Mammals Monitoring Program Technical Report Year 4 (2017/18)

Bipole III Transmission Project
WX17393

Prepared for:

Manitoba Hydro

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

April 2019

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April 11, 2019
WX17393

Mr. James Matthewson
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360 Portage Avenue (5th Floor)
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Dear Mr. Matthewson:

Wood Environment & Infrastructure Solutions (formerly Amec Foster Wheeler Environment & Infrastructure) is pleased to provide the attached 2017/18 Mammals Monitoring Report for the Bipole III Transmission Project.

This report summarizes mammals monitoring conducted to date with an emphasis on the Year 4 (2017/18) results from field surveys and associated analyses for the long-term mammals monitoring program.

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

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Sr. Associate Wildlife Biologist

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Executive Summary

This monitoring report presents an analysis and summary of existing baseline data for mammal VECs potentially affected by the Bipole III Transmission Project ('the Project'). It 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) on mammals 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.

This document reports on monitoring studies undertaken in Year 4 (2017/18 of the long-term mammals monitoring program. 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 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 from 2010 to 2014 and where feasible, data from the construction phase that was initiated in 2014 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 4 (2017/18) from population abundance and distribution studies, telemetry studies, and mortality monitoring.

1. **Population Structure and Trend -** Annual adult female survival rates for collared caribou in Year 4 were all above 85%, 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 for Year 1 through Year 4 of monitoring are consistent with stable populations in the P-Bog, Wabowden, and Charron Lake ranges, and a stable (possibly increasing) population trend in the N-Reed 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 0.042 caribou/km^2 ±4% in P-Bog, 0.051±3% in Wabowden, 0.057 ±3% in N-Reed and 0.078±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** - Abandonment of traditionally used areas can indicate responses to disturbance. Telemetry data from collared female boreal woodland caribou were used to assess movement behavior, habitat selection and distribution on the landscape relative to the Project. Fidelity is the tendency of animals to remain in, or return to, a particular location at different times of the year and is believed to increase an individual's knowledge of the local environment by increasing their ability to find resources while reducing predation risk. Therefore, the monitoring tasks for this Project are focused on assessing whether there are any shifts in annual or seasonal range use or levels of site fidelity to these areas through Project phases. Responses are measured through site fidelity and resource selection analysis, assessing the zone of influence (ZOI) around the Project, and the extent to which the Project ROW acts as a barrier to movement. Responses by caribou to mitigation measures are also assessed to determine the effectiveness of implemented strategies.

   a) **Home Range and Seasonal Range Analyses** - The average size of home range and seasonal range use for boreal woodland caribou varied among the monitored populations. Charron Lake is located in the boreal shield and the average size of home and over-wintering ranges for the Charron Lake caribou were significantly larger than the other monitored populations in both the pre-construction and construction Project phases. Caribou in the boreal plain ranges including Wabowden, P-bog and N- Reed all had similarly sized annual and seasonal range areas in both the pre-construction and construction phases.

   b) **Site Fidelity** – Overall, results suggest that winter range use is scale dependent for some caribou, where females are philopatric to general wintering areas within a larger population range but not necessarily to precise locations within these areas in every year. Conversely, patterns observed from May to September persist across scales suggesting that female caribou are attracted to specific locations during the calving and post-calving period year after year.

There were no differences in behaviour observed in the pre-construction phase in the Charron Lake population compared to P-Bog and Wabowden populations during any portion of the year. However, caribou in the N-Reed range demonstrated a lack of fidelity to wintering areas at both the population and seasonal scales in the years where data was available to analyse.

In both the pre-construction and construction phase, fidelity to calving areas by all collared caribou was strong, suggesting that Project activities were not disruptive to local caribou. Fidelity to wintering areas was also demonstrated during both pre-construction and construction phases in Wabowden, Charron Lake and P-Bog ranges but was weaker than the levels of fidelity displayed by the same caribou during spring and summer months. Cows collared in the P-Bog range showed a lack of fidelity during late winter during the construction phase. Reduced fidelity was limited to the more local seasonal scale (i.e., local sites within a monthly use area) and not a more substantial shift at the larger population range scale and only observed during February and March. This result indicates that construction activities may have disturbed caribou in the P-Bog range for a short period of time. This pattern should continue to be assessed through the operations phase to see whether levels of fidelity return to pre-construction levels in late winter.

1. **Zone of Influence (ZOI)** - The distance at which boreal woodland caribou change their behavior, habitat selection and distribution relative to disturbance has been labeled the ZOI; which is an area of reduced caribou occurrence.

    a) In the **Wabowden range**, the Project widened an already pre-existing linear corridor created by the railroad line. Therefore, avoidance of this existing linear feature could have been present prior to the construction of the Project. Results suggest that female boreal caribou avoided the pre-existing linear corridor by approximately 1 to 2 km prior to the Project being constructed. This avoidance did not change during Project construction, caribou continued to have reduce occurrences within 2 km of the Project.

    b) In the **P-Bog range**, the Project created new linear corridor on the landscape. Results suggest that there has been a short ZOI of approximately 1 to 2 km during the construction phase.

2. **Barrier Effects and Crossing Analysis** - After the completion of the ZOI analysis, caribou behavior was further assessed on a more local scale by evaluating the extent to which the Project acted as a barrier to local movements. This crossing analysis differs from the ZOI analysis in that it evaluates the local movement responses of individual caribou to Project construction; whereas, the ZOI analysis quantifies the overall avoidance response by all collared caribou in each range.

    a) **Wabowden range** - Crossing analysis revealed that there was no significant increase in the level of avoidance from the pre-construction to construction phase by individual caribou; suggesting that the installation of the Project did not significantly increase barriers to movement for caribou. This is likely due to the fact, that a linear corridor was already present on the landscape prior to the initiation of the Project and local caribou may have already exhibited a level of habituation to the corridor.

Results also revealed that collared caribou crossed the Project in the Wabowden range less frequently than expected. This result suggests that although caribou have not increased avoidance of the ROW during construction, they are still significantly avoiding crossing the ROW.

Therefore, in the Wabowden range, boreal female woodland caribou do avoid the Project by a buffer of 1 to 2 km throughout the year, irrespective of Project phase. The Project is a semi-permeable barrier to movement, it does not completely prevent local movement on the landscape, however, it does reduce the frequency of caribou moving through the area directly across the ROW. Caribou do not cross the Project as frequently as would be expected by random, however, they still cross on occasion and the frequency of this behavior has not been altered by construction.

b) **P-Bog range** – Crossing analysis revealed that during the initiation of construction, individual collared caribou continued to move across the Project in similar locations to those used in the pre-construction phase and no avoidance was detected. However, in 2017, caribou began to avoid crossing the ROW, suggesting there was lag effect in response to construction and this avoidance continued in 2018. The ROW was not a complete barrier, caribou crossed the corridor in 2017 but at a significantly reduced frequency than observed in previous years.

Caribou in the P-Bog range continue to use vegetation mitigation areas to cross the Project ROW. The crossing analysis results do not contradict the ZOI results which indicated an overall avoidance buffer of approximately 1 to 2 km by caribou across seasons. Overall, collared caribou do not occur frequently within 1 to 2 km of the Project. However, caribou who decided to cross Project, are doing so less frequently than would be expected randomly. Results indicate that the Project has not been a complete barrier to local movements and may be the result of effective installation of vegetation mitigation areas.

3. **Vegetation Mitigation** - The effectiveness of the vegetation mitigation areas was assessed for the P-Bog range where detailed data currently exists on the location of where vegetation mitigation was applied. Collared female boreal woodland caribou continued to cross at mitigated areas more frequently than non-mitigated areas. Therefore, mitigation applied on the landscape (vegetation-leave areas) ensured that caribou did not alter local movements across the landscape.

   In the Wabowden range, vegetation mitigation was applied along the entire length of the ROW (within caribou range boundaries). Consequently, a statistical comparison of mitigated versus non-mitigated vegetation areas cannot be undertaken. However, given that caribou continue to cross the ROW and the results of the P-Bog range it would be assumed that caribou are benefitting from the mitigative effect of vegetation leave areas along the segment of the ROW.

4. **Caribou-Vehicle Collisions** - There are 2 known caribou-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. No other caribou-vehicle collisions were reported during the construction phase.

Forest-Tundra and Barren-ground Caribou

1. **Forest-Tundra Caribou** - No Cape Churchill caribou were reported in proximity to the project (MB Gov, V. Trim, personal communication October 23, 2018). Pen Island caribou moved into areas in close proximity to the south of N1 construction segment of the Project (Nelson River, Split Lake, Assean Lake, Burntwood River) with majority of subsistence harvesting occurring January 3 to 18, 2018; overlap of Pen Island caribou movements with the Project footprint were considered minimal (MB Gov, V. Trim, personal communication October 23, 2018); the Project footprint did not contribute to the subsistence harvest success that occurred. No aerial recruitment surveys were conducted for either population; the last of the deployed telemetry collars released in September 2018.

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 (Billard 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 4 (2017/18):

1. Population Abundance

   a) **Sensitive Moose Areas** - No Gasaway population surveys were conducted in Year 4. In **Tom Lamb/GHA8** sensitive moose area, the population is currently estimated to be 48% below its long term (1971 to 2015) mean size. Regional moose populations proximate to this area all indicate declines in abundance in recent years, prior to Bipole III disturbance. 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.

      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 of the east slopes of the Porcupine Hills and is thought to serve as a spring moose calving area. There were no specific moose population abundance surveys of Moose Meadows or the Swan-Pelican reference population conducted in Year 4.

      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). No population abundance survey was scheduled or conducted in Year 4.

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) 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 correlation between the occurrence of moose as a function of the distance to the ROW has not been detected in any year (2015 to 2018). 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.

2) **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 4 (2017/18):

3. ***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.

4. **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.

5. **Deer/Elk-Vehicle Collisions** - There have been 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 4 (2017/18) are summarized below and are mainly focused on project effects on predator-prey dynamics and occurrence:

1. **Caribou Predation Mortality** - Mortality investigations (n = 72) of collared adult females, indicates predation constituted 84.0% of known mortality sources (n = 42), primarily by wolves (78.0%). Wolf predations occurred in all months except December, with a distinct peak in July.

   a) In **P-Bog Range**, there were more wolf predations of collared caribou during the pre-disturbance period (2010-2014; n = 9) relative to the construction period (2015-2018; n = 5). 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 construction period (n = 8). 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 3 wolf and 1 bear predations of collared caribou; all occurred prior to construction. Only 1 mortality (cause undetermined) of a collared caribou occurred during the construction period (October 2016; 43.9 km from 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 first 3 years of construction; in Year 4 (2017/18) moose were at significantly greater risk. In Wabowden Survey Area, moose had a greater wolf predation-risk than caribou during Years 1, 2 and 4 of construction. In N-Reed Survey Area, predation risk to boreal woodland caribou was significantly greater than for moose during the first 3 years of construction.

   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. Areas of highest wolf predation-risk to woodland caribou or moose did not appear to be related to the ROW at the landscape scale.

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). 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 predators such as coyote and fox had a positive correlation with the ROW, they were recorded with higher frequency closer to the Project.

Fur-bearers

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 3 years of construction (2014/15 - 2016/17) 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 -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 4 (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, lynx, snowshoe hare, and squirrel. Gray wolf and wolverine are wider ranging species that were not detected in during the Year 4 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.

   b) **Trail Camera Study** - Results from memory cards retrieved from trail cameras deployed during the construction phase (February 2015 through Feburary 2018) were used to compare occurrence of furbearers near the ROW versus 1.5 km. Significant differences were detected for some furbearer species with respect to proximity to ROW. Wolf and fox occurred significantly closer to the ROW; wolverine and lynx occurred significantly further from the ROW. No significant preference was detected for black bear, coyote or marten. Snowshoe hare and squirrel tended to occur further from the ROW, but the trend was not statistically significant. Sample sizes were small for some species; therefore, caution should be used in application of these results. As additional years of data continue to accumulate the analysis and interpretation of this data set will continue to improve. Behavior of some species may also change once construction is complete and sensory disturbance diminishes at the ROW from construction activities.

Environmentally Sensitive Sites (ESS)

No ungulate mineral lick surveys were conducted in Year 4 (2017/18) because all ROW clearing was completed in Year 3 and no potentially affected mineral licks were detected during pre-construction or over the first 3 years of construction. No bear hibernation dens were detected during Year 4 (2017/18) of monitoring. No wolf dens or rendezvous sites were affected during any year of construction. No wolverine dens were encountered during the final year of construction.

Human Access

Human access monitoring activities were undertaken during the first 3 years of construction using on trail camera data acquired along the ROW in association with annual winter ground transect surveys and at all-weather construction access points. Results of the sampling effort during construction (March 2015 to February 2018) indicated the majority of ROW access for a known purpose was for Project construction (99.1% in during Year 1 (March 2015 to February 2016) of camera deployment and 99.2% during Year 2 (March 2016 to February 2017) with limited local public access (0.8% in Year 1 and 0.7% in Year 2 of sampling) for recreation and resource use. The Year 3 (March 2017 to February 2018) camera dataset did not have attributes describing types of human use, which resulted in analytical limitations. Total observed human access (project, public, undetermined) in Year 3 was more than that observed during the previous 2 years of construction, and in part is a result of progressively increasing sampling effort from additional trail camera deployments each year. It is assumed that the proportion of ROW access for a known purpose in Year 3 (March 2017 to February 2018) of camera deployment was construction-related, in proportions similar to the previous 2 years (approximately 99%). Observed human access during the operation phase is expected to be substantially lower. It is not known if public access will increase, now that construction in complete; therefore, ongoing camera study is recommended.

Monitoring and Mitigation Recommendations

Based on the results of the 2017/18 (Year 4) report, the following are mitigation and monitoring recommendations for Year 5 and beyond:

1. **Capture-Mark-Recapture (CMR) Sampling using Non-invasive Genetic Survey (NGS) -** Sampling of all monitored boreal woodland caribou study areas is scheduled for Year 5 (2018/19). Sampling occurs a 2-yr intervals and is intended to support monitoring of population performance (abundance trend, lambda) though each Project phase (construction, operation); sampling frequency should be re-assessed after Year 5 analyses are completed.

