BIPOLE III TRANSMISSION PROJECT:

MAMMALS MONITORING PROGRAM TECHNICAL SUPPLEMENTAL REPORT

2021-2022

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Manitoba Hydro

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EXECUTIVE SUMMARY

Impacts of the Bipole III (BPIII) Transmission Project (referred to as the 'Project') on terrestrial mammals focused specifically on caribou, moose, and furbearers (CEC 2013). The regulatory review of the Environmental Impact Statement (EIS) identified various potential negative effects due to construction and operation of the Project. Mammal Valued Ecosystem Components (VECs) were selected based on their ecological, cultural, and economic importance and associated potential effects related to the Project.

Annual monitoring reports have been submitted during the Construction and Operational phases of the Project (Years 1-6) and address potential impacts to the VECs identified in the EIS, including boreal caribou, barren-ground caribou, moose, elk, white-tailed deer (WTD), grey wolf, black bear, and furbearers (beaver, wolf, wolverine, and marten) (MMPTR 2016, 2017, 2018, 2019, 2020, 2021). Monitoring reports contribute to the annual framework of mammal monitoring studies undertaken each year to assess potential impacts at both a local and landscape scale through Project Construction and Operation.

This supplemental monitoring report presents the results and analyses of boreal caribou Capture-Mark-Recapture (CMR) and WTD fecal (*P. tenuis*) surveys conducted for field data collection in the winters of 2021 and 2022 by Joro Consultants (Joro) during the Operational phase of the Project. These are two mammal Valued Ecosystem Components (VEC's) identified for the Project requiring follow-up monitoring (MH 2018).

Effects monitoring conducted, and the associated results and analyses for the Operational phase of the Project found in this report, include the following data collected in winter 2021 and 2022:

1. **Cumulative Caribou CMR Pellet Collection Surveys and Analysis** for monitoring the population state and genetic changes in three boreal caribou ranges (The Bog, Naosap, and Wabowden ranges) along the BPIII transmission line and one control (Charron Lake) away from the line (Section 4.1).
2. **Replication of WTD Fecal Collection Surveys** for monitoring meningeal parasites and disease risk changes in WTD in the Swan River and The Pas areas in proximity to the BPIII transmission line, including *P. tenuis* (brainworm) and *P. andersoni* (muscle worm) (Section 4.2).

The results to date, including the results of CMR analysis and parasite examination of deer fecal samples, do not indicate any measurable long-term effects on boreal caribou or moose populations because of the BPIII Project through Construction and Operation. A discussion on the results of supplementary analysis is provided, as well as recommendations specific to caribou and WTD fecal collection methodologies and future monitoring.

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LIST OF ACRONYMS

BPIII	Bipole III
CMR	Capture-Mark-Recapture
COV	Coefficient of Variation
DNA	Deoxyribonucleic Acid
EIS	Environmental Impact Statement
GPS	Global Positioning System
MB Hydro	Manitoba Hydro
MB Gov	Government of Manitoba
LP	Lincoln-Peterson estimates
N-Reed	The Reed portion of the Naosap-Reed boreal woodland caribou population
P-Bog	The Bog (The Pas North-South) portion of the Pasquia-Bog boreal woodland caribou population
P. tenuis	*Parelaphostrongylus tenuis* larval nematode causing brainworm
P. andersonii	*Parelaphostrongylus andersoni* larval nematode causing muscleworm
RD	Robust Design models
ROW	Project Right-of-Way
VEC	Valued Ecosystem Component
WTD	White-tailed Deer
ZOI	Zone of Influence

1.0 INTRODUCTION

Manitoba Hydro (MB Hydro) received an Environment Act License from the Government of Manitoba (MB Gov 2013) on August 14, 2013, authorizing the construction, operation, and maintenance of the Bipole III (BPIII) Transmission Project (referred to as the 'Project'). Clearing activities for the Project commenced during the winter of 2013-14, followed by the completion of the Construction phase in July 2018. In 2019 the Project transitioned into the Operational phase with monitoring activities guided by the overall Biophysical Monitoring Plan established as part of the environmental licensing process (MB Hydro 2018).

The Project's impact assessment on terrestrial mammals primarily concentrated on caribou, moose, and furbearers (CEC 2013). During the regulatory review of the Environmental Impact Statement (EIS), potential adverse effects stemming from both Project Construction and Operation were identified. Concerns regarding ungulates centered around habitat modification, altered access, and increased human activity, which could result in displacement and population decline resulting from the BPIII Transmission Project. Annual monitoring reports have been submitted during all phases of the project describing the methodologies and results of monitoring activities (MMPTR 2016, 2017, 2018, 2019, 2020, 2021).

Mammal Valued Ecosystem Components (VECs) were chosen based on their ecological, cultural, and economic significance, along with their associated potential effects concerning the Project. These VECs encompassed boreal woodland caribou (caribou), forest-tundra woodland caribou, barren-ground caribou, moose, elk, white-tailed deer (WTD), black bear, and furbearers (including beaver, wolf, wolverine, and marten). This supplemental report follows the 2019/20 Year 6 Monitoring Report (2021) previously submitted by Joro and expands on the results of boreal caribou Capture-Mark-Recapture (CMR (DNA)) studies, as well as assessing the presence of brainworm (*Parelaphostrongylus tenuis* (*P. tenuis*)) expansion northward into The Pas regions. This parasite potentially affects boreal caribou and moose populations through transmission from WTD, causing increased animal mortality and reduction in rates of caribou female survival, recruitment, and population status as determined through CMR studies.

As identified in the EIS and regulatory review, monitoring activities for these VECs were to show that potential Project effects are measurable and verify if mitigation and adaptive management actions have accomplished their objective to minimize potential effects relative to disturbance, displacement, increased mortality, or negative population responses via apparent competition.

2.0 MONITORING OBJECTIVES AND FRAMEWORK

The objectives of the overall Environmental Monitoring Plan were to:

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

Specifically, detailed monitoring objectives for caribou and WTD for all phases of the Project are found in Appendix 1 Table 1-2.

Based on the commitments outlined by MB Hydro in the Project EIS, the overall objectives of the mammals monitoring program include (MMPTR 2021):

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

2.1.1 Boreal Woodland Caribou

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

1. Expand baseline knowledge of distribution, abundance and population characteristics of boreal woodland caribou interacting with the Project.
2. Investigate Project influence on woodland caribou at local and range (P-Bog, Wabowden, N-Reed, and Charron Lake) scales.
3. Assess effectiveness of mitigation measures if required.

2.1.2 White-tailed Deer (WTD)

WTD monitoring plan objectives (Appendix 1 Table 2) are to:

1. Monitor presence of *P. tenuis* and change in risk to ungulates in relation to Project-related effects of WTD distribution (i.e., potential deer ingress into woodland caribou local population ranges). The northward expansion of *P. tenuis* because of habitat alteration from clearing and transmission line maintenance, resulting in increased mortality to boreal caribou and moose, was hypothesized.

The Operational monitoring conducted in this report is based on the commitments described in the BPIII Biophysical Monitoring Plan (MB Hydro 2018). As outlined above, emphasis includes results reported for caribou and WTD. Section 3.0 describes the details of monitoring activities for the components of this report.

3.0 MONITORING ACTIVITIES

Operational monitoring activities and analysis for this report have replicated and augmented select surveys conducted previously within the Boreal Shield and Boreal Lowlands Ecozones (Figure 1). Monitoring activities conducted through the life of the Project previously include:

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

3.1 Field Activities – Winter 2021-2022

The following is a summary of field activities conducted for the Operational phase monitoring period during winter 2021 and winter 2022 on the selected components found in this report, replicating, and augmenting previous surveys completed during the Construction phase.

1. **Caribou CMR Surveys** involving fecal pellet collections and DNA analysis conducted in four boreal woodland caribou study areas (P-Bog, Wabowden, N-Reed, and Charron Lake; Figure 1) to collect information on caribou populations and changes in population state/genetic viability in comparison to previous Construction phase surveys and assess effects of the BPIII transmission line. See Section 4.1 for specific methodologies followed.

