035.09	5615.76	4214.63	95.96	23343.2	23247.25	1.26	1.15	226.64
Deer	495	1463.18	1088.96	1127.5	1317.47	905.31	46.42	6997.71	6951.3	1.22	1.46	48.95
Elk	244	1310.73	683.22	1070.61	1290.29	522.06	28.08	4208.98	4180.9	0.75	0.83	43.74
Moose	2707	3670.2	4639.69	2049.51	2622.76	1876.67	5.47	25925.96	25920.48	2.5	6.47	89.18
Wolf	297	3351.18	4646.8	2009.11	2292.4	1908.67	12.85	23642.55	23629.7	2.89	8.37	269.63

Kruskal-Wallis rank sum test
Distance to snowmobile by observation
Kruskal-Wallis chi-squared = 527.54, df = 4, p-value << .0001

Pairwise comparisons using Conover's all-pairs test
Distance to snowmobile by Species

	Caribou	Deer	Elk	Moose
Deer	<< .0001	-	-	-
Elk	<< .0001	1	-	-
Moose	<< .0001	<< .0001	<< .0001	-
Wolf	<< .0001	<< .0001	<< .0001	0.77

(p-value adjustment method: Bonferroni). Ties are present. Quantiles were corrected for ties.

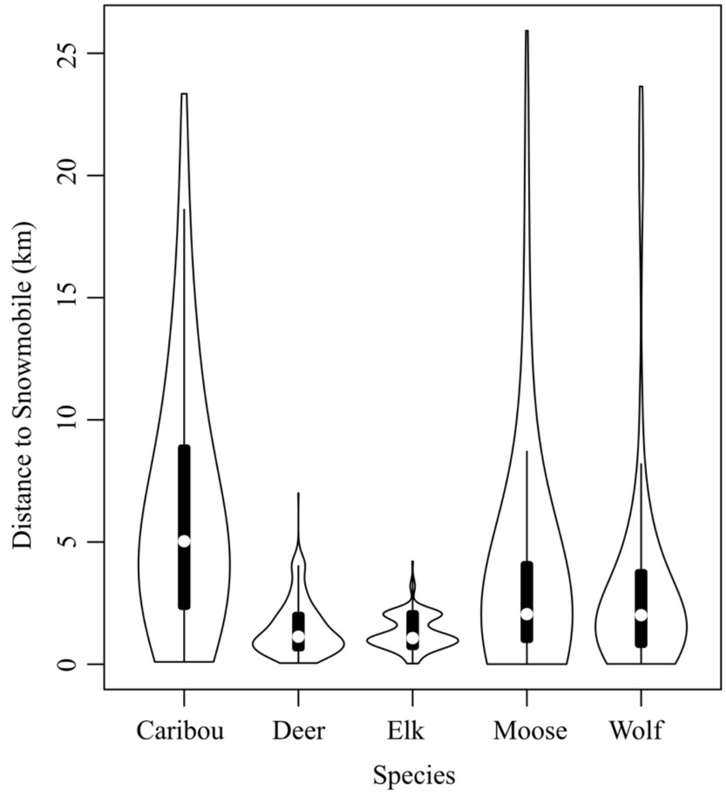


Figure 9: Violin plot of distributions of distances from human activity (snowmobile tracks) to species observations pooled across the entire study area.

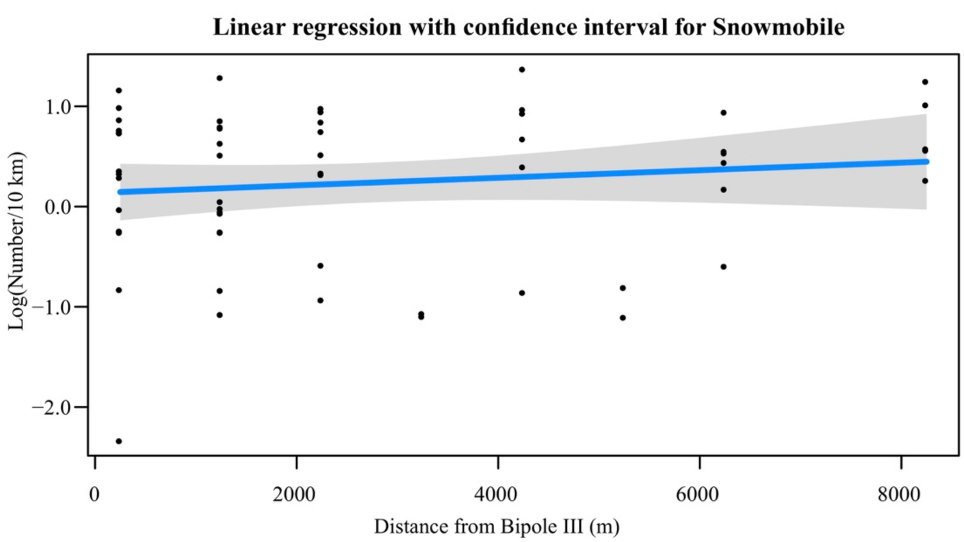


Figure 10: Violin plot of distributions of distances from human activity (snowmobile tracks) to species observations pooled across the entire study area.

6.0 MONITORING RECOMMENDATIONS

These recommendations are also found in Part B of the Mammals Monitoring Program Technical Report (Part B).

For caribou, attrition of functional collars and reduced sample size will affect the efficacy of future comparisons in Construction and Operation analyses. A review of functional collars is recommended prior to future analyses, and it is possible that winter 2020-2021 data may be adequate for replication in Year 7 reporting.

For moose, continue to include ARD survey results to verify population status through Operation and consider other moose management implications to population response (hunting). Future analysis of Keeyask Generation Station Moose Monitoring is scheduled for 2022 and will further inform ARD on status of moose populations in proximity to the BPIII Project during the Operation phase.

For furbearers, continue with trail camera deployments and consider utility of fur harvest records as an indicator of furbearer abundance.

7.0 REFERENCES

Adler, D. and Kelly, S. 2020. vioplot: violin plot. R package version 0.3.5 https://github.com/TomKellyGenetics/vioplot

Bergerud AT. 1967. The distribution and abundance of Arctic Hares-in Newfoundland. Can. Field Natur. 81: 242-248.

Bergerud AT, JP. Elliot. 1986. Dynamics of caribou and wolves in northern British Columbia. Can. J. Zool. 64: 1515-1529.

