Bipole III Transmission Project: Mammal Monitoring Program Technical Report Year 5 (2018/19) - Part A

WX1739301

Prepared for:

Manitoba Hydro

Licensing and Environmental Assessment, 360 Portage Avenue (5th Floor), Winnipeg, Manitoba, R3C 0G8

February 2020

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WX1739301

Mr. James Matthewson
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Dear Mr. Matthewson:

Wood Environment & Infrastructure Solutions is pleased to provide the attached 2018/19 Mammals Monitoring Technical Report (Part A) for the Bipole III Transmission Project.

This report (Part A) summarizes mammals monitoring conducted to date with an emphasis on the Year 5 (2018/19) results from field surveys and associated analyses for the long-term mammals monitoring program, excluding analyses associated with woodland caribou telemetry datasets (which will be provided in a separate report – Part B).

We greatly appreciate the opportunity to provide support for the Bipole III Transmission Project. Should you have any questions regarding the study, please do not hesitate to contact us.

Yours sincerely,
Wood Environment & Infrastructure Solutions
a Division of Wood Canada Limited

Al Arsenault

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Executive Summary

This monitoring report (Part A) presents an analysis and summary of existing monitoring program data for mammal VECs potentially affected by the Bipole III Transmission Project ('the Project'). Results of the Woodland caribou telemetry studies will be provided in a separate report *Mammals Monitoring Program Technical Report Year 5 (2018/19) – Part B* (hereafter "Part B"). This report provides an information base and reporting framework for annual reporting of mammal monitoring studies undertaken at two scales (local and landscape) to assess long-term effects of the Project (through each Project phase) with respect to:

1. Habitat alteration, population ecology and community dynamics;

2. Effectiveness of mitigation measures and management activities; and

3. 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, 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.

The report quantifies the pre-construction baseline condition (2010 to 2014) and where feasible, data from the Construction phase (initiated in late 2014 to mid 2018) and Operation phase (beginning mid 2018) has also been evaluated. The following is a summary of key findings.

Woodland Caribou

The following is a summary of results of woodland caribou monitoring activities conducted in Year 5 (2018/19) from population abundance and distribution studies, telemetry studies, and mortality monitoring.

1. **Population Structure and Trend** - Annual adult female survival rates for collared caribou above 85%, is conducive to population stability or growth when the proportion of calves in the population is >12% or when the calf recruitment rate (calves/100 cows) is >28.9 (Bergerud 1974, Stuart-Smith et al. 1997, Dzus 2001, Arsenault 2003). The demographic indicator metrics of winter calf recruitment (% calves and calves/100 cows) and Kaplan-Meier adult female survival for Year 1 through Year 5 of monitoring are consistent with stable populations in the Pasquia-Bog (P-Bog) and Wabowden ranges, a stable to declining population trend in the Naosap-Reed (N-Reed) range, and a stable to increasing trend in the Charron Lake range.

2. **Abundance** – Population models based on genetic capture-mark-recapture (CMR) methods were applied to estimate abundance. All monitored populations are occurring at natural levels of abundance and are currently estimated to be 0.018 caribou/km^2 ±4% in P-Bog, 0.038±3% in Wabowden, 0.032 ±3% in N-Reed and 0.070±4% in Charron Lake. These are preliminary density estimates using closed-population estimators. Application of open-population model estimation or spatially explicit Capture-Recapture (sCR) analyses should be undertaken to refine assessment of population abundance and trend metrics once Year 5 genotyping results are available

3. **Telemetry Studies** – These data will be presented in a separate report (Part B).

4. **Caribou-Vehicle Collisions** - There were 2 known vehicle collisions with collared caribou. The occurrence in P-Bog range (animal BOG1408 on December 25, 2014) was 18.1 km from the ROW and was unrelated to Project-related activities (MB Hydro, T. Barker, personal communication, October 6, 2015). The collision with a Wabowden caribou (WAB1304 on April 23, 2017) was 17.9 km from the ROW and was unrelated to Project Construction (MB Hydro, T. Barker, personal communication, November 17, 2017. No other caribou-vehicle collisions were reported during the Construction phase. Mammal-vehicle collision monitoring was not required in the Operation phase.

Forest-Tundra and Barren-ground Caribou

The monitoring commitment during Construction was achieved once the project shifted into the Operation phase in July 2018; no monitoring for forest-tundra or barren-ground caribou was required in Year 5. The following summarizes monitoring during the Construction phase:

1. **Forest-Tundra Caribou** – Cape Churchill and Pen Islands caribou ranges partially overlap with the N1 Construction segment of the Project. Cape Churchill caribou were reported in proximity to the Project in January 2016 (Year 2 of Construction) and Pen Island caribou were in proximity to the Project in January 2018 (Year 4 of Construction). Caribou movements (based on telemetry study and local knowledge sources) confirmed that there were no movements or occurrence intersecting the Project during the Construction phase (MB Gov, V. Trim, personal communications, February 22, 2016 and

October 23, 2018). The Project did not contribute to local subsistence harvest success from either caribou population when local caribou groups were in proximity of the Project.

2. **Barren-ground Caribou** - The last known occurrence in the Project area (proximate to the N1 Construction segment) was in 2004 (about 10,000 caribou). Qamanirjuaq caribou were >75 km from the Project (Billiard Lake on Churchill River) during the final year of Bipole III Construction (MB Gov, V. Trim, personal communication, October 23, 2018).

Moose

The state of moose populations (depressed density of occurrence; population decline) in the Project area in recent years is not related to the Bipole III Project. A comprehensive review of long-term population data (1970 to present) for the sensitive moose ranges and adjacent reference populations demonstrates varying rates of population decline that began years ahead of any Project-related physical alteration to moose habitat, or Project-related changes in access for hunters or predators. The following is a summary of results of moose monitoring activities conducted in Year 5 (2018/19).

1. **Population Abundance**

    a) **Sensitive Moose Areas** - No Gasaway population surveys were conducted in Year 5 in or proximate to a sensitive moose area.

    In **Tom Lamb / GHA8** sensitive moose area, the population is currently estimated to be 47% below its long term (1971 to 2016) mean size. Regional moose populations proximate to this area all indicate declines in abundance in recent years, prior to Bipole III disturbance. The most recent survey conducted for GHA 8 occurred during Construction Year 2 (January 2016), resulting in an estimated population of 339 ±18.5% (90% CL) moose (0.107 moose/km^2).

    The **Moose Meadows (portion of GHA 14)** sensitive moose area is locally referred to as Bellsite Swamp. It is a low-lying area considered to be a sensitive winter foraging refuge for moose seasonally moving off the east slopes of the Porcupine Hills and is also thought to serve as a spring moose calving area. The most recent survey (January 2011) conducted for the GHA 14 portion of the Swan-Pelican Population (GHA14/14A) resulted in a population estimate of 109 ±12.8% (90% CL) moose (0.028 moose/km^2). The Swan-Pelican Population (GHA 14/14A) is estimated to be 89% below its long term (1971 to 2016) mean winter population size.

    The **Pine River (GHA 14A / 19A)** sensitive local moose population potentially interacts with the Project ROW. Moose population demographic data are limited for this population. Based on modelling of available survey data, it appears the population significantly declined from a high of 1,047 moose (0.336 moose/km^2) in January 1992 to 213 (0.068 moose/km^2) in January 2002, and has since remained at a low level. The most recent survey (January 2013) estimated the population at 91 ±12.8% moose (0.033 moose/km^2). The population is estimated to be 81% below its long term (1971 to 2016) mean size.

    b) **Split Lake** - This moose study area overlaps the northern portion of N2 and most of N1 Construction segments of the Bipole III Transmission Project ROW. Although the area was not identified as a sensitive moose range, it was added to the Bipole III moose monitoring program because it represents an area occupied by moose on the boreal shield ecozone that is intersected by the Bipole III ROW. MB Hydro conducted a moose survey for the Keeyask Project in January

2018 (MB Hydro, J. Wiens, personal communication, January 23, 2018). The population abundance was estimated to be 1,159 ±26.9% (90% CL) moose (0.069 moose/km²) and is not significantly different from the January 2015 or January 2010 surveys because the 90% confidence intervals of all 3 surveys overlap, suggesting the population is stable. The next survey of this population is scheduled for January 2021.

2. **Occurrence and Distribution**

   a) **Ungulate-Wolf Winter Distribution Surveys** were conducted annually during the Construction phase in four monitored boreal woodland caribou ranges) to assess ungulate (woodland caribou vs moose) predation risk from wolves and is discussed below in the summary for grey wolf and black bear.

   b) A **Multi-Species Aerial Survey** was repeated by MB Hydro along transects paralleling Construction segments N1, N2, N3, N4, and north half of C1 to assess coarse scale local moose distribution relative to the ROW. A relationship between the occurrence of moose as a function of the distance to the ROW has not been detected in any year (2015 to 2019). This result is similar to that quantified through the ground surveys, where moose occurrence did not have a significant positive or negative correlation with where they occurred relative to the ROW.

3. **Moose-vehicle Collisions** – No project-related collisions occurred during the Construction phase.

Deer and Elk

The following is a summary of results of deer and elk monitoring activities conducted in Year 5 (2018/19):

1. ***Parelaphostrongylus tenuis (P. tenuis)* Monitoring** – No deer pellet sampling was undertaken; re-sampling of the *P. tenuis* monitoring areas is recommended to occur in 2021/22.

2. **Occurrence and Distribution** – Multiple data collection methods are used to collect deer and elk occurrence data relative to the ROW which include: remote cameras, winter ground track transects, Ungulate-Wolf Distribution Surveys of woodland caribou study areas and a Multi-species Aerial Survey using transects parallel to the ROW at various distances. There is minimal evidence to date of white-tailed deer ingress into the P-Bog Caribou range and no evidence of elk ingress into areas outside of historical occurrence as a result of the ROW and associated Project disturbance.

3. **Deer / Elk-Vehicle Collisions** – During the Construction phase there were 3 deer-vehicle collisions involving Project vehicles in proximity to the S1 Construction segment. One collision occurred during Year 2 (December 7, 2015) and two occurred during Year 4 (August 6, 2017 and September 16, 2017). No project-related deer-vehicle collisions occurred for remainder of the Construction phase which ended in July 2018 (MB Hydro, T. Barker, personal communication, November 20, 2018). No elk-vehicle collisions related to the project occurred during Construction.

Gray (Timber) Wolf and Black Bear

Results of wolf and black bear monitoring activities undertaken in Year 5 (2018/19) are summarized below and are mainly focused on project effects on predator-prey dynamics and occurrence:

1. **Caribou Predation Mortality** - Mortality investigations (n = 86) of collared adult females, indicates predation constituted 85.5% of known mortality sources (n = 47), primarily by wolves (80.0%). Wolf predations occurred in all months, with a distinct peak in July.

    a) In **P-Bog Range**, there were more wolf predations of collared caribou during the pre-disturbance period (2010 to 2014; n = 9) relative to the disturbance period (2015 to 2019; n = 6). During the Construction period, there was 1 documented bear predation (February 2016; 34.8 km from the ROW. The closest documented wolf predation during the Construction phase was 2.9 km from the ROW in October 2016; the remaining wolf predations were >9.5 km from the ROW.

    b) In **Wabowden Range**, there were more wolf predations of collared caribou during the pre-disturbance period (n = 11) and disturbance period (n = 7). There were no records of bear predation. The closest documented wolf predation mortality was 1.8 km from the cleared ROW (December 2015); the remaining predation mortalities were >9.5 km from the cleared ROW.

    c) In **N-Reed Range**, there were 4 wolf and 1 bear predations of collared caribou prior to Construction and 3 wolf predations during Construction. The closest documented wolf predation mortality was 32.4 km from the cleared ROW (November 2015); the remaining predation mortalities were further from the cleared ROW).

2. **Ungulate Predation-risk**

    Predation-risk assessment within each woodland caribou study area using Ungulate / Wolf Distribution Aerial Survey data was undertaken by comparing the **distances** of observed moose and woodland caribou from recent wolf sign and observed wolves. In P-Bog Survey Area, there were no statistically detectable differences between woodland caribou vs moose with respect to wolf predation-risk during the Construction phase; this pattern continued during first winter of Operation phase in Year 5 (2018/19). In Wabowden Survey Area, moose had a greater wolf predation-risk than caribou during Years 1, 2 and 4 of the Construction phase, and in the first winter of Operation phase (2018/19). In N-Reed Survey Area, predation risk to boreal woodland caribou was significantly greater than for moose during the first 3 years of the Construction phase but were not significantly different during the last year of Construction, nor first year of Operation.

    Among monitored boreal woodland caribou ranges, predation-risk to caribou each year was greatest in the N-Reed study relative to the other woodland caribou study areas as a function of caribou distance to wolf. In Charron Lake Survey Area, predation risk to boreal woodland caribou was significantly greater than for moose annually. In addition, there were substantially less observations of moose each year relative to woodland caribou, further supporting the notion that wolves were likely focusing on caribou as primary prey in mid-winter in the Charron Lake Survey Area.

    a) Ungulate predation-risk assessment using relative density surfaces for each boreal woodland caribou survey area consistently revealed that the overlap of highest wolf density corresponded to areas of greater relative ungulate prey density (typically associated with moose). Areas of highest wolf predation-risk to woodland caribou or moose did not appear to be related to the ROW at the landscape scale during the Construction phase in any of the woodland caribou survey areas.

3. **Occurrence and Distribution**

   a) Winter Ground Track Transect Surveys and Trail Cameras were progressively deployed during Construction to collect local occurrence data for multiple furbearer species including bears and wolves. Surveys began along N2 and N3 Construction segments in Year 1 (2014/15), then expanded to N1 Construction segment in Year 2 (2015/16), and further expanded to N4 in Year 3 (2016/17) and Year 4 (2017/18). Based on trail camera data collected during the Construction phase, wolves occurred significantly more frequently on the ROW relative to 1.5 km from the ROW; bear frequency of occurrence on the ROW was not significantly different from locations 1.5 km from the ROW. Camera trap results are similar to those revealed through analysis of ground transect data, where data pooled from 2015 to 2019 revealed that predators such as coyote and fox had a positive correlation with the ROW, they were recorded with higher frequency closer to the Project.

   b) Multi-spp Aerial Survey – there were no significant relationships measured between any ungulate or furbearing species as a function of the distance to ROW using the aerial survey data.

Furbearers

A summary of results of furbearer monitoring activities initiated in Year 4 (2017/18) are below:

1. **Harvest Monitoring** - Four furbearer species (beaver, marten, wolf, wolverine) were identified in the Bipole III Project EIS as having particular concern because of potential Project disturbance effects (i.e., access resulting in overharvest, direct habitat loss and/or sensory disturbance). Annual harvest for these four species is variable across Construction segments. This is in part due to differences in the number (and physical extent) of traplines within each Construction segment that are physically intersected or directly adjacent to the ROW. The same pattern is evident in the harvest rates for these species. The following summarizes harvest analyses for these 4 species:

   a) **Beaver** - Harvest (number of pelts) and harvest rate (harvest / license) during the first 4 years of Construction (2014/15 to 2017/18) was consistently lower in Construction segments N1-N4 relative to the 5-year (2009/10 to 2013/14) Pre-construction means).

   b) **Marten** - Harvest was significantly higher during Construction compared to the 5-year (2009/10 to 2013/14) Pre-construction mean in N1 and N4. However, no significant differences were evident with respect to harvest rate, suggesting trapper success was not affected.

   c) **Wolf** – A significant difference in harvest was detected in N2 when comparing pre-disturbance to Construction phase, but this was not reflected in harvest rate in the monitored Construction segments.

   d) **Wolverine** - No significant difference was detected when comparing pre-disturbance to Construction phase with respect to harvest or harvest rate in the monitored Construction segments or the pooled ROW harvest data.

   e) The only significant differences detected (Pre-construction vs Construction) with respect to harvest rate were for beaver (Construction segments N1-N4), cross fox (N2), and weasel (N3); all were lower during Construction phase. No other significant harvest trends were detected for the remaining furbearer species with respect to harvest rate.

2. **Distribution and Occurrence**

   a) **Winter Ground Track Transects** surveyed during Year 5 (n = 31) along Construction segments N1, N2, N3, and N4 detected most of the expected furbearing species including weasel, mink marten / fisher (genus *Martes*), otter, fox, coyote, Canada lynx, snowshoe hare, and squirrel. grey wolf and wolverine are wider ranging species that were not detected in during the Year 5 ground transect survey but were detected in previous years. Analysis revealed a negative correlation between track density and distance to the Project for predators such as coyote and fox; tracks of these species were observed more frequently at distances closer to the Project than farther away during the winter Construction period. Marten, ermine and rabbit all had positive correlations with distance to the ROW, being detected more frequently as greater distances from the ROW. Predators may be using the linear corridor to hunt and/or ease of movement, whereas marten, ermine and rabbit may have avoided the ROW due to higher predator presence and/or sensory disturbance from Construction. During the first year of Operations, most species had the same correlations to the ROW as that observed during the Construction phase. However, fisher / marten, ermine / weasel and squirrel did not have significant correlations with distance to the ROW during the first year of Operations and during the Construction phase they were significantly avoiding the ROW. These relationships should continue to be evaluated as more data accumulates as it may be a factor of low sample size with just one year of data (2019)

   b) **Trail Camera Study** - Results from memory cards retrieved from trail cameras deployed during the Construction phase (February 2015 through February 2019) were used to compare occurrence of furbearers near the ROW versus 1.5 km away from the ROW. Significant differences were detected for some furbearer species with respect to proximity to ROW. As expected, gray wolf and fox occurred significantly closer to the ROW; wolverine and marten occurred significantly further from the ROW. Canada lynx and snowshoe hare tended to be further from the ROW but the relationship was not statistically significant. Behavior of some species may also change now that Construction is complete.

Human Access

Human access monitoring activities were undertaken during the Construction phase using trail camera data acquired along the ROW and at all-weather construction access points. Results of the sampling effort during Construction (March 2015 to February 2019) indicated most of the ROW access for a known purpose was for Project Construction and ranged from 99.1 to 99.6% during each year of Construction, and with limited local public access (ranging from 0.4 to 0.9% during each year of sampling) for recreation and resource use. Observed human access during the Operation phase is expected to be substantially lower, now that Construction is complete. It is not known if public access will increase during the Operation phase (began in July 2019), therefore ongoing camera study is recommended.

Monitoring and Mitigation Recommendations

Based on the results of the 2018/19 (Year 5) report, the following are mitigation and monitoring recommendations for Year 6 and beyond:

1. **Capture-Mark-Recapture (CMR) Sampling using Non-invasive Genetic Survey (NGS) -** Sampling occurred a 2-yr intervals (i.e., Year 1, 3 and 5) and is intended to support monitoring of population performance (abundance trend, lambda) though each Project phase (Construction, Operation); sampling frequency should expanded to 4-year intervals for populations that are stable (i.e.,

Wabowden and Charron Lake) and remain at 2 year intervals for population(s) in decline (i.e., P-Bog and N-Reed).

2. Continue with annual winter **Boreal Woodland Caribou Recruitment Surveys** (aided by telemetry relocations) and concurrently conduct **Ungulate-Wolf Winter Distribution Surveys** in all four monitored woodland caribou study areas to monitor for changes in mortality risk, white-tailed deer ingress, and altered predator-prey dynamics.
3. **Woodland Caribou Telemetry Study** - Continue to acquire boreal woodland caribou telemetry locations in each monitored caribou study area to evaluate behavioural responses to the Project during the Operation phase, to evaluate effectiveness of the vegetation leave areas, and to monitor adult female boreal woodland caribou mortality and survival rates. Maintain an average sample of 20 collars / study area.
4. **Winter Ground Track Transects** - Limit sampling to transects in Construction segments N1-N4 (n = 40 transects) that have associated trail cameras in Year 6. The Project commitment is to sample annually during the Construction phase, and for 3 years Post-construction (until 2020/21 inclusive).
5. **Multi-species Aerial Survey** – Repeat survey in 2019/20 to sample mammal VECs during the second year of Operation.
6. **Remote Trail Camera Study** - Continue sampling to acquire additional data to compare Construction phase (2014/15 to 2017/18) to Operation phase (2018/19 to 2020/21; 3 years Post-construction).

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List of Acronyms

BACI	Before-After-Control-Impact (Design)
CMR	Capture-Mark-Recapture
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
EIS	Environmental Impact Statement
ELC	Ecological Land Classification
EOSD	Earth Observatory for Sustainable Development
ESS	Environmentally Sensitive Sites
GHA	Game Hunting Area
kV	kilovolt
MB Hydro	Manitoba Hydro
MB Gov	Government of Manitoba
MMU	Moose Population Monitoring Unit
NGS	Non-invasive Genetic Sampling
N-Reed	The Reed portion of the Naosap-Reed boreal woodland caribou population
P-Bog	The Bog portion of the Pasquia-Bog boreal woodland caribou population
RCM	Retrospective Comparative Monitoring (Design)
RMNP	Riding Mountain National Park
RSF	Resource Selection Function
ROW	Project Right-of-Way
VEC	Valued Ecosystem Component
WMA	Wildlife Management Area
ZOI	(Project) Zone of Influence

1.0 Introduction

On August 14, 2013, the Government of Manitoba (MB Gov) granted an Environment Act License (EA License; MB Gov 2013) to Manitoba Hydro (MB Hydro) for the construction, operation, and maintenance of the Bipole III Transmission Project (the 'Project'). Mechanized clearing for the Project began during the winter of 2013/14. Clearing delays were encountered in the N1 and N4 construction segments during the winter of 2014/15 (Monitoring Year 1), and in N4 in 2015/16 (Monitoring Year 2), which impaired full implementation of ground-based mammal monitoring field programs as originally planned. Construction was completed in July 2018. The Project is now in the Operation phase.

Project-related concerns about wildlife were focused largely on caribou, moose and migratory birds (CEC 2013). The Environmental Impact Statement (EIS), technical report addendums, and regulatory review documents identify several predicted effects on wildlife VECs. These effects vary by scale and Project phase. Construction and Operation of the Project potentially affects several disturbance sensitive mammalian species. Mammal valued ecosystem components (mammal VECs) selected for effects monitoring were specified in the Bipole III EIS and related documents. These include boreal woodland caribou, forest-tundra woodland caribou, barren-ground caribou, moose, elk, white-tailed deer, grey wolf, black bear and furbearers (beaver, wolf, wolverine and marten in particular). These mammal VEC's were selected because of their ecological, cultural, and economic importance, and their sensitivity to Project-related stressors. The Bipole III mammals monitoring program study design assesses population effects on select mammal VECs, disturbance thresholds (i.e., disturbance / displacement / avoidance) relative to mammal VEC responses within the Project ZOI, as well as altered mortality risk (i.e., increased disease risk, altered harvest and/or predation mortality). The focus of effects monitoring varies by mammal VEC and Project construction segment.