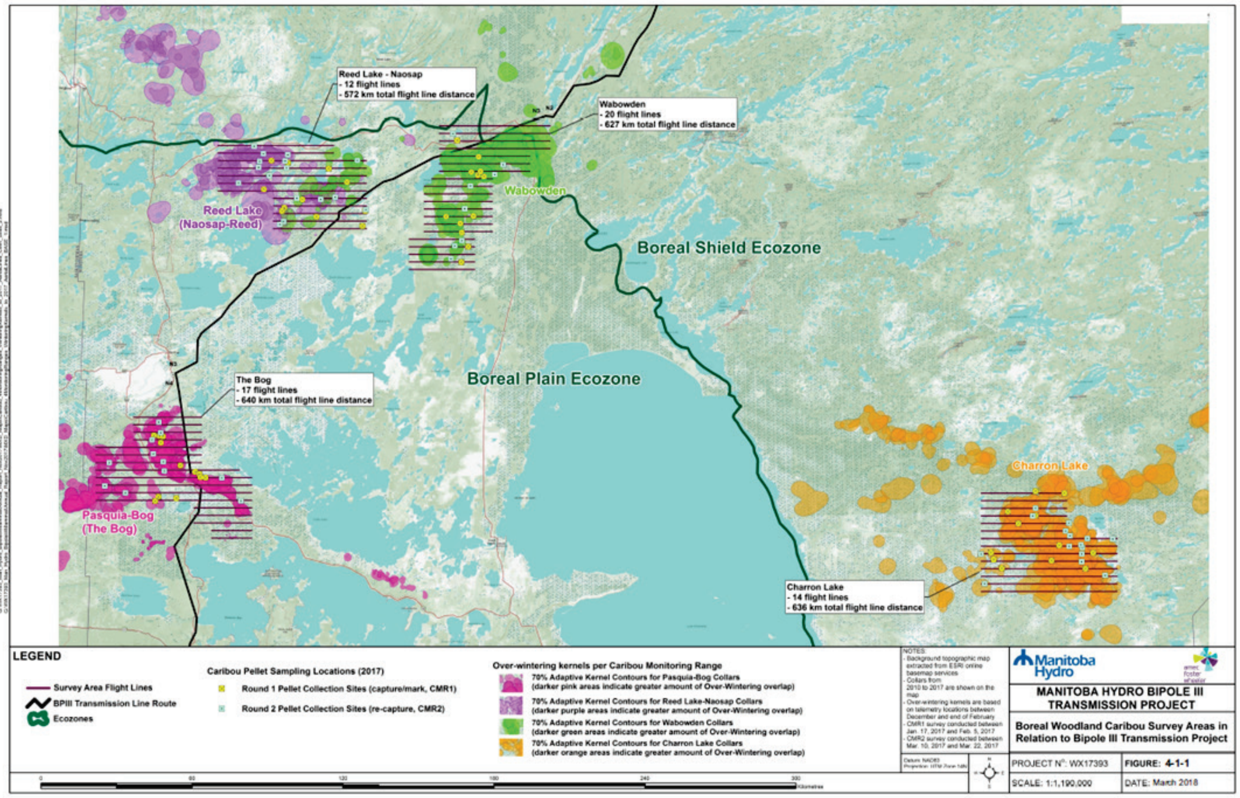

Figure 1: Woodland Caribou CMR Survey Areas (from Bipole III Transmission Project, Mammal Monitoring Program Technical Report 2016/17, Year 3 (MMPTR 2017)

2. **WTD Fecal Collection Surveys** in two survey areas including The Pas and Swan River to determine presence of meningeal parasites including *P. tenuis* (brainworm) and *P. andersoni* (muscle worm) to assess change in P. tenuis presence and distribution relative to the BPIII transmission Project. See Section 4.2 for specific methodologies followed and locations of sampling sites.

4.0 METHODS

The following section summarizes field and analytical methods used to quantify and compare results from the Construction phase (December 2014 to July 2018) to the Operational phase (August 2018 to January 2022).

4.1 Boreal Woodland Caribou

4.1.1 Caribou CMR Fecal Pellet Collection Survey

Non-invasive genetic sampling and analyses were undertaken by Trent University for monitoring the boreal woodland caribou population using scientifically accepted methods, which are detailed in previous reports (MMPTR 2016). Sampling occurred in 2015, 2017, 2019 and 2022 through the collection of fecal pellets at forage cratering sites using a helicopter in conjunction with boreal caribou recruitment surveys following transects that were developed in 2015. The systematic sampling effort used fixed transects (East-West orientation), spaced at 3 km intervals and flown at an altitude of 200 m via helicopter, to facilitate observations within 500 m of the flight path. The survey crew consisted of 2-3 experienced observers and a pilot. Surveys followed each transect at a constant speed suitable to observe caribou and caribou sign (tracks, cratering). The survey crew strayed off the transect when recent tracks were intersected, or to investigate potential cratering sites to sample or to track collared animals in proximity to the transect. Accessible pellet collection sites were sampled as they are encountered. All caribou observations, sign, and collection sites were recorded and marked using a GPS.

The pellet sampling protocol minimized contamination and maximized detection of individual samples. Each sample was individually collected (using sterile methods to avoid DNA contamination) into a labelled Nasco Whirl-Pak sample bag. All samples from a particular collection site were then bagged together with a unique collection site number and maintained in frozen state for genetic profiling. Frozen pellets consolidated into a single mass (>20 pellets) were collected in preference to individual scattered pellets (which may represent more than one individual). At each collection site, sampling effort attempted to achieve more samples than the number of estimated animals to maximize detection of individual genotypes.

Sampling was conducted in two phases within the caribou ranges identified in Figure 1 generally after three days of a significant fresh snowfall. The capture phase (1st round of pellet collection) occurred in mid-January to early February. In general, CMR Surveys for BPIII monitoring were completed in late January through March depending on winter conditions. Two rounds of CMR surveys involving caribou fecal pellet collection were conducted in the P-Bog, Wabowden, N-Reed, and Charron Lake caribou ranges (Figure 1). Approximately 100 samples from 9-12 sites were collected throughout each range. The first three ranges were sampled using the Pas as the base location, while Charron Lake range was sampled using Hecla Island as the base.

Fecal pellet collections were further assisted by tracking collared caribou along and off transects to find groups associated with each functioning collar. During these sampling periods, the number of functioning collars declined through years as collaring objectives on other monitoring requirements were met. By 2022, there were no functioning collars. Transects were revisited 3 to 4 weeks after the first collection and utilized as the genetic re-capture event (CMR2) within each caribou study area (Figure 1). Winter snow and temperature conditions were reported to be variable between, and among, years, and sampling followed helicopter safety standards for weather conditions and using two home base locations as mentioned above, the Pas and Hecla.

Subsequent genotyping analysis of the fecal pellet samples through CMR laboratory analysis, as completed by Trent University under Dr. Paul Wilson and Dr. Micheline Manseau (2023), yields data used for CMR population estimation for both open and closed populations. As indicated in previous reports, initial estimates of population size and population growth (Lambda ∑) were generated based on assessing close populations (no immigration or emigration). In 2022, open population analyses were used and considered appropriate for this type of analysis (Iijima 2020). Data from these multiple years provided estimates of population size, capture rates, and estimates of growth (∑). Open population estimates with the Robust Design model were used in all ranges apart from the Charron Lake Range in 2022, where Lincoln-Peterson (LP) estimates (closed population) were only available from the data provided. Further detail is provided in Section 6.0.