Calenge, C. 2006. The package adehabitat for the R software: a tool for the analysis of space and habitat use by animals. Ecological Modelling. 197: 516-519

CEC (Manitoba Clean Environment Commission). 2013. Bipole III Transmission Project – Report on public hearing. Winnipeg (MB): CEC. 150 pp.

Fieberg J and Kochanny CO. 2005. Quantifying home-range overlap: the importance of the utilization distribution. J. Wildl. Manage. 69: 1346–1359.

Holling CS (ed). 1978. Adaptive environmental assessment and management. Chichester (UK): John Wiley and Sons. 402 pp.

Holt RD 1977. Predation, Apparent Competition, and the Structure of Prey Communities. Theor. Pop. Biol. 12(2): 197- 229.

Holt RD, Grover J and Tilman D. 1994. Simple rules for interspecific dominance in systems with exploitative and apparent competition. Am. Nat. 144: 741–771.

Lancia R, Braun C, Collopy M, Dueser R, Kie J, Martinka C, Nichols J, Nudds T, Porah W, Tilghman M. 1996. ARM! For the future: adaptive resource management in the wildlife profession. Wildl. Soc. Bull. 24: 436-442.

Laurian C, Dussault C, Ouellet J-P, Courtois R, Poulin M, Breton L. 2008. Behaviour of moose relative to a road network. J. Wildl. Manage. 72: 1550-1557.

Leblond M, Dussault C, St-Laurent M-H. 2014. Development and validation of an expert-based habitat suitability model to support boreal caribou conservation. Biol. Conserv. 177: 100-108.

Legendre P and Legendre L. 2012. Numerical ecology. New York (NY): Elsevier. 1006 pp.

Lounsberry ZT, Forrester TD, Olegario MT, Brazeal JL, Wittmer HU, Sacks BN. 2015. Estimating sex- specific abundance in fawning areas of a high-density Columbian black-tailed deer population using fecal DNA. J. Wildl. Manage. 79(1): 39-49.

MB Gov (Government of Manitoba). 2013. The Environmental Act License. License No. 3055. Issued to Manitoba Hydro on 2013 August 14. For construction, operation, and maintenance of the Bipole III Transmission Project.

MB Hydro (Manitoba Hydro). 2018. Bipole III Transmission Project - Biophysical Monitoring Plan. Prepared for Manitoba Conservation and Water Stewardship, Environmental Approvals Branch, 10 July 2018. 78 pp.

Mammals Monitoring Program Technical Report Year 1 (2014/15). 2016. Mammal Monitoring Program Technical Report 2014/15. Submitted by AMEC Foster Wheeler to Manitoba Hydro Licensing and Environmental Assessment. March 2016.

Mammals Monitoring Program Technical Report Year 2 (2015/16). 2017. Manitoba Hydro Bipole III Transmission Project – Mammal Monitoring Program Technical Report Year 2 (2015/16). Submitted by AMEC Foster Wheeler to Manitoba Hydro Licensing and Environmental Assessment. March 2017.

Mammals Monitoring Program Technical Report Year 3 (2016/17). 2018. Manitoba Hydro Bipole III Transmission Project – Mammal Monitoring Program Technical Report Year 3 (2016/17). Submitted by AMEC Foster Wheeler to Manitoba Hydro Licensing and Environmental Assessment. March 2018.

Mammals Monitoring Program Technical Report Year 4 (2017/18). 2019. Manitoba Hydro Bipole III Transmission Project – Mammal Monitoring Program Technical Report Year 4 (2017/18). Submitted by Wood to Manitoba Hydro Licensing and Environmental Assessment. April 2019.

Mammals Monitoring Program Technical Report Year 5 (2018/19). 2020. Manitoba Hydro Bipole III Transmission Project – Mammal Monitoring Program Technical Report Year 5 (2018/19). Submitted by Wood to Manitoba Hydro Licensing and Environmental Assessment. February 2020.

R Core Team. 2019. R: A language and environment for statistical computing. Vienna (AT): R Foundation for Statistical Computing. Available from https://www.R-project.org/.

Serrouya R, Seip DR, Hervieux D, McLellan BD, McNay R, Steenweg R, Heard DC, Hebblewhite M, Gillingham M, Boutin S. 2019. Saving Endangered Species Using Adaptive Management. PNAS 116(13): 6181-6186. Available from www.pnas.org/cgi/doi/10.1073/pnas.1816923116.

Yee TW and Mitchell ND. 1991. Generalized additive models in plant ecology. J. Veg. Sci. 2(5): 587-602. Available from https://doi.org/10.2307/3236170

Walters C. 1986. Adaptive Management of Renewable Resources. New York (NY): MacMillan Publishing Co. 374 pp.

APPENDIX 1

Appendix 1 Table 1: Monitoring Activities for Caribou

Phase	Task	Environmental Indicator	Site Location	Duration	Frequency	Timing	Measurable Parameter
Construction Post-construction	Population monitoring	Change in population state (viability, structure, abundance)	P-Bog, N-Reed, Wabowden, Charron Lake (reference) woodland caribou ranges	≤25 years or until suitable knowledge acquired	3 year intervals	Winter	Significant range (landscape) scale change in population abundance, structure, growth rate and/or viability
Post-construction	Distribution monitoring	Change in distribution (core use areas) or movements (barrier effects)	P-Bog, N-Reed, Wabowden, Charron Lake (reference) woodland caribou ranges	4 years via telemetry study (maintain 20 collars / range)	Annual, continuous via telemetry study	Year round via telemetry study	Range and local scale Project-related range contraction, barrier effects altered site fidelity levels, altered Project ROW use and zone of influence (ZOI).
Construction Post-construction	Mortality investigation, calf recruitment survey	Change in collared adult female mortality, vehicle collisions, calf recruitment	P-Bog, N-Reed, Wabowden, Charron Lake (reference) woodland caribou ranges	Up to 4 years	Annual via telemetry study and aerial surveys	Year round via telemetry study	Range and local scale changes in mortality or recruitment rate relative to historical trend
Construction Post-construction	Functional habitat availability monitoring via telemetry studies and systematic surveys	Change in occurrence, prevalence, distribution, movements and/or habitat use	P-Bog, N-Reed, Wabowden, Charron Lake (reference) woodland caribou ranges	3 years via telemetry studies in combination with aerial, surveys	Annual, continuous via telemetry study	Year round via telemetry study	Detection of a zone of influence affecting occurrence or prevalence
Construction Post-construction	Aerial distribution surveys, IR camera studies, winter ground transects,	Altered predator-prey dynamics	P-Bog, N-Reed, Wabowden, Charron Lake (reference) woodland caribou ranges	Minimum 2 years post construction	Annual	Winter (aerial surveys, ground transects), year-round (IR cameras)	Change in mortality or mortality risk relative to Project disturbance
Construction	Sensory disturbance monitoring	Presence / absence in N1 LSA	N1, Pen Islands, Cape Churchill populations	2 years	Annual	Winter	Proximity relative to construction