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 5. The Project commitment is to sample annually during the construction phase, and for 3 years post-construction.

5. **Multi-species Aerial Survey** – Repeat survey in 2018/19 to sample mammal VECs during the first 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 - 2020/21; 3 years post-construction).

7. **Environmentally Sensitive Site (ESS) Monitoring –** Discontinue searching/monitoring for ungulate mineral licks, black bear winter hibernation dens, and wolverine maternal dens since construction is complete (July 2018) and the monitoring obligation is met.

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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). These delays affected full implementation of ground-based mammal monitoring field programs as originally planned. Construction was scheduled for completion in 2018 and was achieved in July 2018.

Project-related concerns about wildlife are focused largely on caribou, moose and migratory birds (CEC 2013). Construction and operation of the Project potentially affects several disturbance sensitive mammalian species including caribou, moose, wolves, bears, wolverine, and marten. 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 has 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 will continue 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 is implemented to deal with uncertainties as they arise; poorly performing mitigation strategies or monitoring techniques are modified or replaced where warranted.

Mammal valued ecosystem components (mammal VECs) selected for effects monitoring were specified in the Bipole III Environmental Impact Statement (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 focus of effects monitoring varies by mammal VEC and Project construction segment.

The EIS, technical report addendums, and regulatory review documents identify several predicted effects on mammal VECs. These effects vary by scale and Project phase. The 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).

Project construction was initiated in 2014 and was completed in July 2018. It is currently in the operation phase of the Project cycle.

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 of each mammal VEC 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; and

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; and

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 *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); and

2. Assess Project-related change in mortality risk (harvest, predation, vehicle collisions) to elk as a consequence of altered Project access, sensory disturbance and/or habitat alteration.

2.1.4 Wolf and Black Bear

Wolf and Black Bear monitoring plan objectives (Table 2-1-4) are to:

1. 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 objectives (Table 2-1-5) are to:

1. 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).

2.1.1 Human Access

Human access monitoring plan objectives (Table 2-1-6) are to:

1. Assess changes in access to the Project area by humans.

2.1.2 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 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 (Figure 2-3-1):

1. Habitat Effects;
2. Population Effects; and
3. Community Effects.

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 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. 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 an addendum (Arsenault & Hazell 2014 a and b) to the Bipole III Transmission Project Biophysical Monitoring Plan (Manitoba Hydro 2015) 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.

A moose monitoring plan is evolving for the Project and currently includes winter population surveys of the sensitive moose ranges, moose distribution surveys concurrent with boreal woodland caribou recruitment surveys, 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.

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 will be 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 will be 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 have been 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

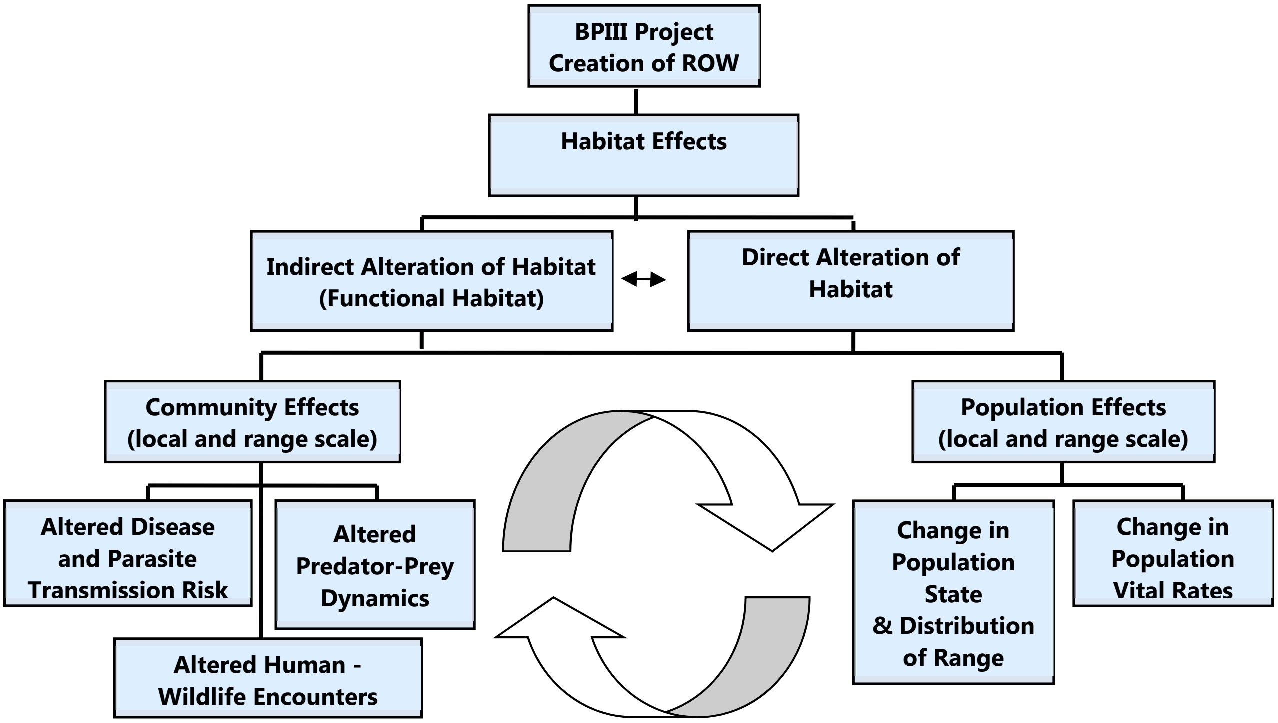
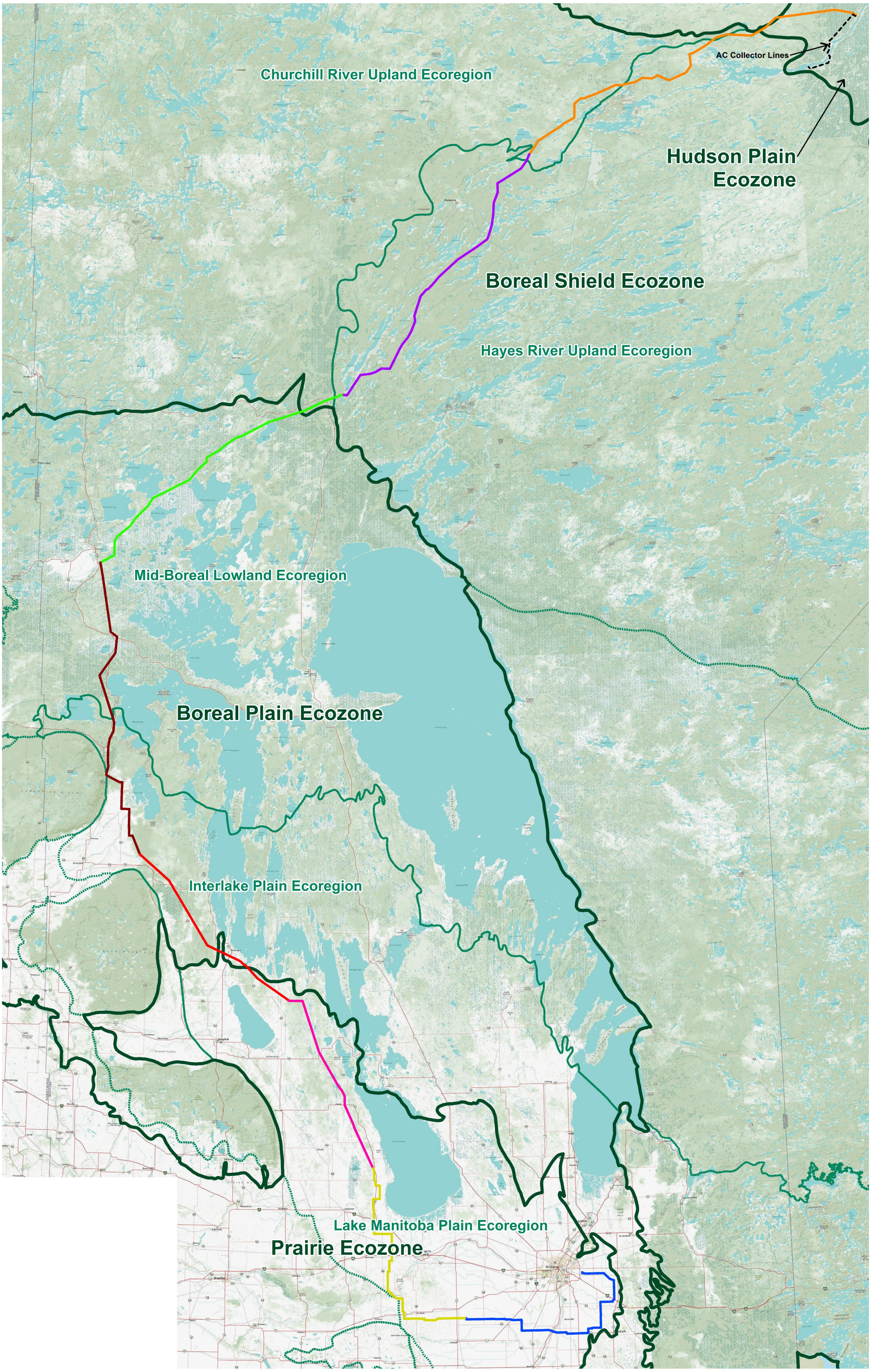


Figure 2-3-1: Monitoring Design Conceptual Overview of Effects Pathways



LEGEND

- Ecozones
- Ecoregions

BPIII Transmission Line Route

By Section

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

0 70 140 210 280 350 Kilometres

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

Datum: NAD83
Projection: UTM Zone 14N

N W E S

Manitoba Hydro

wood.

MANITOBA HYDRO BIPOLE III TRANSMISSION PROJECT

Bipole III Transmission Project Overview

PROJECT N°: WX17393	**FIGURE: 2-3-2**
SCALE: 1:2,300,000	DATE: March 2019

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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 acquisition and review of existing information and baseline data for the Bipole III Project, including 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 plan scope, which is a component of the Bipole III Transmission Project Biophysical Monitoring Plan (Manitoba Hydro 2015).

Year 1 (2014/15) Monitoring - The mammals monitoring plan is presented in AMEC's Year 1 monitoring workplan and was presented at a meeting (September 17, 2014) with Manitoba Conservation and Water Stewardship (Arsenault & Hazell 2014a and b). Mammals monitoring results for Year 1 were presented in Amec Foster Wheeler 2016.

Year 2 (2015/16) Monitoring – a summary of activities and results for Year 2 are provided in Amec Foster Wheeler 2017.

Year 3 (2016/17) Monitoring – a summary of activities and results for Year 3 are provided in Wood 2018.

Year 4 (2017/18) Monitoring – a summary of activities and results for Year 4 are presented in this report.

3.1 Data Acquisition – Year 4 (2017/18)

Data obtained from sources outside of that collected by Wood Environment & Infrastructure Solutions (formerly Amec Foster Wheeler) include the following:

1. MB Hydro - Boreal woodland caribou GPS satellite telemetry data collected by MB Hydro from 2010 to 2018 were acquired for each monitored boreal woodland caribou population (P-Bog, N-Reed, Wabowden) for analysis of baseline movement behaviors in ranges directly intersected and adjacent to the Project, as well as for a reference population (Charron Lake).

2. 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. Annual moose harvest statistics for individual moose populations were not readily available for this report.

3. MB Gov - Pre-disturbance (2001/02 to 2013/14) annual furbearer harvest statistics were acquired from MB Gov for all 42 registered traplines intersected by the Bipole III ROW. Harvest results during Construction (2014/15 to 2016/17) of Project disturbance were also acquired; harvest statistics for Year 4 (2017/18) of construction were not available, therefore these data are not included in calculations presented in this report. Future annual fur harvest data sets will be integrated into subsequent annual monitoring reports as it becomes available to allow comparison of pre- versus post-disturbance furbearer harvest statistics.

4. MB Hydro - Large and medium-sized mammal winter occurrence data collected via a Multi-species Aerial Survey (MB Hydro using helicopter) during Year 3 and Year 4 based on the transect survey design used in Year 2 (Alaskan Trackers using fixed-wing).

5. MB Hydro - Woodland caribou telemetry collar mortality investigation results were obtained annually from MB Hydro.

3.2 Field Activities – Year 4 (2017/18)

Field survey programs conducted during the winter of 2017/18 (Year 4 of monitoring) included the following primary data collection methods (see 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. **Ungulate-Wolf Winter Distribution Survey** -conducted in 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 to assess predator-prey dynamics (i.e., changes in predation-risk to moose and woodland caribou).

3. **Woodland Caribou GPS Telemetry Study -** ongoing monitoring of caribou movements in each woodland caribou study area to assess Project effects on caribou occurrence and movement dynamics using GPS satellite telemetry data obtained from MB Hydro.

4. Boreal woodland caribou **Telemetry Collar Mortality Investigations** (conducted by MB Hydro)

5. **Multi-species Aerial Survey** – The winter distribution data collected from this survey are used to assess coarse scale shifts in large mammal winter distribution and use of areas proximate to the Bipole RoW through each Project phase. The information may also inform potential *P. tenuis* risk to woodland caribou in relation to changes in deer and elk distribution using the Bipole III RoW. The survey was conducted by MB Hydro via helicopter, using the same survey design applied in Year 2 by the Alaskan Trackers via fixed wing.

6. **Winter Mammal Ground Track Transect Surveys** were conducted (February 6 to 16, 2018) in construction segments N1 through N4, but access limitations hindered sampling in N1 and N2. A total of 23 of 40 camera transects and 8 additional transects were sampled to document mammal VEC occurrence on the ROW, and to supplement the data set for analyses of potentially altered habitat use by furbearer VECs at various distance bands from the ROW.