4.2 White-Tailed Deer (WTD)

4.2.1 Genetic Sequencing

The meningeal worm, known as *P. tenuis*, has been recognized as a potential cause of mortality among moose and caribou due to increased transmission of parasites because of habitat alteration favoring WTD and the northward migration of this parasite from its previously documented regions of infection in Western Manitoba (Wasel and Crichton, 2003). The examination of WTD fecal samples was conducted along the BPIII route during both the Construction and Operation phases in areas near Swan River and The Pas (Figure 7-Figure 8). Sampling occurred during monitoring Years 1, 2, 3, and 7 (see 4.2.2 below). The larval meningeal worms found in WTD feces include both *P. tenuis*, which is fatal to moose and caribou, and *P. andersoni*, a common muscle worm found in Manitoba ungulates. These larvae are known as dorsal-spine larvae (DSL) and are morphologically identical, necessitating genetic examination of DSL within fecal samples collected in all years. The ability to genetically distinguish between these two worm species has only been available since 2021 and has allowed improvements in fecal parasite monitoring by removing the assumption that all DSL species previously found were *P. tenuis*. The specific methods for DSL DNA amplification and identifying positive *P. tenuis* locations are detailed in Pidwerbesky et al. (2023). Sampling and analyses followed the Baermann technique to obtain larvae and sequence partial cytochrome oxidase 1 and internal transcribed spacer 2 genes for DSL species identification (Pidwerbesky et al. 2023). Zero-inflated models provided the location of *P. tenuis* occurrence for mapping and discussion within this report.

4.2.2 WTD *P. tenuis* Fecal Collection Survey

The following summarizes WTD fecal collection 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 Biophysical Monitoring Plan (MB Hydro 2018) 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. 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 21-23, 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. 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 is recommended to be repeated in 5 years to assess for changes in deer distribution along the ROW as well as changes in *P. tenuis* prevalence.
- **Year 7 (2020/2021)** - Ground-based pellet collection was conducted February 6-22, 2021, by Joro based out of Swan River and The Pas (Figure 7-Figure 8). 50 total samples were collected at five different sites. Each site had ten samples collected within a 100 m radius and marked with date, location, and sample number. Sampling was initiated in the Swan River area on February 6, but paused due to high amount of recent snowfall, and later completed February 22 when snow depth conditions were more suitable. Sampling occurred in the Pas area on February 7-8. The weather was extremely cold during this 2-week period (i.e. -40C), so the crew utilized helicopter "no fly" days due to extreme cold during concurrent aerial survey work to complete all ground-based pellet collections. The samples were submitted to the Detwiler Lab, Department of Biological Sciences (University of Manitoba) to assess via Baermann technique for presence of spiney-tailed larvae, which is indicative of probable *P. tenuis* infection.

5.0 RESULTS

5.1 CMR Boreal Caribou Genetic Results

The advanced CMR model addresses potential biases and uncertainties inherent in traditional population estimation techniques. The CMR method incorporates factors such as variability in capture probabilities, mortality rates, and the potential loss of marks (genetically identified individual caribou) over time. The approach and sequencing tool and models employ dual sampling, where recaptures occur both between, and within years, allowing for an open population between years (accounting for migration, birth, and death) and assuming a closed population within each year. These within-year assumptions are upheld by appropriately timed sampling intervals; for this Project, samples were divided into first and second sampling events with specific dates dependent on weather and temperatures. The time lapse between the first and second samples was approximately two weeks to one month and varied for the years reported on. This gap also guaranteed the accumulation of fresh fecal samples that could be collected.

Recapture distances from encounter histories using matched clusters (genotypes) provided a capture history. This was accomplished by connecting a uniquely identified individual from its first location of occurrence to a later scat sample from that individual (based on having the individual identified within a matched genetic cluster). This distance was constrained to the sampling area/transects and recapture distances exceeded 1000 m for most ranges. Some ranges and years displayed shorter distances (i.e., Reed Lake 2019 at 401 m, Wabowden 2019 at 42 m, and Charron Lake 2015 at 296 m).

While sample locations varied annually, the dispersion of samples and sampling efforts across the landscape remained consistent and well dispersed, ensuring temporal and spatial independence, aligning with the model's assumptions. Each range recorded multiple within-year recaptures over the reporting period, notably in 2015 and 2017. Collared animals between 2015-2019 aided in targeting potential sampling locations based on their last known positions. In 2022, last known locations were not usable and likely introduced a bias in sampling, potentially influencing recapture rates. Nonetheless, the number of samples collected in all ranges was consistent throughout the monitoring period.

Estimates of population were reported based on separate Robust Design Models (RD). This involved annual (primary) sampling occasions involving multiple within-year surveys (secondary samples). Populations were assumed “open” among years (subject to recruitment and losses) and population were assumed closed across secondary samples and samples were assumed independent. There is a trade-off: if secondary samples are too close in time, sighting independence fails and if too far apart, closure fails.

In summary, the results provide population estimates and Lambda values that varied between years, although there was no evidence of difference in capture rates between sexes for Charron Lake and The Bog, with some differences detected in Reed Lake and Wabowden. For these latter populations, model averaging was used to provide robust Lambda estimates.

Population sizes vary both for individual ranges and across ranges, with Wabowden and The Bog being the smallest, and Reed and Charron Lake being the largest. Charron Lake had considerable variation in population estimates and coefficient of variation for males and females across years. Lambda was not significantly different from 1 throughout all ranges as illustrated within the confidence interval estimates provided. It was not possible to include the 2022 data in the combined capture history and only a closed population estimate using LP was possible for 2022.

Table 1 provides an estimate of caribou population size by range. Appendix 1, Figures 1-4, 7 and 8 illustrate capture rates by range. Appendix 1, Figures 5, 6 and 9-11 illustrate combined male and female population estimates and associated low and high confidence intervals by range, and where data is available, estimates of Lambda. Table 2 and Figures 2-6 provides a review of all fecal pellet collections within years and sampling dates for each range studied. The figures further show an overview of the first and second fecal collections and a line trajectory of re-marked individuals for males and females. Recaptures include all past years' genetic clusters or individuals identified through the DNA sequencing conducted by Trent University (2023).

Table 1: Summary by Year of Population Estimates Per Range

Range	Year	Population Estimate (N)
The Bog	2015	126
	2017	180
	2019	92
	2022	241
Naosap-Reed	2015	284
	2017	372
	2019	195
	2022	429
Wabowden	2015	108
	2017	142
	2019	137
	2022	107
Charron Lake	2015	806
	2017	218
	2019	1163
	2022	721

Table 2: The Within-year Sampling Periods (secondary samples) used for the Capture-Mark-Recapture Robust Design Model

Range	Year	First Sample Start and Stop Dates	Second Sample Start and Stop Dates
The Bog	2015	January 26 – 30	February 19 – 22
	2017	January 20 – 25	March 10 – 11
	2019	February 3 – 4	February 25 – 26
	2022	January 17 – 24	February 17 – 24
Naosap-Reed	2015	January 29 – February 1	February 22 – 24
	2017	January 26 – 27	March 12 – 13
	2019	February 5 – 7	February 24 – 25
	2022	January 25 – 29	February 25 – March 1
Wabowden	2015	January 19 – 30	February 18 – 20
	2017	January 17 – 18	March 13 – 15
	2019	February 5 – 6	February 23
	2022	January 29 – February 3	March 2 – 3
Charron Lake	2015	February 3 – 6	February 25 – 27
	2017	February 1 – 5	March 18 – 21
	2019	January 22 – 27	February 20 – 21
	2022	February 6 – 12	March 14 – 22