Appendix 1 Table 2: Monitoring Activities for Moose

Phase	Task	Environmental Indicator	Site Location	Duration	Frequency	Timing	Measurable Parameter
Post-construction	Assess changes in moose browse	Change in NDVI value	ROW within defined Sensitive moose ranges (GHA 8, Moose Meadows, GHA14A/19A)	2014 (pre-disturbance) and 2019 (post-construction)	Once	Year-round	Significant change in NDVI value from pre-disturbance to post construction periods
Construction and Post-construction	Distribution monitoring	Change in winter distribution relative to the ROW	N1-N4 and C1 and woodland caribou monitoring blocks (P-Bog, N-Reed, Wabowden)	3 years post-construction (2020)	Annual	Winter	Significant changes in relative density distribution across years in relation to the ROW
Construction and Post-construction	Population monitoring	Change in population abundance trend over time	Moose populations intersected by the ROW (GHA 8, Moose Meadows, GHA14A/19A and Split Lake)	3 years post-construction (2020)	Annual (if collected by MB Hydro, or Provincial / Federal agency)	Winter	Significant difference in regional moose abundance trend in GHAs intersected by the ROW relative to adjacent reference populations
Construction and Post-construction	Assess wolf presence on ROW	Change in wolf presence on the ROW	N1-N4 and C1 and woodland caribou monitoring blocks (P-Bog, N-Reed, Wabowden)	3 years post-construction (2020)	Annual	Winter	Distance to feature analysis (N1-N4 and C1) and predation-risk analysis (within woodland caribou survey blocks)
Construction and Post-construction	Assess human presence on ROW	Change in human presence on ROW	N1-N4 and GHA 19a sensitive moose area	5 years post-construction (2022)	Annual	Year-round (trail camera study)	Change in annual frequency of occurrence by construction segment
Construction	Moose-vehicle collision monitoring	Moose-vehicle collision reports	ROW and access	2014-2018	Annual	Year-round	Frequency, occurrence and distribution of moose-vehicle collisions by construction segment

Appendix 1 Table 3: Monitoring Activities for Deer and Elk

Phase	Task	Environmental Indicator	Site Location	Duration	Frequency	Timing	Measurable Parameter
Construction Post-construction	*P. tenuis* sampling via deer feces collection	Presence / absence	N3, N4	2-5 years	Annual or as necessary	Winter	*P. tenuis* presence in deer faeces along Project ROW
Post-construction	Distribution monitoring	Change in white-tailed deer and/or elk distribution	N3, N4, C2	3-10 years	2-3 years	Winter (aerial and ground transects) Year-round (IR cameras)	Presence / absence at local scale (Project ROW use)
Construction Post-construction	Monitor elk mortality	Local change in elk mortality	N4, C1, C2	3 years	Annual	Annual	Increased mortality detection from harvest statistics, local reports, vehicle collisions, hunter use of Project ROW
Construction Post-construction	Distribution monitoring	Change in seasonal distribution and local occurrence	N3, C2	3 years	Annual,	Annual	Local scale, Project-related change in presence / absence

Appendix 1 Table 4: Monitoring Activities for Wolf and Black Bear

Phase	Task	Environmental Indicator	Site Location	Duration	Frequency	Timing	Measurable Parameter
Construction Post-construction	Predator-prey distribution surveys and IR camera traps	Presence / absence / distribution	Caribou ranges and sensitive moose ranges intersected by N2, N3, N4	3 years post-construction	Annual	Winter (aerial) and annual (cameras)	Relative proximity and abundance of ungulate and predators and regional and local scales
Pre-construction Construction Post-construction	Telemetry assisted caribou mortality investigations	Mortality signal	P-Bog, N-Reed, Wabowden, Charron Lake (reference) woodland caribou ranges	3 years	Continuous / annual	Year-round	Change in seasonal mortality rate or type
Construction	Detect, mitigate dens encountered during clearing and construction	Sensitive sites (dens)	Project ROW	Clearing and construction period	Annual	Winter	Den detected