Potential significant residual effects (i.e., after mitigations are applied) include direct habitat loss, functional habitat loss, sensory disturbance, altered mortality risk, and/or altered predator-prey dynamics. MB Hydro committed to implementing mitigation strategies intended to offset potential and predicted Project effects, as well as monitoring to assess the effectiveness of mitigations and predicted effects. Types of ecological monitoring implemented to gather and analyze data include baseline, implementation, effectiveness and compliance monitoring. Once construction began, monitoring emphasis switched to effectiveness and compliance monitoring; baseline monitoring continued in areas adjacent to the impact areas and reference areas outside the zone of influence (ZOI) of the Project. The monitoring program identifies and measures potential effects on these species, informs the mitigation strategy, and monitors effectiveness of the strategy. A passive adaptive management framework was implemented to deal with uncertainties as they arise; poorly performing mitigation strategies or monitoring techniques are modified or replaced where warranted.

This monitoring report (Part A) presents an analysis and summary of existing monitoring program data for mammal VECs potentially affected by the Bipole III Transmission Project ('the Project'). Results of the Woodland caribou telemetry studies will be provided in a separate report *Mammals Monitoring Program Technical Report Year 5 (2018/19) – Part B* (hereafter "Part B").

2.0 Monitoring Objectives and Framework

The Bipole III mammals monitoring program was designed with multiple objectives per mammal VEC in mind, and with the intent to examine spatio-temporal behavioral responses, as well as population level responses at multiple scales as warranted. Monitoring programs should consider disturbance factors at coarse (landscape) and fine (local) scales with respect to effects on species occurrence, persistence and viability, and to inform mitigations and management interventions (Haufler et al. 2002, Christiansen et al. 2015). Long-term effects of human disturbance on population status requires long-term monitoring and a means of demonstrating a causal relationship between exposure to disturbance and effects on population demography (Christiansen et al. 2015). This is because human development may influence population abundance but not resource selection for some species (Keim et al. 2011). Short-term direct effects are relatively easy to measure and can be directly linked to the disturbance source but are often not placed into context to understand demographic relevance (Christiansen et al. 2015). Indirect effects and lag effects are more difficult to relate to the disturbance source.

The Bipole III mammal monitoring program uses multiple indicators per mammal VEC to assess potential effects. Counts, indices, population estimates, and habitat selection lie at the core of monitoring programs because they provide guidance for species management, measuring effect of management activities or disturbance, documenting compliance with regulatory requirements and detecting incipient change (Gibbs et al. 1998). Estimates of animal abundance and composition are needed to monitor small or at-risk populations (Antao et al. 2011, Hansen et al. 2015, Joseph et al. 2006), to manage harvested species (Lounsberry et al. 2015, McCullough 1999), and to quantify population responses to inform defensible management decisions. Robust estimates of mammal abundance can be obtained using capture-mark-recapture (CMR) methods (Amstrup et al. 2005, Otis et al. 1978). Current population abundance is a function of past abundance and the demographic processes of survival, productivity, immigration and emigration (Skalski et al. 2005). The amount of resource use by a species is a function of both their resource selection and population abundance (Keim et al. 2011).

Mammals commonly exhibit sex and age-specific differences in life history strategies, home range sizes, habitat use patterns and cause-specific mortality rates (Caughley 1966, Cederlund & Sand 1994), which can be affected differently by disturbance (Laurian et al. 2008, Polfus et al. 2011) and season. Any disturbance is likely to vary spatially and temporally, with effects on mammals also being inherently variable with respect to species, their susceptibility to disturbance, exposure to disturbance, seasonal distribution and their behavioral response (Christiansen et al. 2015, Clutton-Brock et al. 1987). Therefore, where such information exists or is being collected, the Bipole III monitoring program takes into account factors such as seasonality, age and sex to control to understand the variation in measured Project responses.

Mammal-habitat relationships are fundamental to mammal ecology because of their central role in species distribution and biogeography, population dynamics, state and vital rates and individual life histories and behavioral ecology (Aldridge & Boyce 2008, Allen 1999, Cooper & Millspaugh 1999, Leblond et al. 2014).

2.1 Objectives

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 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 ROW creation 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.

There are species-specific monitoring objectives and parameters, which are summarized below.

2.1.1 Caribou

Caribou monitoring plan objectives (Table 2-1-1) 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 2018 and are presented in Table 2-1-2.

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 WMU / GHA8, Moose Meadows (Bellsite Swamp in GHA14) and Pine River GHA 14A / 19A) using remote sensing (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 Project influence of the ROW as a wolf travel corridor.

5. Investigate human presence on the ROW.

6. Determine change in Project related vehicle-moose collisions.

2.1.3 Deer and Elk

Deer and Elk monitoring plan objectives (Table 2-1-3) 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 (Table 2-1-4) is to assess changes in predation-risk to woodland caribou and moose due to Project effects on predator occurrence and distribution.

2.1.5 Furbearers

Furbearer monitoring plan objective (Table 2-1-5) is to assess Project-related changes in furbearer harvest statistics, furbearer occurrence and distribution relative to changes in 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 (Table 2-1-6) is to assess changes in access to the Project area by humans.

2.1.7 Adaptive Management Framework

Monitoring is a key component of adaptive management. A passive adaptive management framework was adopted for the overall mammals monitoring program to allow for an ongoing evaluation of monitoring results as they relate to the effectiveness of the mitigation strategies and monitoring methods. This information will also be used to inform the associated adjustments required to improve effectiveness, and involves:

1. Providing the necessary information to plan, modify and/or implement adaptive mitigation measures, when and where necessary, to minimize mortality and/or disturbance to local mammal populations;

2. Modification of the mammals monitoring design to improve rigor, efficiency and/or duration; and

3. Adjust for unforeseen Project effects encountered.

In addition, active adaptive management is applied with respect to evaluating habitat mitigations applied to boreal woodland caribou corridors by using different clearing prescriptions in each range.

Project activities will cause direct and indirect changes to mammal VEC habitats through direct and/or indirect (i.e., functional) habitat loss or gain. These changes can then alter wildlife population or community dynamics through altered population vital rates, state, range occupancy, predator-prey dynamics, disease and parasite transmission risk and human–wildlife encounters. Population and community level effects are strongly linked through recruitment and mortality rates via predator-prey, hunter / trapper and disease transmission dynamics. Consequently, key monitoring activities and the assessment of Project effects have been categorized into: 1) habitat effects; 2) population effects; and 3) community effects (Section 2.2).

Monitoring objectives are simultaneously met for multiple components (habitat, population and community) through integrated field and analytical approaches. Types of ecological monitoring implemented to gather and analyze data on mammal VECs largely include:

1. Baseline monitoring is intended to identify temporal and spatial variability within an ecosystem, biological community, or population in order to understand the historical range of variability prior to disturbance by Bipole III. Baseline monitoring will continue in areas prior to construction and clearing the ROW. After construction, baseline monitoring will be focused in reference areas outside of the Project ZOI.

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 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.

Based on the commitments outlined by MB Hydro in the Bipole III EIS, associated technical reports, and the EA License, there are species specific monitoring commitments unique to each mammal VEC that are incorporated into the study design. In particular, moose and boreal woodland caribou have comprehensive and detailed monitoring objectives which are provided in the methods section of this report (Section 4.0).

2.2 Study Design

To achieve the principal purpose of the follow-up mammals monitoring program for the Bipole III Transmission Project, key monitoring activities and the assessment of predicted and potential Project effects were grouped under three main components: (1) Habitat Effects; (2) Population Effects; and (3) Community Effects (Figure 2-3-1). All monitoring objectives and parameters for each mammal VEC fall under one or more of these three components. Biological systems are highly complex and interrelated and all three components share common indicators, as well as field and analytical methods. Consequently, monitoring objectives can be simultaneously met for multiple components through integrated field and analytical approaches.

Project activities will cause direct and/or indirect changes to mammal VEC habitats through functional habitat loss or gain (Figure 2-3-1). These changes can then alter wildlife population or community dynamics through altered population vital rates, state, annual / seasonal range distributions, predator-prey dynamics, disease and parasite transmission risk and human-wildlife encounters (Figure 2-3-1). Population and community level effects are strongly linked through recruitment and mortality rates via predator-prey, hunter harvest, and disease transmission dynamics (Figure 2-3-1).

Central to the conservation of mammal populations and community ecology is an understanding of factors contributing to spatial and temporal variation in the state (distribution and abundance) and demographics (population structure and vital rates) of mammals, as well as understanding of the disturbance threshold responses of species sensitive to project effects. This understanding is achieved through monitoring to measure disturbance effects and detect incipient change (Gibbs et al. 1998). Population monitoring has two explicit roles; it provides information on population state and it contributes to knowledge of effects of management actions (e.g., mitigations) on populations. Habitat monitoring is concerned with monitoring key habitat attributes (structure, composition) over time and contributes to understanding the ecological response of habitat to disturbance and management actions (restoration efforts, mitigations). Population and habitat monitoring are both required to understand project disturbance and mitigation effects on wildlife-habitat relationships and ultimately on community dynamics and ecosystem integrity.

Study designs were developed for each mammal VEC based on monitoring commitments and available data from the EIS and addendum technical reports. Additional details pertaining to these designs are provided in Arsenault & Hazell 2014 a and b, and in the Bipole III Transmission Project Biophysical Monitoring Plan (Manitoba Hydro 2018) and are also provided in detail in the methods section of this report for each VEC (Section 4.0).

Scale of assessment has a strong influence on the probability of detecting effects (Polfus et al. 2011, Vistnes & Nellemann 2008). At local, seasonal, and/or population scales, the monitoring program examines Project effects on the abundance and distribution of mammal VECs. The exact scale(s) of assessment are specific for each unique VEC. In collaboration with MB Gov, boreal woodland caribou and moose are monitored at the population range (landscape) scale, as well as the local scale. Wolves and wolverine are primarily assessed at a larger landscape scale because of their wide-ranging nature. The remaining mammal VECs are small fur bearing mammals assessed solely at the local scale. Telemetry studies and non-invasive genetic sampling methods are implemented to monitor boreal woodland caribou populations interacting with the Project, as well as a reference range.

The moose monitoring plan has evolved for the Project and currently includes landscape scale moose distribution surveys concurrent with boreal woodland caribou recruitment surveys, coarse local scale moose distribution via multi-species aerial transect survey, and local occurrence along the Project ROW using a combination of methods including remote IR cameras at access points and along the ROW, winter ground transects, and as a component of the multi-species aerial survey of N1 through C1 construction segments. A study design for a moose telemetry study was proposed and developed in consultation with MB Gov during Year 1 (2014/15) for implementation in Year 2 (2015/16) of the mammals monitoring program but was not implemented in response to local public consultation conducted by MB Gov in 2015. A non-invasive genetic sampling design was then proposed as an alternative to the moose telemetry study but was not supported for implementation by MB Gov. Planned periodic population surveys of the sensitive moose ranges within the mammals monitoring program design was replace by MB Hydro's commitment in 2018 to support the MB Gov regional moose population survey program.

To test mammal VEC specific hypothesis, a Before-After Control-Impact (BACI) study design (McComb et al. 2010) was applied where pre-existing and/or reference data permitted. Where feasible, the ZOI around the Project is determined for each mammal VEC and used as the minimum boundary between impacted and non-impacted areas. For mammal VECs where reference / control site and/or comprehensive pre-construction data are not available, effects monitoring is documented through temporal analysis focused on characterizing long-term trends, involving comparison of pre-disturbance versus post-disturbance within a Retrospective Comparative Monitoring (RCM) design (McComb et al. 2010) or analogous alternative. The Project intersects the Prairie, Boreal Plain, Boreal Shield and Hudson Plain ecozones (Figure 2-3-2). As mammalian communities may have different characteristics across different ecozones, survey locations have been selected to collect data across a diversity of habitat types within the ecozones where significant Project effects for particular mammal VECs are anticipated. Locations, methods, and study area extent employed during pre-construction surveys are incorporated where feasible to facilitate comparisons of before and after impact.

It should be noted that true replication in natural systems is often impossible. Designs involving treatment and control at large scales is impractical because of natural variation; ecosystems are dynamic. It is not possible to design monitoring programs to measure the dynamics of every species and every ecosystem process (Christensen et al. 1996). Also, gathering data in relation to patterns of ownership, access to areas and sampling technique limitations and biases are additional issues that complicate large scale study design and analysis, and should be reflected in any interpretations or conclusions (Christensen et al. 1996). The design, development and maintenance of monitoring programs requires commitment and long-term vision (Christensen et al. 1996).

Table 2-1-1: 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

Table 2-1-2: 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 MHydro, 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

Table 2-1-3: 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

Table 2-1-4: 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

Table 2-1-5: 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

Table 2-1-6: 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	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

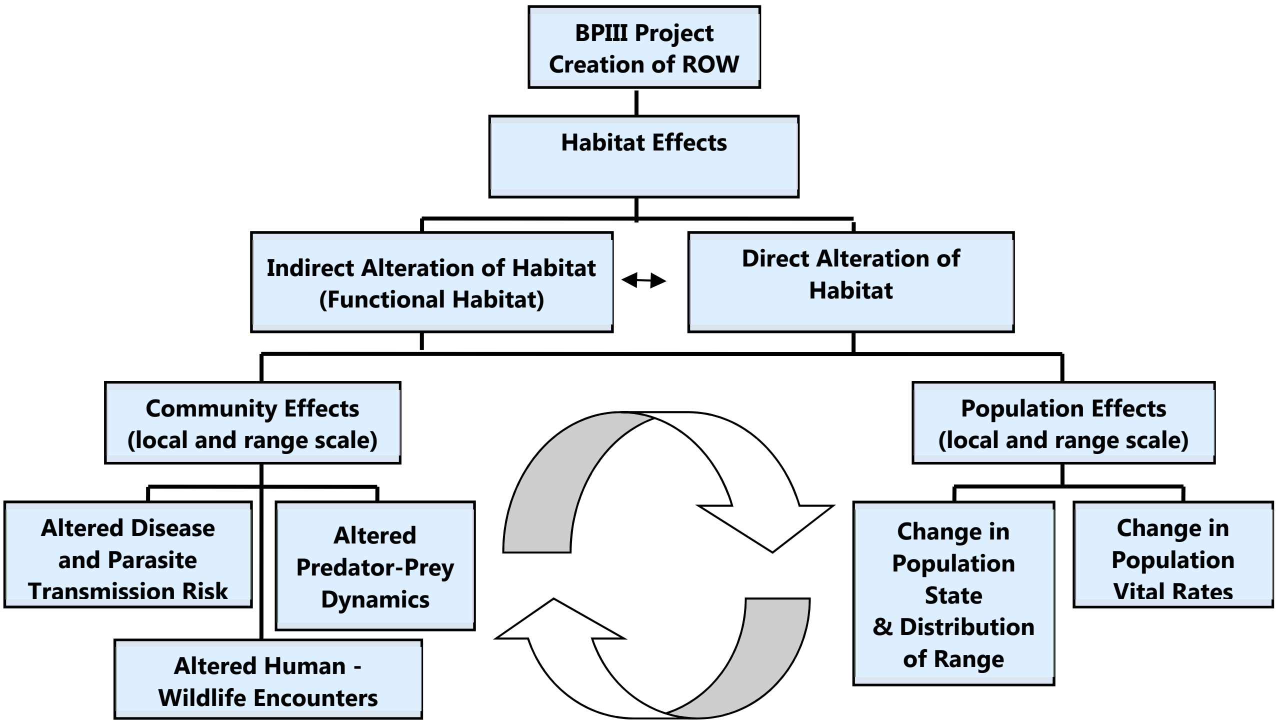
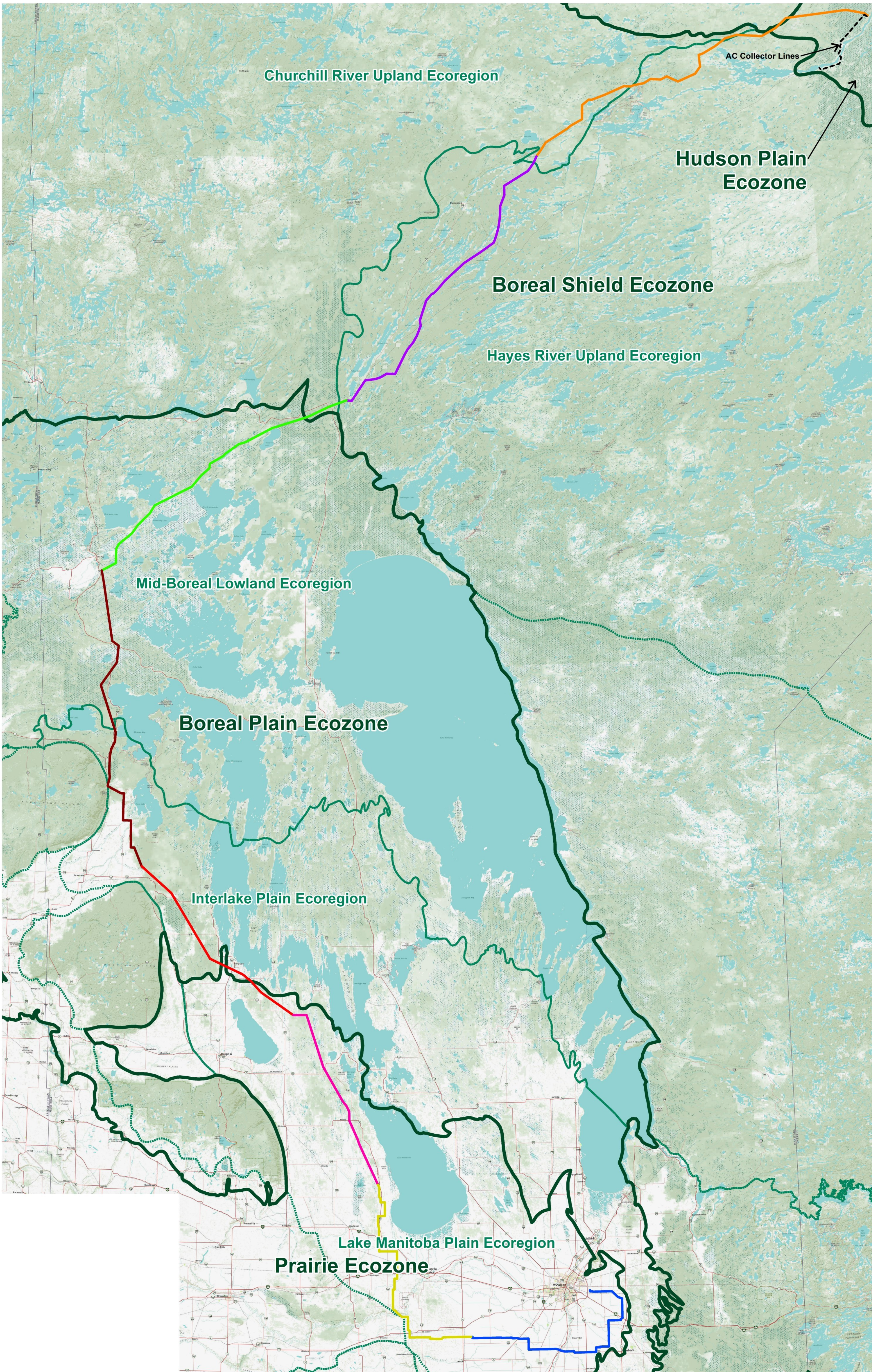


Figure 2-3-1: Monitoring Design Conceptual Overview of Effects Pathways



LEGEND

- Ecozones
- Ecoregions

BPIII Transmission Line Route

By Section

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

- AC Collector Lines

NOTES:
- Background topographic map extracted from ESRI online basemap services
-

Manitoba Hydro | wood.

MANITOBA HYDRO BIPOLE III TRANSMISSION PROJECT

Bipole III Transmission Project Overview

Datum: NAD83
Projection: UTM Zone 14N

0 | 70 | 140 | 210 | 280 | 350 Kilometres

PROJECT N°: WX17393 | **FIGURE: 2-3-2**

SCALE: 1:2,300,000 | DATE: December 2019

G:\WX17393_Man_Hydro_Bipoleiii\Mammal\Annual_Report_2019\MXD_Maps\BPIII_Overview_7.mxd
G:\WX17393_Man_Hydro_Bipoleiii\Mammal\Annual_Report_Nov2018\MXD_Maps\BPIII_Overview_BASE_3.mxd

3.0 Monitoring Activities

Pre-monitoring (2013/14) - Pre-monitoring activities conducted by MB Hydro in 2013/14 are presented in AMEC (2014). These activities included review of existing information and acquisition of baseline datasets for the Bipole III Project from the Project's EIS regulatory review documents and associated technical reports and included compilation of Project commitments. This informed the planning and development of a comprehensive and rigorous mammals monitoring program and is a component of the Bipole III Transmission Project Biophysical Monitoring Plan (Manitoba Hydro 2018).

Construction Phase (2014 to 2018) - The mammals monitoring program was presented in AMEC's Year 1 monitoring workplan and at a meeting (September 17, 2014) with MB Gov (Arsenault & Hazell 2014a and b). Annual mammals monitoring reports were prepared for Year 1 (2014/15 - see Amec Foster Wheeler 2016), Year 2 (2015/16 - see Amec Foster Wheeler 2017), Year 3 (2016/17 - see Wood 2018), and Year 4 (2017/18 - see Wood 2019) of construction.

Operation Phase (2018 – Ongoing) - The project transitioned from the Construction phase to Operation phase in July 2018. A summary of monitoring activities and results for Year 5 (2018/19), excluding woodland caribou telemetry analyses, are presented in this report.

3.1 Data Acquisition – Year 5 (2018/19)

Data obtained from sources outside of that collected by Wood Environment & Infrastructure Solutions include the following:

1. MB Gov - Provincial moose population survey results for populations intersected by (or adjacent to) the Project were acquired annually from MB Gov to facilitate updating of discrete time moose population demographic trend models and monitoring of population performance relative to Project activities and phase.

2. MB Gov - Annual furbearer harvest statistics were acquired from MB Gov for all 42 registered traplines intersected by the Bipole III ROW to compare the pre-disturbance (2009/10 to 2013/14) state to the Project Construction phase (2014/15 to 2017/18).

3. MB Hydro - Large and medium-sized mammal winter occurrence data collected via a Multi-species Aerial Survey during Year 3, 4 and 5 based on the transect survey design used in Year 2.

4. MB Hydro - Woodland caribou telemetry collar mortality investigation results to estimate survival and assess patterns in location, timing and cause of adult female mortalities during the Pre-construction phase (January 2010 to December 2014) in relation to the Construction phase (January 2015 to August 2018).

3.2 Field Activities – Year 5 (2018/19)

Field survey programs conducted during the winter of 2018/19 (Year 5 of monitoring) included the following primary data collection methods (Section 4.0 for details of survey design):

1. Woodland Caribou Recruitment Survey - Aerial 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. Non-invasive Genetic Sampling (NGS) for Capture-Mark-Recapture (CMR) population abundance assessment of each woodland caribou study area (n = 4), replicating the study design established in Year 1.

3. 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 dynamics.

4. Woodland Caribou GPS Telemetry Study - ongoing monitoring of caribou occurrence and movement dynamics in each woodland caribou study area using GPS satellite telemetry data obtained from MB Hydro. Fresh collars were deployed (16-20 February 2019) in Charron Lake (n = 19; 2 failed), Wabowden (n = 21) and P-Bog (n = 18) caribou ranges.