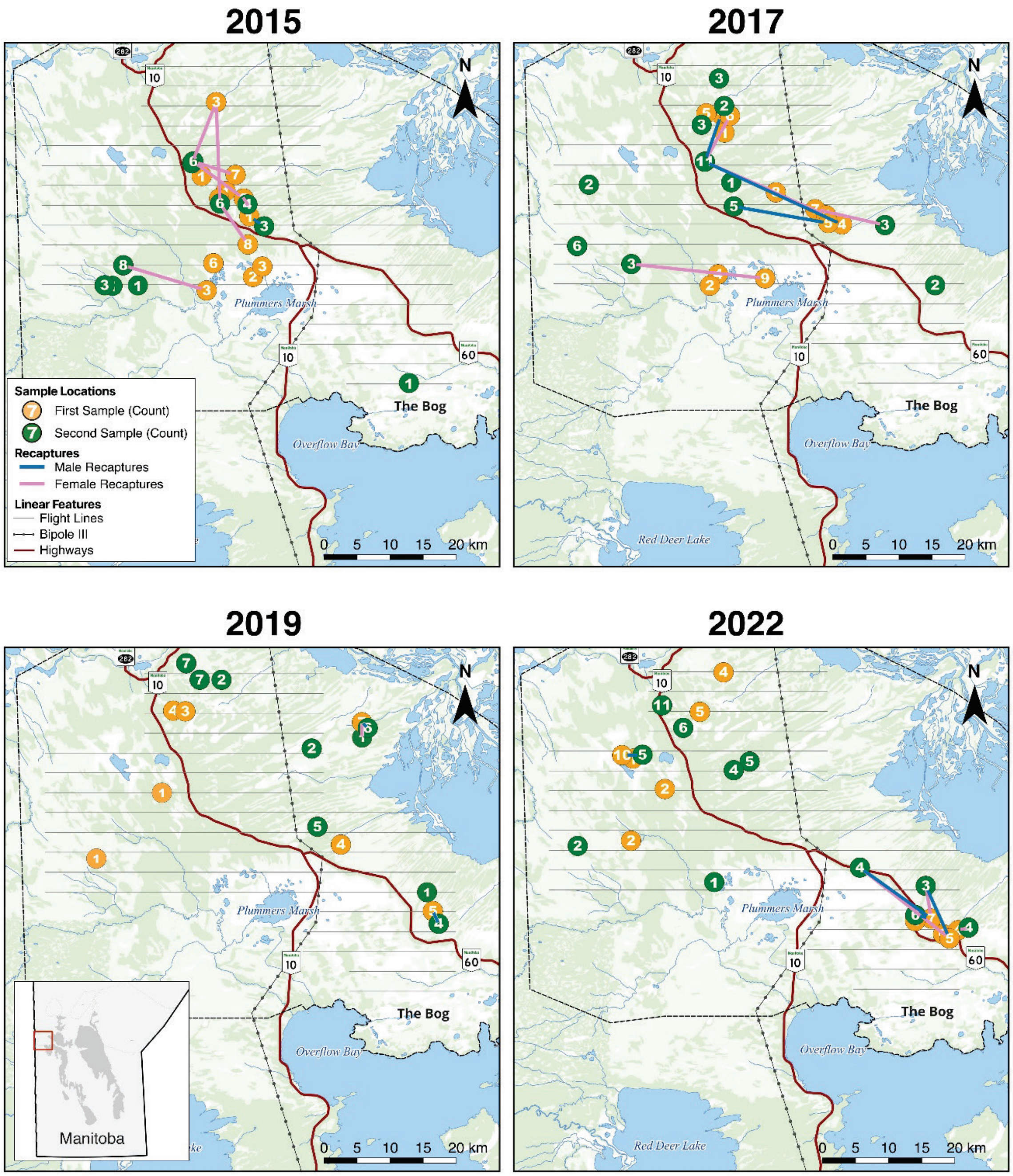

Figure 2: Within Year Scat Collection and Recaptures for the Bog Range with lines connecting previously captured individuals from all years

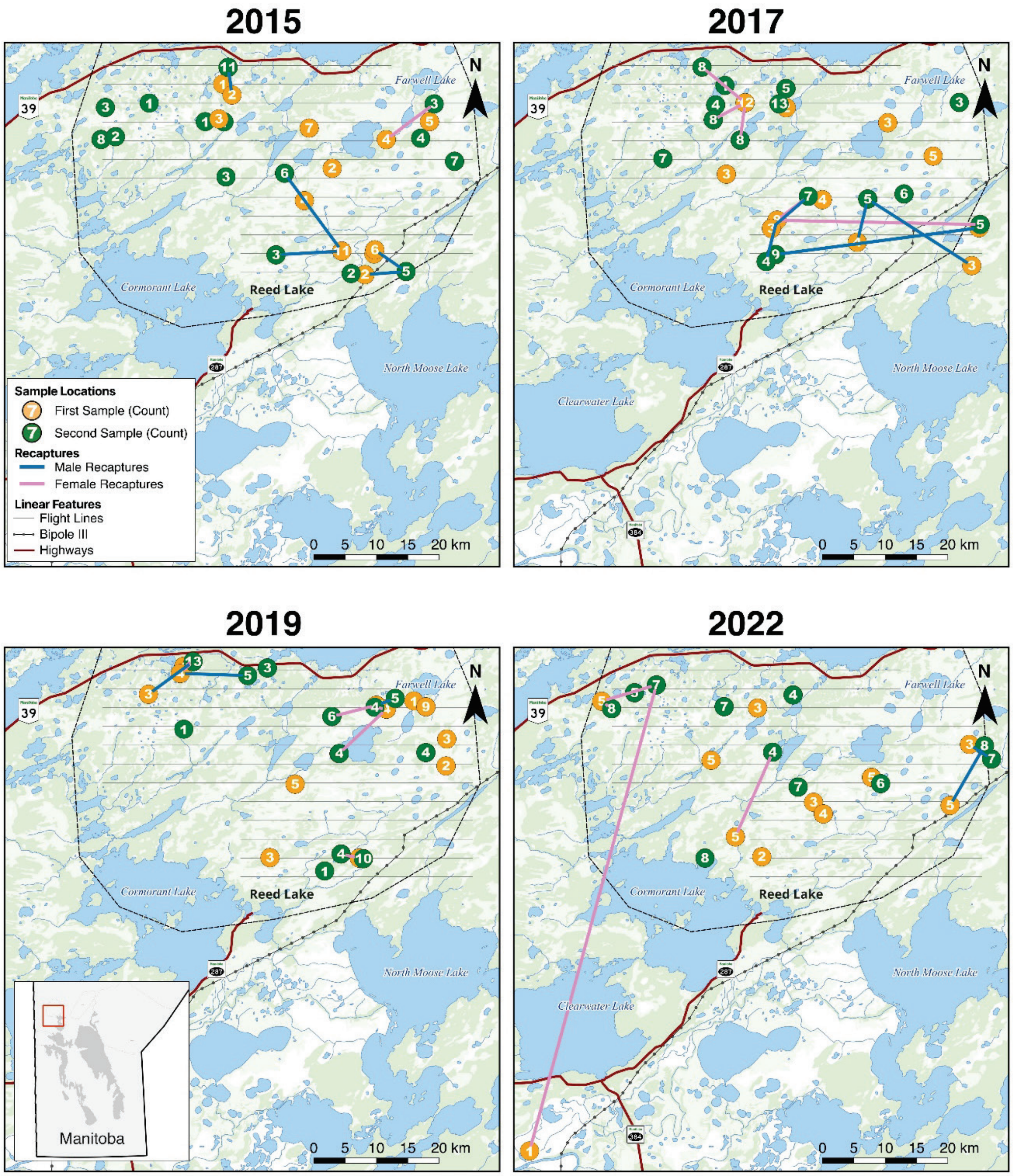

Figure 3: Within Year Scat Collection and Recaptures for the Naosap-Reed Range with lines connecting previously captured individuals from all years