7. **Camera Traps** – 46 of 68 deployed cameras from Year 3 were serviced 6-16 February 2018 on N1 (n = 6 of 17 refurbished; 2 were replaced; 9 were not accessible to refurbished), N2 (n = 5 of 17 refurbished; 1 retrieved; 11 not accessible to refurbish), N3 (n = 16 of 18 refurbished; 2 replaced) and N4 (14 of 20 refurbished; 6 not accessible to refurbish) construction segments. The cameras collect data on seasonal mammal use proximate to the ROW and up to 1.5 km from the ROW. A total of 46 active and 26 unserviced cameras were deployed for Year 4.

8. **Human Access Monitoring** involved servicing of remote IR trail cameras at all-weather ROW access points (n = 9 of 10 locations), as well as those from the Remote Trail Camera Study situated at the ROW along N1 (n = 8 of 10 locations), N2 (n = 10 of 10 locations), N3 (n = 9 of 10 locations, and N4 (10 of 10 locations) construction segments.

3.3 Planned Monitoring Activities – Year 5 (2018/19)

Monitoring field activities planned for Year 5 (2018/19) include:

1. **Woodland Caribou Recruitment Survey** assisted by GPS telemetry relocations in all woodland caribou study areas
2. **Ungulate-Wolf Distribution Survey** concurrent with Woodland Caribou Recruitment Survey
3. **Caribou Fecal Pellet Sampling** for Genetic spatial Capture-Mark-Recapture analyses in all woodland caribou study areas.
4. **Multi-species Aerial Survey** (MB Hydro led) of the Bipole III ROW (N1-N4, and north portion of C1 construction segments).
5. **Winter Ground Track Transect Survey** - sample all transects (N1-N4) that have remote trail cameras (n = 40).
6. **Remote Trail Camera Study** – service all trail cameras concurrent with Winter Ground Track Transect Survey.
7. **Woodland Caribou Telemetry Study** – MB Hydro intends to deploy telemetry collars to maintain sample of 20 collars/study area.

4.0 Methods

This report focuses on quantifying and comparing results from the pre-construction phase (2010 to November 2014) to the construction phase (December 2014 to July 2018). The following section provides summaries of field and analytical methods.

4.1 Boreal Woodland Caribou

Three woodland caribou ranges (P-Bog, N-Reed and Wabowden) 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 4 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 snow event to distinguish recent 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 not conducted in Year 4, but is scheduled for Year 5. Pending results of Year 5 analyses, NGS sampling interval may be extended to 3 years.

4.1.3 GPS Satellite Telemetry Studies

GPS satellite collar telemetry studies were initiated for the Project in 2010 and are currently underway 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. 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 through long term monitoring data of satellite collared caribou and defined by MB Gov (Government of Manitoba 2014). Telemetry was continued in Year 4 of this monitoring program, including 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 20 collars per range was also undertaken in February 2019, data from these collars would be included in the Year 5 report.

A Before-After-Control-Impact (BACI) study design has been 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; and; 3) post-construction. Specifically, monitoring objectives for the woodland caribou satellite telemetry program are to:

1. Quantify whether there are any shifts in annual or seasonal range use through Project phases. Shifts in range use can indicate responses to disturbance or suggest adaptation to variation in local abiotic or biotic factors.

2. Quantify whether there are any shifts in levels of site fidelity to annual and/or seasonal ranges areas through different phases of the Project. Abandonment of traditionally used areas can indicate responses to disturbance.

3. Quantify resource selection functions and use RSF models to control for habitat related variation in ZOI.

4. Determine whether there is a detectable ZOI around the Project demarcating the change in behaviour of caribou relative to the Project location.

5. Determine whether the Project has caused a barrier to movement on the landscape.

6. Quantify the extent to which caribou are using or benefitting from mitigative tools installed on the landscape such as vegetation leave areas.

Annual and seasonal range use and site fidelity analyses were completed for all ranges. Analysis of the ZOI around the Project was completed for the Wabowden and the P-Bog ranges for both the pre-construction and construction phases. Too few animals in the N-Reed range have spent enough time in proximity to the Project to quantify the ZOI for this range. ZOI analysis will not be undertaken for the Charron Lake range as it is not impacted by the Project and is a reference range.

In the Wabowden range, the Project widened an already pre-existing linear corridor providing the unique opportunity to examine the response of caribou to the widening of an existing linear disturbance. A ZOI around this linear feature could have been in the pre-construction period, prior to the Project widening it. Subsequently it was decided that the analysis would; 1) assess whether there was a ZOI associated with the pre-existing linear feature during the pre-construction phase and then 2) assess the extent to which the ZOI changed as a result of the Project installation.

In the P-Bog range, aside from some limited areas adjacent to Highway 10, the Project created a largely new corridor on the landscape allowing for the assessment of the response of caribou to the creation of a new corridor. Accordingly, the analysis assessed whether there was a ZOI around the Project during the construction.

4.1.3.1 Range Use

Kernel analysis was undertaken to ascertain the annual home range for each GPS collared animal and the relative probabilities of use within that home range (Worton 1989) using ArcGIS 10.1 Spatial Analyst Extension and Home Range extension v9. Kernels are used as one of the bases in the resource selection, zone of influence and site fidelity analysis.

Kernel volume contours are generated by connecting areas of equal probability of animal occurrence based on the utilization distribution, a measure of the geographic spread of observation points, and the defined smoothing factor (h). For example, a 90% kernel contour represents the region within which (during a given monitoring period), there is a 90% chance of finding the animal during the monitoring period.

The smoothing (h) factor defines the spread of the probability kernel generated over each observation point. The probability kernels are combined into a probability surface called the utilization distribution. The adaptive kernel method allows the kernel (smoothing factor) to vary slightly from the defined smoothing factor based on the density of observation points. This method is used to minimize both over and under estimation of the home range.

To ensure direct comparisons with baseline information and analysis (2010 – 2014, Joro 2014), home ranges per collared animal were generated using a 90% volume adaptive kernels (h=0.4). Seasonal range areas such as overwintering and calving areas were generated per animal using 70% volume adaptive kernels (h = 0.4). Core over-wintering areas included data from December 1 to February 28 and core calving areas included data from May 1 to June 30. Core overwintering areas are also used to inform the genetic CMR and calf recruitment surveys in January and February and based on the success of locating animals were accurate delineations of where high concentrations of caribou spend the winter months.

4.1.3.2 Site Fidelity

Fidelity is the tendency of animals to remain in, or return to, a particular location at different times of the year (Switzer 1993) and is believed to increase an individual's knowledge of the local environment by increasing their ability to find resources while reducing predation risk (Schaefer et al. 2000). Disturbance within home range or local core use areas can cause species to abandon those areas or shift their distribution (Dyer et al. 2001, Antoniuk 2007). Therefore, demonstrating site fidelity to an area suggests that Project activities have not disturbed these individuals to the extent that they are avoiding or abandoning traditionally used areas; or, that they are not sensitive to this type of disturbance.

Studies of site fidelity have been hampered by arbitrary designations of spatial scale and the lack of null models for comparison, however Schaefer et al. (2000) developed a method to deal with both issues using empirical data to define null expectations. Following Schaefer et al. (2000), fidelity was defined as the propensity for consecutive year locations of an individual to be closer together than random pairs of locations from satellite collared caribou bounded by their distribution over a specified time. We defined the total population range as the space denoted by locations of all satellite collared animals within each respective range (i.e., Wabowden, P-Bog, N Reed and Charron Lake) during all portions of the annual cycle. We defined the seasonal range as the space denoted by the locations of all satellite collared caribou within each respective range (i.e., Wabowden, P–Bog, N-Reed and Charron Lake) during a specific month of the annual cycle.

Null expectations of fidelity were generated at different scales and then compared to empirically based distances between consecutive year locations for each caribou. Null expectations define what we would expect to see if caribou were behaving randomly and no particular behaviour or site selection was being demonstrated. This analysis used an informed "null" such that random expectations are still derived from the empirical caribou telemetry locations themselves so are not completely random. Null expectations were generated at both a large population range scale and more local seasonal range scale. The population range null was defined by computing distances between random pairs of locations during any period of the annual cycle from any year of monitoring within each range (i.e., Wabowden, P-Bog, N-Reed and Charron Lake). A bootstrapping method was used to generate the null expectation, whereby a random subsample of 100 locations was repeatedly generated to calculate the mean distance of all possible pairs and the repeated until the estimate of the mean stabilized. Therefore, the null model is consistent across all months, representing the entire extent available for the year (Schaefer et al. 2000). The seasonal range was defined as the locations of all collared caribou within each range within each month. The null expectations were derived by calculating distances between all possible pairs of locations within each month within each range for any location at least one year apart. The null model was generated separately per month and could therefore vary from month to month.

For the observed pattern, distances between consecutive year "locations" were calculated using harmonic means of monthly range use for each collared caribou. Harmonic means are a measure of the centroid of use for a given period of time; they are an average "location" per sample period (in this case, per month). Ranges may still overlap from year to year but the centre of activity within a given range can change, making harmonic means an appropriate indicator of disturbance. Harmonic means were calculated for each month for each year for each collared caribou for both the pre-construction (2010 to 2014) and construction phases (2014 – 2018). Larger distances between monthly harmonic means from year to year indicate weaker fidelity, smaller distances between harmonic means indicates stronger fidelity.

Site fidelity was denoted as occurring when the null value was outside the confidence interval for that month. Analysis was undertaken for both the pre-construction and construction phases to assess whether any changes had occurred as a result of the Project. All statistical analyses were performed using R (The R Foundation for Statistical Computing).

4.1.3.3 Resource Selection models and Zone of Influence

Resource selection function (RSF) models were used to quantify selection and disturbance responses through ZOI analysis of monitored caribou during each season using recent methods developed in detail for caribou effects assessments (Johnson et al. 2005, Boulanger et al. 2012 and Johnson & Russell 2014). The base RSF models were developed and used to facilitate intra year comparisons of ZOI. The RSF model acts to control for habitat differences when quantifying the ZOI around the Project.

Individual logistic analysis was applied to determine the statistical significance of individual predictor variables for the early winter, late winter, spring, summer and fall seasons. This approach allowed for the assessment of any obvious differences in habitat selection and/or ZOI across seasons. Daily woodland caribou locations and random points were compared using conditional (paired) logistic regression (Hosmer & Lemeshow 2000) using "ClogitL1" in R (Reid & Tibshirani 2014). Random locations were selected within a buffer around the observed caribou location that represented the potential movement distance of that individual (Johnson et al. 2005). This approach also ensures that the RSF model is premised on habitat availability of where the caribou could have gone based on observed movement potential which provides for an ecologically relevant definition of availability (Compton et al. 2002; Johnson et al. 2005; Boulanger et al. 2012; Johnson & Russell 2014).

As behaviour may shift throughout the year, data was broken into five seasons; early winter, late winter period/movement to calving areas, spring calving period, summer post–calving period and fall rutting period/movement to over-wintering areas (Ferguson & Elkie 2004) and analyzed separately. The 95th percentile daily movement distances displayed for caribou (24 hour relocation interval) was generated for each season to assess the level of variability throughout the year.

As movement rates varied significantly throughout the year, RSF and ZOI analysis were undertaken within each season (Amec Foster Wheeler 2017). The average number of locations for an individual varied across season (Table 4-1-1 and 4-1-2). The maximum percent for any one individual varied (Table 4-1-1 and Table 4-1-2), therefore the effect of individuals was not controlled as each individual had a relatively small contribution to the pool of locations used (Johnson and Russell 2014).

Base Habitat Model

Vegetation classes from the Earth Observation for Sustainable Development (EOSD, available at: http//www.geobase.ca/geobase/en/data/landcover/ index.html) and Digital Elevation Models (DEM) were used (Table 4-1-3). The enhanced land classification created for the Project was assessed for potential suitability for use in this analysis, however, its coverage is not broad enough for inclusion (i.e., it covers <50% of the caribou range areas). The enhanced classification would have to cover 100% of the caribou range areas for inclusion in the model. Development of the model including statistical approaches to control variation and error in vegetation distribution are in Amec Foster Wheeler 2017. We selected the most parsimonious habitat model for each season using Akaike information criterion (AIC). The top model for each season was used to spatially predict the probability of occurrence and used in the ZOI analysis for the corresponding range and season. The predictability of each model was assessed using K fold cross validation (Burnham and Anderson 1998).

Other information such as recent and/or old forestry blocks, forest fires, as well as smaller linear disturbance such as snow mobile tracks and/or seismic cut lines could be considered for inclusion in future RSF analyses. Inclusion would allow for a more comprehensive assessment of behavioural responses to all disturbance types including the Project, however would require a much more comprehensive landscape mapping exercise to quantify these layers. A predation-risk layer generated from observations of wolves collected during the annual winter calf recruitment surveys can also be considered in future years, contingent on sample size.

Zone of Influence (ZOI)

The distance at which caribou change their behaviour, habitat selection and distribution relative to disturbance has been labelled the ZOI (Johnson et al. 2005, Johnson and St. Laurent 2011, Boulanger et al. 2012) and has implications for measuring cumulative effects on wildlife (Johnson & Russell 2014, Dyer et al. 2001, Vors et al. 2007, Quinonez-Pinon et al. 2007, Leblond et al. 2011, Polfus et al. 2011 and Dussault et al. 2012). It is a measurement of reduced occurrence of caribou around a given disturbance and controls for habitat quality at a given location.

Project ZOI within Wabowden and P-Bog ranges was quantified during the construction phase; both ranges have an accumulation of caribou telemetry locations within 10 km of the Project from 2015 to 2018. The ZOI analysis in the Wabowden range quantifies the behavioral response of caribou to widening of an existing corridor. Whereas the ZOI analysis in the P-Bog range quantifies the behavioral response of woodland caribou to a newly created linear corridor. The N-Reed range will continue to be considered for inclusion in this assessment in following years, however, currently does not have a large enough sample size of caribou location points near the Project for this analysis.