5. Boreal woodland caribou Telemetry Collar Mortality Investigations.

6. Multi-species Aerial Survey provides coarse local scale information to assess large mammal winter distribution proximate to the Bipole ROW, and to assess P. tenuis risk to woodland caribou during winter in relation to changes in deer and elk distribution along the Bipole III ROW. The survey was conducted January 12 to 20 and February 11 to 14, 2019 by MB Hydro.

7. Winter Mammal Ground Tracking Transect Surveys to assess fine scale occurrence of furbearer VECs relative to the ROW during Construction and Operation project phases. All 40 camera transects in construction segments N1 through N4 were sampled February 5 to 11, 2019.

8. Camera Traps to collect data on seasonal mammal use proximate to the ROW and up to 1.5 km from the ROW. All cameras (n = 71) deployed on winter mammals ground tracking transects along N1 through N4 were accessed and serviced; one additional camera was deployed.

9. Human Access Monitoring involved trail cameras at ROW locations associated with the winter ground transect survey (N1 (n = 8 locations), N2 (n = 8 locations), N3 (n = 10 locations), and N4 (10 locations) construction segments. No data was provided for the all-weather ROW access points for 2017/18 and 2018/19 (n = 9 locations based on previous years).

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 year of the Operation phase (August 2018 to July 2019).

4.1 Boreal Woodland Caribou

Three woodland caribou ranges (P-Bog, N-Reed and Wabowden) potentially interact with the Bipole III Project (Figure 4-1-1). In addition, Charron Lake is used as a reference woodland caribou range for population demographic and telemetry analytical comparisons.

4.1.1 Aerial Surveys

Woodland Caribou Recruitment Survey - Annual winter calf recruitment, population structure and distribution were assessed in Year 5 by aerial observations (aided by GPS telemetry relocations of collared woodland caribou), using the methods and survey design implemented in Year 1. Systematic transects spaced at 3 km intervals oriented in an east-west direction (Figure 4 1-1) were flown by helicopter at ±200 m ground height and ±90 km/hr ground speed to search for caribou and caribou sign (tracks and cratering). At least 20 cm snow cover and minimal overcast are required for contrast to maximize detectability. Ideally the survey is conducted 2 or 3 days following a significant snowfall event to distinguish recent sign from old sign. The helicopter would stray off transect to relocated telemetry collar signals, or to verify caribou sign, or to classify caribou detected, before returning to transect. Classification of individuals to sex and age category was conducted by experienced caribou biologists to minimize observer bias. Effort was made to avoid overstressing caribou, to minimize risk of stress myopathy. Animals were identified to sex and age category based on physical characters including antler configuration, presence of vulva patch / penis sheath, shape of rump patch stature (physical size) and behavior (within group association). Number of calves, number of adult females, number of adult males, and number un-classified were recorded.

Ungulate-Wolf Distribution Survey - Moose, deer, elk, wolverine and wolf recent sign and observations were recorded in each woodland caribou survey area concurrently during the Woodland Caribou Recruitment Survey. These species provide insight into coarse (landscape) scale patterns of caribou distribution. The annual survey provides data for analysis of wolf predation risk, to monitor changes in community dynamics, to monitor changes in ungulate, wolverine and wolf relative distribution, as well as to assess disease risk (potential for *P. tenuis* transmission from overlap of other ungulate species with caribou, or from ingress of white-tailed deer into caribou range) relative to woodland caribou.

4.1.2 Non-invasive Genetic Sampling (NGS)

Non-invasive genetic sampling is undertaken at 2-year intervals and was conducted in Year 5. Sampling interval may be undertaken at 4-year intervals for populations considered stable or growing and occur at 2-year intervals for population considered to be declining.

4.1.3 GPS Satellite Telemetry Studies

GPS satellite collar telemetry studies were initiated for the Project in 2010 in four woodland caribou ranges. Two of the woodland caribou ranges (P-Bog, Wabowden) interact with the Project and have been included in the monitoring program to assess the extent (if any) that the Project alters movement dynamics of woodland caribou within each of these ranges. Caribou within the N-Reed range have not demonstrated frequent interaction with the Project footprint since the monitoring program was initiated in 2014. Therefore, use of telemetry in monitoring project effects on this population were recommended to discontinue after existing collars expire (Wood 2019). Charron Lake is included in the monitoring program as a reference range that is isolated from the Project, as well as other forms of cumulative disturbance (e.g., mining and forestry). These ranges were all delineated using long-term monitoring data of satellite collared caribou and defined by MB Gov (Government of Manitoba 2014). Telemetry was continued in Year 3 of the monitoring program, consisting of deployment of 20 additional collars (7 in P-Bog, 7 in Wabowden and 6 in Charron Lake) in February 2016 to ensure a continued sample size of 20 collars / caribou range (MB Hydro 2016). Deployment of additional collars was undertaken February 16 to 20, 2019 in:

- **P-Bog** - 18 new collars were deployed, 1 caribou was recollared, and 2 existing collars were active, for a total of 21 collars.
- **Wabowden** - 19 new collars were deployed and 2 caribou were recollared, for a total of 21 collars.
- **N-Reed** – no new collars were deployed because geospatial analyses of satellite telemetry from this population did not demonstrate interaction with the project area during preconstruction, nor during the four years of construction.
- **Charron Lake** - 14 new collars were deployed, 3 caribou were recollared, 2 additional collars failed at deployment, and 2 existing collars remained active, for a total of 19 collars.

A Before-After-Control-Impact (BACI) study design was implemented to assess for potential shifts in behaviour relative to baseline conditions observed during the pre-construction period and/or the reference location, as well as across all phases of the Project including: 1) pre-construction; 2) during construction (2014/15 to 2017/18); and; 3) post-construction. The telemetry study and associated analyses are presented in a separate report (Part B).

4.2 Forest-tundra and Barren-ground Caribou

4.2.1 Field Studies

The Operation phase of the Bipole III Project initiated in July 2018, therefore no further monitoring of winter occurrence of forest-tundra (Cape Churchill or Pen Islands populations) or barren-ground (Qamanirjuaq population) caribou (Figure 4-2-1) was required during Year 5 (2018/19). See Wood 2019 for details of occurrence during the Construction phase.

4.2.2 Mitigation Monitoring

During the Construction phase, mitigation measures involved avoiding effects from Project construction activities if / when herd migration movements overlap Construction segment N1. MB Hydro environmental monitors from local communities were on site to advise if concentrations of forest-tundra or barren-ground caribou are in proximity of the Project during winter construction. No monitoring was required during Year 5 (2018/19) once the project shifted into the Operation phase in July 2018.

4.3 Moose

Three sensitive moose ranges intersected by the Bipole III Transmission Project were identified in the Biophysical Monitoring Plan (Manitoba Hydro 2015), which was updated in 2018 (Manitoba Hydro 2018). The sensitive ranges are Tom Lamb / GHA 8, Moose Meadows (portion of GHA 14) and Pine River (GHA 14A / 19A). In addition, MB Hydro conducts a periodic moose survey as a component of the Terrestrial Effects Monitoring Plan for the Keeyask Generation Project. Area 5 of the Keeyask moose survey (i.e., Split Lake Moose Monitoring Area) overlaps an eastern portion of GHA 9 that is intersected by construction segment N1 of the Bipole III ROW. The four monitored moose populations and adjacent reference populations are presented in Figure 4-3-1.

4.3.1 Aerial Surveys

Aerial Moose Population Surveys - Surveys using a modified Gasaway method (Gasaway et al. 1986, Lynch & Shumaker 1995) are conducted by MB Gov as determined by annual provincial survey priorities. MB Hydro participates in the survey effort when a survey is scheduled for a Bipole III sensitive moose range and also conducts periodic surveys of the Split Lake moose population. The following summarizes moose surveys conducted during the Project Construction phase:

- **Year 1 (2014/15)** - A survey of the Split Lake Moose Monitoring Area (eastern portion of GHA 9) was conducted by MB Hydro in January 2015.
- **Year 2 (2015/16**) - Surveys were conducted in two GHAs (Tom Lamb / GHA 8 sensitive moose area, and in GHA 11) that overlap the Bipole III ROW in mid-January to mid-February 2016.
- **Year 3 (2016/17)** - Surveys of Moose Meadows (GHA14) and Pine River (GHA14A / 19A) sensitive moose areas were scheduled to occur in Year 3 as a component of the Bipole III Mammals Monitoring Program. However, these surveys were deferred by MB Gov to a later year in order to prioritize modified Gasaway surveys of the Porcupine Hills (GHA 13+13A) and Duck Mountain (GHA18+18A+18B+18C) reference populations in late January / early February 2017.
- **Year 4 (2017/18)** – No surveys were conducted in Year 4 on any of the sensitive moose ranges. A survey was conducted on the Split Lake moose population as part of the Keeyask monitoring program in January 2018. The Split Lake survey is scheduled to be repeated in January 2021.
- **Year 5 (2018/19)** – No surveys were conducted in Year 5 on any of the sensitive moose ranges or Split Lake population. Several requests (including April 11, May 6, June 6, 2019) were made to MB Gov for survey results of any moose surveys conducted on populations adjacent to the sensitive moose areas, but no response was received.

Ungulate-Wolf Distribution Survey - Moose distribution (observed moose and fresh tracks) are recorded concurrent with the annual Woodland Caribou Recruitment Survey in each boreal woodland caribou survey area annually and are summarized below:

- **Year 1 (2014/15)** – First winter of construction - The survey was conducted January 6, 2019, February 2015 concurrent the Caribou NGS (first sampling) effort and Caribou Winter Recruitment Survey.

- **Year 2 (2015/16)** - The survey was conducted January 12 to 19, 2016 (N-Reed, Wabowden and Charron Lake survey areas) and February 25 and 25, 2016 (P-Bog survey area). The P-Bog survey was delayed because of a moose survey being conducted by MB Gov at the same time.

- **Year 3 (2016/17)** - The survey was conducted January 5, 2017 to February 2017 concurrent with the Caribou NGS (first sampling) effort and Caribou Winter Recruitment Survey.

- **Year 4 (2017/18)** – Final year of construction - The survey was conducted January 22 to February 3, 2018.

- **Year 5 (2018/19)** – The survey was conducted January 22 to February 7, 2019 concurrent with the Caribou NGS (first sampling) effort and Caribou Winter Recruitment Survey.

Multi-species Distribution Survey – The annual survey provides coarse scale information of winter wildlife (including moose) occurrence in proximity to the Bipole III ROW along construction segments N1-N4 and north portion of C1. The current survey design samples 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 are flown at 10.25 km from the ROW in the sensitive moose areas (Pine River / GHA 14A / 19A, Moose Meadows and Tom Lamb / GHA 8) and along the ROW from Thompson (northern portion of N2 construction segment) to the Keewatinoow Converter Station (N1 construction segment) (Figure 4-3-2). The Project commitment is to conduct the survey annually for up to 4 years post-construction. The Construction phase was complete as of July 2018.

- **Pre-construction (2013/14)**
  - Survey was conducted by Alaskan Trackers along transect intervals of 0.25, 1.25 and 3.25 km parallel to the ROW.

- **Construction (2014 to 2018)**
  - **Year 1 (2014/15)** - No survey conducted; Alaskan Trackers not available to conduct the survey.
  - **Year 2 (2015/16)** - The survey was conducted by the Alaskan Trackers in late January through mid-February 2016 via fixed wing aircraft; the 5.25 and 10.25 km transect intervals were added to the survey design to improve data acquisition for wider ranging and/or sparsely distributed species (i.e., wolverine, wolf, ungulates).
  - **Year 3 (2016/17)** - The survey was conducted by MB Hydro via helicopter in February 2017.
  - **Year 4 (2017/18)** – The survey was conducted by MB Hydro via helicopter on January 9 and 12, 2018 and February 4 to 7, 2018. This was the final survey during the Construction phase.

- **Operation (2019 and onward)**
  - **Year 5 (2018/19)** - The survey was conducted by MB Hydro via helicopter on January 12 to 20 and February 11 to 14, 2019. This was the first survey during the Operation phase.

4.3.2 Population Modelling

In order to understand population change, it is necessary to investigate causes and processes; reliable information on population dynamics is central to that effort (Taber & Raedeke 1979). By first developing a model of how a typical population acts, inferences can be drawn on population performance, including effects of disturbance (Taber & Raedeke 1979). Time series population (demographic and abundance) trend models for each monitored population were constructed in Microsoft Excel using available moose survey results obtained from MB Gov. Each population model utilizes linear interpolation between successive surveys to approximate a reference condition (i.e., pre-disturbance baseline status and historical range of variability). Through ongoing monitoring, population modelling of population state (abundance, structure) and vital rates (λ, adult sex ratio, calf recruitment) using baseline population metrics collected prior to Bipole III disturbance, can be compared with post-disturbance conditions for each sensitive moose range to assess population performance. Population performance provides insight and context for Project-related effects on the metrics of state or vital rates at the population scale and facilitates comparisons of sensitive moose range population metrics with regional trends of adjacent reference moose populations that are not directly intersected by Bipole III.

4.3.3 Moose Browse

In a future report, once normalized difference vegetation index (NDVI) remote sensing data are available, NDVI will be used to compare pre-disturbance (2014) to post-disturbance (2019 or later) changes in the index of potential browse quality along the ROW. The purpose is to determine with statistical confidence when a negative difference value is indicative of a practically-meaningful reduction in NDVI value between the two assessment years (MB Hydro 2018). Statistical analysis would include frequency histograms and quartile analyses to understand the character and distribution of mean pre and post ROW values (MB Hydro 2018). Values will be plotted against the expected normal distribution to evaluate differences between actual and expected values (MB Hydro 2018).

4.4 Deer and Elk

4.4.1 *P. tenuis* Monitoring

The *P. tenuis* survey design is illustrated in Figure 4-4-1. The following summarizes sampling methods and efforts by monitoring year:

- **Year 1 (2014/15)** - Two surveillance areas were identified during Year 1 (2014/15) of the monitoring program to locate areas of winter deer activity and to obtain winter fecal pellet samples for evaluation of presence of spiney-tailed larvae, which would indicate probable *P. tenuis* in the deer population. The surveillance areas were determined using coarse scale observation data from the Multi-species Aerial Survey conducted in January / February 2014 prior to significant Project disturbance from vegetation clearing of the ROW. However, no pellet sampling occurred because that portion of the Project Biophysical Monitoring Plan (MB Hydro 2015) had not yet been approved for the planned survey window.

- **Year 2 (2015/16)** – Boundaries of the two surveillance areas were modified and an aerial transect survey design was implemented (Wood 2018). The purpose was to obtain ungulate distribution along the ROW on either side of the P-Bog caribou range, with specific intent to locate areas of white-tailed deer activity, and to obtain winter fecal pellet samples for *P. tenuis* analysis. However, access restrictions to private land precluded landing for pellet sample collection.

- **Year 3 (2016/17)** - Ground-based pellet collection was conducted February 21 to 23, 2017 by MB Hydro using UCN (University College of the North) and OCN (Opaskwayak Cree Nation) student volunteers to acquire deer fecal pellet samples from Surveillance Area 1 (south end of N3 near The Pas), Surveillance Area 2 (including additional areas along N4 to the south of Surveillance Area 2), and north end of C1 construction segment (Wood 2018). The samples were submitted to Prairie Diagnostic Services (University of Saskatchewan) to assess via Baermann technique for presence of spiney-tailed larvae, which is indicative of probable *P. tenuis* infection.

No sampling occurred during Year 4 or 5. Sampling within the 2 surveillance areas (Figure 4-4-1) is recommended to be repeated in 2021/22 to assess for changes in deer distribution along the ROW as well as changes in *P. tenuis* prevalence.

4.4.2 White-tailed Deer Ingress

Deer ingress and elk occurrence along the ROW are assessed using several methods discussed elsewhere in this report, but include:

1. Winter Ground Track Transect Survey of N1, N2, N3 and N4 construction segments;
2. Remote IR Camera Traps associated with the Winter Ground Track Transect sampling design;
3. Ungulate-Wolf Distribution Survey of woodland caribou study areas concurrent with the annual Woodland Caribou Winter Calf Recruitment Survey;
4. Aerial Moose Population Surveys (modified Gasaway method) of sensitive moose ranges and GHAs intersected by the ROW;
5. Multi-species Aerial Survey of C1 (north portion) and N1-N4 construction segments of the Bipole III ROW; and
6. Incidental observations of deer and deer sign by the Project Environmental Monitors.

4.5 Furbearers

4.5.1 Harvest Monitoring

The Bipole III Transmission Project directly intersects 42 registered traplines (Table 4-5-1; Figure 4-5-1). Annual harvest statistics for each trapline were obtained from MB Gov to calculate baseline harvest statistics by furbearer species for each construction segment intersecting the registered traplines. The objective is to compare the Pre-disturbance phase (baseline harvest statistics 2001/02 to 2013/14) to the Construction phase (2014/15 to 2017/18), and to continue to monitor for effects for the first 3 years of the Operation phase. Focal species for furbearer harvest monitoring include American beaver, pine marten, wolf and wolverine. However, additional harvested species including coyote, red fox (cross, red, silver), arctic fox (white), fisher, Canada lynx, mink, muskrat, otter, red squirrel, and weasel are also assessed.

4.5.2 Distribution Monitoring

4.5.2.1 Winter Ground Track Transect Survey

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 phase to quantify local behaviour relative to 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 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 Project installation; quantifying furbearer species distribution along the ROW was undertaken through the multispecies aerial survey.

The ground transect intercept sampling design utilizes L-shaped transects spaced at ±10 km intervals along construction segments N1 - N4 of the ROW (n = 80 transects; 20 transects / construction segment; Figure 4-5-2). Each L-shaped transect has 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. Transect sampling is integrated with remote camera traps (i.e., 2 cameras on approximately every second transect; 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. After the initial year of camera deployments along a particular construction segment, priority of repeat sampling (annually in February) is on those transects with cameras (n = 40 transects). Additional transects (n = ±10 transects with no cameras deployed) are sampled annually subject to available budget, weather conditions and staff resources, to improve statistical power of distance-to-feature analyses.

The following summarizes sampling effort by monitoring year:

- **Year 1 (2014/15)** - Sampling was initiated on construction segments N2 (n = 20 transects) and N3 (n = 19 transects) in conjunction with remote camera deployments on every second transect. Sampling (n = 39 transects) and camera deployments were conducted March 13 to 19, 2015. N1 and N4 were not sampled during Year 1 because of access restrictions and limited ROW clearing progress along those construction segments.

- **Year 2 (2015/16)** - Sampling was expanded to construction segment N1 (n = 15 transects, including remote camera deployments), and was repeated on the N2 (n = 10 transects) and N3 (n = 10 transects) that had remote cameras deployed. Sampling (n = 35 transects) of N1, N2 and N3 construction segments was conducted February 18 to 25, 2016, and included memory card retrieval and servicing of remote cameras deployed the previous winter in construction segments N2 and N3; access restrictions prevented sampling of N4.

- **Year 3 (2016/17)** - Sampling was conducted February 4 to 14, 2017, and included remote camera servicing of most accessible cameras that were previously deployed on N1, N2 and N3 construction segments. Sampling was expanded to N4 (n = 20 transects) and was repeated in N1 (n = 15 transects), N2 (n = 10 transects with IR cameras and n = 3 without cameras) and N3 (n = 7 of 10 transects with IR cameras and n = 1 transect without cameras deployed; 2 transects were not accessed because of line stringing) construction segments. A total of 56 transects were sampled to improve statistical power of distance-to-feature analyses for select mammal VECs.

- **Year 4 (2017/18)** – Sampling was conducted February 6 to 16, 2018 and included concurrent servicing of camera traps on all transects that were possible to access. Transect sampling of N1 (4 of 10 camera transects) and N2 (3 of 10 camera transects were accomplished by ground / vehicle access. Transect sampling of N3 (9 of 10 camera transects and 4 additional transects) and N4 (7 of 10 camera transects and 4 additional transects) was accomplished using helicopter access only. The remaining camera transects (N1 – N4) were not sampled because of active line stringing or were not accessible by vehicle. A total of 23 of 40 camera transects and 8 additional transects were sampled.

- **Year 5 (2018/19)** – Sampling was conducted February 5-11, 2019 on all 40 camera transects along N1 to N4, the majority via helicopter access. All 71 deployed trail cameras were serviced or replaced, and one additional camera was deployed.

All data manipulation and statistical analyses with the ground transect data were conducted in R (The R Foundation for Statistical Computing). Some covariate categories were simplified, transformed and/or pooled to reduce autocorrelation among vegetation types and satisfy the assumptions of the statistical models used. Data were binned by intervals of 200 m from the Project. The short leg of each transect was considered as distance 0 m from the Project and the long leg of each transect was divided into 200 m bins. Observations were summed within each bin and corrected for distance surveyed. To obtain covariates for habitat type within the survey area, a point was generated at every 10 m along each transect and land cover type at each point was extracted from vegetation classes from EOSD mapping (http//www.geobase.ca/geobase/en/data/landcover/index.html). These land cover covariates were made into multiple columns (one per landcover code) of binary data. Land cover type binary values were summed and transformed into proportions of each land type within each bin. A separate categorical column was also created for the dominant land type within each segment. Snow depths were averaged along both the long and short legs of each transect. For all other covariates (temperature, wind speed, cloud cover, snow type and noise level) a single value was measured for each survey of each transect.

Separate analyses were conducted for each species. Track observations for all species were relatively sparse with respect to sampling effort resulting in the distribution of the data being strongly skewed towards zero. The focus of this analysis is modelling behaviour relative to the installation of the ROW, therefore only locations where the species was recorded could be included. For each species, all transects where at least one detection occurred were included in the analysis. Transects where that species was not detected, were not included.

A negative binomial generalized linear mixed model with transect as a random effect was used for species that have higher numbers of transect replicates (i.e., the species was detected across multiple transects). However, for species with few transect replicates, a negative binomial generalized linear model with no random effects was used. In both instances negative binomial models were used to aid in controlling for the high numbers of zeros within each selected transect (i.e., in many instances a given species was not detected in all distance bins)

Track data were tested for normality and log- or natural log- transformed when non-normal. Linear mixed models (R package lme4) were used to test for a correlation between track density and distance to the Project ROW and for a difference between years. Up to 745 models were tested with ‘distance to ROW’ and ‘year’ as fixed effects, ‘transect’ as a random factor, and various combinations of covariates. The model with the lowest AIC was selected as the model that best fit the data.

4.5.2.2 Trail Cameras

The purpose of camera trapping was to monitor Project disturbance effects on mammal species and relative predator distribution at fine scale by comparing occurrence and distribution near the Project ROW vs away from the Project ROW across seasons and Project phases during the construction and initial Operation (3 years Post-construction; until July 2021) phases (see Amec Foster Wheeler 2016 for a description of the sampling design). In addition, the camera traps document large predator (wolf, black bear and wolverine) occurrence relative to the ROW, as well as potential white-tailed deer ingress proximate to the Project ROW. The following summarizes sampling effort by year:

- **Year 1 (2014/15)** - 37 remote cameras were systematically deployed March 13 to 19, 2015 on winter ground survey transects in N2 (n = 18 cameras on 10 transects) and N3 (n = 19 cameras on 10 transects).