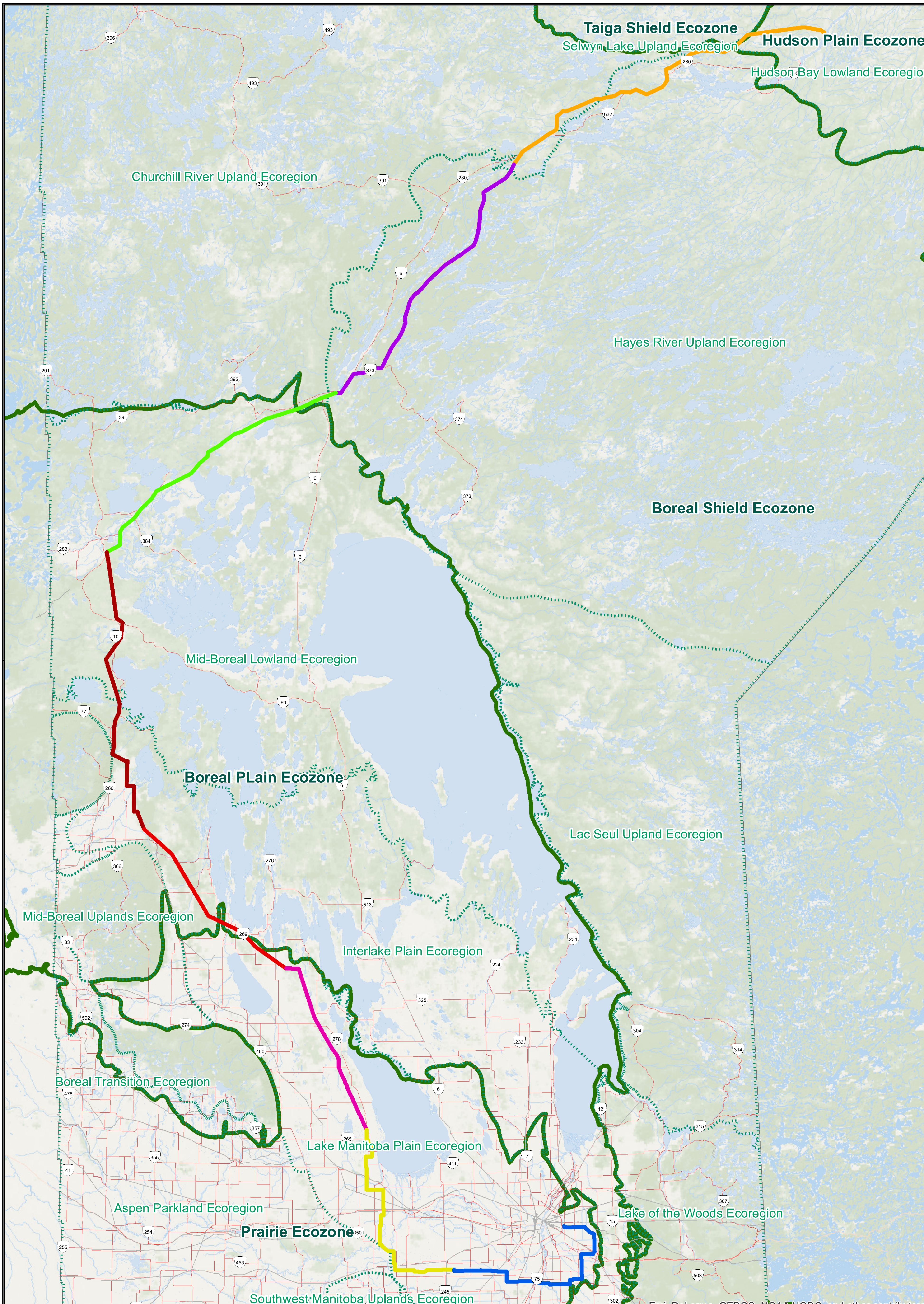
Appendix 1 Table 5: Monitoring Activities for Furbearers

Phase	Task	Environmental Indicator	Site Location	Duration	Frequency	Timing	Measurable Parameter
Construction Post-construction	Furbearer distribution and occurrence surveys	Presence / absence / distribution	N1, N2, N3, N4	3 years post-construction	Annual ground transect surveys Continuous IR cameras survey	Winter transects Year-round cameras	Presence / absence
Pre-construction Construction Post-construction	Fur harvest monitoring	Harvest by species and trapline	N1-N4 traplines intersected by the Project	3 years	Annual	Annual	Change in harvest success
Post-construction	Community trapping program	Sensitive sites (dens)	Community traplines proximate to the Project	3 years	Annual	Annual	Presence / absence Harvest success

Appendix 1 Table 6: Monitoring Activities for Human Access

Phase	Task	Environmental Indicator	Site Location	Duration	Frequency	Timing	Measurable Parameter
Construction Post-construction	IR Cameras to monitor human use of ROW at major access points along with supplemental human access data collected through multi-species surveys. Results to be included in Part B report.	Human presence / absence	N1, N2, N3, N4	During construction and 5 years post-construction	Continuous	Year-round	Presence and magnitude of human use of ROW

MAPS



LEGEND

Ecoregions

Ecozones

BPIII Transmission Line Route By Section

- C1
- C2
- N1
- N2
- N3
- N4
- S1
- S2

NOTES:
Data Sources:
ESRI Online Services
Joro, MB Hydro

Manitoba Hydro | Joro Consultants

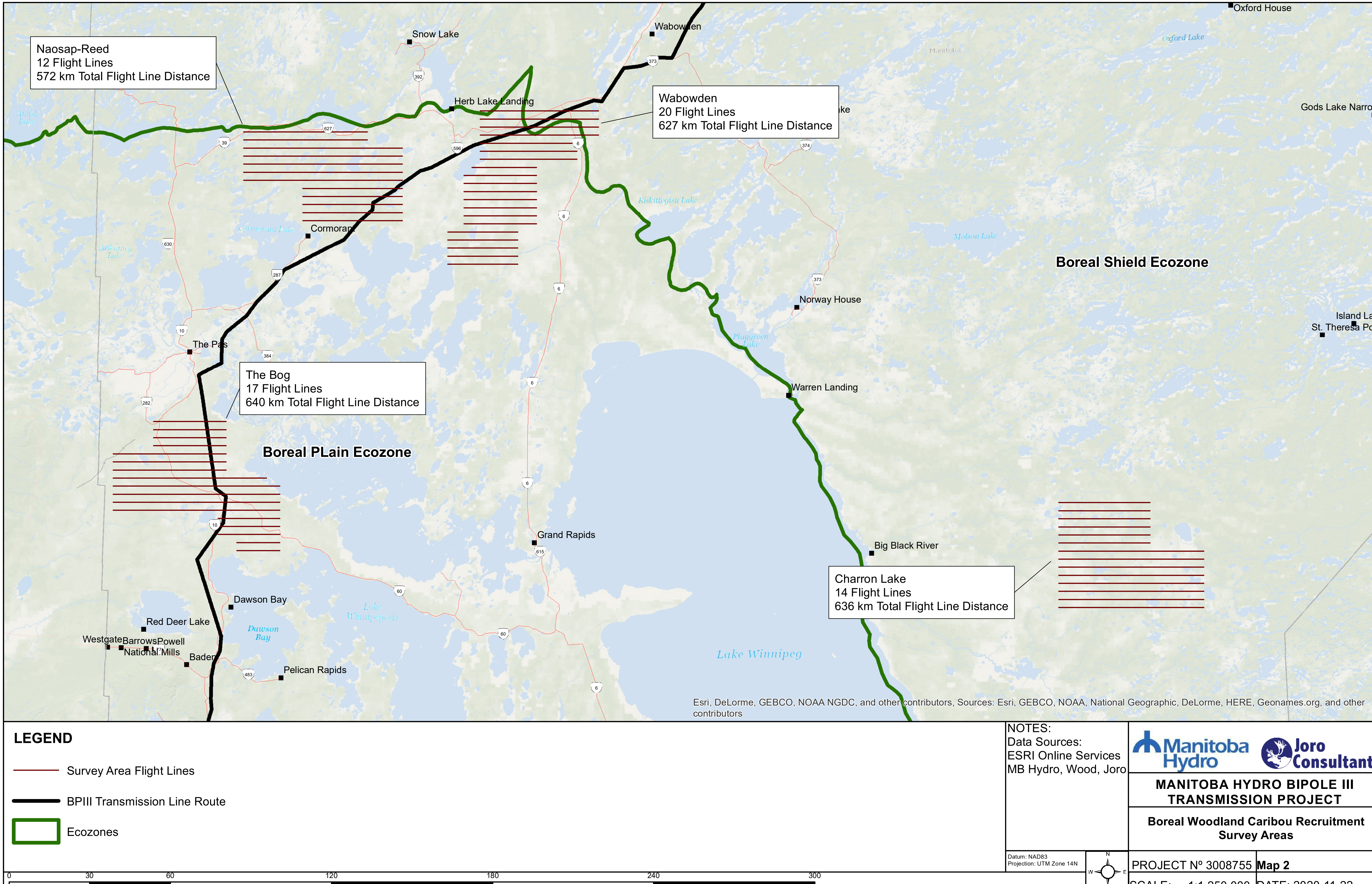
MANITOBA HYDRO BIPOLE III TRANSMISSION PROJECT