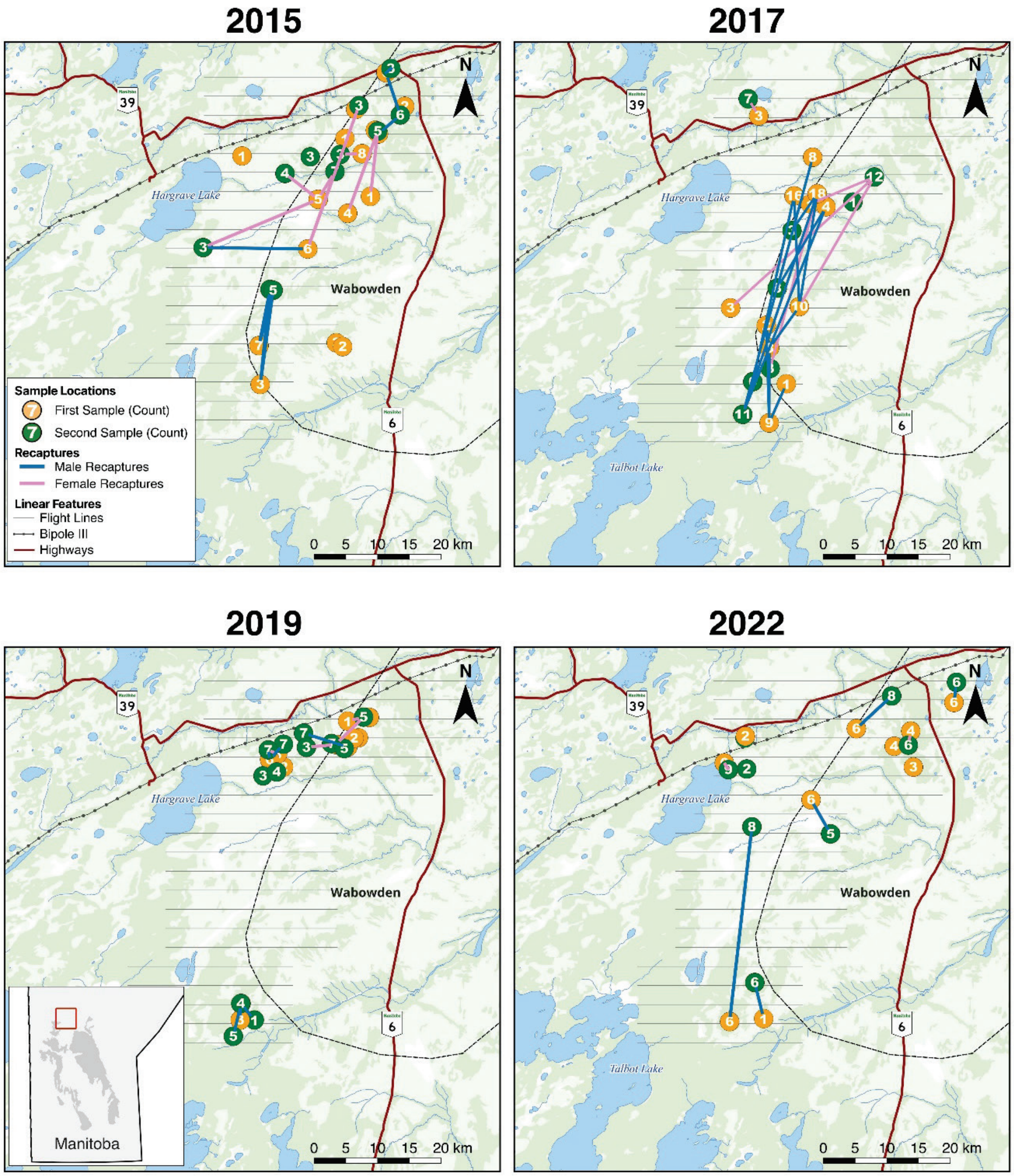

Figure 4: Within Year Scat Collection and Recaptures for the Wabowden Range with lines connecting previously captured individuals from all years.

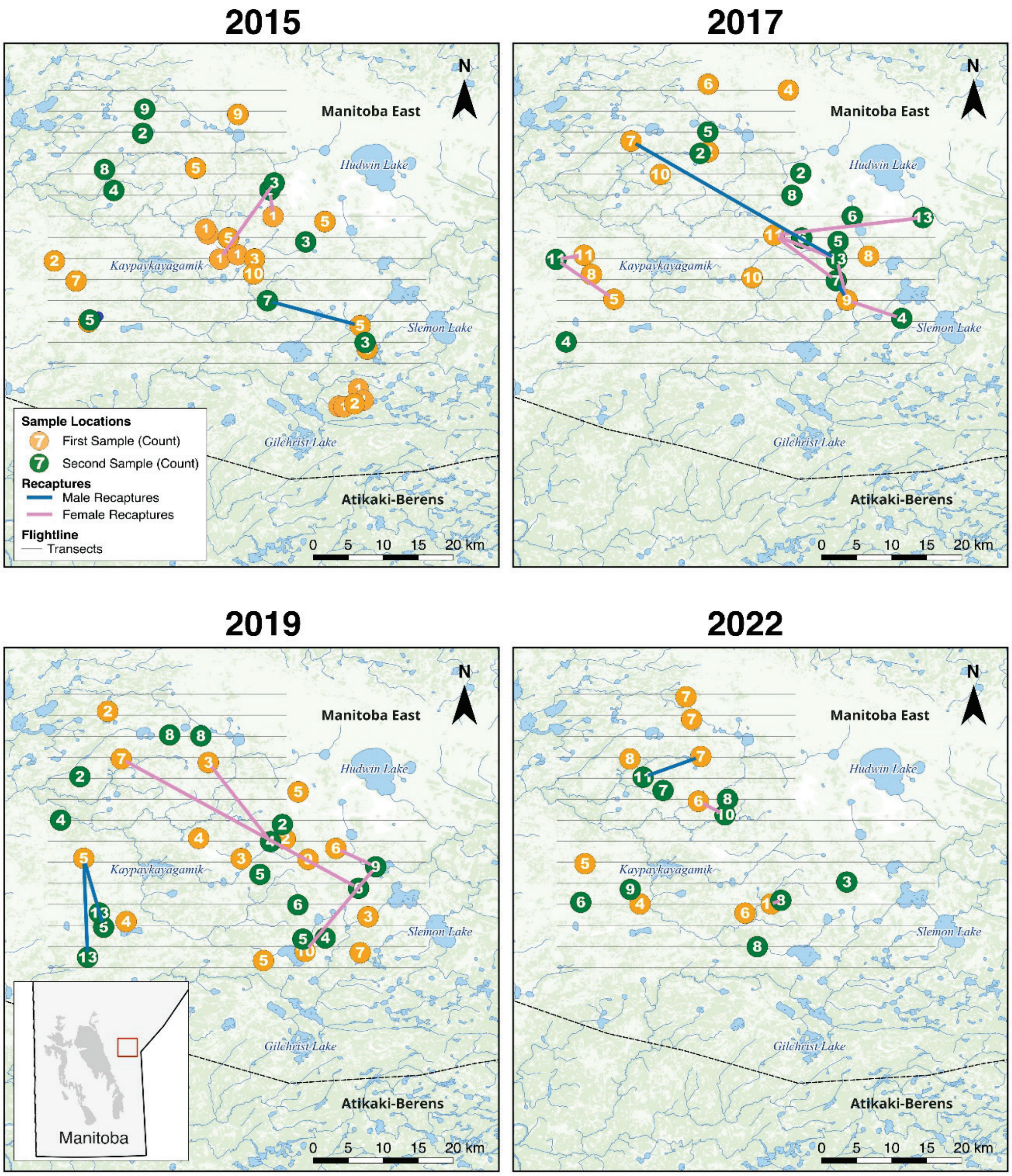

Figure 5: Within Year Scat Collection and Recaptures for the Charron Lake Range with lines connecting previously captured individuals from all years.

See Appendix 1 for population estimate figures (Appendix 1, Figures 1-10) based on excel data provided by Trent University (2023) that illustrate capture rates for three of the four ranges surveyed. A figure of abundance for Charron Lake was reproduced from Trent University data from the LP estimate (closed population) for 2022 (Appendix 1, Figure 11).

5.2 WTD *P. Tenuis* Results

No *P. tenuis* was found in The Pas region, while both *P. tenuis* and *P. andersoni* species were found in the Swan River region (Figure 7-Figure 8). Of 129 total samples analyzed for blast species in both regions, 69 samples (53.5%) were positive for *P. tenuis*, 38 samples (29.5%) positive for *P. Andersoni*, and 22 samples (17%) negative for presence of either species (Table 3). See Table 3 for further breakdown of blast species by Station and Location.