- **Year 2 (2015/16)** - All remote cameras deployment locations on N2 (n = 18) and N3 (n = 19) winter ground transects were accessed to service cameras. On N2 construction segment, 3 cameras failed and were replaced, 1 camera was stolen and not replaced, and 2 additional cameras were installed, resulting in 19 active remote cameras deployed in N2 after servicing. On N3 construction segment, one camera along the Project ROW was missing because the trees at its location were knocked over, and a second camera failed and was replaced, resulting in 18 active cameras in N3 after servicing. N1 construction segment had 20 cameras deployed. No cameras were deployed in N4 construction segment because of access restrictions. After servicing / deployment was completed February 18 to 25, 2016, a total of 57 remote cameras were in service on N1 - N3 ground transects.

- **Year 3 (2016/17)** - 11 cameras deployed in N1 (n = 20) were serviced, 2 were retrieved, 3 were missing (presumed stolen) and 4 were not serviced or retrieved because the locks were seized or keys not available at time of transect sampling to access or retrieve the cameras. This resulted in 11 active and 4 inactive cameras deployed on 10 transects in N1 after transect sampling. On N2 (n = 19), 16 cameras were serviced, 2 were retrieved, and 1 was replaced, resulting in 17 active cameras deployed on 10 transects in N2 after transect sampling. On N3 (n = 18), 13 cameras were serviced, 2 were retrieved with replacements deployed, and 3 were not serviced because of active line stringing in proximity of the transect, and/or sampling time constraints, resulting in 15 active and 3 inactive cameras deployed on 10 transects in N3 after transect sampling. On N4, 20 active cameras were deployed on 10 transects. After servicing / deployment was completed February 4 to 14, 2017, a total of 63 active and 7 unserviced remote cameras were deployed on 40 transects in N1 – N4.

- **Year 4 (2017/18)** – In N1, 6 cameras were serviced, 2 were deployed at locations where the camera was retrieved in 2017, 9 were not accessible, 3 locations require a camera. In N2, 5 cameras were serviced, 1 was missing and replaced, and 13 were not accessible. In N3, 16 cameras were serviced, 2 malfunctioning cameras were replaced, and 1 malfunctioning camera was retrieved but not replaced. In N4, 14 cameras were serviced and 6 were not accessible because of line stringing. After ground transect sampling was completed February 6 to 16, 2018, a total of 46 active and 26 unserviced cameras were deployed on 40 transects in N1-N4; 6 additional locations require a camera deployment in Year 5.

- **Year 5 (2018/19)** – In N1, 16 previously deployed cameras were replaced and 1 was refurbished; 3 locations (N1-11 at 1.5 km from ROW, N1-13 at ROW and N1-15 at ROW) do not have a camera deployed. In N2, 10 previously deployed cameras were replaced and 6 were refurbished; 2 locations do not have cameras deployed (N2-04 at 1.5 km from ROW and B2-04 at ROW); 2 additional cameras were missing / stolen and not replaced (N2-10 at ROW and N2-16 at ROW). In N3, 8 previously deployed cameras were replaced, 10 were refurbished and 1 additional camera was deployed; 1 location (N3-01 at 15 km from ROW) does not have a camera deployed. In N4, all 20 cameras were accessed and replaced. A total of 72 active trail cameras were deployed on 40 camera transects as of February 11, 2019.

Figure 4-5-2 provides an overview of the Remote IR Camera Trap sampling design. Trail camera data were compared using one-tailed z-tests to access differences in occurrence (near versus away from the ROW) for individual furbearer species where sufficient location data had accumulated over the past 4 years (2015/16 through 2018/19) of camera deployment during the construction Phase. To achieve a sufficient sample size for analysis, data from all 4 years were pooled.

4.5.2.3 Aerial Surveys

Multi-species Aerial Survey – The survey was conducted via helicopter during Year 5 (2018/19); January 12 to 20 and February 11 to 14, 2019) by MB Hydro. The survey provides coarse scale winter local distribution data on medium and large furbearer species (i.e., wolf, wolverine) species in proximity to the ROW, and predator-prey distribution (i.e., ungulates and wolf).

Ungulate-Wolf Winter Distribution Survey - The survey provides opportunity to record supplemental distribution (observations and sign) data for wolverine and wolf in P-Bog, N-Reed and Wabowden woodland caribou study areas relative to ROW disturbance. However, the primary purpose of the survey is to collect data on wolf distribution relative to potential ungulate prey species to evaluate changes in predation risk for ungulate species, and to monitor for white-tailed deer ingress into woodland caribou range, as potential effects of the ROW.

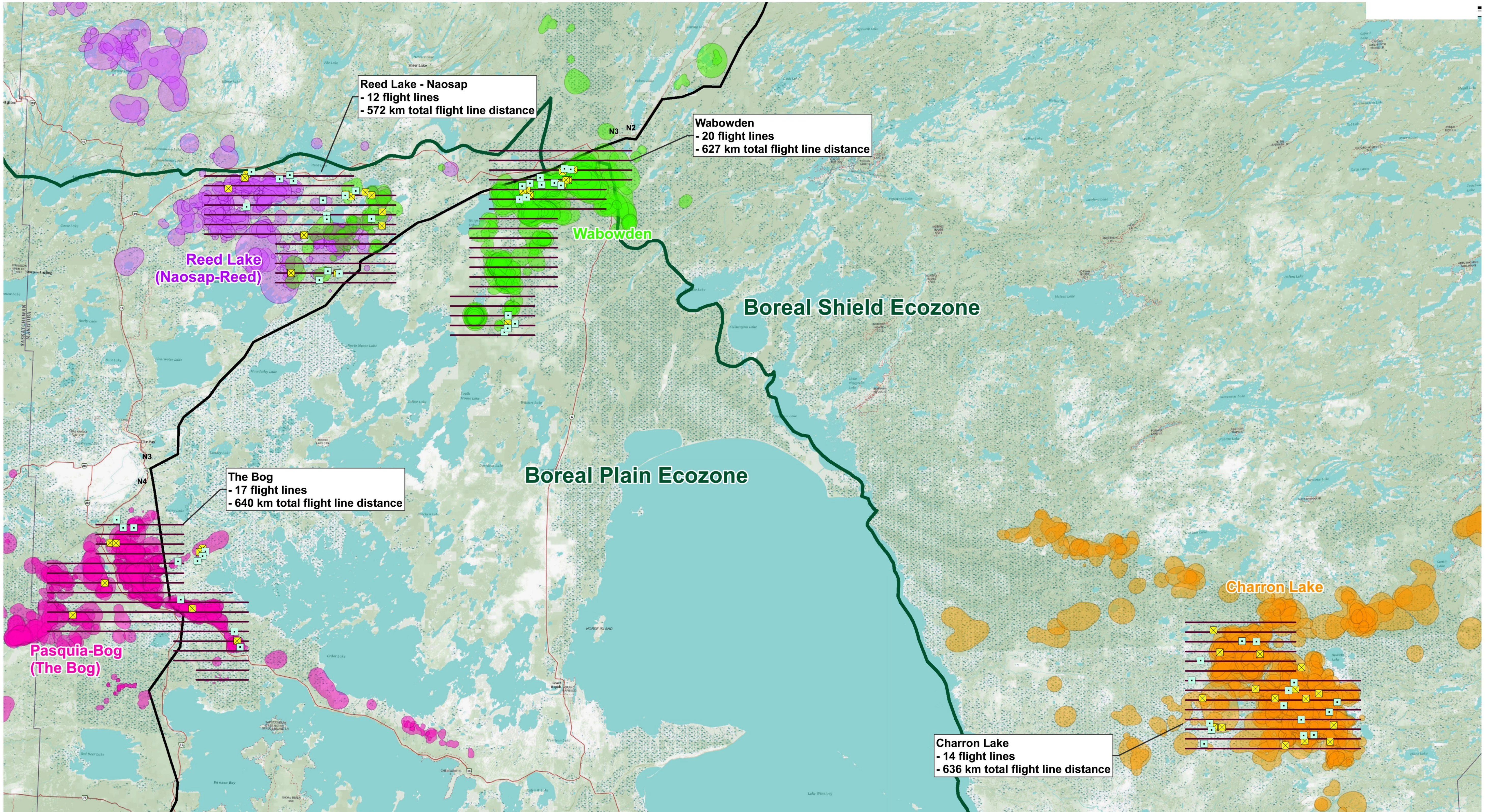
All data manipulation and statistical analyses were conducted in R (The R Foundation for Statistical Computing). The distance sampling (ds) function in the R package 'Distance' (Miller, 2017) was used to estimate density of animals within the area surveyed along each transect to assess how density varied with distance from the ROW. Density of animals is estimated with a Horvitz-Thompson-like estimator and a detection function that models the probability of detection based on the distribution of counts with distance from the observer (Miller et al., 2016; Thomas et al., 2002). The analysis therefore estimates the density of animals for each transect by accounting for the effect of distance from the transect and other covariates (such as habitat) on an observers' ability of see the animal. Confidence intervals (95%) for each estimate are calculated and when comparing density of animals at different distances from the ROW, overlap in confidence limits between two distance groups signified that they were not statistically significant (Ridgway, 2010).

A total of 25 models were tested, each containing one of three detection functions: half normal, hazard-rate, or uniform (Miller et al., 2016). Each candidate model also contained a combination of covariates which included: 1) land cover type (Table 4-1-4); 2) the type of observation (tracks / animal / other); 3) observer and; 4) canopy height. Three of the models tested did not contain covariates, but a strict constraint on monotonicity was specified for their detection functions since, in the absence of covariates, it is likely that the number of detections would decrease with distance from the observer (Miller, 2017). The fit of each model to the data was tested with a Cramer-von Mises goodness of fit test and final model selection was made by comparing AIC values. Separate analyses were conducted for each species and for each year to detect potential differences in density patterns across years.

To try and control for high levels of variation across year we also ran separate mixed models for three of the most abundant species (moose, grey wolf, caribou) on the raw density counts. Density of a given species at each transect was calculated as the number of observations of that species divided by the length of the transect. For transects flown but where the focal species was not observed, the transect was assigned an observation count of zero and a random land type code selected (with replacement) from the pool of land types observed throughout the entire project area. Land type was transformed from long to wide format to obtain a single binary column for each land type category (where "1" indicates presence, and "0" indicates absence). The observation data was then summed across each transect for each species to obtain a value per transect per species. A principal component analysis (PCA) was used to summarize the large number of correlated land type variables into fewer uncorrelated variables that accounted for a large proportion of the variance in the land type data. By including the scores of the first two PCA axes (which, combined, accounted for 43% of the variance in the land type data) in the density models, the effect of habitat could be accounted for in the models without including large numbers of variables which would overfit the model and lead to convergence errors.

Table 4-5-1: Registered Traplines Intersected by Construction Segment

Construction Segment	Registered Traplines	Community Traplines	Intersected Total
N1	8	2 (Limestone 530-05, Split Lake 520-25)	10
N2	14	2 (Thicket Portage 440-10, Wabowden 430-21)	16
N3	13	1 (Cormorant 350-04)	14
N4	2	0	2
Total	**37**	**5**	**42**



LEGEND

- Survey Area Flight Lines
- BPIII Transmission Line Route
- Ecozones

Caribou Pellet Sampling Locations (2019)

- Round 1 Pellet Collection Sites (capture/mark, CMR1)
- Round 2 Pellet Collection Sites (re-capture, CMR2)

Over-wintering kernels per Caribou Monitoring Range

- 70% Adaptive Kernel Contours for Pasquia-Bog Collars (darker pink areas indicate greater amount of Over-Wintering overlap)
- 70% Adaptive Kernel Contours for Reed Lake-Naosap Collars (darker purple areas indicate greater amount of Over-Wintering overlap)
- 70% Adaptive Kernel Contours for Wabowden Collars (darker green areas indicate greater amount of Over-Wintering overlap)
- 70% Adaptive Kernel Contours for Charron Lake Collars (darker orange areas indicate greater amount of Over-Wintering overlap)

NOTES:
- Background topographic map extracted from ESRI online basemap services
- Collars from 2010 to 2019 are shown on the map
- Over-wintering kernels are based on telemetry locations between December and end of February
- CMR1 survey conducted between Jan. 22, 2019 and Feb. 7, 2019
- CMR2 survey conducted between Feb. 20, 2019 and Feb. 26, 2019

Datum: NAD83
Projection: UTM Zone 14N

0 60 120 180 240 300 Kilometres

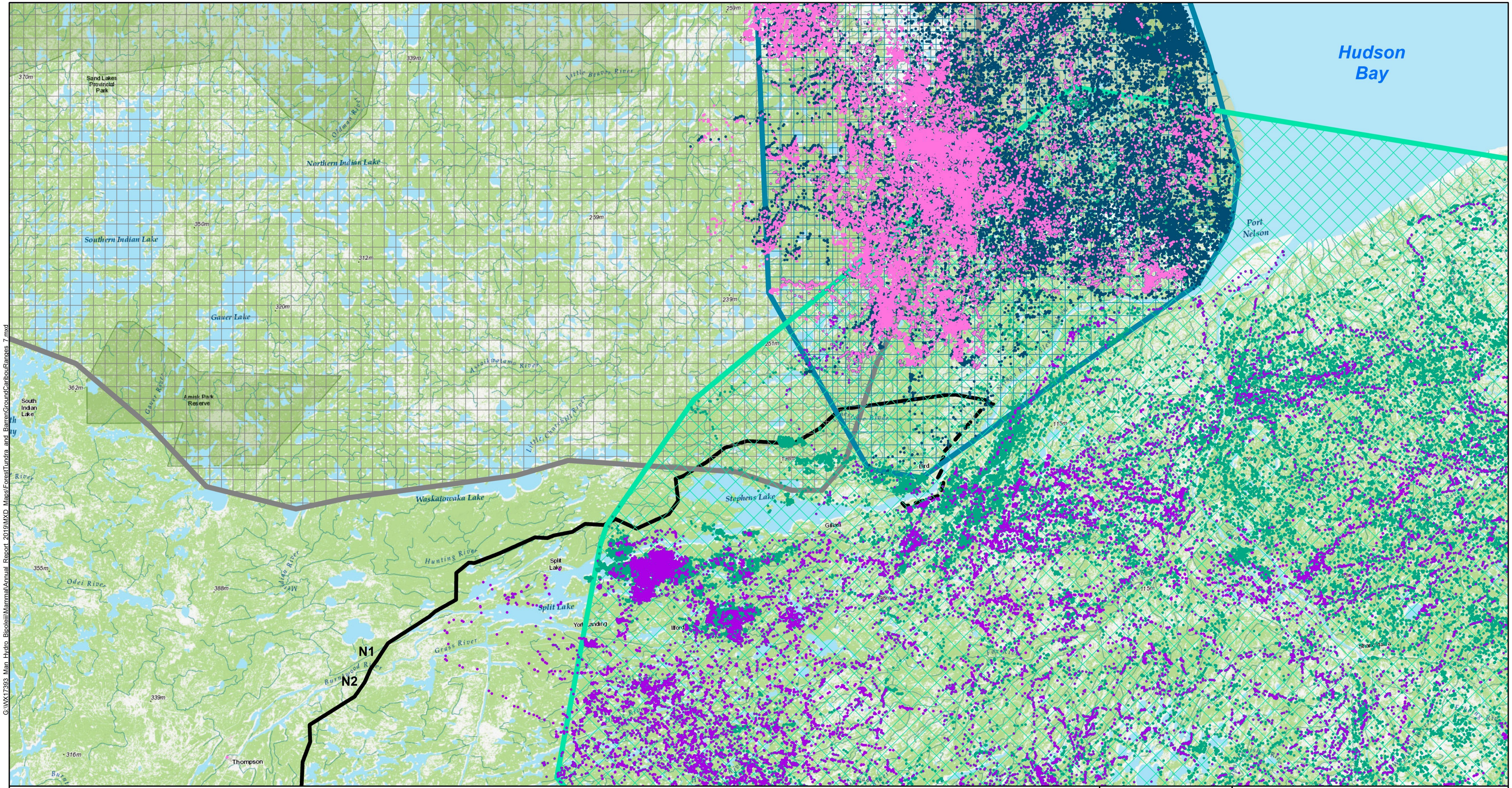
Manitoba Hydro

wood.

MANITOBA HYDRO BIPOLE III TRANSMISSION PROJECT

Boreal Woodland Caribou Survey Areas in Relation to Bipole III Transmission Project

PROJECT N°: WX17393	FIGURE: 4-1-1
SCALE: 1:1,190,000	DATE: December 2019



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LEGEND

Caribou Coastal/Forest-tundra/Barren ground Ranges

- Cape Chruchill Range Boundary (2013)
- Pen Islands Range Boundary (2013)
- Beverly Qamanirjuaq Range Boundary (2010)
- AC Collector Lines
- BPIII Transmission Line Route
- Pen Islands Winter Telemetry Points (December 1st - March 31st)
- Cape Churchill Winter Telemetry Points (December 1st - March 31st)
- Pen Islands Telemetry Points (all season 2010 - Sept. 2018)
- Cape Churchill Telemetry Points (all season 2010 - January 2015)

NOTES:
- Background topographic map extracted from ESRI online basemap services
- Telemetry point for Cape range from 2010 to mid-January 2015.
- Telemetry point for Pen Is. range from 2010 to mid-September 2018.
- Winter telemetry selected as December-January-February-March

Datum: NAD83
Projection: UTM Zone 14N

0 60 120 180 240 300 Kilometres

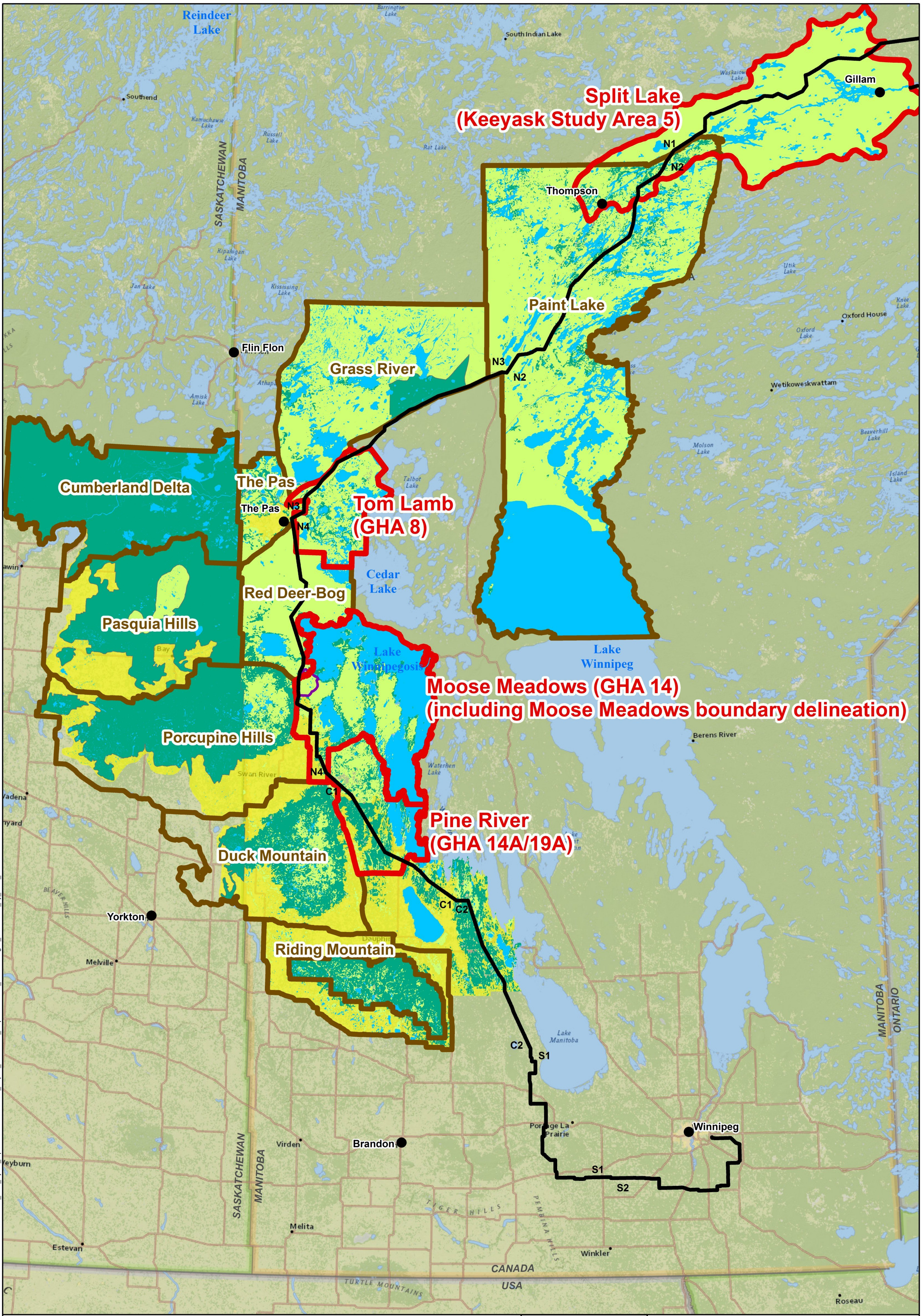
Manitoba Hydro

wood.

MANITOBA HYDRO BIPOLE III TRANSMISSION PROJECT

Forest-tundra Caribou and Barren Ground Ranges and Wintering Occurrences in Relation to Bipole III Transmission Project

PROJECT N°: WX17393	FIGURE: **4-2-1**
SCALE: 1:1,170,000	DATE: December 2019



LEGEND

- BPIII Transmission Line Route (labelled at segment divides)
- AC Collector Lines
- Monitored Moose Populations (labelled with name)
- Reference Moose Populations (labelled with name)
- Moose Meadows Boundary

Moose Range

- Primary Range
- Secondary Range (Forest)
- Secondary Range (Agriculture)
- Waterbody within Moose Ranges

0 60 120 180 240 300 Kilometres

NOTES:
- Background topographic map extracted from ESRI online basemap services
- Land cover data aggregated from NRCan Land Cover database Geobase.ca

Datum: NAD83
Projection: UTM Zone 14N

Manitoba Hydro

wood.