Overview

Datum: NAD83
Projection: UTM Zone 14N

0 35 70 140 210 280 350 Kilometers

PROJECT Nº 3008755	**Map 1**
SCALE: 1:2,300,000	DATE: 2020-12-06



LEGEND

Survey Area Flight Lines

BPIII Transmission Line Route

Ecozones

NOTES:
Data Sources:
ESRI Online Services
MB Hydro, Wood, Joro

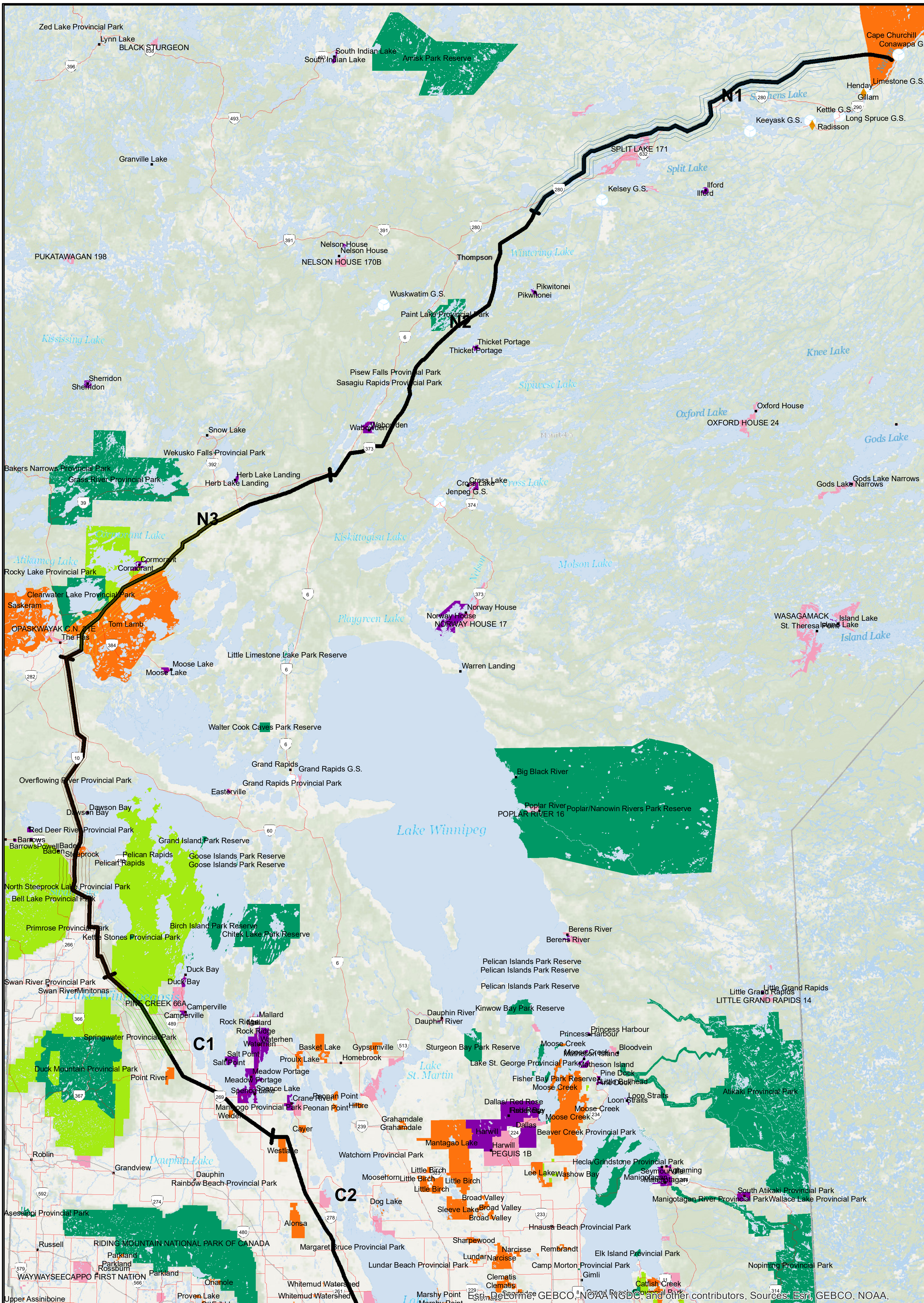
Datum: NAD83
Projection: UTM Zone 14N

Manitoba Hydro | Joro Consultants

MANITOBA HYDRO BIPOLE III TRANSMISSION PROJECT

Boreal Woodland Caribou Recruitment Survey Areas

PROJECT Nº 3008755	**Map 2**
SCALE: 1:1,250,000	DATE: 2020-11-22



LEGEND

BPIII Transmission Line Route

- BPIII Transmission Line Route
- Existing Converter Station
- Existing Generating Station
- First Nation
- Northern Affairs Community
- Wildlife Management Area
- National/Provincial Park
- Provincial Forest