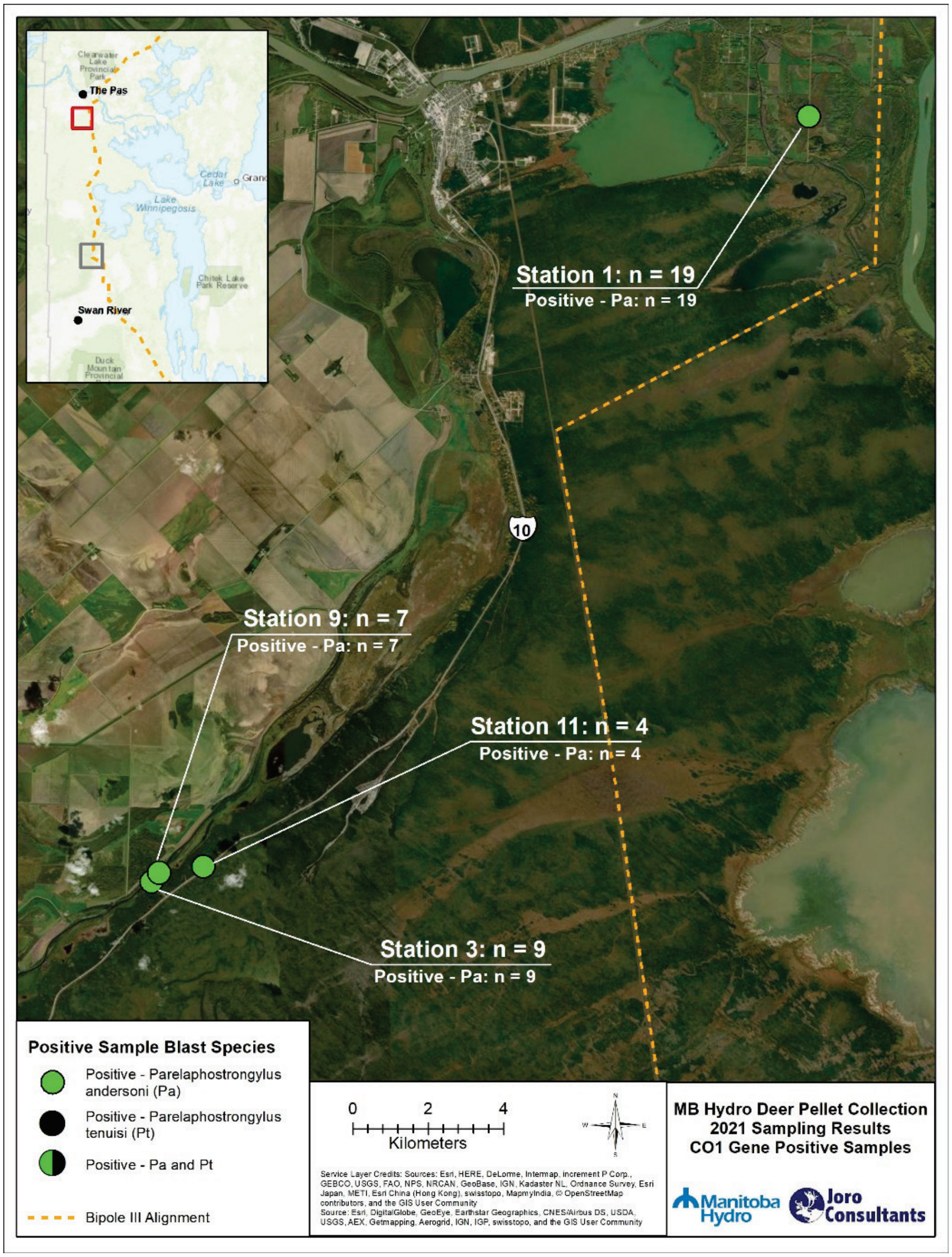

Figure 6: Positive blast species in the Pas region (*P. andersoni* (Pa) detected, but no *P. tenuis* (Pt))

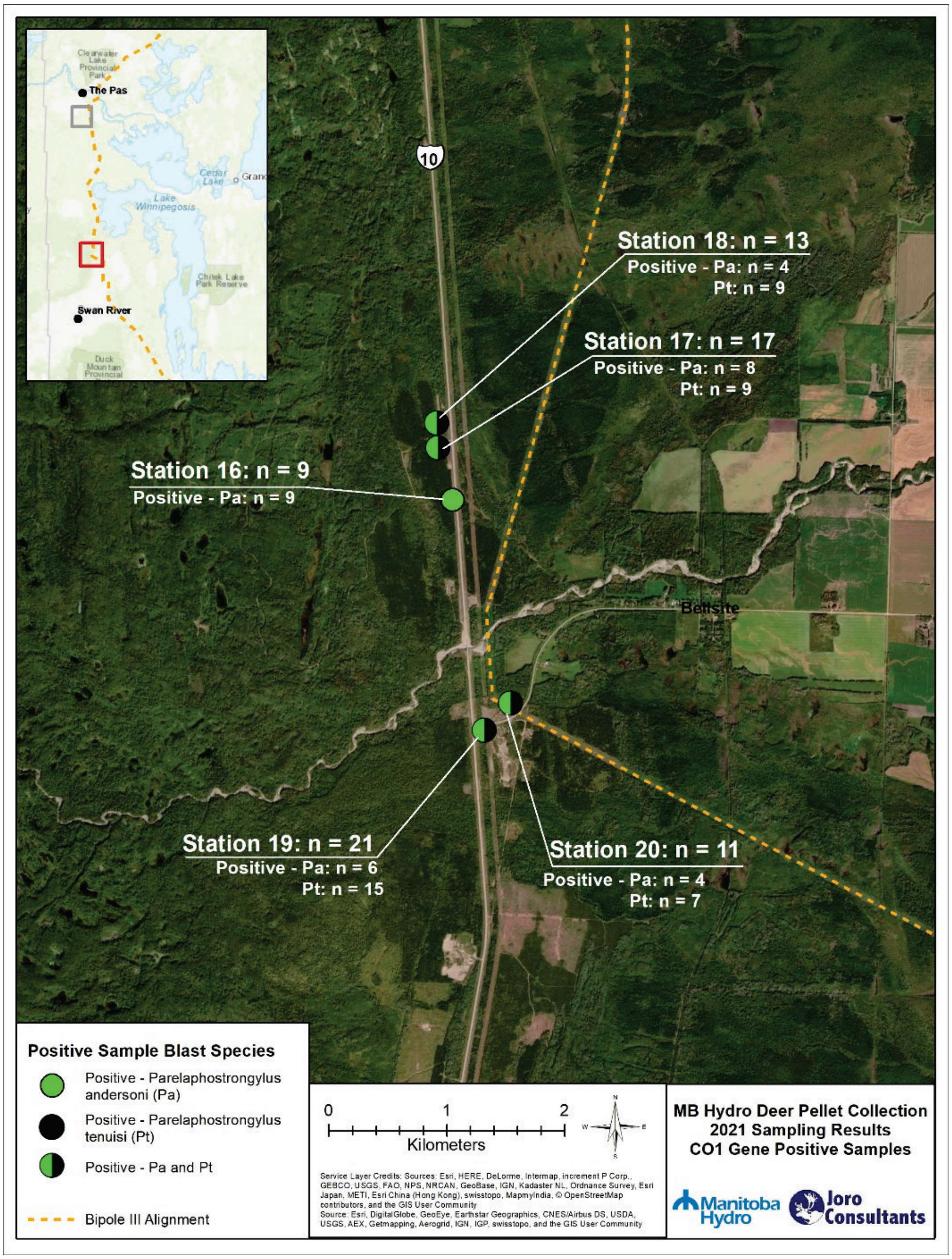

Figure 7: Positive blast species in the Swan River region (P. andersoni (Pa) and P. tenuis (Pt) detected)