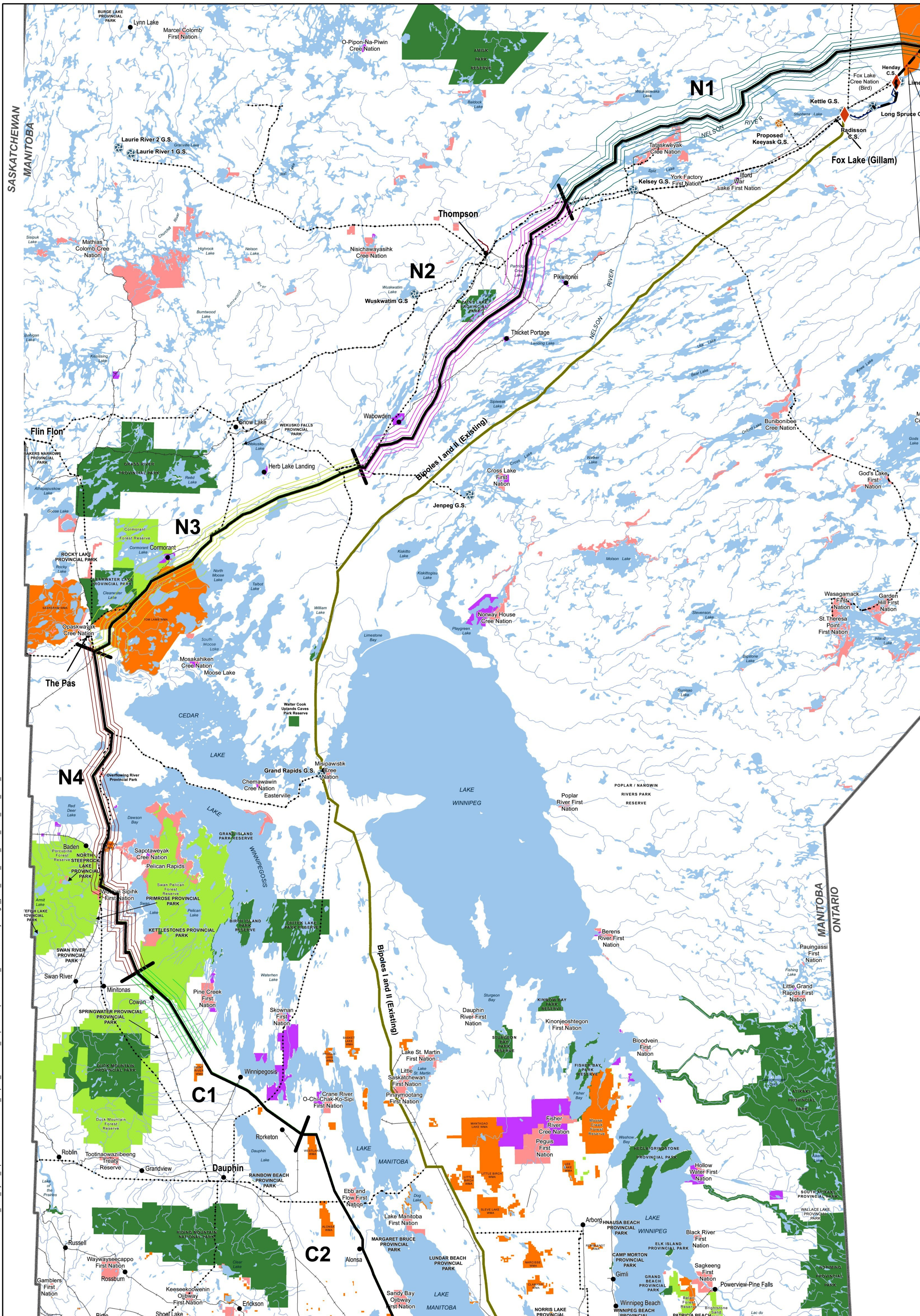
MANITOBA HYDRO BIPOLE III TRANSMISSION PROJECT

Sensitive and Monitored Moose Ranges Intersected by the Bipole III Transmission Project

PROJECT N°: WX17393 | FIGURE: 4-3-1

SCALE: 1:2,500,000 | DATE: December 2019

G:\WX17393_Man_Hydro_BipoleIII\Mammal\Annual_Report_2019\MXD_Maps\Monitored_MooseRanges_Intersected_by_BPIII_4.mxd



LEGEND

- BPIII Transmission Line Route (labelled at segment divides)
- AC Collector Lines

Multi-species Aerial Survey Flight lines

- C1 - North portion flown in 2016, 2017, 2018 and 2019
- N1 - Western 3/4 flown in 2016, 2017, 2018 and 2019 (10km line not flown)
- N2 - Not flown in 2014, 2016, 2017, 2018 or 2019
- N3 - Southern 1/2 flown in 2019, 2018, 2017, 2016 and 2014 (10km line and parts of 5km line not flown, expanded areas > 2.5km only flown in 2016, 2017, 2018 and 2019)
- N4 - Flown in 2014, 2016, 2017, 2018 and 2019 (10km line not flown in 2014, parts of 5km not flown in 2019, 2018, 2017, 2016 or 2014)
- ACCollector - North portion flown in 2016, 2017, 2018 and 2019

- Existing Converter Station
- Proposed Converter Station
- Existing Generating Station
- Proposed Generating Station
- First Nation
- Wildlife Management Area
- Northern Affairs Community
- National/Provincial Park
- Provincial Forest

0 40 80 120 160 200 Kilometres

NOTES:
- Map extracted from Manitoba Hydro "BPIII Transmission Project" map.

Datum: NAD83
Projection: UTM Zone 14N

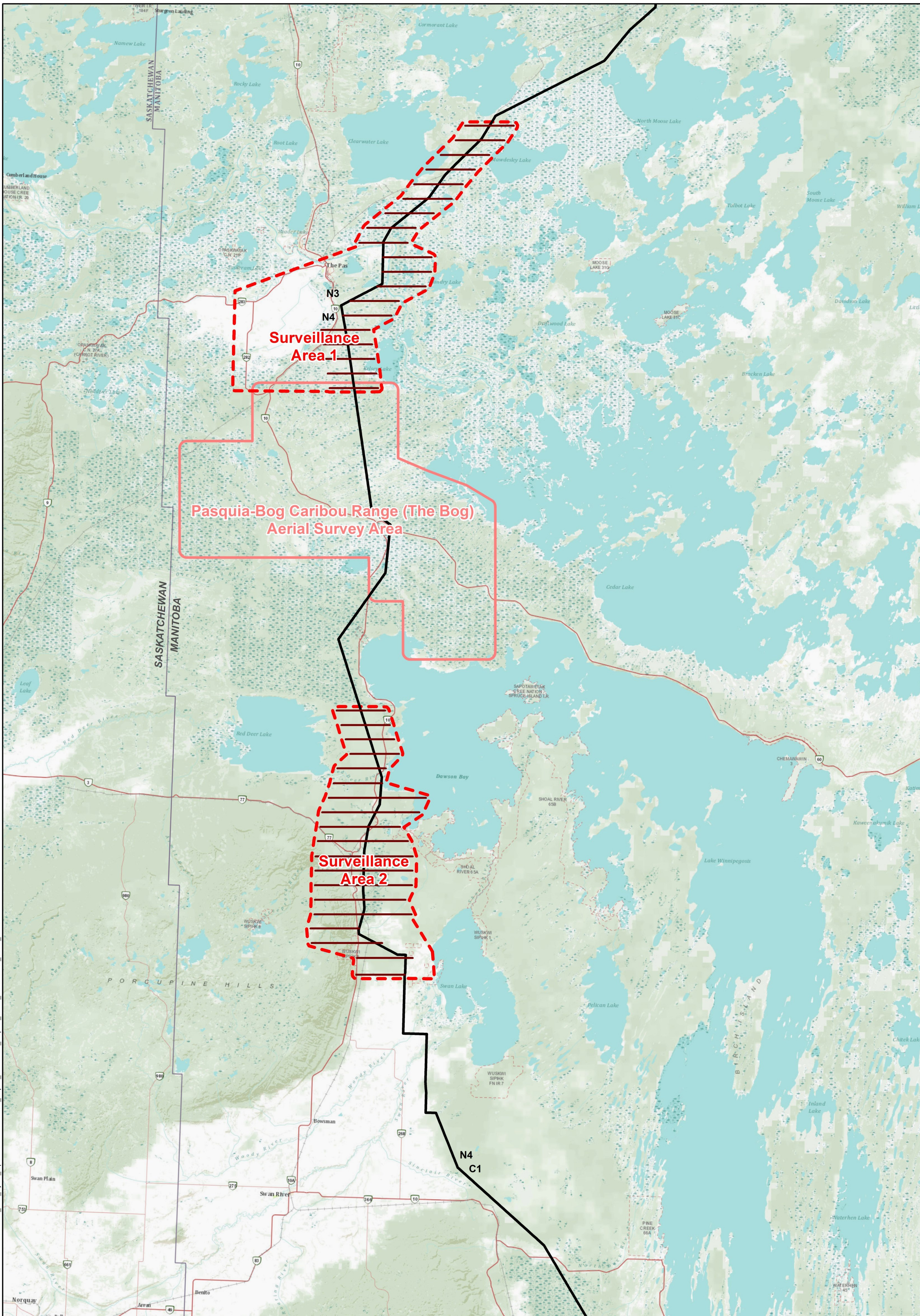
Manitoba Hydro

wood.

MANITOBA HYDRO BIPOLE III TRANSMISSION PROJECT

Multi-species Aerial Transect Survey Design for BPIII for 2014 - 2019

PROJECT N^{o}: WX17393	FIGURE: 4-3-2
SCALE: 1:2,000,000	DATE: December 2019



G:\WX17393_Man_Hydro_Bipoleiii\Mammal\Annual_Report_2019\MXD_Maps\P_tenuis_Surveillance_Areas_2.mxd

LEGEND

- BPIII Transmission Line Route (labelled at segment divides)
- P. tenuis Flight Line Transects (Year 2 - Feb. 2016)
- P. tenuis Surveillance Area Boundary
- Pasquia-Bog (The Bog) Aerial Survey Area Boundary

NOTES:
- Background topographic map extracted from ESRI online basemap services

Manitoba Hydro

wood.

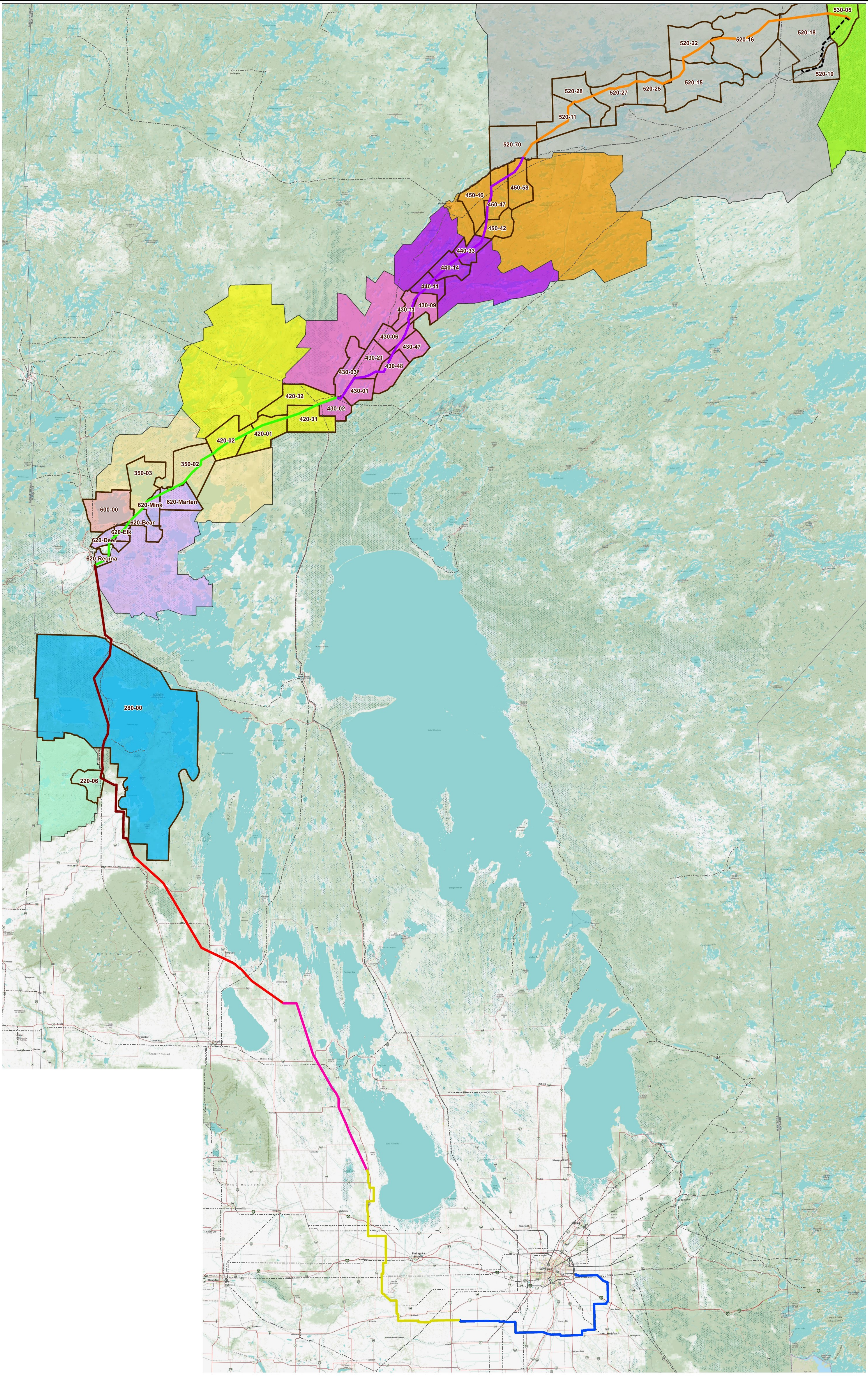
MANITOBA HYDRO BIPOLE III TRANSMISSION PROJECT

P. tenuis Surveillance Areas

Datum: NAD83
Projection: UTM Zone 14N

0 20 40 60 80 100 Kilometres

PROJECT N°: WX17393	**FIGURE: 4-4-1**
SCALE: 1:745,000	DATE: December 2019



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G:\WX17393_Man_Hydro_Bipoleiii\Mammal\Annual_Report_Nov2018\MXD_Maps\Traplines_Intersected_by_BPIII_BASE_3.mxd

LEGEND

530-05 Registered Trapline Area (Lablelled with ID)

Registered Trapline Area Section by Name

- CLEARWATER
- CORMORANT
- HERB LAKE
- LIMESTONE
- PIKWITONEI
- PORCUPINE
- RED DEER - SHOAL RIVER
- SPLIT LAKE
- SUMMERBERRY
- THICKET PORTAGE
- WABOWDEN

BPIII Transmission Line Route By Section

- N1
- N2
- N3
- N4
- C1
- C2
- S1
- S2
- AC Collector Lines

Transmission Line

NOTES:
- Background topographic map extracted from ESRI online basemap services
- Transmission lines extracted from CanVec10 (geogratis.ca)

Datum: NAD83
Projection: UTM Zone 14N

N W E S

0 60 120 180 240 300 Kilometres

Manitoba Hydro

wood.

MANITOBA HYDRO BIPOLE III TRANSMISSION PROJECT

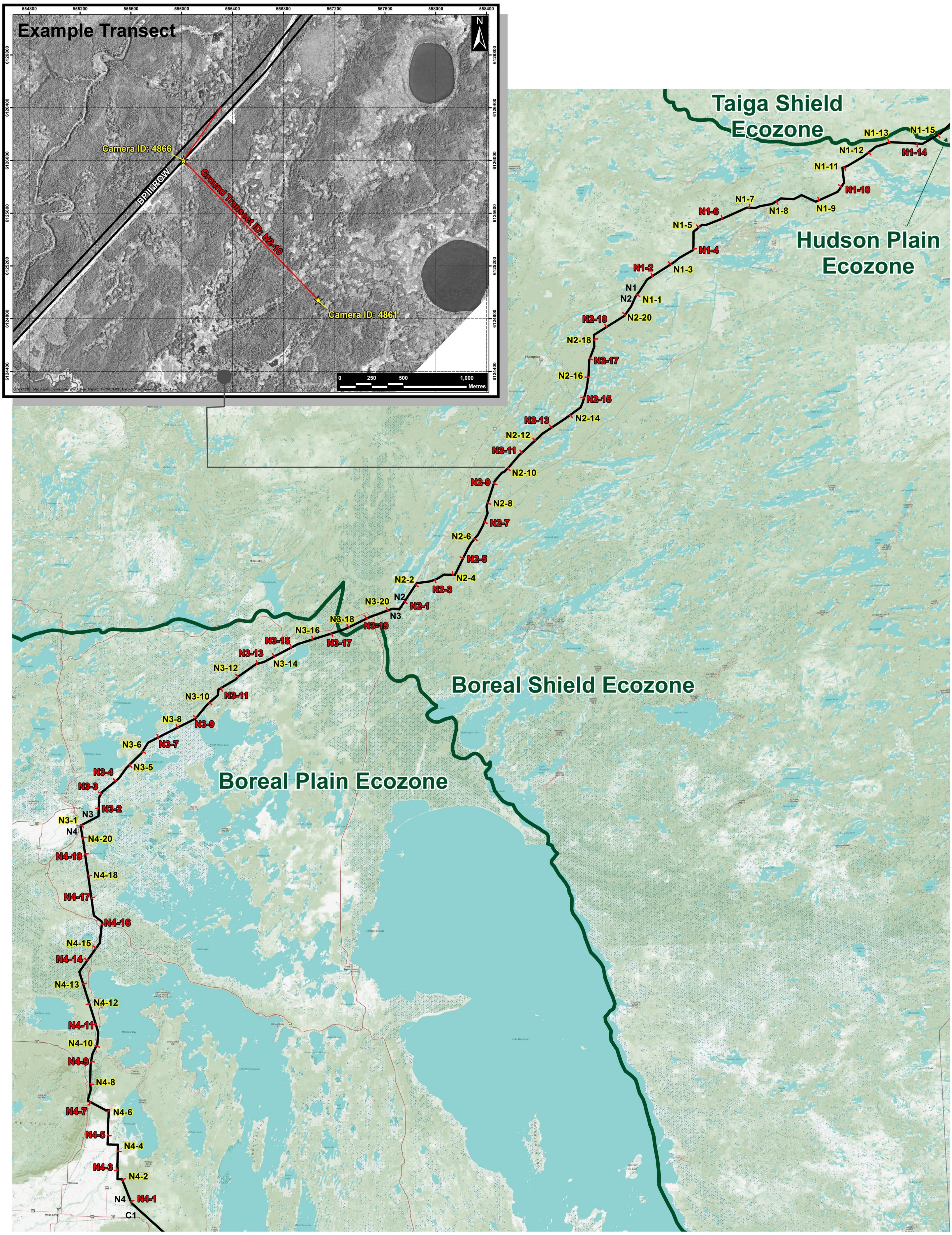
Registered Traplines intersected by the Bipole III Transmission Project

PROJECT N°: WX17393

FIGURE: **4-5-1**

SCALE: 1:2,300,000

DATE: December 2019



G:\WX17393_Man_Hydro_Bipoleiii\Mammal\Annual_Report_2019\MXD_Maps\Winter_GroundTransects_and_Camera_Info_3.mxd
G:\WX17393_Man_Hydro_Bipoleiii\Mammal\Annual_Report_Nov2018\MXD_Maps\Winter_GroundTransects_and_Camera_Info_BASE_2.mxd

LEGEND

- Winter Ground Transects (labelled with transect ID)
- N2-9 Ground Transects without Trail Cameras (label colour)
- N2-9 Ground Transects with Trail Cameras (label colour)
- BPIII Transmission Line Route
- Ecozones

0 50 100 150 200 250 Kilometres

NOTES:
- Background topographic map extracted from ESRI online basemap services
-

Datum: NAD83
Projection: UTM Zone 14N

Manitoba Hydro

wood.

MANITOBA HYDRO BIPOLE III TRANSMISSION PROJECT

Winter Ground Transect and Trail Camera - Sampling Design Overview

PROJECT N°: WX17393

FIGURE: **4-5-2**

SCALE: 1:1,770,000

DATE: December 2019

5.0 Results and Discussion

5.1 Boreal Woodland Caribou

The monitoring program involves three boreal woodland caribou ranges (P-Bog, N-Reed, Wabowden) intersected by the Bipole III Transmission Project and one reference population (Charron Lake) (Figure 4-1-1).

GPS satellite telemetry study was used for range scale and fine scale assessment of winter core use areas, habitat use patterns, movement, and mortality rates / sources (for collared adult female caribou).

Population status assessment was initiated in Year 1 (2014/15) of the monitoring program using Non-invasive Genetic Sampling (NGS) and Capture-Mark-Recapture (CMR) population estimation methods; NGS / CMR was repeated in Year 3 (2016/17), and in Year 5 (2018/19) to assess population size and to inform population models to calculate λ. In addition, annual aerial survey methods were used to assess winter calf recruitment, population structure and mortality risk.

5.1.1 Population Demography

5.1.1.1 Population Structure and Calf Recruitment

Calf mortality is greatest during the first six months after birth, with survival increasing to adult levels after six months (Gustine et al. 2006, Pinard et al. 2012, Traylor-Holzer 2015). Estimation of calf recruitment provides valuable insight into population state and provides a measure of calves produced and surviving to a point where they are considered recruited into the yearling / adult caribou population. Assuming annual adult survival is >85%, populations are likely growing if the proportion of calves (% Calves) in winter is >15%, stable if 12 to 15%, or in decline if <10% (Bergerud 1974, Stuart-Smith et al. 1997, Dzus 2001, Arsenault 2003). A population viability analysis conducted by Environment Canada (2008, 2011) suggests calf recruitment rates >28.9 calves/100 cows indicates a stable to increasing population (assuming annual adult female survival is >85%). If calf recruitment drops below this threshold and/or annual female survival rates are <85%, the population is likely declining.

Calf recruitment estimates (Table 5-1-1) were obtained from aerial surveys conducted January 22 to February 7, 2019. Annual adult female survival was estimated from telemetry data for each boreal woodland caribou range using the Kaplan-Meier method of survival analysis (Pollock et al. 1989) with a staggered entry design to account for multiple collar deployments. The telemetry data were right-censored with time-at-risk based on the number of months since the animal was live-captured. Kaplan-Meier plots for each boreal woodland caribou are presented in Figure 5-1-1 and were used to determine the annual adult female survival rates reported in Table 5-1-1. Annual adult female survival rates for collared caribou in Year 5 were all above 88%, which is conducive to population stability or growth when the proportion of calves in the population is >12% or when the calf recruitment rate (calves/100 cows) is >28.9. The demographic indicator metrics of winter calf recruitment (% calves and calves/100 cows) and Kaplan-Meier adult female survival (Table 5-1-1) for Year 1 through Year 5 of monitoring are consistent with stable populations in the P-Bog, Wabowden, and Charron Lake ranges. The population trend in N-Reed has been more variable during the monitoring program with indications of decline (Table 5-1-1), which may reflect the population adjusting to extensive fire disturbance (Arlt et al. 2015).

Adult female survival rates during the five years of monitoring (Table 5-1-1) indicate slightly lower rates for Wabowden and N-Reed populations compared to P-Bog and Charron Lake (reference population in a relatively undisturbed range).

5.1.1.2 Abundance and Trend

NGS / CMR methods were used to obtain initial population estimates using closed population model estimators for each monitored woodland caribou range (P-Bog, N-Reed, Wabowden and Charron Lake) in Year 1 (2014/15). Sampling was repeated in Year 3 (2016/17) and Year 5 (2018/19) to assess population state (abundance, trend (λ), and sex ratio). No phylogenetics or kinship / pedigree analyses are planned for this monitoring study. No population genetic structure / health assessments are planned to assess inbreeding, genetic diversity, genetic variation or genetic drift for any of the monitored populations. Results of sampling efforts are presented in Table 5-1-2.