0 30 60 120 180 240 300 Kilometers

NOTES:
Data Sources:
ESRI Online Services
Joro, MB Hydro

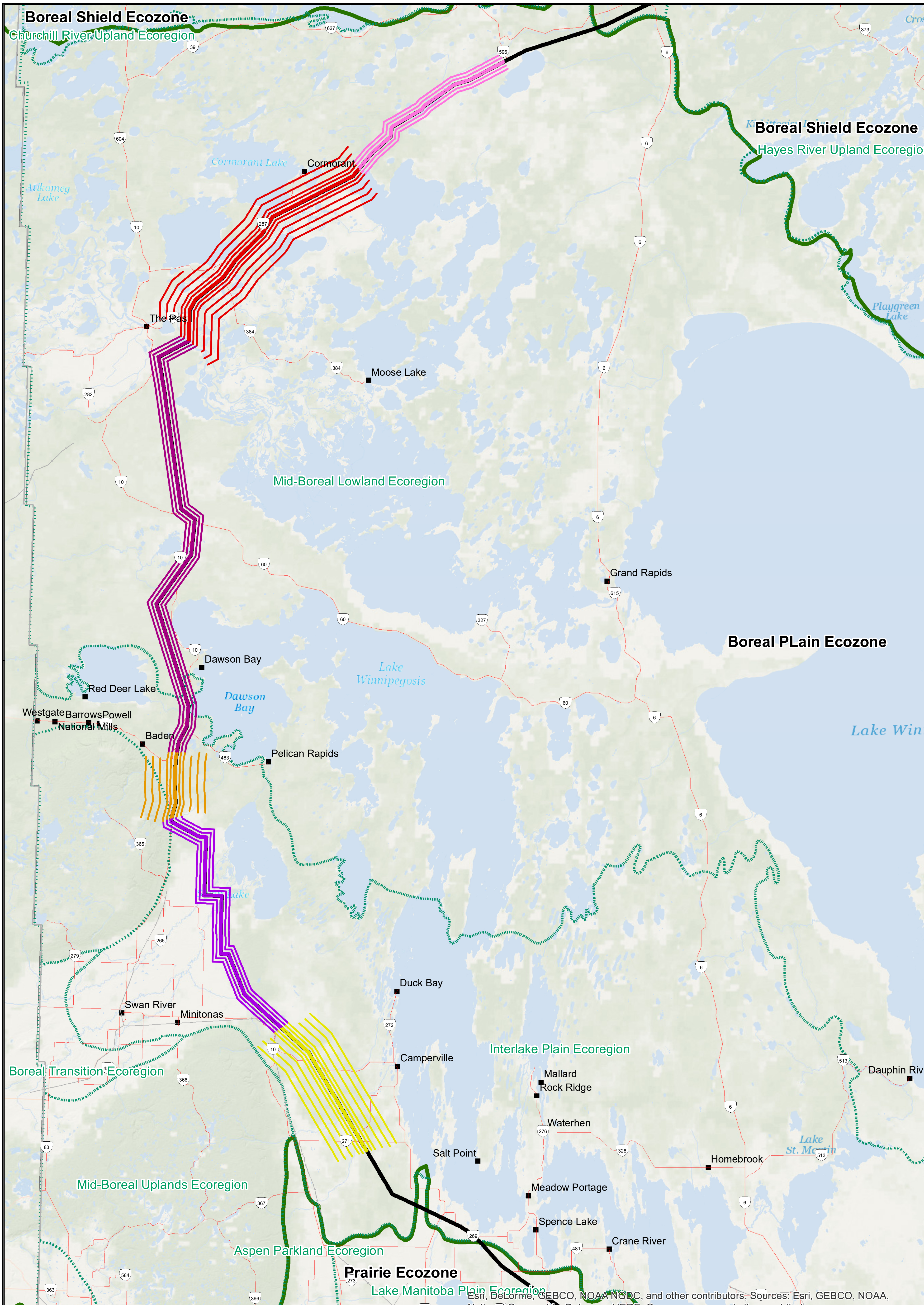
Datum: NAD83
Projection: UTM Zone 14N

Manitoba Hydro Joro Consultants

MANITOBA HYDRO BIPOLE III TRANSMISSION PROJECT

Multi-species Aerial Transect Survey Design 2014 - 2020

PROJECT Nº 3008755	**Map 3**
SCALE: 1:2,000,000	DATE: 2020-12-06



LEGEND

Zone

- North
- Moose Management Area North
- Moose Management Area Mid
- Moose Management Area South
- North-Central
- Bog
- Agricultural
- BPIII Transmission Line Route