The base habitat model was used to iteratively estimate the Project ZOI through a piecewise conditional regression approach with distance to the Project as an additional predictor variable (Boulanger et al. 2012). As a linear corridor was present in the Wabdowden prior to the initiation of the Project, a ZOI in both the pre-disturbance and construction phase was quantified. Whereas in the P-Bog range, the Project created a new linear corridor on the landscape, therefore ZOI was solely quantified for the construction phase.

The habitat model accounted for caribou distribution due to habitat selection with ZOI predictor variable and associated regression coefficient. A procedure analogous to a piece-wise regression was undertaken to determine an optimal cut-point (Hudson 1966). The influence of increased distance was assessed for each category by setting all distances greater than the current distance category to that categories cut value. For example, when a 1 km distance was tested, all locations >1 km were set to 1 km regardless of how far out they were. By doing this, the odds ratio of selection relative to the Project was able to change linearly up to the hypothesized ZOI at which point it would asymptote and remain constant for distances >ZOI. Thus, the odds ratio was allowed to vary up to a maximum at the ZOI. The model fit (log-likelihood) should increase to a maximum at the ZOI, before decreasing. If there is no ZOI there would be no pattern in the log likelihood or it would remain constant across the range of distances. The distance at which the log likelihood is maximized is the estimate for the ZOI; the maximum distance where an influence of the Project can be detected.

4.1.3.4 Crossing Analysis

In the P-Bog range, the Project created a new linear corridor on the landscape in most areas. The current accumulation of monitoring data allows for the quantification of movements across the landscape prior to the Project being installed and then any changes in movement behavior in areas where the Project was constructed. Whereas in the Wabowden range, the Project follows an existing linear corridor which was subsequently widened to accommodate the Project. Therefore, the current accumulation of data allows for the quantification of any barrier effects from the pre-existing linear corridor during the pre-construction phase, as well as widening of the ROW through the Project construction phase.

We calculated the degree of avoidance for each individual by comparing the actual number of crossings made by individual caribou, to the number of crossings that would have made by a randomly moving caribou on the landscape (Row et al. 2007). The number of crossings made by a randomly moving caribou was generated from 100 random walk (Turchin 1998) movement paths for each individual in R (package "adehabitatLT"). Each random movement path started at the same location as its paired caribou movement path and had the same chronological series of distances moved. A randomly determined bearing was used between each move.

For this most recent report, we compared the difference between actual and random crossings during the construction phase. In both ranges, individuals tracked across both phases were considered independent within each time period. We also confirmed the results by comparing the observed average random crossings within an individual using a linear model.

We subsequently tested for avoidance of crossing by comparing the overall difference between observed and random crossings against 0 using a mixed model. We confirmed the overall avoidance of crossing using a t-test of the mean difference against 0 for the average random crossings.

4.1.3.5 Effectiveness of Vegetation Mitigation Analysis

There are two types of vegetation clearing undertaken within caribou ranges;

1. **Full ROW Clearing** - is the entire ROW to a width of 66 m. Full ROW clearing was applied in areas that were not designated as sensitive for caribou.

2. **Centerline Clearing** - are areas where vegetation mitigation has been applied. In these areas, the centerline of the ROW has been cleared, as well as any trees taller than the 40% line of sight (LOS) angle to the edge of the ROW and beyond. As a result, there are more trees and shrubs that are left standing as only the danger trees are removed.

The locations of these vegetation mitigation areas were selected based on the movement behavior and distribution of caribou during the pre-construction phase. Mitigation was applied in areas that had previously been used by caribou and was focused on providing as much cover as logistically possible and shortening the width of open area the caribou would have to cross to move across the ROW. Therefore, if the mitigation strategy was effective we would expect to see caribou continue to use these areas to cross the Project more than areas that had not been mitigated.

- In the P-Bog range, the site-specific locations of the vegetation mitigation prescriptions is known. Analysis is undertaken to assess the extent to which these mitigation areas effectively facilitated movement across the ROW (comparison of mitigated to unmitigated areas within the range)

- In the Wabowden range, mitigation was applied the entire length of the ROW within the range. Therefore, a comparison of mitigated versus unmitigated areas cannot be undertaken as the mitigation was applied everywhere.

In the P-Bog range, we assessed the extent to which caribou used the vegetation mitigation areas (Full Centerline) versus the unmitigated (Full ROW) areas to cross the ROW. We tested this by comparing the proportion of mitigated crossings to unmitigated crossings from observed caribou and 100 random caribou (same starting locations and distances, random directions). If caribou were preferentially crossing at mitigated areas, we expected a higher proportion of mitigated crossings for observed caribou. Any sequential location that was greater than 6 hours was split into separate tracks (hereafter called bursts), because we had to assume that the crossing location on either side of the ROW corresponded to the straight-line path between the locations. Longer time periods between locations increases the likelihood that this assumption is not valid. Although 3 hours could also be used, this resulted in very short bursts for many individuals. We also removed any bursts that did not cross the ROW at least twice, because the goal was to determine "where", not "if" individuals were crossing and thus bursts with zero crossings did not assist with the analysis. We used a mixed model with a random effect for individuals and a t-test on individual means to determine if individuals had a significantly higher proportion of mitigated crossings than random. Because of the similar results for the different models only t-test results are shown.

4.2 Forest-tundra and Barren-ground Caribou

4.2.1 Field Studies

There are no formal field studies of forest-tundra woodland caribou (Cape Churchill and Pen Islands populations) or barren-ground (Qamanirjuaq herd) caribou specific to the Bipole III Mammals Monitoring Program. However, an 8-year (initiated in 2010) collaborative caribou satellite telemetry collar study involving MB Gov, MB Hydro, and Fox Lake, Split Lake and York Factory Resource Management Boards to monitor Cape Churchill and Pen Islands populations was ongoing during the pre-construction and construction phases of the Bipole III Transmission Project. The telemetry study was intended to monitor changes in post-calving range use, describe current seasonal range use, and identify changes in population abundance using a combination of telemetry and aerial survey methods (Trim 2015). Cape Churchill and Pen Islands caribou ranges overlap the northern extent of the N1 construction segment (Figure 4-2-1) and infrequently occur in the Project area in some years. The 8-year telemetry study has concluded, with no further collar deployments or recruitment surveys planned (MB Gov, V. Trim, personal communication October 23, 2018).

Qamanirjuaq caribou may occasionally occur (during winter) in proximity to the Project (Figure 4 2-1), however the population range is adjacent to the northwest range bounds of the Cape Churchill population (Gunn et al. 2011). No formal field studies of Qamanirjuaq caribou are being conducted in proximity to the Bipole III Project.

4.2.2 Mitigation Monitoring

Mitigation measures involve avoiding effects from Project construction activities if/when herd migration movements overlap construction segment N1. MB Hydro environmental monitors from local communities are on site to advise if concentrations of forest-tundra or barren-ground caribou are in proximity of the Project during winter construction.

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.

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 Lk 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 22 January 22 to February 3, 2018.

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 (2014-2018)
  - **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.

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 and adjacent reference populations were updated to incorporate 2017/18 moose survey results; see Amec Foster Wheeler 2016 for a description of the models. Each population model establishes 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, is compared with post-disturbance conditions for each sensitive moose range to assess population performance. Population modelling provides insight and context for Project-related effects on any of these 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) 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.

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, 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 across 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) 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 transects that were accessed. Transect sampling of N1 and N2 were attempted by ground/vehicle access because helicopter access was not available. On N1, 4 of 10 camera transects were sampled. On N2, 3 of 10 camera transects were sampled. Transect sampling of N3 and N4 was accomplished using helicopter access. On N3, 9 of 10 camera transects were sampled as well as 4 additional transects. On N4, 7 of 10 camera transects were sampled as well as 4 additional transects. 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.

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 753 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.

Power analyses have been conducted (package simr) using 1000 Monte Carlo simulations based on the best fit model for each species and re-running simulations for different sample sizes until a power of 80% was reached. Power analysis results we used to adjust transect numbers in previous years where feasible for target species (Amec Foster Wheeler 2017).

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.

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 3 years (2015-16 through 2017/18) of camera deployment during the construction phase. To achieve sufficient sample size for analysis, data from all 3 years were pooled. The image interpreted dataset provided by MB Hydro for 2017/18 (3rd year) was not broken down by image date, therefore no analysis of seasonality was possible.

4.5.2.3 Aerial Surveys

Multi-species Aerial Survey – The survey was conducted via helicopter during Year 4 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 to correct for this bias (Miller et al., 2016; Thomas et al., 2002). 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 23 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.

Table 4-1-1: Seasonal Sample Size Satellite Telemetry Locations for the P-Bog Range

Season	Number of Individuals	Number of Locations	Average Number of Locations / Individual	Average Percent Contribution per Individual	Maximum Percent Contribution for an Individual
Early Winter (1 Dec - 28 Feb)	15	1350	90	6.7	6.7
Fall (16 Sep - 30 Nov)	17	1218	71	5.9	6.2
Late Winter (1 Mar - 30 Apr)	15	892	59	6.7	6.8
Spring (1 May - 30 Jun)	14	840	60	7.1	7.1
Summer (1 Jul –15 Sep)	19	1333	70	5.7	5.7

Table 4-1-2: Seasonal Sample Size Satellite Telemetry Locations for the Wabowden Range

Season	Number of Individuals	Number of Locations	Average Number of Locations / Individual	Average Percent Contribution per Individual	Maximum Percent Contribution for an Individual
Early Winter (1 Dec - 28 Feb)	16	1245	77.8	6.3	7.2
Fall (16 Sep - 30 Nov)	16	1200	75.0	6.3	6.3
Late Winter (1 Mar - 30 Apr)	11	610	55.4	9.1	10.0
Spring (1 May - 30 Jun)	9	534	59.3	11.1	11.2
Summer (1 Jul - 15 Sep)	19	1241	65.3	5.3	6.1

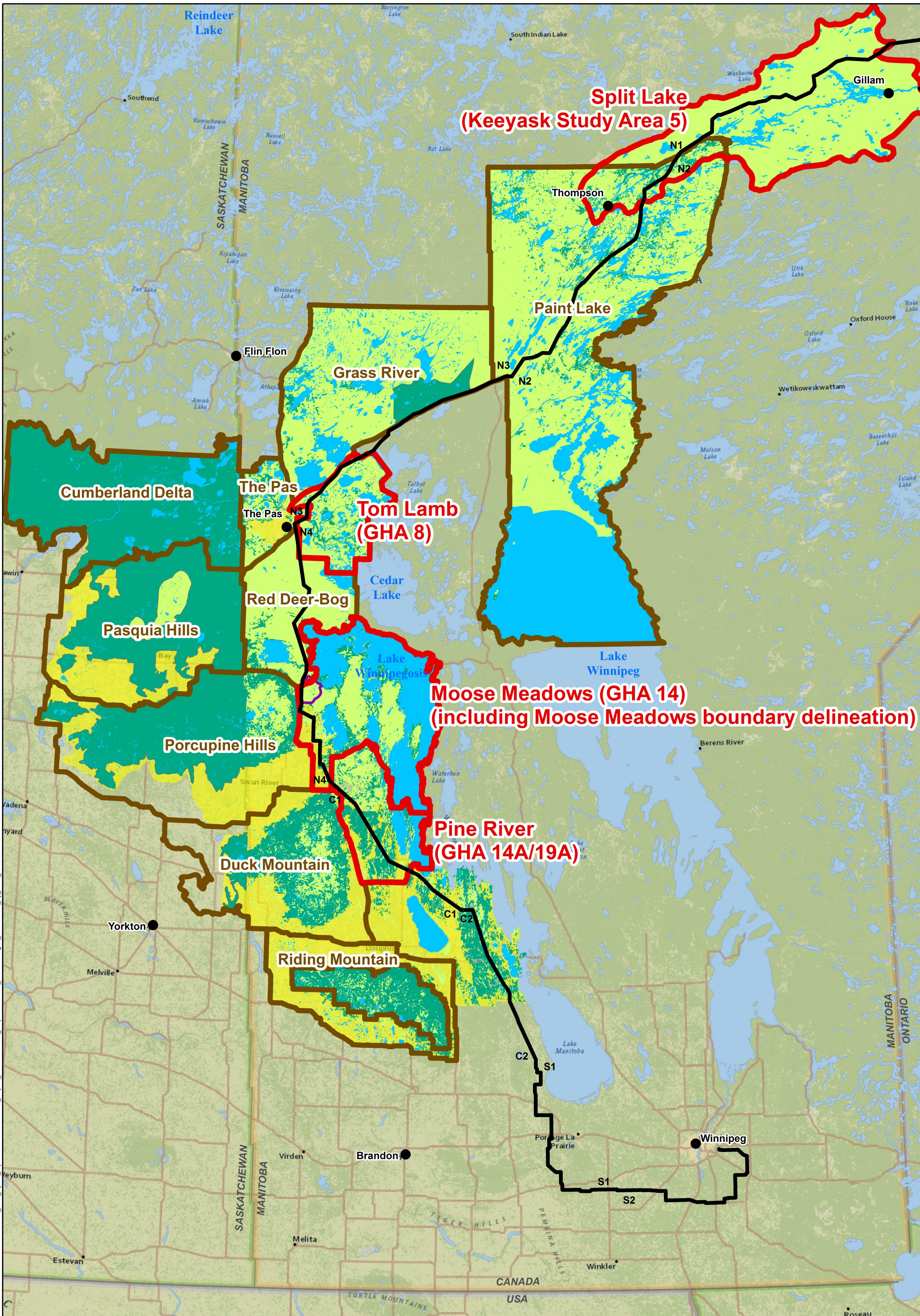
Table 4-1-3: Descriptions of Vegetation Classifications for the Earth Observatory for Sustainable Development (EOSD) Landsat