Preliminary population abundance trend models were developed for the 2009 to 2017 interval for each monitored woodland caribou local population (Figure 5-1-2). A third-degree polynomial was used to fit a long-term population trend line to the abundance estimates for each moose management unit (Kuzyk 2016). The polynomial was used because it is more sensitive to fluctuations in population size than a linear or log-linear trend line (Kuzyk 2016, Arsenault et al. 2019). The objective of model fitting was to examine population trend within the 2008/09 to 2018/19 period of assessment.

Results of the genotyping and preliminary trend modelling (2008/09 to 2018/19) using closed model CMR estimators indicate each local population is occurring at natural levels of abundance:

- **P-Bog** local population averaged about 0.0311 caribou/km^2, with a lower density estimate of 0.0177 ±4.12% caribou/km^2 obtained from the Year 5 NGS-CR results; the population appears to be in decline ($\lambda_{(mean2010\text{-}2019)}$ = 0.964) and should be reassessed in 2 years.

- **Wabowden** local population has remained stable, averaging 0.0400 caribou/km^2 through the assessment period, with a density estimate of 0.0379 ±2.62% caribou/km^2 obtained from the Year 5 NGS-CR results; the population appears stable ($\lambda_{(mean2010\text{-}2019)}$ = 1.002) and should be reassessed in 4 years.

- **N-Reed** local population has remained stable (possibly increasing), averaging about 0.0480 caribou/km^2, with a density estimate of 0.0321 ±2.46% caribou/km^2 obtained from the Year 5 NGS-CR results; the population appears to be in decline ($\lambda_{(mean2010\text{-}2019)}$ = 0.973) and should be reassessed in 2 years.

- **Charron Lake** local population has remained stable, averaging about 0.0742 caribou/km^2), with a density estimate of 0.0704 ±3.69% caribou/km^2 obtained from the Year 5 NGS-CR results; the population appears to be stable ($\lambda_{(mean2010\text{-}2019)}$ = 1.006) and should be reassessed in 4 years.

Application of open-population model estimation or spatially explicit Capture-Recapture (sCR) analyses should be undertaken to refine assessment of population abundance and trend; additional population estimates in future years of monitoring are required to improve the modelled abundance trend assessment and to assess for lag effects of the Project footprint on population state.

Genetic population structure analyses indicate the Charron Lake population has a large proportion of the eastern migratory haplotype lineage mixed with smaller proportions of barren-ground and western and southern Manitoba haplotype lineages (Klütch et al. 2012, Manseau et al. 2014).

Estimates of population trend (lambda; λ) for each monitored boreal woodland caribou range were revised after analysis of pellet samples collected in Year 5 (2018/19) of the monitoring program. Population trend models for the 2009 to 2019 period were used to calculate mean λ estimates for each local population ($\lambda < 1.0$ indicates population decline; $\lambda = 1.0$ indicates stability; $\lambda > 1.0$ indicates population growth). Mean lambda (λ) estimates for the 2008/09 to 2018/19 modelling interval indicate declining local populations for P-Bog ($\bar{x}_{(2010\text{-}2019)}$ $\lambda = 0.96$) and N-Reed ($\bar{x}_{(2010\text{-}2019)}$ $\lambda = 0.97$), and stable populations for Wabowden ($\bar{x}_{(2010\text{-}2019)}$ $\lambda = 1.00$) and Charron Lake ($\bar{x}_{(2010\text{-}2019)}$ $\lambda = 1.00$).

5.1.2 Distribution and Occurrence

Trail cameras deployed from February 2015 through February 2019 provided assessment of fine scale local occurrence of woodland caribou relative to the ROW in comparison to woodland caribou detections at trail cameras placed 1.5 km from the ROW. There were more woodland caribou observations at cameras placed near the ROW (42 observations detected at 5 stations across years; $\bar{x} = 4.2$ observations / camera) compared to cameras located 1.5 km from the ROW (34 observations at 5 stations across years; $\bar{x} = 3.1$ observations / station). However, no significant preference was detected ($z = 0.5010$; $p = 0.3442$) with respect to distance from the ROW during construction.

During the Construction phase, there was insufficient ground track data for **local / fine scale** to assess the distribution and density of caribou relative to the ROW within 1 km of the ROW to assess. However, during the first year of Operation (2019) multiple caribou tracks were recorded (Figure 5-1-3). Caribou were recorded more frequently farther from the ROW than closer to the ROW ($P < 0.0001$, Figure 5-1-3).

The Multi-spp Aerial Survey data were used to assess **local / coarse** scale (within 10.5 of ROW) distribution and occurrence relative to the ROW. Analysis of aerial survey data revealed that there was no significant relationship between density of caribou and distance to the ROW (Figure 5-1-4). Variation in density estimates across years is high contributing to a lack of significance. The spatial distribution of relative density areas for caribou also indicate no clear avoidance or preference of the ROW using this method at this scale (Figures 5-1-5 and 5-1-6).

Landscape scale (i.e., caribou range) distribution and occurrence, movement, site fidelity and habitat use are in Part B monitoring report.

5.1.3 GPS Satellite Telemetry Studies

Analysis results for range use, site fidelity, zone of influence, crossing analysis and effectiveness of mitigation strategies are provided in a separate report (Part B).

5.2 Forest-tundra and Barren-ground Caribou

The Bipole III Construction phase was completed in July 2018. Therefore, no further monitoring of Forest-tundra or Barren-ground caribou winter occurrence during construction was required in Year 4 (2017/18) or Year 5 (2018/19) per the project commitment. See Wood 2019 for details of monitoring during the Construction phase.

5.3 Moose

Three sensitive moose ranges were identified for long-term monitoring (Manitoba Hydro 2015) which include: Tom Lamb Wildlife Management Area (GHA 8), Moose Meadows (portion of GHA 14) and Pine River (GHA 14A / 19A). All three sensitive ranges occur in the boreal plain ecozone. One additional moose range (Split Lake) bisected by N1 construction segment of the Bipole III ROW occurs on the boreal shield ecoregion and was added (in Year 2) to the Bipole III moose monitoring program. Figure 4-3-1 illustrates the locations of each monitored moose range relative to adjacent reference moose populations.

5.3.1 Population Demography

Trends in regional moose population dynamics are important to understand to provide context to the baseline condition of each monitored moose range, and to ascertain through long-term monitoring whether the Bipole III Transmission Project will cause a significant positive or negative incremental effect on population performance of any of the sensitive moose ranges. Current population size is a function of past abundance and the demographic processes of survival, productivity, immigration and emigration (Skalski et al. 2005). These processes and their relative interactions affect population growth and abundance. The finite rate of population change (λ) characterizes the relative change in population abundance over time. Multiple surveys of winter populations across years provides a sequential time series of population abundance estimates that can be used to model population trend and demographic change (Arsenault et al. 2019) to monitor population performance.

5.3.1.1 Tomb Lamb WMA (GHA 8)

The Saskatchewan River Delta is an extensive alluvial landscape feature straddling the Saskatchewan-Manitoba border, consisting of upper and lower portions separated by The Pas Moraine ecodistrict, and totals about 10,000 km^2 in area. The delta landscape is significantly affected by two hydroelectric dams, E.B. Campbell Dam in Saskatchewan (upstream side at the outlet of Tobin Lake) and Grand Rapids Dam in Manitoba (downstream side at the outlet of Cedar Lake). Extremes of flood events are moderated by the dams since their construction in the 1960's. Mean annual hydrographic outflow from the delta have declined by 25 to 30% since records began in 1913, largely attributed to upstream irrigation consumption along the South Saskatchewan River. Collectively, the moderated flood regime and decline in hydrographic flow have likely affected the delta ecology, including vegetation succession / maturation, moose habitat suitability, and predator-prey dynamics.

Tom Lamb WMA / GHA 8 includes a large portion of the lower Saskatchewan River Delta (CEC 2013), and is situated east of the upper portion of the Saskatchewan River Delta (which includes the Cumberland Delta in Saskatchewan and GHA6 / 6A in Manitoba), and is also adjacent to the north east portion of the Red Deer-Bog population (GHA 11 / 12), the north shore of Cedar Lake. Grass River population (GHA7 / 7A) abuts to the north edge of Tom Lamb WMA.

Population census data indicates Tom Lamb WMA has a moose population trend characterized by a history of fluctuation (Figure 5-3-1) affected by unsustainable harvest regimes and periodic flooding events (2005, 2007 and 2011) affecting distribution (Kent Whaley, 2015 GHA 8 Moose Survey Proposal, June 2, 2015). Regional moose population trends of surrounding moose populations all indicate declines in abundance of moose populations since at least 2000 (Arsenault et al. 2019). The following summarizes population assessment results for Tom Lamb WMA (GHA 8) by monitoring year:

- **Year 1 (2014/15)** – Amec Foster Wheeler (2016) conducted a population trend analysis of regional moose populations proximate to Tom Lamb WMA / GHA 8, which indicated a general regional population decline in moose population abundance in recent years (prior to Bipole III disturbance), including the Tom Lam WMA / GHA8 sensitive moose range.

- **Year 2 (2015/16)** - a Gasaway Population Survey of GHA 8 was conducted by MB Gov in January 2016 that yielded an estimate of 339 ±18.5% moose (0.107 moose/km^2). There was no significant change in winter moose abundance detected since the previous survey (317 ±32.0%, 0.101 moose/km^2; 47% below the long term mean) conducted in January 2012), suggesting that the declining trend in moose population abundance may have stabilized at a lower level of abundance, currently at 48% below the long-term (1971 to 2016) winter population mean (Table 5-3-1, Figure 5-3-1). The winter population structure estimates indicate an increase in the proportion of adult cows from 43.2% (January 2012) to 47.5% (January 2016) and calves from 20.2% (January 2012) to 24.8% (January 2016) in the winter population relative to adult bulls (36.6% in January 2012 to 27.4% in January 2016). This suggests the population has a slightly improved capacity for potential growth (greater reproductive capacity and greater calf recruitment into the adult population) compared to January 2012, assuming there are sufficient numbers of bulls in the population to allow effective breeding during the rut. Twinning rate also increased from 8.0% (January 2012) to 12.9% (January 2016).

- **Year 3 (2016/17)** - The population abundance and trend for Year 3 is expected to be similar to that of Year 2.

- **Year 4 (2017/18)** - MB Gov conducted a survey of GHA 7 (adjacent to the north side of Tom Lamb / GHA 8) in January 2018. The survey results indicate the Grass River MMU (GHA 7 / 7A) is a stable, but low density (0.077 moose.km^2) population. This is consistent with the previous two surveys (January 2012 and January 2016) of the Tom Lamb MMU (GHA8) which indicate a stable population that is below its long-term mean abundance.

- **Year 5 (2018/19)** – No survey was scheduled or conducted on any of the monitored populations.

5.3.1.2 Moose Meadows (Portion of GHA 14)

Moose Meadows represents a sensitive local moose area that potentially interacts with the Bipole III ROW. Moose Meadows, also known as Bellsite Swamp (Shared Values Solutions 2015), is characterized as a low-lying area and considered to be a sensitive winter foraging refuge for local moose moving off of the east slopes of the Porcupine Hills (Manitoba Hydro 2014), as well as a spring moose calving area (Shared Values Solutions 2015). An additional habitat patch referred to as Novra Swamp lies immediately to the south of Moose Meadows (Shared Values Solutions 2015). Both swamps are adjacent to the east edge of the Porcupine Hills and are contiguous with the western portion of the Interlake Plain Ecoregion; both swamps lie within the Swan-Pelican MMU (GHA14 / 14A). Swan Lake and farmland occur to the south of Moose Meadows. The Bipole III ROW passes between Moose Meadows and the Porcupine Hills, paralleling a segment of Highway 10 that links the communities of Whitmore and Mafeking.

Moose Meadows is a small western portion of GHA 14 that tends to fluctuate in moose numbers depending on snow conditions in the Porcupine Hills (MB Gov, K. Rebizant, personal communication, November 3, 2014). Empirical evidence (telemetry) to confirm this habitat condition mediated movement is lacking. The Porcupine Hills are a large landscape hill complex mainly in Saskatchewan but extending into Manitoba. Historically, the Saskatchewan portion of the population was relatively stable across decades at about 5,300 moose (0.763 moose/km^2), with significant recent decline below the long-term mean (Arsenault et al. 2019). The Manitoba portion of the population is much smaller and over the last 10 years appears to be stable (Figure 5-3-1, Table 5-3-1). A Gasaway population survey of the MB portion of the Porcupine Hills was conducted by MB Gov in early February 2017. Results indicate the Manitoba portion of the population is at 1057±16.4% (0.408 moose/km^2). The long-term population trend for the Porcupine Hills differs substantially with that observed for Moose Meadows sensitive moose area and GHA 14 (Figure 5-3-1).

There are no specific moose population surveys of Moose Meadows, as it is a portion of GHA 14. Typically, GHA 14 has been surveyed by MB Gov on its own, or in association with GHA 14A. As a moose population monitoring unit (Swan-Pelican MMU), moose in GHA 14/14A have experienced a significant decline beginning in the early-1990's (approximately 3,300 moose; 0.687 moose/km^2) to the current level of about 150 moose (0.030 moose/km^2; 89% below the long term mean) based on population surveys conducted in January 2011 and January 2014 (Table 5-3-1). The following summarizes population assessment results for Moose Meadows by monitoring year:

- **Year 1 (2014/15)** – Amec Foster Wheeler 2016 conducted a population trend analysis of regional moose populations proximate to Moose Meadows, which indicated a general regional population decline in moose population abundance in recent years (prior to Bipole III disturbance), including the Moose Meadows sensitive moose range.
- **Year 2 (2015/16)** - No survey was scheduled or conducted.
- **Year 3 (2016/17)** - No survey was conducted. A moose population survey led by MB Gov was recommended to occur in Year 3 (2016/17) for the Swan-Pelican MMU population (GHA 14/14A) in January 2017 as part of the Bipole III Mammals Monitoring Program. However, MB Gov advised that this population is not on the 2016/17 moose population survey schedule (MB Gov, V. Harriman, personal communication, November 4, 2016). No survey is scheduled for Year 4 (2017/18) by MB Gov for Swan-Pelican MMU (GHA 14/14A).
- **Year 4 (2017/18)** – No survey was scheduled or conducted.
- **Year 5 (2018/19)** - No survey was scheduled or conducted.

5.3.1.3 Pine River (GHA 14A / 19A)

Pine River (GHA 14A / 19A) represents a sensitive local moose population that potentially interacts with the Bipole III ROW. GHA 14A is considered to be sensitive because it is an area of winter use in an area of limited remote habitat adjacent to the northeast side of the Duck Mountains (Manitoba Hydro 2014). Highway 10 passes between the Duck Mountains and Pine River (GHA 14A / 19A). Swan Lake and Pelican Lake are at the north edge of GHA 14A, and Lake Winnipegosis is on the east edge (Figure 4-3-1). GHA 14A and GHA 19A are transected by a section of Highway 20 linking the communities of Cowan and Camperville. GHA 19A has higher levels of anthropogenic disturbance and access development.

Moose population demographic data are limited for this population but based on modelling of available survey data for GHA14A / 19A, it appears the population significantly declined from a high of 1,047 moose (0.336 moose/km^2) in January 1992 to 213 (0.068 moose/km^2) in January 2002 and has remained at a low level (Figure 5-3-1). The winter population in January 2014 was assessed by MB Gov to be about 100 ±19.0% moose (0.032 moose/km^2). Trends in regional moose population abundance (Swan Pelican

MMU and Duck Mountain MMU) over the long term indicates a general decline (Wood 2018). However, a Gasaway population survey of Duck Mountain MMU conducted in early February 2017 by MB Gov suggests this population is stable and possibly beginning to increase (Wood 2018). The Duck Mountain MMU winter population was estimated to be 1,958 ±15.1% (0.269 moose/km^2), which is about 12.1% below the long term mean of 2,228 moose (0.310 moose/km^2). There are no data available since January 2014 to confirm any change in Pine River population trajectory (Figure 5-3-1). The following summarizes population assessment results for Pine River (GHA 14A / 19A) by monitoring year:

- **Pre-construction (2013/14)** – A survey was conducted by MB Hydro in January 2014 that yielded a population estimate of 100 moose ±19.0 (95% CI) and a population structure ratio of 1.38 Bulls: Cow: 0.77 Calves. A survey conducted by MB Gov in January 2013 which yielded a population estimate of 91 ±12.8 (95% CI) and population structure ratio of 0.38 Bulls: Cow: 0.88 Calves. There are no significant differences between the abundance estimates, but historical trend data suggest a substantial population decline occurred for this population sometime between 1992 and 2001.

- **Year 1 (2014/15)** - No survey was scheduled or conducted. Amec Foster Wheeler 2016 conducted a population trend analysis of regional moose populations proximate to Moose Meadows, which indicated a general regional population decline in moose population abundance in recent years (prior to Bipole III disturbance), including the Pine River sensitive moose range.

- **Year 2 (2015/16)** - No survey was scheduled or conducted.

- **Year 3 (2016/17)** - No survey was conducted in Year 3 (2016/17). A moose population survey led by MB Gov (in collaboration with MB Hydro) was recommended for this population for January 2017 as part of the Bipole III Mammals Monitoring Program. However, MB Gov advised that this population was not on the 2016/17 moose population survey schedule (MB Gov, V. Harriman, personal communication, November 4, 2016).

- **Year 4 (2017/18)** – No survey was scheduled or conducted.

- **Year 5 (2018/19)** - No survey was scheduled or conducted.

5.3.1.4 Split Lake Moose Study Area (GHA 9A)

MB Hydro monitors moose as a component of their Terrestrial Effects Monitoring Plan for the Keeyask Generation Project. The Keeyask survey area occurs in the eastern portion of GHA 9, with lesser portions in adjacent GHAs 1, 3 and 3A and 9A. A portion of the Keeyask survey area, specifically Study Zone 5 (hereafter referred to as Split Lake Moose Study Area) straddles the Nelson River from Thompson, through Split Lake to Stephens Lake, and is situated primarily in GHA 9A. The Split Lake moose study area overlaps the northern portion of N2 and most of N1 construction segments of the Bipole III Transmission Project ROW (Figure 4-3-1). Although the area was not identified as a sensitive moose range, it was added to the Bipole III moose monitoring program because it represents an area occupied by moose on the boreal shield ecozone that is intersected by the Bipole III ROW. The following summarizes population assessment results for the Split Lake Study Area:

- **Year 1 (2014/15)** - During January 2015 a moose population survey of the Keeyask survey area (including Split Lake study area) was conducted. Comparison of population abundance survey data obtained from MB Hydro indicates no significant difference between January 2010 (961 ±21.0%) and January 2015 (1,349 ±22.6%) because the confidence intervals of both estimates overlap.

- **Year 2 (2015/16)** - No survey was scheduled or conducted by MB Hydro for this population.
- **Year 3 (2016/17)** - No survey was scheduled or conducted by MB Hydro for this population (MB Hydro, T. Barker, personal communication, November 3, 2017).
- **Year 4 (2017/18)** – MB Hydro conducted a moose survey for the Keeyask Project in January 2018 (MB Hydro, J. Wiens, personal communication, January 23, 2018). The population abundance was estimated to be 1,159 ±26.9% (90% CL) and is not significantly different from the January 2015 or January 2010 surveys because the 90% confidence intervals of all 3 surveys overlap (Figure 5-3-1), suggesting the population is stable. The next survey of this population is scheduled for January 2021.
- **Year 5 (2018/19)** - No survey was scheduled or conducted.

5.3.2 Distribution and Occurrence

Trail cameras deployed from February 2015 through February 2019 provided assessment of **fine scale local occurrence** of moose relative to the ROW in comparison to moose detections at trail cameras placed 1.5 km from the ROW. These results indicate that during construction, there were fewer observations of moose at trail cameras placed near the ROW (48 observations at 16 camera stations $\bar{x}$ = 1.6 moose observations / camera) compared to cameras located 1.5 km from the ROW (100 observations at 16 camera stations; $\bar{x}$ = 3.2 moose observations / camera); no statistically significant difference was detected ($z = -1.2699$, $p = 0.1021$) because of significant large variance ($F = 0.1320$; $p<0.0001$) in the dataset. Analysis of ground transect data revealed that there is no significant relationship between track density and distance to the ROW for moose during the Construction phase (2015 to 2018) of the Project (Figure 5-3-2), the first year of Operations (2019, Figure 5-3-3) or across all years monitored (2015 -2019, Figure 5-3-4).

Moose distribution within 10 km of the ROW (N1-N4 and north part of C1) was recorded as a component of the Multi-species Aerial Survey to assess **coarse scale local distribution** occurrence to the ROW. Analysis of aerial survey data revealed that there was no significant relationship between density of moose and distance to the ROW (Figure 5-3-5) Overlap in confidence limits for moose densities in each distance bin from revealed that there is currently no significant relationship between density of moose and distance to ROW for any year monitored (Figure 5-3-5). The spatial distribution of relative density areas for moose also indicate no clear avoidance or preference of the ROW (Figures 5-1-5 and 5-1-6).

Moose sightings and activity data were collected during the Ungulate-Wolf Distribution Survey concurrently with the Woodland Caribou Calf Recruitment Survey. These data are useful to assess moose distribution and occurrence, as well as predator-prey dynamics at the **landscape scale**, and are discussed in Section 5.6.2.

5.3.3 Moose Browse Availability

This analysis will be undertaken once 2019 NDVI values are available (after the growing season is completed) and will be reported in a subsequent monitoring report.

5.4 Deer and Elk

Presence / absence and distribution of deer and elk were monitored using several methods which included (1) annual Ungulate-Wolf Distribution Surveys conducted concurrently with the Woodland

Caribou Recruitment Survey, (2) Multi-species Aerial Survey of the Bipole III ROW along N1 – N4 and north half of C1 construction segments, (3) Winter Ground Transect Surveys, and (4) Remote IR Camera traps.

5.4.1 *P. tenuis* Monitoring

In recent decades, research attention to wildlife movement corridors has increased, concurrent with concerns related to habitat fragmentation, and the spread of invasive species and disease vectors (Panzacchi et al. 2015). Climate change may facilitate northward range expansion of white-tailed deer (Dawe 2011) with certain types of anthropogenic disturbances (including power line corridors) providing ecotones with excellent ungulate browse resources and accessible hiding cover in adjacent forest (Reimers et al. 2000, Wunschmann et al. 2015), and functioning as corridors for range expansion.

Parelaphostrongylus tenuis (*P. tenuis*; meningeal brain worm) was identified in the Bipole III EIS and Biophysical Monitoring Plan (Manitoba Hydro 2015) as the primary focus for monitoring. Meningeal worm is prevalent and common in white-tailed deer populations in eastern and central Canada (Lankester 2001). White-tailed deer have built up a resistance to the parasite and does not normally cause neurological symptoms. Other ungulate species (moose, elk and caribou) are less resistant, and even low intensity of parasite infections can cause severe neurological disorders leading to death (Trainer 1973, Weiland 2008, Lankester 2010). In some areas, infected white-tailed deer populations overlapping with moose and caribou have resulted in declines of these species (Weiland 2008).