NOTES:
Data Sources:
Basemap - ESRI
Joro, MB Hydro

Manitoba Hydro
Joro Consultants

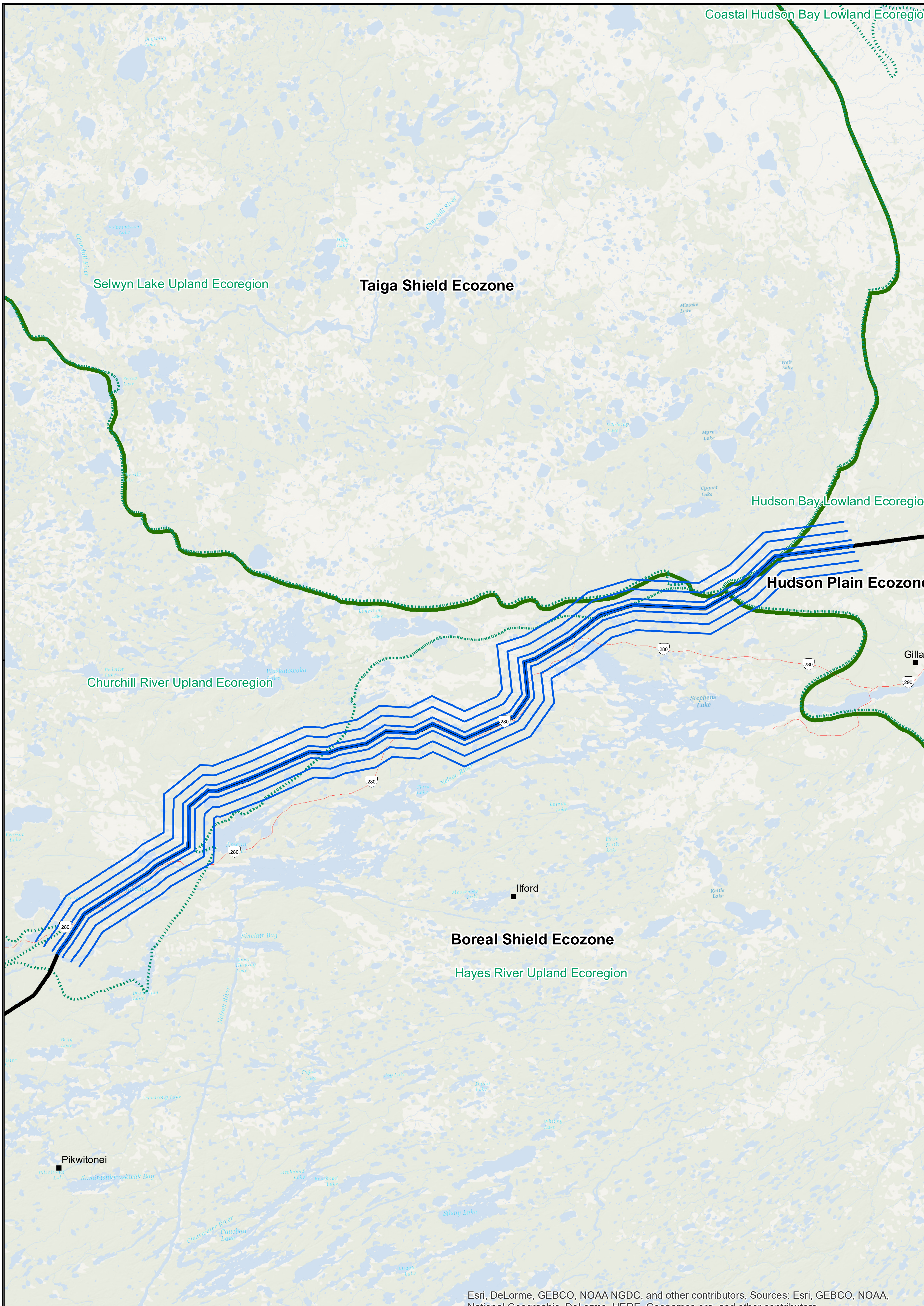
MANITOBA HYDRO BIPOLE III TRANSMISSION PROJECT

Multispecies Survey Zones Southern Portion

Datum: NAD83
Projection: UTM Zone 14N

0 15 30 60 90 120 150 Kilometers

PROJECT Nº 3008755	Map 4
SCALE: 1:1,000,000	DATE: 2020-12-06



LEGEND

Zone

- North
- Moose Management Area North
- Moose Management Area Mid
- Moose Management Area South
- North-Central
- Bog
- Agricultural
- BPIII Transmission Line Route

0 10 20 40 60 80 100 Kilometers

NOTES:
Data Sources:
Basemap - ESRI
Joro, MB Hydro

Datum: NAD83
Projection: UTM Zone 14N

Manitoba Hydro
Joro Consultants

MANITOBA HYDRO BIPOLE III TRANSMISSION PROJECT

Multispecies Survey Zones Northern Portion

PROJECT Nº 3008755	**Map 5**
SCALE: 1:750,000	DATE: 2020-12-06

LEGEND

BPIII Winter Ground Transects

BPIII Transmission Line Route

Ecozones

NOTES:
Data Sources:
ESRI Online Services
MB Hydro, Wood, Joro

Manitoba Hydro | Joro Consultants

MANITOBA HYDRO BIPOLE III TRANSMISSION PROJECT

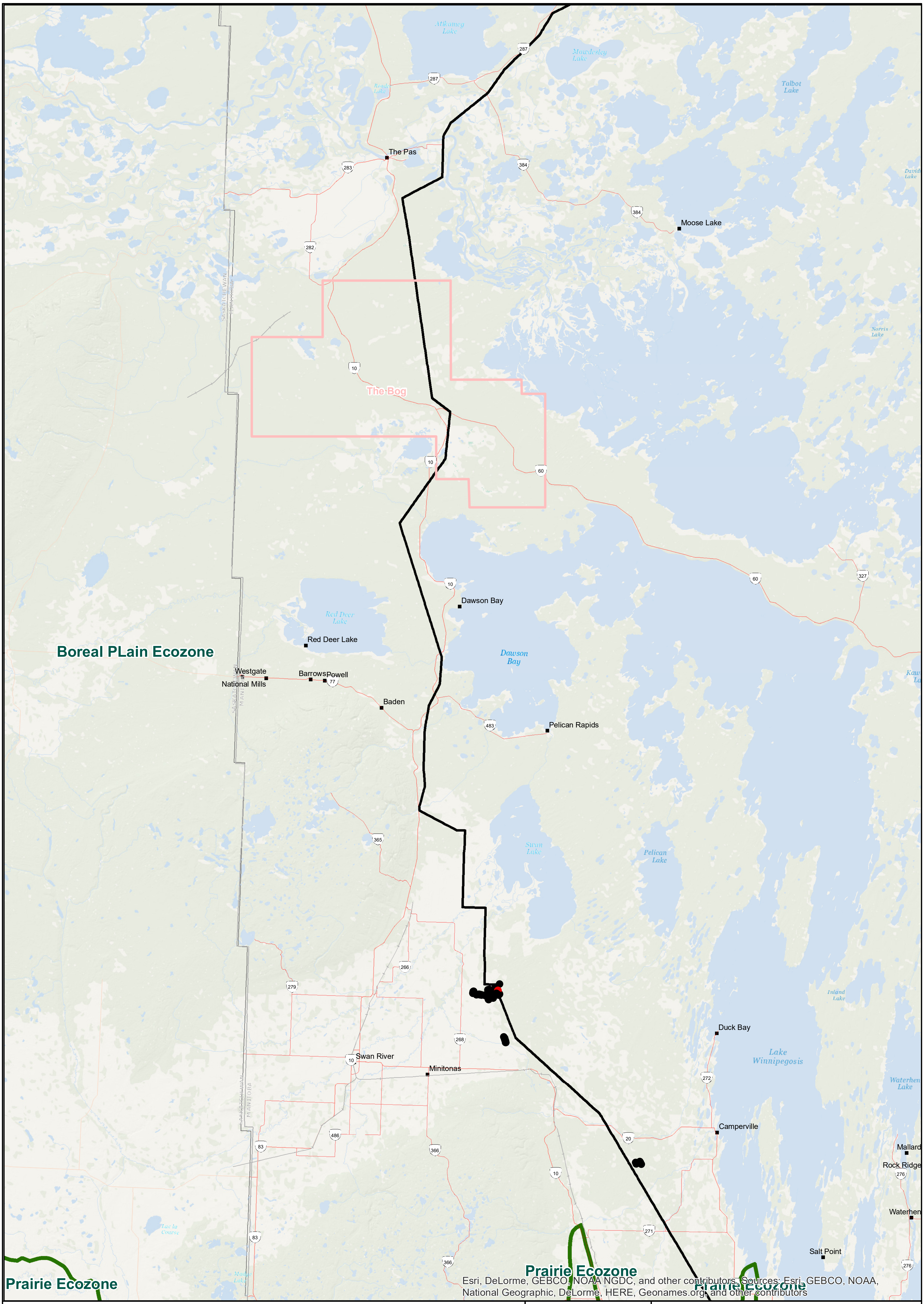
Winter Ground Transect and Trail Camera Survey Design