EOSD Cover Type	Description
Wetlands	Land with a water table near/at/above soil surface for enough time to promote wetland or aquatic processes (semi-permanent or permanent wetland vegetation, including fens, bogs, swamps, sloughs, marshes)
Treed Wetland	Land with a water table near/at/above soil surface for enough time to promote wetland or aquatic processes; the majority of vegetation is coniferous, broadleaf, or mixed wood
Shrub Wetland	Land with a water table near/at/above soil surface for enough time to promote wetland or aquatic processes; the majority of vegetation is tall, low, or a mixture of tall and low shrub
Herb Wetland	Land with a water table near/at/above soil surface for enough time to promote wetland or aquatic processes; the majority of vegetation is herb
Forest Stands	Predominantly forested or treed areas; comments: this class is mapped only if the distinction of sub-forest covers is not possible
Dense Coniferous Forest	Greater than 60% crown closure; coniferous trees are 75% or more of total basal area
Open Coniferous Forest	26-60% crown closure; coniferous trees are 75% or more of total basal area
Sparse Coniferous Forest	10-25% crown closure; coniferous trees are 75% or more of total basal area
Dense Broadleaf Forest	Greater than 60% crown closure; broadleaf trees are 75% or more of total basal area
Open Broadleaf Forest	26-60% crown closure; broadleaf trees are 75% or more of total basal area
Sparse Broadleaf Forest	10-25% crown closure; broadleaf trees are 75% or more of total basal area
Dense Mixedwood Forest	Greater than 60% crown closure; neither coniferous nor broadleaf tree account for 75% or more of total basal area
Open Mixedwood Forest	26-60% crown closure; neither coniferous nor broadleaf tree account for 75% or more of total basal area
Sparse Mixedwood Forest	10-25% crown closure; neither coniferous nor broadleaf tree account for 75% or more of total basal area
Shrub	Predominantly woody vegetation of relatively low height (generally ±2 m); comments: may include grass or grassland wetlands with woody vegetation, regenerating forest

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**

Figure 4.1.1 and Figure 4.2.1 are redacted



LEGEND

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

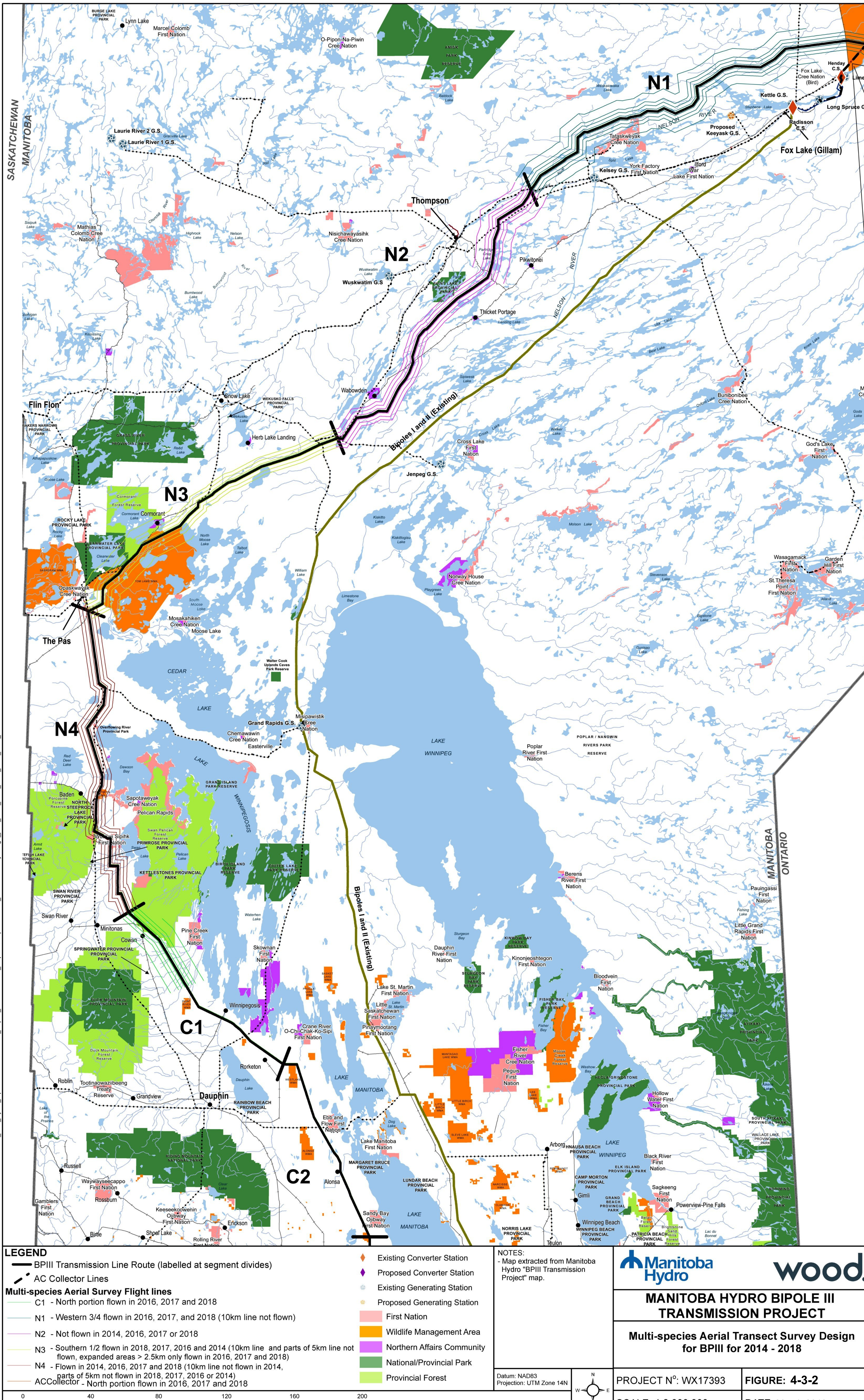
Datum: NAD83
Projection: UTM Zone 14N

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: March 2019


N1
N2
N3
N4
C1
C2
Thompson
Fox Lake (Gillam)
Flin Flon
The Pas
Dauphin
LAKE WINNIPEG
CEDAR LAKE
LAKE WINNIPEGOSIS
LAKE MANITOBA
Bipoles I and II (Existing)
SASKATCHEWAN
MANITOBA
ONTARIO
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 and 2018
N1 - Western 3/4 flown in 2016, 2017, and 2018 (10km line not flown)
N2 - Not flown in 2014, 2016, 2017 or 2018
N3 - Southern 1/2 flown in 2018, 2017, 2016 and 2014 (10km line and parts of 5km line not flown, expanded areas > 2.5km only flown in 2016, 2017 and 2018)
N4 - Flown in 2014, 2016, 2017 and 2018 (10km line not flown in 2014, parts of 5km not flown in 2018, 2017, 2016 or 2014)
ACCollector - North portion flown in 2016, 2017 and 2018
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
NOTES:
- Map extracted from Manitoba Hydro "BPIII Transmission Project" map.
Datum: NAD83
Projection: UTM Zone 14N
0 40 80 120 160 200 Kilometres
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MANITOBA HYDRO BIPOLE III TRANSMISSION PROJECT
Multi-species Aerial Transect Survey Design for BPIII for 2014 - 2018
PROJECT N°: WX17393
FIGURE: 4-3-2
SCALE: 1:2,000,000
DATE: March 2019
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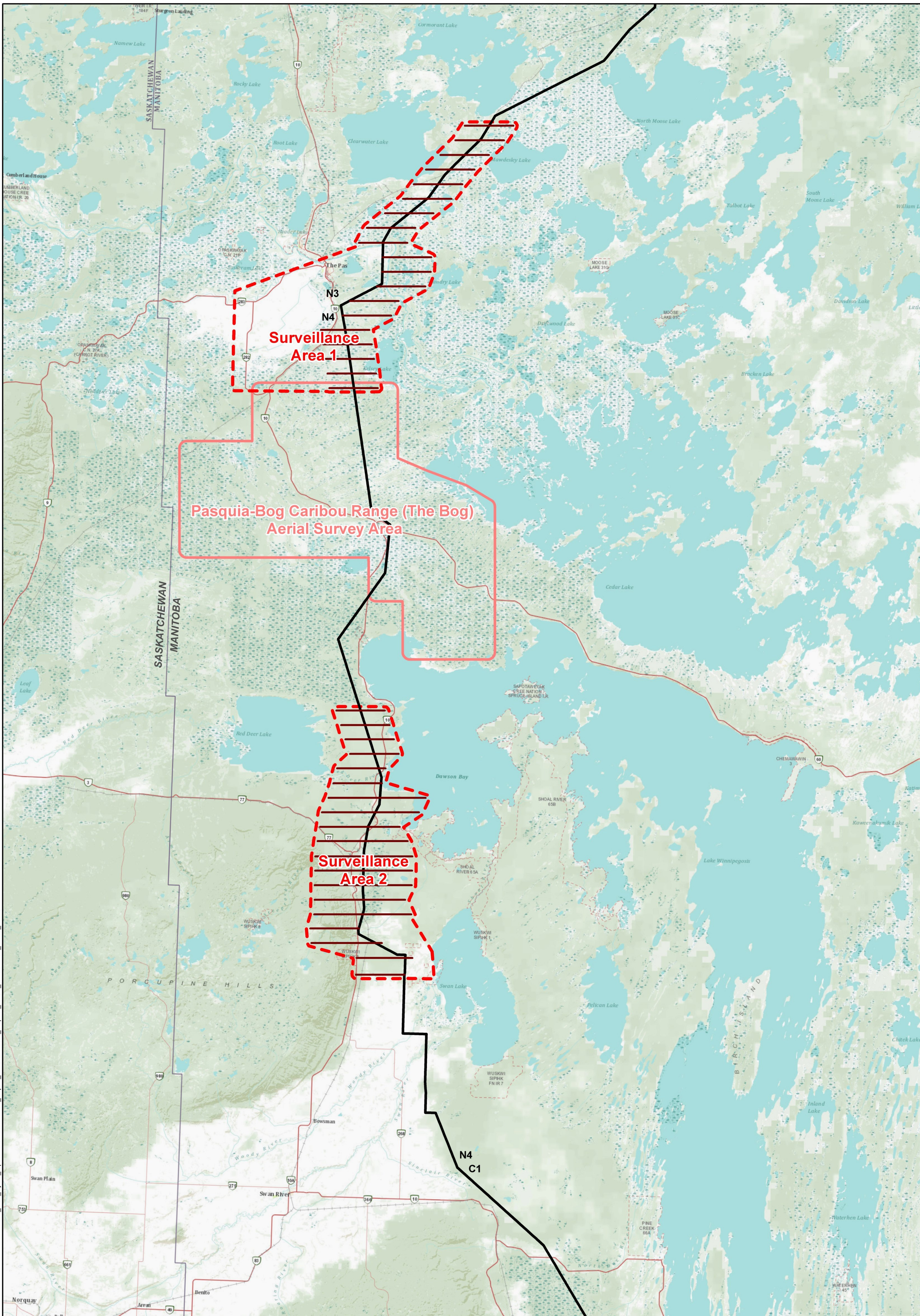

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LEGEND

- 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

0 20 40 60 80 100 Kilometres

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

Datum: NAD83
Projection: UTM Zone 14N

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MANITOBA HYDRO BIPOLE III TRANSMISSION PROJECT

P. tenuis Surveillance Areas

PROJECT N°: WX17393

FIGURE: 4-4-1

SCALE: 1:745,000

DATE: March 2019

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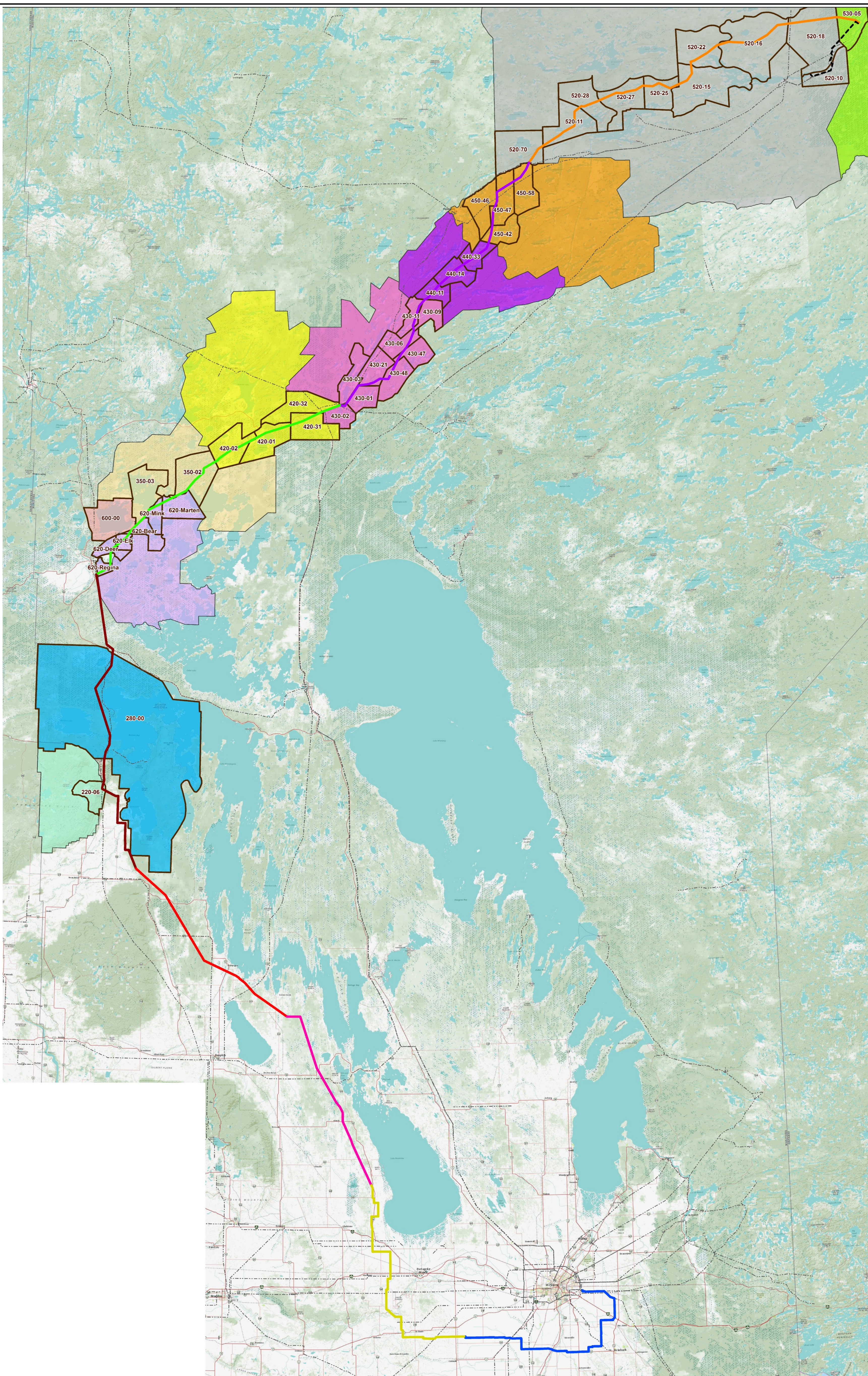