P tenuis is a long-lived ungulate nematode parasite that can persist in adult form in the ungulate host for many years, which facilitates continual shedding of first stage larvae in ungulate fecal mucosa (Slomke et al. 1995). Gastropods (snails and slugs) ingest the first stage larvae when they feed on the mucosa. While in the gastropod host, the larvae develop into second and third stage larvae which are capable of infection. Infected gastropods residing on ungulate forage are incidentally ingested by the ungulate host, at which point the larvae move to the ungulate host's stomach wall, enter the central nervous system and brain where they develop into the third (adult) stage. In the ungulate host, female worms shed eggs into the host's circulatory system; the eggs migrate to the host's lungs where they develop into first stage larvae, are coughed up, swallowed and pass unharmed in ungulate feces to complete the life cycle (Weiland 2008). *P tenuis* transmission is related to deer population density and gastropod host abundance (mediated by temperature and climate). Transmission period is variable and related to the amount of time that ground snow cover is absent.

Diagnosis of *P. tenuis* can be conducted by analyzing deer fecal pellets for first stage larvae, and by post-mortem necropsy of the deer brain cavity to detect present of adult parasites (Wasel et al. 2003, Duffy et al. 2002, Slomke et al. 1995). Forrester & Lankester (1997) present a commonly used technique to generate quantitative estimates of prevalence (proportion of animals passing protostrongylid larvae) and mean intensity of infection (mean number of larvae passed / infected individual) using ungulate fecal samples. The following is a summary of results of the *P. tenuis* sample effort by year:

- **Year 1 (2014/15)** - No deer fecal collection, or collection of harvested adult white-tailed deer heads, was undertaken in of the Bipole III Mammals Monitoring Program; that aspect of the Biophysical Monitoring Plan (Manitoba Hydro 2015) had not yet been approved by MB Gov to permit sampling.

- **Year 2 (February 2016)** - White-tailed deer pellet collection was attempted along the ROW from two surveillance areas using a systematic aerial transect survey method to detect deer activity (Figure 4-4-1). However, sample acquisition was substantially hindered by inaccessibility to private land on portions of the ROW where deer sign was observed. There was minimal deer sign detected in the areas surveyed, consequently, no samples were collected. No deer pellet samples were collected during the winter ground track transect survey, nor by MB Hydro environmental monitors along the ROW during winter construction.

- **Year 3 (2016/17)** - A ground-based community deer pellet sample collection effort was conducted using students from UCN (University College of the North) and OCN (Opaskwayak Cree Nation) on February 21 to 23, 2017. The students gathered samples along the south end of N3 within Surveillance Area 1 (n = 114 samples), along N4 (including within Surveillance Area 2; n = 86 samples), and from the north end of C1 (n = 26). The samples (n = 226) were submitted to Prairie Diagnostic Services (University of Saskatchewan) to undergo Baermann testing for presence of nematode spiney-tailed larvae (indicative of probable *P. tenuis* infection). Positives (n = 93) were detected in samples from all collection sites, suggesting a *P. tenuis* prevalence of 41.1% in the regional white-tailed deer population. Prevalence was lower (25.4%, n = 114) in samples collected north of P-Bog Woodland Caribou Range (N3*, P. tenuis* Surveillance Area 1). Prevalence was greater (60.5%, n = 86) in samples collected south of the P-Bog Woodland Caribou Range (N4, including *P. tenuis* Surveillance Area 2) and along C1 (46.2%, n = 26).

- **Year 4 (2017/18)** – deer pellet sampling was undertaken by MB Hydro but no analyses were undertaken.

- Re-sampling of the *P. tenuis* monitoring areas was recommended to occur in 2021/22 (Wood 2018).

5.4.2 Distribution and Occurrence - White-tailed Deer Ingress

A combination of winter aerial species distribution surveys, winter ground track transects, and trail cameras are used to monitor potential for Project-related white-tailed deer ingress and occurrence across seasons into areas transected by the ROW that historically have limited or no deer occurrence. The following summarizes deer and elk occurrence and distribution results relative to the ROW (Figures 5-4-1, 5-4-2, 5-4-3 and 5-4-4):

Year 1 (2014/15)

- Ungulate-Wolf Distribution Surveys were conducted in the P-Bog N-Reed and Wabowden Woodland Caribou Range survey areas; no white-tailed deer or elk observations or sign were detected.

- Winter Ground Track Transect Surveys were conducted along N2 and N3 construction segments, including deployment of Remote IR Trail Cameras during March 2015 to monitor deer presence along the N2 and N3 portions of the ROW and within 1,500 m of the ROW; no deer evidence was detected during the winter ground track transect surveys or trail camera deployment effort.

Year 2 (2015/16)

- Ungulate-Wolf Distribution Surveys were repeated in P-Bog, N-Reed and Wabowden woodland caribou range survey areas with no evidence of deer or presence detected. Surveys were also flown in two *P. tenuis* surveillance areas situated along the ROW on either side of the P-Bog woodland caribou survey area; deer were detected on private land portions of the survey area in areas of historical occurrence; no elk or elk sign was observed.

- The Alaskan Trackers conducted a Multi-species Aerial Survey; they detected deer in areas of historical occurrence, including near the P-Bog woodland caribou range along the ROW east of Red Deer Lake (Figure 5-4-1).

- Winter Ground Track Transects were conducted in N1, N2 and N3, with no evidence of deer detection outside of areas of historical occurrence; there was one deer record of occurrence on N2-10).

- Trail Cameras deployed during Year 1 along N2 and N3 detected deer activity on transect N3-05 and N3-06, as well as at the BPIII_ACCESS_003 human access monitoring location.

Year 3 (2016/17)

- Ungulate-Wolf Distribution Surveys were repeated in P-Bog, N-Reed and Wabowden woodland caribou range survey areas with no evidence of white-tailed deer or elk presence detected (Figures 5-4-1 and 5-4-3).

- MB Hydro repeated the Multi-species Aerial Survey; the survey detected deer in areas of historical occurrence with minimal evidence of recent occurrence within the PBog Population.

- Winter Ground Track Transect Surveys were conducted in N1, N2, N3, and N4 with no evidence of deer detection outside of areas of historical occurrence; of the 50 transects sampled, white-tailed deer activity was detected only on N4-07, which is within the expected area of occupancy.

- Trail Cameras deployed during Year 2 along N1, N2 and N3 detected deer activity on transect N3-05 and N3-06, as well as at the BPIII_ACCESS_003 human access monitoring location. During Year 3 deer were detected at BPIII Access_002 and again detected at N-06. No elk were detected either Year.

Year 4 (2017/18)

- Ungulate-Wolf Distribution Surveys were repeated in P-Bog, N-Reed and Wabowden woodland caribou range survey areas; one observation of white-tailed deer was noted on 29 January 2018 within the northwest corner of the survey area along Highway 10, near adjacent farmland, and 16.7 km from the ROW Figure 5-4-1).

- MB Hydro repeated the Multi-species Aerial Survey; the survey detected deer in areas of historical occurrence with no evidence of elk in close proximity of the P-Bog caribou study area (Figure 5-4-3). One observation of white-tailed deer tracks was documented on 14 January 2017, 260m from the ROW at the north end of the P-Bog Caribou range, within the P-Bog survey area (Figure 5-4-1).

- Winter Ground Track Transect Surveys were conducted in N1, N2, N3, and N4 with no evidence of deer detection outside of areas of historical occurrence; of the 31 transects sampled, white-tailed deer activity was detected only on N4-02, which is within the expected area of occupancy. No elk were detected.

- Trail Cameras deployed during Year 4 along N1, N2, N3 and N4 detected deer activity on transect N3-05, N3-06, N4-02, N4-04, N4-06, N4-08 and N4-10. Elk were detected at transect N4-02 and N4-04.

Year 5 (2018/19)

- Ungulate-Wolf Distribution Surveys were repeated in P-Bog, N-Reed and Wabowden woodland caribou range survey areas; there were no observations of white-tailed deer within the survey area in Year 5 (Figure 5-4-1).

- MB Hydro repeated the Multi-species Aerial Survey; the survey detected deer in areas of historical occurrence with no evidence of elk in close proximity of the P-Bog caribou study area (Figure 5-4-3). No observations of white-tailed deer or sign (tracks) were documented in Year 5 (Figure 5-4-1).

- Winter Ground Track Transect Surveys were conducted during Year 5 in N1, N2, N3, and N4 with no evidence of deer detection outside of areas of historical occurrence; of the transects sampled, white-tailed deer activity was detected on N4-02 and N4-04, which is within the expected area of occupancy. No elk were detected.

- Trail Cameras deployed during along N1, N2, N3 and N4 detected deer activity on transect N3-05, N3-06, N4-02, N4-04, and N4-06. Elk were detected at transect N4-04.

Trail cameras deployed during the Construction phase (February 2015 through February 2018) along N1 through N4 provided local scale assessment of white-tailed deer and elk relative to the ROW in comparison to locations 1.5 km from the ROW. These results indicate that during construction, there were more observations of white-tailed deer at trail cameras placed near the ROW (71 observations at 5 camera stations) compared to cameras located 1.5 km from the ROW (15 observations at 3 camera stations); this difference was statistically significant ($z = 2.0595$, $p = 0.0197$). There were insufficient data for analysis of elk observations; 2 observations were near the ROW and 2 were 1.5 km from the ROW.

During the Construction phase (fall 2015 to July 2018), no ingress of white-tailed deer into the P-Bog woodland caribou survey area was detected along the ROW in via the trail camera study, winter ground transect survey, or P-Bog Caribou Calf Recruitment Survey. However, the 2017 Multi-spp Aerial Survey conducted by MHydro detected one occurrence of white-tailed deer at the north end of the ROW within the P-Bog survey area. In addition, white-tailed deer ingress into the northwest portion of the P-Bog caribou range was documented along the Hwy 10 ROW during the 2018 Woodland Caribou Recruitment Survey (Figure 5-4-1). No elk occurrence was documented within the P-Bog survey area during the Construction phase (Figure 5-4-2).

During the first few months of the Operation phase (August 2018 to February 2019) no white-tailed deer or elk detections were documented by any survey / sampling method within (nor in close proximity to) the P-Bog caribou survey area. The distribution of white-tailed deer and elk observations were similar to previous years (Figure 5-4-1, Figure 5-4-3).

Analysis of multi-species aerial survey data revealed that there was no significant relationship between density of white-tailed deer or elk and distance to the ROW (Figures 5-4-2 and 5-4-4). Twenty–five models per species are tested (Section 4.5.2.3) and include combination land cover type, the type of observation, observer and canopy height and the best model fit evaluated using AIC. Overlap in confidence limits for white-tailed deer and elk densities in each distance bin from revealed that there is currently no significant relationship between density of white-tailed deer and distance to ROW for any year monitored. The confidence limits for each estimate are wide, contributing to a lack of discernable trend in the data, however estimates appear to be getting narrower each year that more data is collected.

5.5 Furbearers

5.5.1 Harvest Monitoring

Annual furbearer harvest statistics were used to monitor effects of Bipole III on changes of annual fur harvest (by species and construction segment) from 42 registered traplines intersected by the transmission line across Project phases (i.e., Pre-disturbance, Construction and Operation). There is a lag in MB Gov furbearer harvest statistics availability, therefore only pre-disturbance baseline data (2001/02 through 2013/14) and the 4 years of construction disturbance (2014/15 through 2017/18) were available for this report. Annual harvest (Table 5-5-1) and harvest rate (Table 5-5-2) of many of the other furbearer species from the monitored traplines were limited and highly variable because of a combination of factors including:

1. Trapping effort - some traplines have no or limited harvest records in some years, which is likely related to trapping conditions in a particular year, trapper interest, trapping success, and pelt prices (Todd & Boggess 1999).

2. Variable fur prices - reduced trapping effort during low fur pelt prices.

3. Cyclical population fluctuations (Wolfe & Chapman 1999) – e.g., Canada lynx have a classic population cycle linked to prey (hare) availability (Seton 1911, Elton 1924), marten in Manitoba cycle at 4-year intervals (MB Gov, D. Berezanski, personal communication, September 1, 2015).

4. Species distributions - some species are rare or absent as a function of their latitudinal distribution or habitat requirements (e.g., coyote, wolverine) relative to the Project location (Allen 1999, COSEWIC 2003).

5. Variation in annual trapping license sales (number of trappers harvesting fur). There were significantly fewer active trappers during the Construction phase (4 yr mean = 224.8 ±81.6 (95% CL)) compared to the Pre-construction phase (5 yr mean = 455.8 ±74.1 (95% CL)) (Table 5-5-2). Therefore, harvest rate is a more accurate indicator than harvest with respect to potential project effects because of variation in number of active trappers.

Four furbearer species (beaver, marten, wolf, wolverine) were identified in the Bipole III Project EIS (Manitoba Hydro 2011) as having particular concern because of potential Project disturbance effects (i.e., access resulting in overharvest, direct habitat loss and/or sensory disturbance). Harvest statistics for these species in particular are monitored and assessed as annual harvest data becomes available. The majority of annual harvest for these four species is variable across construction segments (Table 5-5-1). This is in part due to differences in the number (and physical extent) of traplines within each construction segment that are intersected or directly adjacent to the ROW. The same pattern is evident in the harvest rates for these species (Table 5-5-2). The following is a summary by species of the fur harvest statistics:

- **Beaver** - Harvest (number of pelts) and harvest rate (harvest / license) during the first 4 years of construction (2014/15 to 2017/18) was consistently lower in construction segments N1-N4 relative to the 5-year (2009/10 to 2013/14) pre-construction means (Tables 5-5-1 and 5-5-2). This suggests there may be a reduced harvest of beavers in traplines intersected by the Bipole III ROW during Construction. This is most likely attributed to significantly fewer trappers trapping beaver during Construction phase ($\bar{x}$ = 245.5 ±135.6 trappers) compared to preconstruction ($\bar{x}$ = 455.8 ±74.1

trappers), particularly in N4 where the largest proportion of beaver are harvested annually (Table 5-5-2).

- **Marten** - Harvest was significantly higher during construction compared to the 5-year (2009/10 to 2013/14) pre-construction mean in N1 and N4 (Table 5-5-1). However, no significant differences were evident with respect to harvest rate (Table 5-5-2), suggesting trapper success was not affected, and that the observed pattern is a reflection of number of trappers (i.e., more trappers were trapping marten during Pre-construction than during Construction; trapping success was not affected for those that trapped during both Project phases).

- **Wolf** – No significant difference was detected when comparing Pre-disturbance to Construction phase with respect to harvest or harvest rate in the monitored construction segments or the pooled harvest data (Tables 5-5-1 and 5-5-2).

- **Wolverine** - No significant difference was detected when comparing Pre-disturbance to Construction phase with respect to harvest or harvest rate in the monitored construction segments or the pooled ROW harvest data.

- The only significant differences detected with respect to harvest rate were for beaver (Construction segments N1-N4), and cross fox (N2), all were lower during Construction phase. No other significant harvest trends were detected for the remaining furbearer species with respect to harvest rate (Tables 5-5-1 and 5-5-2). The significant difference for cross fox is most likely an artifact of small sample size in the harvest dataset for this species.

5.5.2 Distribution and Occurrence

5.5.2.1 Winter Ground Transect Surveys and Multi-Spp Aerial Surveys

Winter ground track transects surveyed during Year 5 (n = 31) along construction segments N1, N2, N3, and N4 detected most of the expected furbearing species including weasel, mink marten / fisher (genus *Martes*), otter, fox, coyote, Canada lynx, snowshoe hare, and squirrel (Figures 5-5-1 to 5-5-7). Beaver, gray wolf and wolverine are wider ranging species that were not detected in during the Year 5 ground transect survey but were detected in previous years and are detected during the Multi-spp Aerial Survey (Figures 5-5-8 to 5-5-10).

For this report, data from Year 2 to Year 5 (2015/16 winter to 2018/19 winter) were pooled to assess overall patterns of distribution during the construction phase of the Project. Each species distribution was modelled separately to assess levels of occurrence as a function of the distance to the Project (Figures 5-5-1 to 5-5-7). For animals that are wide-ranging with large home ranges (e.g., wolf, wolverine) the assumption of independence of detection data from different sample units is likely to be violated (Webb & Merrill 2012). Responses to the Project varied across species (Figures 5-5-1 to 5-5-7. As the ground transects are measuring occurrence within 1 km from the Project, resultant patterns reflect local scale responses to the Project. Generally, predators such as coyote and fox were found to occur in close proximity to the ROW compared to locations farther away (Figures 5-5-1 and 5-5-2) and likely these species are using the ROW as a movement corridor. Species which can be prey such as marten, ermine and rabbit occurred farther from the Project (Figures 5-5-3 to 5-5-7), perhaps in response to larger predator presence or due to sensory disturbance from construction. Distributions of Canada lynx, moose and squirrel were not correlated to the ROW at this scale. Results from the multi-species aerial surveys, management unit and range surveys better reflect distribution of these species relative to the ROW at a more appropriate scale.

Power analysis was undertaken in Year 2 and 3 (2016, 2017) to assess whether more transects would be required in following years to meet analytical requirements. All power analyses were run using effect sizes from the best model fits with and without covariates. In 2017, power analysis revealed that the larger mammals including caribou, moose, gray wolf and Canada lynx still required between 30 to 50 more transects to be sampled per year to achieve a power of 80%, but that aside from squirrel the remaining species had sufficient sample sizes for the analysis. These results reflect the large scale these larger mammals operate on. So, although tracks of caribou, moose, gray wolf and Canada lynx are recorded during ground transects, the annual aerial surveys and satellite telemetry are also used to monitor these species at a larger scale more suitable for their range use and distribution.

Efforts were made in this report to pool across species and control variation from year to year (Figure 5-5-11). Mixed models result for three of the most abundant species (moose, grey wolf, caribou) on the raw density counts. Even with the effect of habitat accounted for, there was no significant relationship between species density and distance to the ROW (Figure 5-5-11). Density of a given species at each transect was calculated as the number of observations of that species divided by the length of the transect. The observation data was summed across each transect for each species to obtain a value per transect per species. A principal component analysis (PCA) was used account for a large proportion of the variance in the land type data (which, combined, accounted for 43% of the variance in the land type data) in the density models.

5.5.2.2 Camera Traps

Camera trap deployments that are paired with winter ground transects are summarized in Table 5-5-13 and below:

- **Year 1 (2014/15)** - Camera traps (n = 37) were deployed in construction segments N2 and N3 during March 2015 and were serviced in January 2016. ROW clearing progress and access restrictions prevented camera deployments in N1 and N4.

- **Year 2 (2015/16)** - Memory cards were retrieved in February 2016 from the N2 and N3 camera traps and the cameras were serviced to continue image collection. Camera images were classified by an independent consultant on behalf of MB Hydro. The cameras captured images of most of the expected mammal species, however, sample sizes were low for many of the mammal species, preventing meaningful statistical analysis. In addition, 20 cameras were deployed on N1, resulting in a total deployment of 57 remote cameras.

- **Year 3 (2016/17)** - Camera traps (n = 57) were deployed in Year 2 along N1, N2 and N3 construction segments of which 41 were serviced, 6 were retrieved with 2 replacements deployed, 3 were missing, and 7 were not serviced. An additional 20 cameras were deployed on N4, resulting in a total deployment of 63 serviced and 7 un-serviced cameras deployed in N1-N4.

- **Year 4 (2017/18)** – Camera traps (n = 70; 63 serviced +7 un-serviced as of February 2017) deployed along N1, N2, N3 and N4 construction segments were checked in February 2018. The February 2018 effort resulted in 41 cameras refurbished, 5 replacement cameras were deployed (1 stolen camera replaced; 2 malfunctioning cameras replaced; 2 deployed at locations where cameras were retrieved in 2017), 1 malfunctioning camera was retrieved / not replaced, and 26 were not accessed (primarily along N1 and N2 construction segments) because of active line stringing or were not accessible (no helicopter; no vehicle access possible). As of February 2018, a total of 72 cameras [46 active + 26 unserviced (not accessed in February 2018)] were deployed along N1-N4.

- **Year 5 (2018/19)** – Results from memory cards retrieved from trail cameras deployed during the Construction phase (February 2015 through February 2019) were used to compare occurrence of furbearers near the ROW versus 1.5 km (Figure 5-5-12 and 5-5-13). Significant differences were detected for some furbearer species with respect to proximity to ROW (Table 5-5-14). Wolf and fox occurred significantly closer to the ROW; wolverine and marten occurred significantly further from the ROW (Table 5-5-14, Figure 5-5-12). No significant preference was detected for black bear, coyote, fisher or squirrel. Snowshoe hare and Canada lynx tended to occur further from the ROW, but the trend was not statistically significant (Table 5-5-14).

Behavior of some species may change now that construction is complete and sensory disturbance diminishes along the ROW from construction activities.

5.6 Altered Mortality

The mammals monitoring program study design includes cause-specific direct mortality hazards for various mammal VECs using several methods (discussed in the subsequent report sections):

1. Telemetry collar Mortality Signal Investigations of boreal woodland caribou.

2. Winter Ungulate-Wolf Distribution Surveys conducted concurrently with annual Woodland Caribou Winter Calf Recruitment Surveys, and periodic Moose Aerial Population Surveys.

3. Furbearer Harvest Monitoring (furbearer trapping statistics) obtained from MB Gov.

4. Incidental Ungulate Harvest Monitoring during the Construction phase by MB Hydro environmental monitors. NOTE: ungulate licensed harvest data are not collected at a resolution sufficient to monitor at a GHA scale and are more appropriately applied at a larger regional scale (V. Harriman, personal communication, October 6, 2016). Therefore, provincial ungulate hunter harvest statistics are not useful as a component of the Bipole III Mammals Monitoring Program applicable at a spatial scale needed to monitor for potential harvest mortality effects resulting from ROW access.

5. Documentation of Project-related wildlife-vehicle collisions during the Construction phase by MB Hydro environmental monitors.

6. Ungulate disease / parasite monitoring specifically for Parelaphostrongylus tenuis (P. tenuis; meningeal brain worm) prevalence and occurrence in white-tailed deer populations associated with the Project ROW.

7. White-tailed deer ingress monitoring using Remote IR Camera Traps, Winter Ground Track Transects and incidental observations during Wildlife Aerial Surveys to document potential annual changes (e.g., ingress) in white-tailed deer occurrence in proximity to the ROW relative to other ungulate species.

8. Human access monitoring using Remote IR Camera Traps to capture seasonal occurrence of non-Project construction related human access of the ROW at main access points and along construction

segments N1 through N4. The information may provide insights on Project effect of altered access in relation to hunting activity.

5.6.1 Telemetry Collar Mortality Signal Investigations

5.6.1.1 Woodland Caribou

Observed mortality (for adult female boreal woodland caribou fitted with biotelemetry collars) involved investigation of mortality location and probable cause. Investigations were conducted as soon as possible after receipt of a mortality signal. Mortality investigations (n = 86) of collared adult females, indicate predation constituted 85.5% of known mortality sources (n = 47), primarily by wolves (80.0%) (Table 5-6-1, Figure 5-6-1). Wolf predations occurred in all months, with a distinct peak in July (Figure 5-6-1).