Datum: NAD83
Projection: UTM Zone 14N

0 25 50 100 150 200 250 Kilometers

PROJECT Nº 3008755	**Map 6**
SCALE: 1:1,750,000	DATE: 2020-12-06

Six (6) Pages Redacted



LEGEND

BPIII Transmission Line Route

BPIII Transmission Line Route

Ecozones

Elk Observation Type:

Animal

Animal Track

NOTES:
Data Sources:
ESRI Online Services
Joro, MB Hydro

Manitoba Hydro | Joro Consultants

MANITOBA HYDRO BIPOLE III TRANSMISSION PROJECT

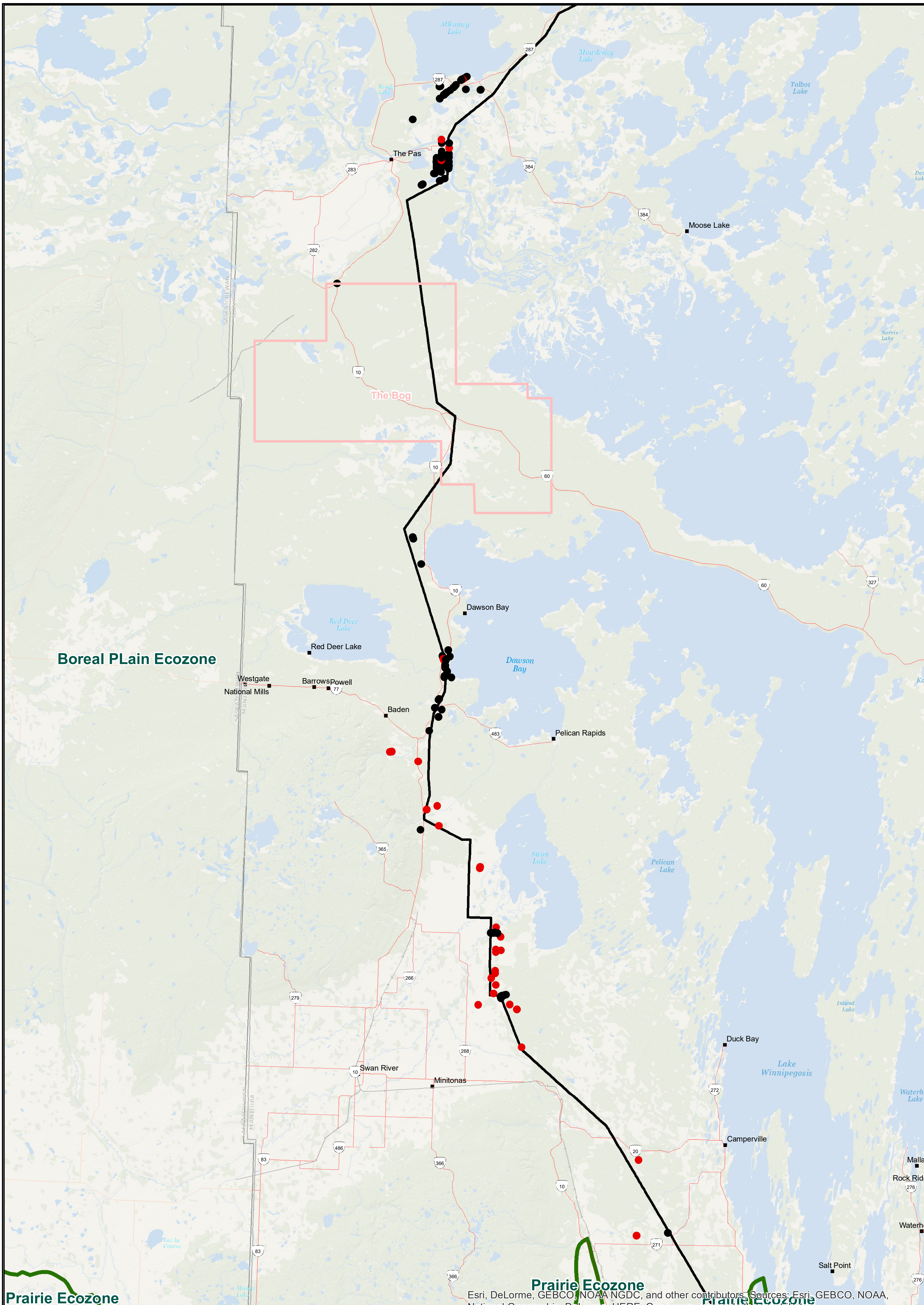
Elk Distribution Summary 2020

Datum: NAD83
Projection: UTM Zone 14N

0 10 20 40 60 80 100 Kilometers

PROJECT Nº 3008755 | **Map 13**

SCALE: 1:750,000 | DATE: 2020-12-06



LEGEND

BPIII Transmission Line Route

BPIII Transmission Line Route

Ecozones

White-tailed Deer Observation Type:

Animal

Animal Track

NOTES:
Data Sources:
ESRI Online Services
Joro, MB Hydro

Manitoba Hydro
Joro Consultants

MANITOBA HYDRO BIPOLE III TRANSMISSION PROJECT

White-tailed Deer Distribution Summary 2020

Datum: NAD83
Projection: UTM Zone 14N

PROJECT Nº 3008755	**Map 14**
SCALE: 1:750,000	DATE: 2020-12-06

0 10 20 40 60 80 100 Kilometers

Available in accessible formats upon request.