LEGEND

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

0 60 120 180 240 300 Kilometres

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

Datum: NAD83
Projection: UTM Zone 14N

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MANITOBA HYDRO BIPOLE III TRANSMISSION PROJECT

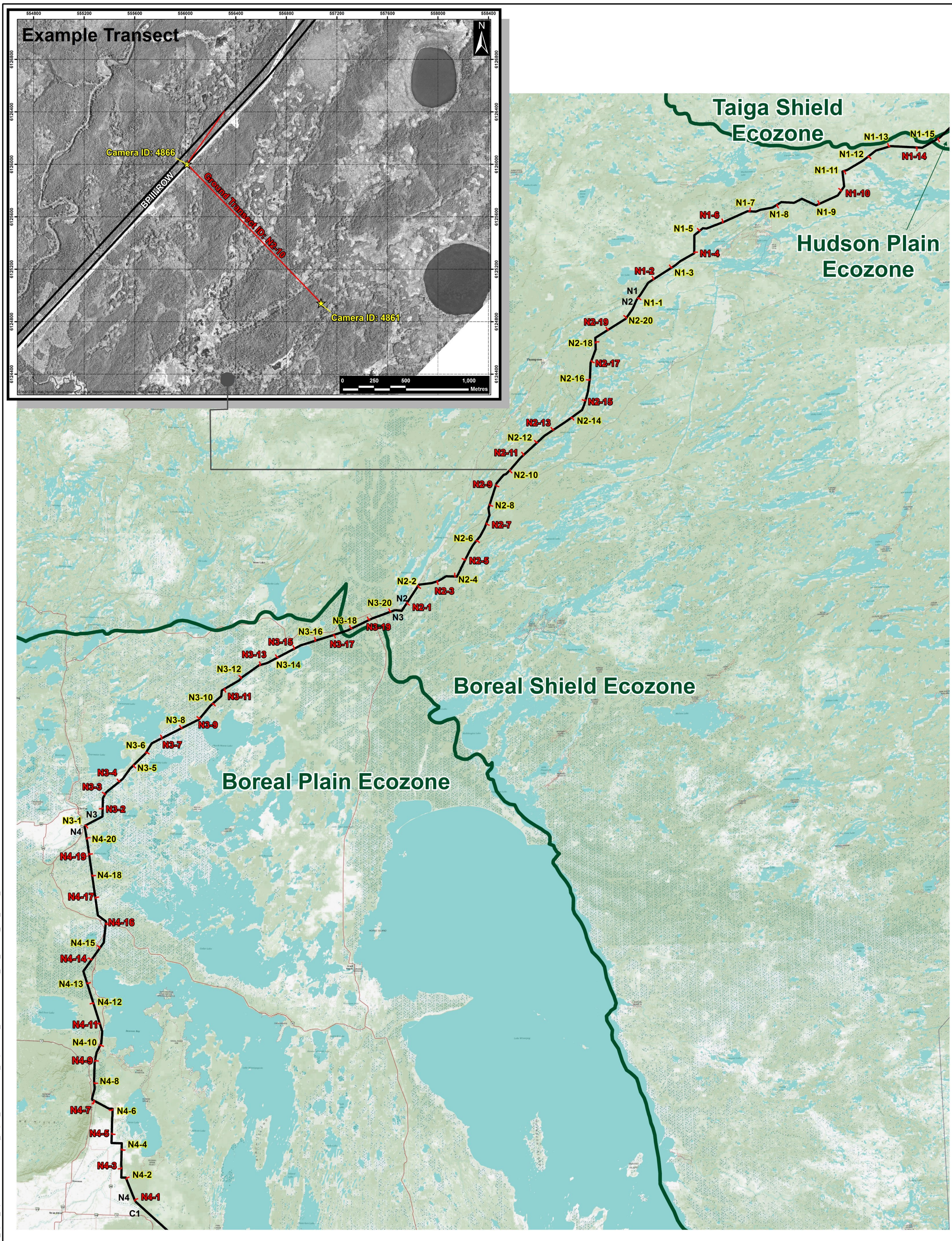
Registered Traplines intersected by the Bipole III Transmission Project

PROJECT N^{o}: WX17393

FIGURE: 4-5-1

SCALE: 1:2,300,000

DATE: March 2019



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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

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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: March 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 is 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), to assess population size and to inform population models to calculate λ. No NGS/CMR was scheduled in Year 4, but is planned to occur in Year 5 (2018/19). 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 3, 2018. 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 4 were all above 85%, 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 4 of monitoring are consistent with stable populations in the P-Bog, Wabowden, and Charron Lake ranges, and a stable (possibly increasing) population trend in the N-Reed range.

Adult female survival rates over the past 4 years (Table 5-1-1) of monitoring 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 Lk) in Year 1 (2014/15). Sampling was repeated in Year 3 (2016/17) and is scheduled to be repeated in 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). The objective of model fitting was to examine population trend within the 2008/09-2017/18 period of assessment. These population models should be updated once results of sCR analyses are available.

Results of the genotyping and preliminary trend modelling (2008/09 – 2017/18) using closed model CMR estimators indicate each local population is stable and occurring at natural levels of abundance:

- **P-Bog** local population averaged about 0.0329 caribou/km^2, with a higher density estimate of 0.0419 ±4.03% caribou/km^2 obtained from the Year 3 CMR results.
- **Wabowden** local population has remained stable, averaging 0.0405 caribou/km^2 through the assessment period, with a density estimate of 0.0513 ±3.06% caribou/km^2 obtained from the Year 3 CMR results.
- **N-Reed** local population has remained stable (possibly increasing), averaging about 0.0505 caribou/km^2, with a density estimate of 0.0565 ±3.09% caribou/km^2 obtained from the Year 3 CMR results.
- **Charron Lake** local population has remained stable, averaging about 0.0755 caribou/km^2), with a density estimate of 0.0781 ±3.54% caribou/km^2 obtained from the Year 3 CMR results.

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; 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 possible after analysis of pellet samples collected in Year 3 (2016/17) of the monitoring program. Population trend models for the 2009 to 2017 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 2008/09-2017/18 modelling interval indicate stable local populations for P-Bog ($\lambda = 1.01$), Wabowden ($\lambda = 0.99$), N-Reed ($\lambda = 1.03$) and Charron Lake ($\lambda = 1.00$).

5.1.2 Distribution and Occurrence

There are insufficient trail camera data or track data for **local/fine scale** (i.e., within 1 km of the ROW) analysis of occurrence near vs away from ROW.

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.

Landscape scale (i.e., caribou range) distribution and occurrence are discussed in section 5.1.3 and 5.6.2.

5.1.3 GPS Satellite Telemetry Studies

5.1.3.1 Range Use

Distributions of annual and seasonal range areas for each monitored population have not shifted since the monitoring program was initiated and largely show similar patterns of distribution from year to year. The average home range and seasonal range use size for caribou varied across ranges in the as illustrated by the high variation around the average sizes for each range type (Table 5-1-3). The average annual and season ranges for caribou in Charron Lake caribou are significantly larger than those for any other ranges ($P<0.05$). Annual and seasonal range sizes between N-Reed, Wabowden and P-Bog caribou are not significantly different in most years.

Annual 90% kernel home ranges (Figures 5-1-3 to 5-1-6) and 70% overwintering ranges (Figures 5-1-7 to 5-1-10) for individual collared caribou overlap considerably in all four ranges. The 70% kernel calving ranges for individual collared have some level of overlap but are more spread out that than observed during the winter (Figures 5-1-11 to 5-1-14). From 2014 to 2018, the seasonal range use null models created for the site fidelity analysis corroborated this pattern, revealing that from May to September, collared cows are more spread out from each other than during the winter months as depicted in the higher null expectations for this period.

5.1.3.2 Site Fidelity

Significant philopatry is the tendency of individuals to stay in, or return to, their core use areas. It is present when null models are outside the 95% confidence intervals for empirical means per month (Figures 5-1-15 to 5-1-22).

Collared female caribou displayed varying degrees of site fidelity within each range contingent on season and scale. The larger scale population null demonstrates an annual cycle in the empirical locations across all ranges. Distances between successive year activity centers are smaller during the calving period than other times of the year in all populations, where the majority of collared females within each range show strong fidelity to areas used from May to August, often using activity centers within 1 to 10 km of the previous year (Figures 5-1-5 to 5-1-22). At the population scale, caribou returned to the same calving areas within their larger population range from year to year.

In contrast, during the winter, a broader variation in space use is observed, with some collared females demonstrating weak fidelity, using areas up to 100 km apart from the previous year while others returning to within 10 km of the previous year (Figures 5-1-5 to 5-1-22). In spite of the greater variation observed during the winter, significant philopatry was still observed at the population scale for P-Bog, Charron Lake and Wabowden ranges indicating that animals returned to the same areas within their overall population range from year to year for overwintering. This behaviour was consistent whereby strong fidelity was displayed annually during both pre-construction and construction time periods. Fidelity in the N-Reed range was demonstrated during the calving period but then weakened during the fall and winter period during both the pre-construction and construction phases.

The smaller-scale seasonal null model implies that fidelity within winter range areas was absent for Wabowden and N-Reed ranges during some months in both the pre-construction and construction phases (Figures 5-1-14 and Figure 5-1-16). This suggests that patterns of fidelity to very local areas during the winter did not change as the Project was constructed. Conversely caribou within the P-Bog range demonstrated fidelity to all monthly wintering areas in the pre-construction phase and a lack of fidelity during February and March in the construction phase (Figures 5-1-18 and 5-1-20), suggesting that in P-Bog caribou may have altered the location of their local core activity areas during construction. For all ranges, after May, females displayed attraction to sites occupied the previous year and local areas of concentrated use within monthly ranges remained similar from year to year (Figures 5-1-13 to 5-1-20). Charron Lake caribou are reference animals and did not show a change in levels of fidelity across years or seasons at this local scale.

This analysis at the more local seasonal scale also revealed that collared caribou are closer in proximity to each other than distances between animals observed during warmer months where females tended to spread out from each other. This pattern is reflected in the null model expectations which are derived using distances between collared caribou. The null expectations during winter are lower than those predicted for the summer. The null expectation was generated by calculating distances between all possible pairs of caribou locations within each month within each range. Larger distances between caribou in each month will generate larger null expectations for that month. Null expectations from May to September are increased by 15 km compared to that observed for the winter.

Overall, results suggest that winter range use is scale dependent for some caribou, where females are philopatric to general wintering areas within a larger population range but not necessarily to precise locations within these areas each month. Conversely, patterns observed after May persist across scales indicating consistent site fidelity from calving to breeding periods irrespective of the extent of observations, suggesting that female caribou are attracted to specific locations for the calving and post-calving period from year to year.

Fidelity to wintering areas in the P-Bog range became weaker during the construction phase for both the population and seasonal scales. Looking at the distribution of wintering areas from 2015 - 2018 reveals that caribou have not dramatically shifted their distribution on the landscape away the Project, however these results indicate that their centers of activity within these wintering areas shifted from one year to the next and may have been a response to construction activities. This pattern in P-Bog should continue to be monitored through the operations phase to assess whether caribou strengthen fidelity to wintering areas again now that construction is complete.

For caribou, minimization of predation risk to females and calves is regarded as the underlying drive for space use patterns (Ferguson et al. 1988, Bergerud 1996). Assuming the scale invariant site fidelity by female caribou for the calving and post–calving period is a strategy to minimize predation risk, these monitoring results from 2015 - 2018 support previous studies that report the consistent and limiting effects of predation on the more sedentary forest-forest ecotype populations (Seip 1992, Bergerud 1996, Rettie & Messier 1998, Schaefer et al. 1999 and Schaefer et al. 2000). This hypothesis is also supported by the increased spacing out of female caribou from each other at the more local seasonal scale. Calving in isolation from other caribou is a predator avoidance strategy as detection becomes harder (Bergerud 1996, Leclerc et al. 2012). Caribou in Wabowden, P-Bog and Charron Lake demonstrated fidelity to wintering areas within the larger population range, suggesting they may move to areas that have lower predation risk on the landscape and aerial survey results to date suggest little overlap with wolf in these areas. However, at a smaller scale, fidelity is weaker during the winter and caribou may be decoupling themselves from this predation risk (Schaefer et al. 2000) and preferring sites with better forage access or more optimal snow cover.

5.1.3.3 Zone of Influence

Results suggest that there has been a short ZOI of approximately 1 to 2 km during the construction phase in the P-Bog range (Figure 5-1-23).

Results suggest that there was a short ZOI of approximately 1 to 2 m for the pre-existing linear corridor present during the pre-construction phase in the Wabowden range, as well for the widened corridor created through Project construction (Figures 5-1-24).