Table 3: Total Number and Percentage of Nematodes Present or Absent by Station Location and Blast Species

Station #, Location	No. Samples Nematodes Absent	No. Samples *Pa*[1] Present	No. Samples *Pt*[2] Present	Total No. By Station
001, The Pas	1	18	--	19
003, The Pas	2	9	--	11
009, The Pas	7	7	--	14
011, The Pas	--	4	--	4
016, Swan River	4	9	--	13
017, Swan River	3	8	8	19
018, Swan River	4	4	8	16
019, Swan River		6	15	21
020, Swan River	1	4	7	12
Total No. of All Samples	**22**	**69**	**38**	**129**
Total % of All Samples	**17%**	**53.5**	**29.5**	**100**

1. P. Andersoni
2. P. tenuis

6.0 DISCUSSION AND MONITORING RECOMMENDATIONS

Monitoring recommendations are based on previous requirements outlined in the BPIII Biophysical Monitoring Plan (MB Hydro 2018). Monitoring has guided the ongoing review of tasks and objectives throughout Project Construction and Operation. Based on the overall results to date, the following discussion and recommendations are provided according to the recommended monitoring activities for caribou and WTD VEC's identified in the Project EIS (Appendix 1 Tables 1-3).

6.1 CMR Findings

Sample size relative to the extent to which the population is open may be a factor. Wabowden and Reed Lake estimates had lower Coefficients of Variation (CV) than Charron Lake and less variable estimates. Population estimates generated from the models show increase and decrease through time within very wide confidence intervals. In Wabowden the population rose between 2015 and 2017, and slowly declined between 2017 and 2022; whereas in Reed Lake the population rose between 2015 and 2017, fell between 2017 and 2019, and then rose again between 2019 and 2022. Lambda rates for these ranges are consistent with population estimates; in Wabowden they did not statistically vary from 1, but Lambda was estimated to be <1 for 2017-2019 at Reed Lake (and significantly >1 for the other years). The Bog abundance follows the same pattern as Reed Lake, with large increases in abundance (and Lambda) between 2019 and 2022.

Despite some populations having wider confidence intervals on their estimates, in general, it was found that RD analyses provided better parameter precision in abundance estimates than using within-year LP estimates (e.g. CV was much improved for RD). The wide variation of estimates between years makes it very difficult to associate or detect any Project-related effect. This is also confounded by the cumulative effects of other activities and disturbance including fire, mining, forestry, predator abundance, and natural variation.

Fecal collection has generally been constrained to the areas and transects delineated in 2015 and analyzed as closed populations. The advent of open population analyses was introduced in 2019. As described in the methods, collared individuals and last location data likely increased the opportunity to recapture individuals either for that year, or previous years between 2015 and 2019 when collars were still active. In general, this led to a lower rate of genotypes recaptured between Time 7 and Time 8. Except for Wabowden (39%), most other ranges were much lower for 2022 (Reed Lake 6%, Charron Lake 7% and The Bog 11%). This contrasts with the generally higher genotype recaptures on years with collared animals (Wabowden 2015 had 59%, the highest observed recovery). It should be noted that over the 2015-2019 period, Charron Lake had the lowest recovery rates of any of the ranges (2019 had 6% genotype recapture and the highest was 2017 with 10%), which is likely a result of fewer collars and tracking opportunities.

As mentioned, other factors potentially influencing the reported population densities and Lambda rates relate to the number of active collars, which were deployed for other aspects of boreal caribou monitoring for BPIII. By 2020 all collars were expired or retrieved and may explain samples not being robust enough for the Charron Lake population. There is no question that recovery rates are higher for populations with many active collars to assist in the sampling effort. Future application of fecal collection and genetic analysis would benefit from a concurrent collaring program and GIS analysis.

Additionally, the potential for immigration and emigration and other cumulative effects from human and natural disturbance are not considered with the interpretation of potential BPIII effects. Areas of genetic sampling are not inclusive of the full range for these populations intersecting the BPIII route and in areas where several populations are known to have individuals that move between them (e.g. William Lake, Wabowden, and Wapisu).

Overall, the CMR results did not detect any declines in population status resulting from the Construction or Operation of the BPIII Project. Other considerations are discussed below.

- Future Manitoba Hydro monitoring programs considering DNA as a tool for assessing potential project effects should consider the following:
    - Annual population estimates are variable between years with large confidence intervals making it difficult to link results to a Project-related effect.
    - Fecal sample collections can be influenced by the presence of collared animals and increase the number of recaptures during years where collars are on the landscape. Conversely, when there are no or few active collars, recaptures numbers decline as collars become unfunctional.
- Other potential factors affecting boreal caribou populations, such as natural and anthropogenic cumulative effects or predator/prey demographics, are also critical in range ecology and management. Determining population effects can take years to manifest in terms of detecting population decline or range abandonment and is referred to as a lag effect (Environment and Climate Change Canada 2020, Vors et al. 2007). CMR as a tool to assess population status is consistent with provincial and federal requirements in boreal caribou conservation planning and implementation of Action Plans.
- Historical Manitoba Hydro telemetry data could be further assessed and combined with provincial data from eastern Manitoba to determine extent of collared animal exchange between ranges and populations, through various analyses such as long-distance movement and fuzzy cluster analysis approaches, to determine landscape distribution of boreal caribou and identify open versus closed populations. This could provide future context for Manitoba Hydro monitoring programs on boreal caribou if required.

6.2 WTD Fecal Sampling to Determine *P. Tenuis* Occurrence

As per WTD fecal collections the presence of *P tenuis* has not been documented north of Swan River. All DSL species detected as positive have not been found within sampling areas near The Pas. Based on the overall monitoring of DSL occurrence, there is no evidence of any Project-related effects due to increased infection rates of *P. tenuis* to moose and WTD associated with habitat alteration during Construction and Operation.

The continued northward expansion of WTD across the province and potential effects of *P. tenuis* transmission may require long-term monitoring. Gastropod species that host *P. tenuis* could be monitored to detect potential risk of infection through a periodic provincial monitoring program if deemed necessary. The gastropod species commonly associated with *P. tenuis*, includes snails and slugs, particularly those of the *Polygyridae* family (Lankester and Anderson 1968). These gastropods serve as intermediate hosts for the parasite, facilitating its life cycle in moose and caribou if consumed while grazing. This results in the parasite's larval stage migrating to the central nervous system, ultimately leading to neurological damage and potentially fatal outcomes.

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APPENDIX 1: TABLES AND FIGURES

Appendix 1 Table 1: Monitoring Activities for Caribou

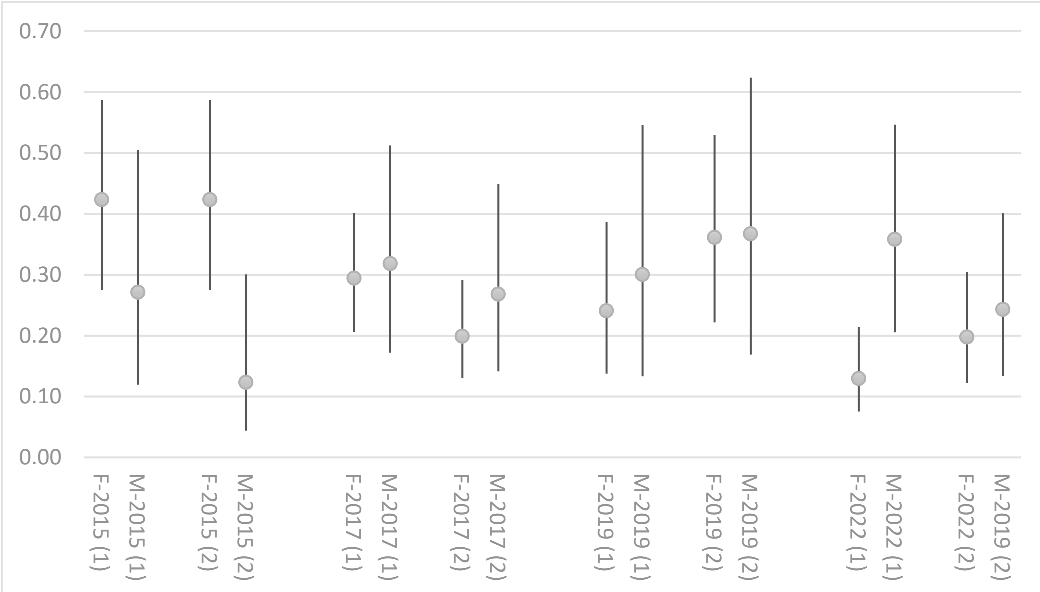
Phase	Task	Environmental Indicator	Site Location	Duration	Frequency	Timing	Measurable Parameter
Construction Post-construction	Population monitoring	Change in population state (viability, structure, abundance)	P-Bog, N-Reed, Wabowden, Charron Lake (reference) woodland caribou ranges	≤25 years or until suitable knowledge acquired	3 year intervals	Winter	Significant range (landscape) scale change in population abundance, structure, growth rate and/or viability