No significant difference was detected ($z = 0.492$, $p = 0.311$) when comparing mean pre-disturbance (2010 to 2014) mortality distance from the ROW [32.83 ±(95%CI) 11.05 km; n = 31] to disturbance (2015 to 2019) mortality distance from the ROW [28.8 ±(95%CI) 11.53 km; n = 21)] for all known mortality sources pooled. The following summarizes pre-disturbance vs disturbance mortality by caribou range:

- In **P-Bog Range**, there were more wolf predations of collared caribou during the pre-disturbance period (n = 9) relative to the disturbance period (n = 6). During the construction period there was also 1 documented bear predation (February 2016; 34.8 km from the ROW) and 1 vehicle collision (December 2014; 18.1 km from the ROW) with a collared woodland caribou. The closest documented wolf predation during the Construction phase was 2.9 km from the ROW in October 2016; the remaining wolf predations were >9.5 km from the ROW.

- In **Wabowden Range**, there were more wolf predations of collared caribou during the pre-disturbance period (n = 10) compared to the disturbance period (n = 8). There were no records of bear predations during either period. There was a vehicle collision with one of the collared caribou 10.9 km from the ROW during construction (April 2017) but was unrelated to construction activities. The closest documented wolf predation mortality was 1.8 km from the cleared ROW (December 2015); the remaining predation mortalities were >9.5 km from the cleared ROW (Figure 5-6-2).

- In **N-Reed Range**, there were 7 wolf and 1 bear predations of collared woodland caribou; 3 wolf predations occurred during construction. Only 5 mortalities (cause undetermined) of collared caribou occurred during the construction period. The closest mortality to the ROW was 10.05 km away (cause undetermined).

5.6.1.2 Forest-tundra Caribou

Telemetry collar mortality assessments have been conducted for the Pen Islands and Cape Churchill Caribou Range Distribution Project (Trim 2015). The mortality assessment investigations (n = 36) identify mortality sources to consist of a mixture of wolf kills (confirmed and suspected), black bear kills (suspected) and hunter harvests (Trim 2015). Some mortalities could be confirmed as non-predator mortalities, but it could not be determined whether the deaths were attributed to natural causes (e.g., old age, disease or malnutrition) or some other cause (Trim 2015). Trim (2015) reported that the majority of mortalities investigated occurred in the spring and summer months when female caribou incur the greatest demands from calving, calf rearing and predation avoidance. No mortality investigations have been conducted since 2015/16, and none are planned because the study has completed.

5.6.2 Altered Predator-Prey Dynamics

Gray wolf and black bear are the primary large predator species occurring in the project area. Large carnivores play a vital role in ecological communities by cascading trophic effects, stabilizing and destabilizing food webs, and by affecting energy and nutrient transfer processes (Lesmeister et al. 2015). Predators select areas where prey are not only more abundant but are also easier to capture (Keim et al. 2011, Messier 1985, Andruskiw et al. 2008). Anthropogenic disturbance can result in substantive changes in predator-prey dynamics by altering prey carrying capacity and predator-prey encounter rates (Leclerc et al. 2012, Wittmer et al. 2007, Festa-Blanchet et al. 2011).

5.6.2.1 Wolf Predation-risk

Wolves are habitat generalists that can have population level effects on ungulates, despite their relatively sparse distribution (Ausband et al. 2014). Wolf predation on adult ungulates can be especially high for low-density prey populations (e.g., woodland caribou) residing in landscapes where alternative ungulate prey support predators at high densities (DeCesare et al. 2010, Wittmer et al. 2013). Wolf pack territory spatial requirements are dictated by access to sufficient prey to sustain the wolf pack (Messier 1985), which ultimately limits wolf population size and distribution at a landscape scale (Messier 1995, Allen 1999, Fuller et al. 2003, Klaczek et al. 2015). They will alter territory size in response to local variation in habitat quality, to balance trade-offs between territorial defense costs and energetic gains from prey acquisition (Kittle et al. 2015). Linear features can improve wolf travel efficiency to access prey resulting in increased susceptibility of prey to predation (Environment Canada 2012). Wolves will select natural (waterways) and anthropogenic linear features for travel. Selection for anthropogenic linear features increases with increasing density of those features, with a compensatory decline in selection of natural travel corridors (Newton et al. 2017). Predation is the proximate limiting factor of woodland caribou populations (Environment Canada 2012, Wittmer et al. 2005). The susceptibility of boreal woodland caribou to predation has led to habitat use and predator avoidance strategies that separate caribou from other ungulate species in the same geographic area (Wittmer et al. 2005).

Landscape Scale

At the **landscape scale**, winter distribution surveys of ungulate species, wolf and wolverine were conducted in each boreal woodland caribou study area concurrent with the Woodland Caribou Recruitment Survey in 2018 to collect data on relative distribution, as this may provide insight into predation-risk. These data are compared annually to assess spatial variation in distribution in order to track annual changes is extent of winter range of these species relative to the Bipole ROW. A reduction in range extent for a population may indicate a declining population and potential diminished probability of population persistence (Makenzie & Nichols 2004, MacKenzie 2005). Ungulate predation-risk was assessed within each boreal woodland caribou study area using Ungulate-Wolf Distribution Survey data by comparing the distance of observed moose and caribou from recent wolf sign and observed wolves (Table 5-6-2, Figures 5-6-3 to 5-6-7):

- **Wabowden Survey Area** – During the Construction phase (years pooled) moose had a significantly greater wolf predation-risk than woodland caribou (Table 5-6-2; Figure 5-6-3, Figure 5-6-4) and that remained consistent during the first year of Operation (Table 5.6.2).

- **P-Bog Survey Area** – During the Construction phase (years pooled) there was no statistically detectable difference between woodland caribou vs moose with respect to wolf predation-risk (Table 5-6-2; Figure 5-6-3, Figure 5-6-5). During Year 5 (first year of Operation) there very limited wolf sign detected (n = 4 track observations) within the survey area which may have resulted in the predation-risk data having a high degree of collinearity of the predation-risk distances for caribou and moose, therefore the results for year 5 is likely spurious.

- **N-Reed Survey Area** – During the Construction phase, predation-risk to boreal woodland caribou was significantly greater than for moose (Table 5-6-2; Figure 5-6-3, Figure 5-6-6). Among monitored boreal woodland caribou ranges, predation-risk to woodland caribou each year was greatest in the N-Reed study relative to the other woodland caribou study areas as a function of caribou distance to wolf (Table 5-6-2; Figure 5-6-3). During first year of the Operation phase, moose were at significantly greater predation-risk compared to woodland caribou (Table 5-6-2; Figure 5-6-3).

- **Charron Lake Survey Area (Control)** – Predation-risk to woodland caribou was significantly greater than for moose annually during the first 4 monitoring years (Table 5-6-2; Figure 5-6-3, Figure 5-6-7). In addition, there were substantially less observations of moose each year relative to woodland caribou, further supporting the notion that wolves were likely focused on woodland caribou as primary prey in mid-winter. The exception is in year 5 of monitoring; no significant difference in predation-risk was detected, which was likely a result of small sample size (limited wolf sign observed, n = 8 observations; Table 5-6-2).

Relative density surfaces were developed using observation data from the Ungulate-Wolf Distribution Survey for each woodland caribou survey area to visually assess areas with greatest overlap of ungulate prey and wolf occurrence, with the intention of understanding relative predator-prey distribution and locations of greatest predation-risk in relation to the Bipole III ROW (Figures 5-6-4 through 5-6-7):

- **Wabowden Survey Area** – Wolf distribution overlapped with moose in two regions of the Wabowden caribou survey area (Figure 5-6-4). Within the survey area woodland caribou were spatially separated from moose and wolves (Figure 5-6-4). This is consistent with a greater relative predation-risk for moose relative to woodland caribou (Figure 5-6-3).

- **P-Bog Survey Area** – During the 2019 ungulate-wolf distribution survey, there was notable minimal sign of woodland caribou and wolf (Figure 5-6-5). Based on relative distribution it appears that wolves were focused on northern periphery of the survey. Moose and woodland caribou had similar distribution (Figure 5-6-5) and showed no significant difference in wolf predation-risk within the study area, which is consistent with previous years (Figure 5-6-3).

- **N-Reed Survey Area** – Woodland caribou maintained greater spatial separation from wolves compared to moose (Figure 5-6-6). There was no significant difference predation-risk to woodland caribou or moose based on distance from wolf (Figure 5-6-3), suggesting wolves were opportunistically selecting ungulate prey as encountered during the ungulate-wolf survey in 2019.

- **Charron Lake Survey Area** – As in previous years, moose occurrence and distribution was minimal compared to woodland caribou (Figure 5-6-7). Moose and caribou were more evenly distributed, but only moose has some overlap with wolf distribution. There was no significant different in wolf predation-risk for caribou compared to moose with respect to distance from wolf during the 2019 ungulate-wolf distribution survey (Figure 5-6-3).

In each woodland caribou survey area, the overlap of highest wolf densities corresponded to areas of greater relative ungulate prey density, which is consistent with studies of wolf occurrence being influenced by prey abundance (Messier 1995, Allen 1999, Fuller et al. 2003, Klaczek et al. 2015). Areas of highest wolf predation-risk to woodland caribou or moose did not appear to be related to the ROW at the landscape scale.

Local Scale

At the **local / fine scale**, winter ground track transects and remote IR cameras were deployed to collect data on ungulates and associated predators relative to the ROW across seasons. Remote IR cameras deployed along the ROW indicate wolves significantly occurred more frequently on the ROW relative to areas 1.5 km from the ROW (Table 5-5-14, Figures 5-5-12 and 5-5-13).

At the **local / course scale**, Multi-species Aerial Survey data were used to assess local scale general relative caribou, moose and wolf distribution along the Project (Figures 5-1-4, 5-1-5, 5-1-6, 5-3-5, 5-5-9. Wolf distribution was associated more strongly with the distribution of moose rather than caribou along the ROW in both the northern (Figure 5-1-5) and southern (Figure 5-1-6) portions of the ROW sampled in January 2019. Wolf distribution did appear to have a closer association with the ROW in areas where moose were more abundant, particularly in the eastern portion of N1 (Figure 5-1-5) and central portion of N4 (proximate to Moose Meadows, Figure 5-1-6) of the ROW.

5.6.2.2 Black Bear Predation Risk

Black bears are generalist consumers (omnivores) that can effectively exploit pulsed forage resources because of their capacity to switch to alternative resources (Rayl et al. 2015). They are known to be predators of ungulate neonates (Tigner et al. 2014) particularly during the first few weeks following birth (Zager & Beecham 2006, Dussault et al. 2012). Consequently, bears can have an additive effect on neonate mortality before calf body condition mediates vulnerability to predation (Zager & Beecham 2006, Rayl et al. 2015). Black bear effect on prey populations is highly variable and is dependent on prey population size, bear population size, prey population resilience to predation intensity, and bear-ungulate neonate encounter rates (Bastille-Rousseau et al. 2011, DeCesare 2012, Hebblewhite et al. 2005). Black bear foraging decisions are determined by food resource availability both spatially and seasonally (Costello & Sage 1994, Gunson 1993, Pelton et al. 1999, Pelton 2000). Although less predatory than wolves, their population density can be an order of magnitude greater that wolves, and therefore can have a significant effect on ungulate neonate mortality in some populations (Tigner et al. 2014). Predation rates are thought to be facilitated by linear development. However, bears will avoid linear development with active human activity Jalkotzky et al. 1997, Forman et al. 1997). They are active foragers in all seasons except during winter hibernation.

Local Scale

Remote IR Cameras installed along N1 through N4 construction segments were used to monitor **local / fine scale** bear occurrence relative to the ROW, and in relation to caribou ranges intersected by the ROW. The Trail Camera data indicate that during construction, black bear occurrences near the ROW relative to areas 1.5 km from the ROW were not significantly different (Table 5-5-14, Figure 5-5-9).

5.6.2.3 ROW Effect on Predator-Prey Distribution

The Multi-species Aerial Survey dataset was used to assess local distribution of large and medium sized mammals as a function of the distance from the ROW. At this time, there seems to be no annual trend or significant effect of ROW distance on density of observations on either side of the ROW even when analysis was corrected for survey effort and observer bias. Variation around the means for each bin is high and likely contributing to the current pattern (Figures 5-6-11 to 5-6-17). Certainly, for wolverine (Figure 5-6-17), white-tailed deer (Figure 5-6-16) and gray wolf (Figure 5-6-14), a trend of higher densities at locations farther from the ROW is apparent. However, this relationship is not currently statistically significant due to wide confidence intervals around the density estimates.

5.6.3 Harvest Mortality

Ungulate licensed harvest data is not readily available from MB Gov and has not been substantively collected in recent years. There are no reliable sources of rights-based subsistence harvest data for ungulates available for the Project area. Therefore, no monitoring of licensed hunting or rights-based subsistence hunting of ungulates is possible as a component of the mammals monitoring for Bipole III Transmission Project.

Furbearer harvest statistics are reported in Section 5.5.1 of this report.

5.6.4 Wildlife-Vehicle Collisions

Project-related vehicle collisions are recorded by MB Hydro staff. The following is a summary of known wildlife-vehicle collisions in the Project area that did not involve Project vehicles:

- **Year 1 (2014/15)** - One of the collared caribou (BOG1408) from the P-Bog range was killed on December 25, 2014 as a result of a wildlife-vehicle collision; the mortality location was 18.1 km from the Bipole III ROW (Figure 5-6-2) and was not associated with a Project access road, nor did it involve a Project construction vehicle.

- **Year 3 (2016/17)** - A caribou-vehicle collision occurred on April 23, 2017 (WAB1304) in the Wabowden range; the caribou mortality location was 10.9 km from the Bipole III ROW along Highway 39 and was not associated with a Project access road or a Project vehicle.

The following is a summary of wildlife-vehicle collisions involving Project vehicles:

- **Year 2 (2015/16)** - A deer-vehicle collision occurred at 18:40 hrs on December 7, 2015 in proximity of S1 construction segment along Highway 16 north of Portage (MB Hydro, T. Barker, personal communication, November 14, 2017).

- **Year 4 (2017/18)** - A deer-vehicle collision occurred at 07:40 hrs on August 6, 2017 in proximity of S1 construction segment on Highway 305 (5.8 km south of Road 48N – Power Line Road). A second deer-vehicle collision occurred at 06:48 hrs on September 16, 2017 in proximity of S1 construction segment on Highway 242 near Westbourne (MB Hydro, T. Barker, personal communication, November 15, 2017). No project-related wildlife-vehicle collisions occurred for remainder of the Construction phase which ended in July 2018 (MB Hydro, T. Barker, personal communication, November 20, 2018).

- No elk or moose-vehicle collisions were documented during construction. Wildlife-vehicle collision monitoring was not required for the operations phase.

5.7 Habitat Disturbance During Construction

Year 1 (2014/15) of construction along C1 and N1- N4 construction segments focused on establishing ROW access points, clearing the ROW centerline and portions of the ROW, including application of mitigations (i.e., routing and selective clearing for vegetation leave areas intended as wildlife movement corridors). Year 2 (2015/16) construction involved completion of ROW clearing and preparation of tower piers. Year 3 (2016/17) construction involved installation of 3,100 towers and line stringing along portions of the ROW. Year 4 (2017/18) involved completion of the Construction phase. Unseasonably warm winters during the Construction phase resulted in a 15-month delay in Project completion. The Project in-service date (Operation phase) began in July 2018.

5.8 Environmentally Sensitive Sites (ESS)

5.8.1 Ungulate Mineral Licks

Mineral licks provide a source of sodium (Na) and minerals such as sulfur (S), calcium (Ca, and magnesium (Mg) to ungulates. Mineral lick use occurs year-round and are related to mineral loss in females due to pregnancy, parturition and lactation and for males related to demands of antler production on mineral balance (Atwood & Weeks 2003). Dietary requirements for these elements are also obtained from natural forages, but mineral licks provide a concentrated source. Several sources of information were used for mineral lick detection which included Traditional Local Knowledge, baseline surveys conducted for the EIS, Multi-species Aerial Survey of the ROW, Ungulate-Wolf Winter Distribution Surveys in woodland caribou ranges (Wabowden, N-Reed, P-Bog), numerous overflights of the ROW, and incidental observations via environmental monitors during the Construction phase. The Manitoba Métis Federation commissioned a Metis land occupancy and use study (Shared Values Solutions 2015) which identified 27 ungulate mineral lick locations within the geographical extent of their study area. Most of those locations are distant from the ROW and would not be affected by Project activities. The three closest locations identified were situated east of Red Deer Lake along construction segment N4 (Figure 5-7-1) and included 5004-22 (678 m from ROW), 4002-15 (961 m from ROW) and 3001-27 (1,003 m from ROW), none of which are anticipated to have a significant interaction with the Project, nor be directly impacted by construction activities, nor during the Project Operation phase. It is unclear from the report as to which sites are dry salt licks versus wet mineral seeps. The following is a summary of mineral lick detections by year:

- **Pre-monitoring Phase (Prior to 2014/15)** - No mineral licks were detected in proximity to the Project prior to implementation of the 2014/15 mammals monitoring program.

- **Year 1 (2014/15)** - No mineral licks were detected during field survey monitoring efforts in close proximity to the ROW.

- **Year 2 (2015/16)** - One mineral lick (wet mineral seep) was detected during aerial surveys on February 28, 2016 at: 14U 362682E 5823496N. The location was 2,408 m from construction segment N4 of the ROW (Figure 5-7-1) and was not in a location that would be disturbed by the Bipole III ROW Construction or Operation activities.

- **Year 3 (2016/17)** - No new mineral licks were detected during field surveys or concurrent with construction activities. Clearing and construction are nearing completion with no additional surface disturbance anticipated, therefore, no further effort is required to monitor for affected mineral licks in Year 4.

- **Year 4 (2017/18)** – no mineral lick monitoring was conducted.

- **Year 5 (2018/19)** – no mineral lick monitoring was undertaken, nor required for the Operation phase of the project. Project construction was completed in July 2018, therefore no further monitoring for ungulate mineral licks is required.

5.8.2 Black Bear Hibernation Dens

Black bears are particularly sensitive to noise disturbance within 200 m of overwintering (hibernation) dens, with effects as great as 1 km, and may abandon the den in response to disturbance, especially early in the denning period (Linnell et al. 2000). Hibernation dens are seldom reused in consecutive years. Therefore, loss of a single denning site from human disturbance is not deleterious if alternative sites are available within the home range (Linnell et al. 2000). Black bear occurrence obtained from annual camera data is illustrated in Figure 5-8-1. The following is an annual summary of bear dens encountered during Project construction:

- **Year 1 (2014/15)** - One bear hibernation den was encountered during winter construction clearing activities (mulching) on February 2, 2015 at the north end of construction segment C2 near tower station 5016 (UTM: 14U 477084E 5690959N) (Figure 5-7-1). See Amec Foster Wheeler 2016 for further details.

- **Year 2 (2015/16)** - No bear dens were encountered during winter construction (MB Hydro, T. Barker, personal communication, October 11, 2016).

- **Year 3 (2016/17)** - No bear dens were encountered during winter construction (MB Hydro, T. Barker, personal communication, November 3, 2017). Mechanized clearing was completed and line construction (tower installation and line stinging) well underway in Year 3. No further monitoring for effects of the Project on bear dens is anticipated to be required in Year 4.

- **Year 4 (2017/18)** – No black bear hibernation dens were encountered or disturbed during the final year of construction (MB Hydro, T. Barker, personal communication, November 20, 2018).

- **Year 5 (2018/19)** – Project construction was completed in July 2018, therefore no further monitoring for black bear dens was required.

5.8.3 Wolverine Winter Dens

Wolverines have specific habitat requirements for natal and maternal den sites; multiple dens may be used in sequence through the duration of maternal litter care. Dens are constructed in boulders, under deadfall, or in snow tunnels, with individuals reoccupying den sites or denning habitats in successive years (COSEWIC 2003). They are snow-dependent in order to den. Den sites may also function as rendezvous sites between females and their kits (COSEWIC 2003). Denning females are sensitive to disturbance, potentially resulting in relocation or litter abandonment. Wolverines mate in summer but fertilized egg implantation is delayed until winter. Typically, <50% of adult females will produce a litter in a given year, making them demographically vulnerable and susceptible to disturbance impacts (Inman et al. 2012, COSEWIC 2003). Gestation is about 45 days long with peak parturition occurring between February and mid-March (Inman et al. 2012). Lactation period occurring over about a 10-week period from February to April (Inman et al. 2012). Young are nutritionally independent from the mother by fall and will on average make exploratory dispersal movements by 11 months of age (Inman et al. 2012). The natal den is occupied for a few weeks before the litter is moved to a maternal den. Annual wolverine winter occurrence is illustrated in Figure 5-8-2. The following is an annual summary of wolverines encountered during Project construction and monitoring:

- **Year 1 (2014/15)** - No wolverine dens were encountered during Project construction.
- **Year 2 (2015/16)** - No wolverine dens were encountered during Project construction. Locations of wolverine sign (tracks) and observations during mammal aerial and ground based field survey programs varied from 227 m to 8,247 m from the ROW, with a median distance of 3,266 m (n = 58 observations).
- **Year 3 (2016/17)** - No wolverine dens were encountered during Project construction (MB Hydro, T. Barker, personal communication, November 3, 2017. Wolverine occurrences detected during aerial and ground based field survey programs varied from 236 to 39,123 m from the project ROW, with a median of 1,228 m (n = 40 observations). Project clearing was completed and line construction (tower installation and line stinging) underway in Year 3.
- **Year 4 (2017/18)** - No wolverine dens were encountered during the final year of Project construction (MB Hydro, T. Barker, personal communication, November 20, 2018).
- **Year 5 (2018/19)** – Project construction was completed in July 2018, therefore no further monitoring for wolverine dens was required.

5.8.4 Wolf Natal Dens and Rendezvous Sites

Wolf den locations are generally randomly situated within the pack territory, with the outer 1 km periphery avoided; the larger the territory, the closer the den is to the center (Mech & Boitani 2003, Packard 2003). Rendezvous site are usually located in the general denning region. Pack foraging excursions may be up to 48 km from the den or pups. Several dens within each home range may be used for pup rearing, with natal dens usually located near water (Packard 2003). Peak of parturition occurs near the end of April through early May. Pups are highly associated with the den for their first 8 weeks. Den proximity to human disturbance is dependent on whether they have experienced negative interactions with humans. Disturbance is unlikely to have an effect unless it is widespread and intensive (Fuller et al. 2003). Dens and rendezvous sites have been documented within 1 to 2 km of active roadways and as close as 400 m to paved roadways (Fritts et al. 2003).

The timing of winter mechanized clearing and winter construction activities in boreal habitats occupied by wolves mitigates potential for negative effects on wolf den disturbance. Consequently, no den searches were necessary because there was no overlap of winter construction activities with spring wolf denning activities. No conflicts occurred with respect to wolf den or rendezvous sites and construction were reported for Year 1 or Year 2 (MB Hydro, T. Barker, personal communication, October 11, 2016), nor in Year 3 (MB Hydro, T. Barker, personal communication, November 3, 2017). ROW mechanized clearing was completed by Year 3 and installation of towers and line stringing was well underway. Construction activities in Year 4 occurred within the existing disturbance footprint and consisted of completion of tower installation and line stringing. Potential for Project effects on wolf dens or rendezvous sites was considered negligible at this stage of construction. Therefore, no monitoring for this ESS type was necessary during Year 4, nor is it required for future years.