As was the case in past years for both ranges, caribou locations were fewer near the Project than areas farther away peaking in abundance at distances 10 to 15 km from the Project. As sample sizes are low within 0 to 2 km of the Project, the level of confidence with which the ZOI can be drawn at 1 km versus 2 km is uncertain. Therefore, very small changes (<1 km) in ZOI may have occurred, however, there are not enough locations to detect these shifts.

Results suggest that caribou in the Wabowden range were already exhibiting avoidance of 1 to 2 km to the existing linear corridor that was in place prior to the implementation of the Project. This response was not significantly altered during the construction phase, likely due to some level of habituation to this feature. There is mixed evidence suggesting a habituation effect for ungulates (Stankowich 2008), some studies reporting weak effects (Cote et al. 2013) or lack of behavioral habituation (Bleich et al. 1994, Frid 2003). Johnson & Russell (2014) identified a large ZOI of 38 km of the Porcupine Herd around human disturbance footprint using a long term, 27 year data set and assessed levels of habituation. Boulanger et al. (2012) found temporal variation in the avoidance response of caribou but no obvious habituation effect. However, reindeer have been found to habituate to power lines shortly after their construction when the lines are not accompanied by other human activity such as vehicular traffic (Reimers et al. 2000).

Woodland caribou are affected by cumulative disturbance within a range (Environment Canada 2012) and behavioral responses to the Project could be affected by other disturbances within the range. In 2015, AIC analysis revealed that models which included both the distance to other linear features such as highways and distance to the existing linear corridor fit the data better than when they were included separately (Amec Foster Wheeler 2016). These responses could be explored and quantified through a more complex RSF model that was not focused on defining the ZOI around the Project in future analysis.

5.1.3.4 Crossing Analysis

After the completion of the ZOI analysis, caribou behavior was further assessed on a more local scale by evaluating the extent to which the Project acted as a barrier to local movements. This crossing analysis differs from the ZOI analysis in that it evaluates individual local movement responses of individual caribou to the Project whereas the ZOI analysis quantifies the overall avoidance response by all collared caribou within a given range. The crossing analysis specifically assesses the extent to which the Project acts as a barrier to individual local movements by caribou whereas the ZOI analysis examines overall distribution of caribou on the landscape relative to the installation of the Project.

Both linear and mixed models were run for the crossing analysis in both the Wabowden and P-Bog ranges to control for individual level responses. Mixed models control for individual level effects without having to compare mean numbers of crossings. As both models provided comparable results we only report the results for the linear model.

In the Wabowden range, there was no overall significant increase in the level of avoidance from the pre-construction to construction phase (df = 1, 76; $p = 0.22$) indicating that widening of the ROW through the installation of the Project did not significantly alter caribou crossing behavior after the initiation of construction. Each year from 2015 through to 2018, collared caribou were found to cross the ROW less frequently than expectations generated through random movement trajectories suggesting that they avoid crossing the ROW frequently (df = 77, $p < 0.0001$) and this behavior has been consistent across pre-construction and construction phases (df = 18, $p < 0.001$).

In the P-Bog range, there was no significant increase in the level of avoidance from the pre-construction to construction phase in the first two years of construction (Amec Foster Wheeler 2017). However, caribou did start avoiding crossing the ROW in 2017 (df = 18, $p = <0.03$) and this continued in 2018 which indicates a lag effect in avoidance behavior.

5.1.3.5 Effectiveness of the Vegetation Mitigation Strategies

From 2016 – 2018, individuals continued to cross the Project in the P- Bog range at mitigated areas more frequently than expected (Figure 5-1-25). This was confirmed by examining the movements of individuals (Figure 5-1-26). Results suggest that mitigated areas were put in place where caribou would naturally cross the ROW and that these locations continued to be used through the construction period.

In the Wabowden range mitigated areas were put in place through the entire length of the range (Figure 5-1-27). Caribou in this range, continued to cross the ROW on occasion after construction widened the corridor, therefore overall it is likely that these mitigations aided in reducing barrier effects. However, it is not possible to assess effectiveness further (i.e., to the same extent it can be examined in the P-Bog range), through statistical comparison of mitigated versus non-mitigated locations in this range as all of the range is considered mitigated.

5.1.3.6 Summary of the ZOI verses Crossing Analysis Results

Wabowden Range - the crossing analysis continues to reveal that in the Wabowden range, there was no significant increase in the level of avoidance to the Project from the pre-construction to construction phase by collared caribou. This is comparable to the results of the ZOI analysis which revealed that the ZOI around the Project did not increase as a result of Project construction (i.e., widening of the corridor). Although not tested directly, these results may be a result of habituation by local caribou to this linear corridor. The crossing analysis also revealed that collared caribou crossed the Project less frequently than expected suggesting that caribou are avoiding crossing the Project even though there may be a level of habituation to the linear corridor.

Therefore, caribou do avoid the Project by a buffer of 1 to 2 km throughout the year, irrespective of Project phase. The Project is also a semi-permeable barrier to movement, it does not completely prevent local movement across the landscape, however, it does impede frequency. Caribou who choose to cross the Project, do not cross as frequently as would be expected by random. Some caribou still do cross the ROW and this behavior has not been not altered by construction.

P-Bog Range - the crossing analysis revealed in 2016 that there was no avoidance of the ROW (Amec Foster Wheeler 2016), however from 2017 to 2018 caribou started to avoid crossing the ROW. This suggests there was a lag effect in how caribou adjusted to the Project. The ROW is semi- permeable barrier to movement on the landscape as some caribou still choose to move cross the ROW. This may be the result of the mitigation provided by installation of vegetation mitigation areas to encourage use.

The crossing analysis results for the P-Bog range do not contradict the ZOI results which indicated an overall avoidance buffer of approximately 1 to 2 km by caribou to the Project. Overall collared caribou did not occur frequently within 1 km of the Project during construction. Individual caribou who decided to cross the Project, were doing so less frequently than what would be expected randomly. This indicates that the Project has not been a complete barrier to local movement which may be the result of effective installation of vegetation mitigation areas. From 2015 to 2018 individuals continued to cross the Project at mitigated areas at a higher proportion of the time than areas without vegetation mitigation and at frequencies higher than expected at random.

5.2 Forest-tundra and Barren-ground Caribou

The Bipole III construction phase was completed in July 2018. Therefore, no further Bipole III construction monitoring of Forest-Tundra or Barren-ground caribou is required per the project commitment

5.2.1 Forest-tundra Caribou

The **Pen Islands** caribou population was estimated to total 10,800 in 1994 (Abraham & Thompson 1998). The population summers along the Hudson Bay coast of Ontario and Manitoba and overwinters inland near the boundary of the Hudson Plain and Boreal Shield ecozones (Biodivcanada.ca 2016). The population in recent years is thought to be decreasing with the population range shifting eastward. Satellite telemetry data (January 2010 to March 2017) indicates there are movements as far west as the Nelson River proximate to the southeast edge of Split Lake and York Factory First Nation in Manitoba (Figure 4-2-1). Typically, <300 caribou from this population occur in the general Project area, although large winter migrations are known to have occurred in 2001, 2005 and February 2013 (LaPorte et al. 2013, WRCS 2016).

The **Cape Churchill** caribou population is considered to be stable with a minimum population size estimate of about 3,000 caribou (Abraham et al. 2012, Biodivcanada 2016). This population resides on Coastal Hudson Bay Lowland ecoregion west of Hudson Bay between the Churchill and Nelson Rivers (Trim 2015), and will seasonally migrate southward occasionally as far as the Bipole III Project in proximity to the N1 construction segment northeast of Stephens Lake (Figure 4-2-1). Satellite telemetry data (2010 to January 2015) indicates most of their activity occurs north of the Nelson River (Figure 4-2-1). Typically, <50 caribou from this population overwinter in the general Project area in most winters (WRCS 2016).

Pen Islands and Cape Churchill caribou are a forest-tundra ecotype, also referred to as coastal caribou (Trim 2015). A collaborative study of these populations was initiated in February 2010 involving MB Gov, MB Hydro and the Fox Lake, Split Lake and York Factory Resource Management Boards. The study has a telemetry, aerial population demographic, and genetic analysis components to assess population spatial structure (including range extent), movement dynamics relative to landscape disturbance, mortality sources, changes in population demographics and population genetic relatedness. Calf recruitment results for the study are presented in Table 5-2-1.

The following summarizes forest-tundra (Pen Islands and Cape Churchill populations) and barren-ground (Qamanirjuaq population) caribou recent occurrence in the Project area:

- **Pre-disturbance** - A large migration of forest-tundra woodland caribou (Pen Islands population) occurred in the Bipole III Project area in winter of 2012/13 (LaPorte et al. 2013).

- **Year 1 (2014/15)** - No forest-tundra woodland caribou or barren-ground (Qamanirjuaq population) caribou occurrences were noted in proximity of the Project during winter clearing/construction activities in 2014/2015 (MB Gov, V. Trim, personal communication, February 22, 2016).

- **Year 2 (2015/16)** – Caribou believed to be from the Cape Churchill population were harvested along Highway 280 between Gillam and Bird (Fox Lake Cree Nation) in January 2016 (MB Hydro, T. Barker, personal communication, October 11, 2016).

- **Year 3 (2016/17)** - No Pen Islands or Cape Churchill caribou were present along the Bipole III ROW during winter construction; GPS collared Pen Islands caribou all remained south of the Nelson River and Cape Churchill caribou remained north of the ROW into at least late February 2017 (MB Gov, V. Trim, personal communication, August 14, 2017). There were no calf recruitment surveys conducted for either population during Year 3. The telemetry study is nearing completion; no additional telemetry collars will be deployed and no calf recruitment surveys are planned for this or future years in relation to the current telemetry study (MB Gov, V. Trim, personal communication, August 14, 2017).

- **Year 4 (2017/18)** – No Cape Churchill caribou were reported in proximity to the project (MB Gov, V. Trim, personal communication October 23, 2018). Pen Island caribou moved into areas in close proximity to the south of N1 construction segment of the Project (Nelson River, Split Lake, Assean Lake, Burntwood River) with majority of subsistence harvesting occurring January 3 to 18, 2018; overlap of Pen Island caribou movements with the Project footprint were considered minimal (MB Gov, V. Trim, personal communication October 23, 2018); the Project footprint did not contribute to the subsistence harvest success that occurred. No aerial recruitment surveys were conducted for either population; the last of the deployed telemetry collars released in September 2018.

5.2.2 Barren-ground Caribou

The Qamanirjuaq caribou population has declined from 349,000 ± (SE) 44,900 (2008 estimate) to 264,000 ±(95%CI) 44,084 (2014 estimate), accompanied by a downward trend in cow:calf ratios indicative of reduced annual calf recruitment (Biodivcanada 2016, Campbell et al. 2010, Campbell et al. 2015). A survey of this population was conducted in June 2017 by Government of Nunavut, resulting in an estimated population of 288,244 ±(95%CI) 46,823 with a non-significant decreasing mean (2008 to 2017) λ estimate of 0.975 ±(95%CI) 0.025 (Boulanger et al. 2018).

This population annually migrates from Nunavut in fall to overwinter in northern Manitoba, and then return to Nunavut in spring to calve. Periodically a small component of the population (usually consisting primarily of bulls) may overwinter as far south as the northern extent of the Bipole III Project area (proximate to N1 construction segment). The last known occurrence in the Project area (proximate to the N1 construction segment) was in 2004 (about 10,000 caribou; WRCS 2016). Qamanirjuaq caribou were >75 km from the project (Billard Lake on Churchill River) during the final year of Bipole III construction (MB Gov, V. Trim, personal communication, October 23, 2018).

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 in order 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. 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 change. The finite rate of population change (λ) characterizes the relative change in population abundance over time. Population trend modelling allows an assessment of various population performance metrics, including λ.

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). Tom Lamb WMA is situated to the 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 (Wood 2018). 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.

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 (Figure 5-3-1). 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 5-3-2).

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.

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.

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.

5.3.2 Distribution and Occurrence

Trail cameras deployed from February 2015 through February 2018 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 more observations of moose at trail cameras placed near the ROW (86 observations at 15 camera stations $\bar{x}$ = 3.2 moose observations/camera) compared to cameras located 1.5 km from the ROW (27 observations at 11 camera stations; $\bar{x}$ = 1.1 moose observations/camera); this difference was statistically significant ($z = 1.7832$, $p = 0.0373$).

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.

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. Annual white-tailed deer observations are illustrated in Figure 5-4-1 and for elk in Figure 5-4-2. The following summarizes deer and elk occurrence and distribution results relative to the ROW by monitoring year:

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 (Figure 5-4-1 and 5-4-2).
- 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 5-4-2). 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.

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 (143 observations at 6 camera stations) compared to cameras located 1.5 km from the ROW (3 observations at 2 camera stations); this difference was statistically significant ($z = 2.9084$, $p = 0.0018$). There were insufficient data for analysis of elk observations; 5 observations were near the ROW and 2 were 1.5 km from the ROW.

There is some indication based on the Multi-species Aerial Survey of possible ingress in 2017 of white-tailed deer into the northern periphery of the P-Bog caribou range along the ROW during the construction phase (Figure 5-4-1); continued monitoring is recommended during the operation phase.

There is no evidence of elk ingress into areas outside of historical occurrence as a result of the ROW and associated Project disturbance during the construction phase (Figure 5-4-2).

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 first 3 years of construction disturbance (2014/15 through 2016/17) 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., 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 will continue to be 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 3 years of construction (2014/15 to 2016/17) 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.

- **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** – A significant difference in harvest was detected in N2 when comparing pre-disturbance to construction phase (Table 5-5-1), but this was not reflected in harvest rate in the monitored construction segments (Table 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), 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 (Tables 5-5-1 and 5-5-2).

5.5.2 Distribution and Occurrence

5.5.2.1 Winter Ground Transect Surveys

Winter ground track transects surveyed during Year 4 (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, lynx, snowshoe hare, and squirrel (Figures 5-5-1 to 5-5-12). Gray wolf and wolverine are wider ranging species that were not detected in during the Year 4 ground transect survey but were detected in previous years.

For this report, data from Year 2 – Year 4 (2015/2016 winter to 2017/2018 winter) was 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 during winter construction, results are summarized for each target species (Tables 5-5-4 to 5-5-12). 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 5-5-12). 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 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, perhaps in response to larger predator presence or due to sensory disturbance from construction. Distributions of 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 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. In 2018, gray wolf and caribou were not detected during the ground surveys and moose and lynx did not have a significant distance relationship with the ROW. These results reflect the large scale these larger mammals operate on. So, although tracks of caribou, moose, wolf and 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. There were no track occurrences of gray wolf in 2018. Track occurrences from 2015 to 2017 were very low (n<10 each year) and a high percentage of the models would not run due to data deficiency. Power analyses were run using an effect size of 0.35 and revealing that 80% power would be obtained by surveying a minimum of 80 transects. Wolf are also recorded during the annual aerial surveys to monitor distribution at a larger scale more suitable for their range use.

- For coyote, the best fit model included vegetation community and year as covariates. Track density was negatively correlated with distance to the ROW indicating that coyote occurrence was lower at distances father away from the Project suggesting they may be using the ROW to facilitate movement. The most recent power analysis was run using the effect size of 0.39 revealed that power was already above 80% and therefore no additional transects are required.

- The best fit model for fox included vegetation community type and year as covariates. Track density was negatively correlated with distance to the ROW indicating that fox occurrence was lower at distances father away from the Project suggesting they may be using the ROW to facilitate movement. Power analyses were run using the effect size for of 0.2 revealing that a power of 80% had been reached for this analysis.

- For lynx, the best fit model included habitat variables, snow depth and abiotic environmental variables (wind, temperature) and revealed that there is no relationship between lynx occurrence and distance to the ROW. Power analyses were conducted using an effect size of 0.074 revealed that 114 transects would have to be surveyed to achieve a power of 80%.

- For moose, the best fit model included vegetation communities as covariates. No correlation was found between track density and distance to the ROW. Power analyses were run using an effect size of 0.096. Results revealed that 85 transects would have to be sampled to achieve a power of 80%. Wolf are also recorded during the annual aerial surveys to monitor distribution at a larger scale more suitable for their range use.

- For fisher/marten the best fit model included vegetation community type, snow depth and abiotic environmental variables (wind, temperature) as covariates. A positive correlation with track density was found for distance to the ROW indicating that more fisher/marten were detected at distances farther from the Project suggesting they may be avoiding the ROW. The most recent power analyses were run using the effect size of 0.059 and revealed that the power is already above 80% for this analysis and therefore no additional transects are required.

- For ermine/weasel, the best fit model included vegetation community, snow depths and year as covariates. A positive correlation with track density was found for distance to the ROW indicating that more ermine/weasel were detected at distances farther from the Project suggesting that they may be avoiding the ROW. The most recent power analysis was run using the effect size for distance to ROW using an effect size of 0.39 revealed that power was already above 80% and therefore no additional transects are required.

- The best fit model for rabbit/hare was that which included vegetation community type, snow depth, year and abiotic factors (wind, temperature). Track density was positively correlated to distance from the ROW suggesting that rabbit/hare avoided the ROW. The most recent power analysis was conducted using an effect size of 0.08 and revealed a power of 99%, therefore transect numbers are sufficient for analysis.

- The best fit model for squirrel included vegetation community, snow depth, year and abiotic factors (wind, temperature) as covariates. Track density did not significantly correlate with distance to ROW. Power analysis using an effect size of 0.027 revealed that 230 transects would have to be sampled to achieve a power of 80%.

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 MBHydro. 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.

Results from memory cards retrieved from trail cameras deployed during the construction phase (February 2015 through February 2018) were used to compare occurrence of furbearers near the ROW versus 1.5 km (Figure 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 lynx occurred significantly further from the ROW (Table 5-5-14, Figure 5-5-13). No significant preference was detected for black bear, coyote or marten. Snowshoe hare and squirrel tended to occur further from the ROW, but the trend was not statistically significant (Table 5-5-14). Sample sizes were small for some species, therefore caution should be used in application of these results.

As additional years of data continue to accumulate the analysis and interpretation of this data set will continue to improve. Behavior of some species may also change once construction is complete and sensory disturbance diminishes at 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 Project 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 Project 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 = 72) of collared adult females, indicate predation constituted 84.0% of known mortality sources (n = 42), primarily by wolves (78.0%) (Table 5-6-1, Figure 5-6-1). Wolf predations occurred in all months, with a distinct peak in July (Figure 5-6-1).

Comparison of mean pre-disturbance mortality distance (all known mortality sources pooled) from the ROW [32.8 ±(95%CI) 11.04 km; n = 31] to post-disturbance mortality distance [22.1 ±(95%CI) 6.76 km; n = 17)] suggests a tendency of shorter mortality distance from the ROW during construction compared to pre-construction, but the relationship was not statistically significant (z = 1.630, p = 0.052). However, there was significantly less variation in mortality distances during construction compared to pre-disturbance (F = 4.872; p <0.001) for mortality of known sources, which indicates collared adult female woodland caribou were more spatially predictable during construction and therefore at greater mortality risk. The following summarizes pre- vs post-disturbance mortality by caribou range:

- In **P-Bog Range**, there were more wolf predations of collared caribou during the pre-disturbance period (2010-2014; n = 9) relative to the construction period (2015-2018; n = 5). 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 = 11) and construction period (n = 8). There were no records of bear predations. There was a vehicle collision will one of the collared caribou 10.9 km from the ROW during the construction phase (April 2017). 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 3 wolf and 1 bear predations of collared caribou; all occurred prior to construction. Only 1 mortality (cause undetermined) of a collared caribou occurred during the construction period (October 2016; 43.9 km from ROW).

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** - moose had a greater wolf predation-risk than caribou during Years 1, 2 and 4 (Table 5-6-2; Figure 5-6-3, Figure 5-6-4).
- **P-Bog Survey Area** - there were no statistically detectable differences between woodland caribou vs moose with respect to wolf predation-risk during the first 3 years of construction; in Year 4 (2017/18) moose were at significantly greater risk (Table 5-6-2; Figure 5-6-3, Figure 5-6-5).

- **N-Reed Survey Area** - the survey data indicates that predation risk to boreal woodland caribou was significantly greater than for moose during the first 3 years of construction (Table 5-6-2; Figure 5-6-3, Figure 5-6-6). 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 (Table 5-6-2).

- **Charron Lake Survey Area** - predation risk to boreal woodland caribou was significantly greater than for moose annually (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 focusing on caribou as primary prey in mid-winter.

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** - There was greater overlap of wolves with moose in the southern portion of the survey area, which was also where most of moose distribution occurred (Figure 5-6-4). Within the survey area woodland caribou were spatially separated from moose and wolves. This is consistent with a greater relative predation-risk for moose relative to woodland caribou (Figure 5-6-3).

- **P-Bog Survey Area** – Wolves were more abundant in the northern portion of the survey area and had special separation from caribou and moose (Figure 5-6-5). Based on relative distribution it appears that wolves were focused on northern periphery of the survey area, possibly focused on ungulate prey (i.e., white-tailed deer) occurring outside of the survey area. Consequently, moose and woodland caribou had similar predation-risk within the study area, which is consistent with previous years (Figure 5-6-3).

- **N-Reed Survey Area** – Woodland caribou maintained spatial separation from wolves, whereas moose and wolf distribution did indicate some overlap (Figure 5-6-6). As there was no significant difference in predation-risk based on distance from wolf (Figure 5-6-3), suggesting wolves were selecting moose for prey over woodland caribou within the survey area.

- **Charron Lake Survey Area** – As in previous years, moose occurrence and distribution was minimal compared to woodland caribou (Figure 5-6-7). Wolves and caribou were more evenly distributed, resulting in greater predation-risk for caribou compared to moose (Figure 5-6-3 and 5-6-7).

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 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, Figure 5-5-13).

Multi-species Aerial Survey data were used to assess local scale general relative caribou moose and wolf distribution along the Project. Wolf distribution was associated more strongly with the distribution of moose rather than caribou along the ROW in both the northern (Figure 5-6-8) and southern (Figure 5-6-9) portions of the ROW sampled in January 2018. Wolf occurrence and densities appear to have increased in frequency from 2015 to 2018 in the southern portion of the study area (Figures 5-6-8 and 5-6-9). Moose are distributed evenly along the northern portion of the study area (Figure 5-6-9) and also occur fairly evenly throughout the southern portion of the study area (Figure 5-6-8). Whereas were detected in a patchy distribution only detected in one or two areas in both the northern and southern portions of the study area (Figure 5-6-8 and 5-6-9). This differences across caribou and moose reflect the contrasting habitat preferences of each species, moose are often associated with recently disturbed more open habitats, whereas as caribou prefer mature coniferous and treed bog habitats.

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 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 5-5-13).

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 have been documented during construction to date.

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 12 to 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. 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). Project construction was completed in July 2018, therefore no further monitoring for black bear dens is 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). Project construction was completed in July 2018, therefore no further monitoring for wolverine dens is 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.

5.9 Human Access Monitoring

Trail cameras were installed to monitor the amount of human access at all-weather construction access points (n =7 in 2015-16, n=9 in 2016-17, and n = 9 in 2017/18) and along the ROW associated with the winter ground track transects (n = 18 along N2 and N3 in 2015-16, n=25 along N1, N2 and N3 in 2016/17, and n = 37 along N1, N2, N3 and N4 in 2017/18).

Results of the 2015-2017 sampling effort indicated the majority of ROW access for a known purpose was for Project construction (99.1% in 2015-16 and 99.2% in 2016-17 with limited local public access (0.8% in 2015/16 and 0.7% in 2016/17) for recreation and resource use (see Wood 2018). The 2017/18 dataset did not have attributes describing types of human use, which resulted in analytical limitations. Total observed human access (project, public, undetermined) in 2017/18 was more than that observed in 2016/17 or 2015/16 (Table 5-9-1), and in part is a result of progressively increasing sampling effort from additional trail camera deployments each year. It is assumed that the proportion of ROW access for a known purpose in 2017/18 was construction-related, in proportions similar to the previous 2 years (approximately 99%). Observed human access during the operation phase is expected to be substantially lower. It is not known if public access will increase, now that construction in complete.

5.10 Mitigation Effectiveness Monitoring

Clearing activities relevant to mammals monitoring were undertaken in the majority of construction segment N3 from February through March 2014, and in N2, south portion of N3 and N4 (primarily centerline clearing), prior to initiation of Year 1 (2014/15) of the mammals monitoring programs in January 2015. Clearing activities along the N3 and N4 ROW construction segments was completed during Year 2 (2015/16). In Year 3 (2016/17) tower erecting and line stringing was undertaken. In Year 4 (2017/18) construction activities were completed and operations phase began in the summer of 2018.

This report concentrates on analysis from the construction phase of the Project for the various mammal VECs being monitored at local and/or landscape scales through each Project phase. An updated assessment of use on mitigation areas within P-Bog range was undertaken as data on the location of each vegetation leave area was available. Caribou did use the vegetation leave areas to cross the Project during the initiation of construction and continued to do so throughout 2016, 2017 and 2018. Results revealed that caribou used these same locations during the pre-construction phase, suggesting that the placement of these mitigation areas was well informed on local caribou movement dynamics. As caribou continued to use these areas during the construction phase, they have been effective in ensuring that caribou continue to move across the landscape in the same ways as before construction, reducing disruption to local movement dynamics.

No project-related effects have been detected during the construction phase with respect to ungulate (i.e., woodland caribou, moose) population abundance or trend (Sections 5.1.2.2, 5.2 and 5.3), or altered annual or seasonal range use or changes in predator-prey dynamics (Section 5.6.2), suggesting that mitigations applied to the project such as project routing, vegetation management mitigations, and winter construction windows have aided in reducing potential impacts to these species. ZOI and crossing analysis have revealed that the Project is a semi-permeable barrier on the landscape; caribou typically avoid spending long periods of time within 1 to 2 km of the Project but will still cross the Project on occasion using the vegetation leave areas. Site fidelity analysis revealed that caribou continued to demonstrate fidelity at both population and local scales to important seasonal areas including calving and over wintering ranges. The one exception to this pattern was observed at the local scale in February and March during construction phase in the P-Bog range where caribou did not displayed fidelity to previously used local sites in these months. This could be due to disturbance from construction, however, it was limited to a very local scale for a period of 2 months. This pattern can continue to be assessed through the operations phase.

Ingress of white-tailed deer into the P-Bog range along the project ROW is a possible project effect and concern because of potential transmission of *P. tenuis* to woodland caribou. White-tailed deer sign was detected along the north end of the P-Bog survey area in Year 3 during the Multi-spp Aerial Survey (Section 5.4). All current monitoring methods should continue to be used to assess the extent of, and potential for, white-tailed deer ingress.

There were 3 deer-vehicle collisions involving project vehicles during the construction phase to date, all collisions were in vicinity of the S1 construction segment and no other project-related wildlife-vehicle collisions have occurred (Section 5.6.4). No incidents of construction project-staff interactions (e.g., staff hunting or feeding wildlife, or problem wildlife incidents) with wildlife have been reported.

Public use of the project for access to date has been minimal (Section 5.9) and unlikely to have altered ungulate mortality from hunting.

No environmentally sensitive site (ESS) issues have been reported during construction with the exception of one black bear hibernation den disturbed during Year 1 along construction segment C2 (Section 5.8).

Effects of the project on furbearer species harvest levels and rates appear to be unaffected by the project during construction with the exception of a suspected reduction of beaver harvest during the initial two years of construction in traplines intersected by the Project. The Multi-spp Aerial Survey indicates beaver are common and widely distributed. This is consistent with predicted project effects of temporary local effects to beaver of no measurable population-level decline; but evidence of localized effects because of sensory disturbance during construction reflected in the lower harvest of beaver (Section 5.5). Some furbearers are more frequently recorded at distances farther from the ROW than closer suggesting a very local level of avoidance for some species. However local avoidance is not anticipated to have population level consequences.

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