Appendix 1 Table 2: Monitoring Activities for Deer

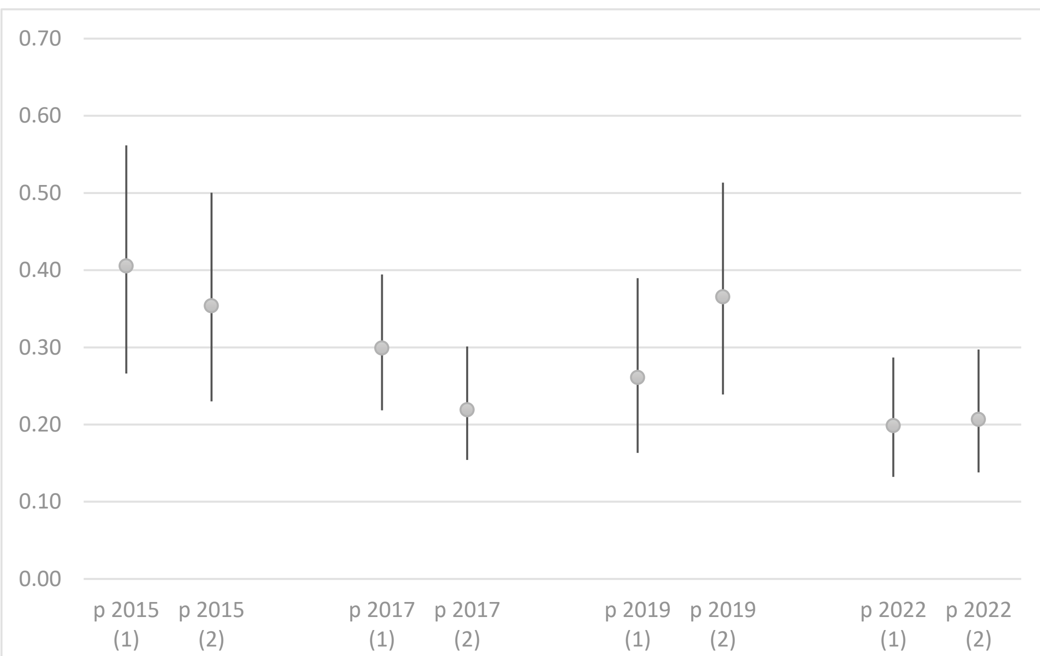
Phase	Task	Environmental Indicator	Site Location	Duration	Frequency	Timing	Measurable Parameter
Construction Post-construction	*P. tenuis* sampling via deer feces collection	Presence / absence	N3, N4	2-5 years	Annual or as necessary	Winter	*P. tenuis* presence in deer feces along Project ROW

Appendix 1 Table 3: Monitoring Program Recommendations for Caribou and Deer

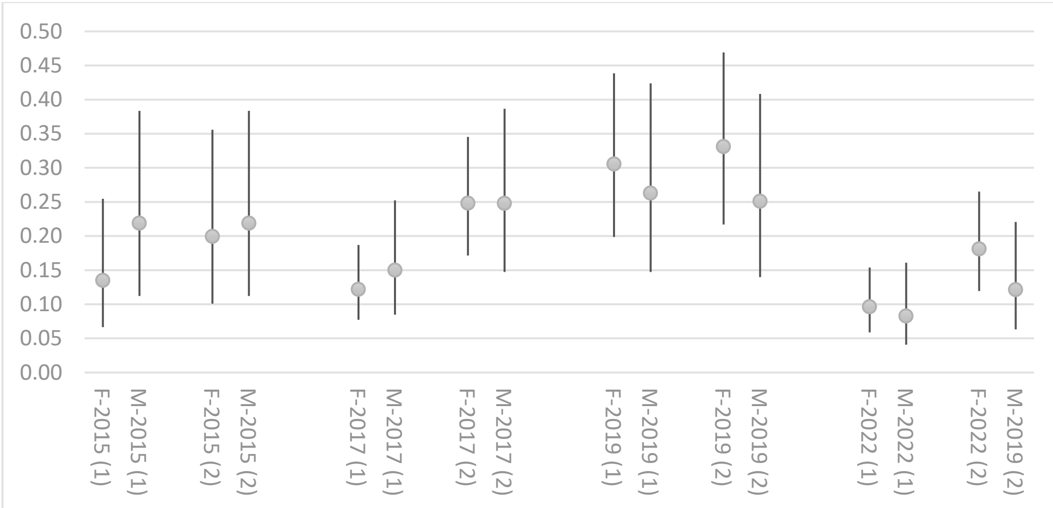
Wildlife VEC	Recommendation	Project Monitoring Commitment
Boreal Woodland Caribou	Continue **Capture-Mark-Recapture (CMR) Sampling** post-construction using Non-invasive Genetic Survey (NGS) methods extending sampling frequency every 3 years up to 25 years.	Monitor periodically up to 25 years or until suitable knowledge is acquired
Deer	***P. tenuis* monitoring** to assess potential of change in prevalence of spiney-tailed larvae shed by deer proximate to the ROW (N2 and N3 construction segments).	Assess during construction and repeat 2- 5 years post-construction



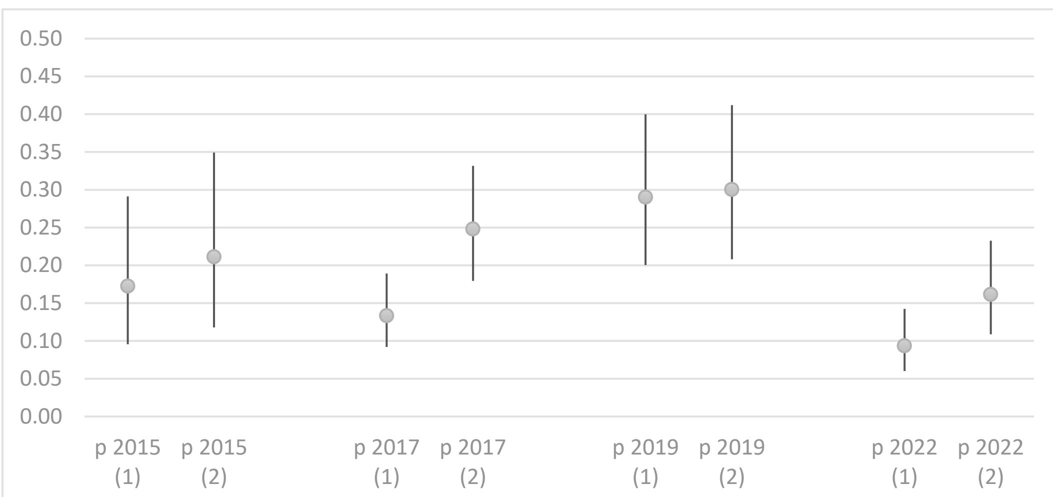
Appendix 1, Figure 1: Capture Rate, p(sex,time) vs Survey Year for the Bog Range



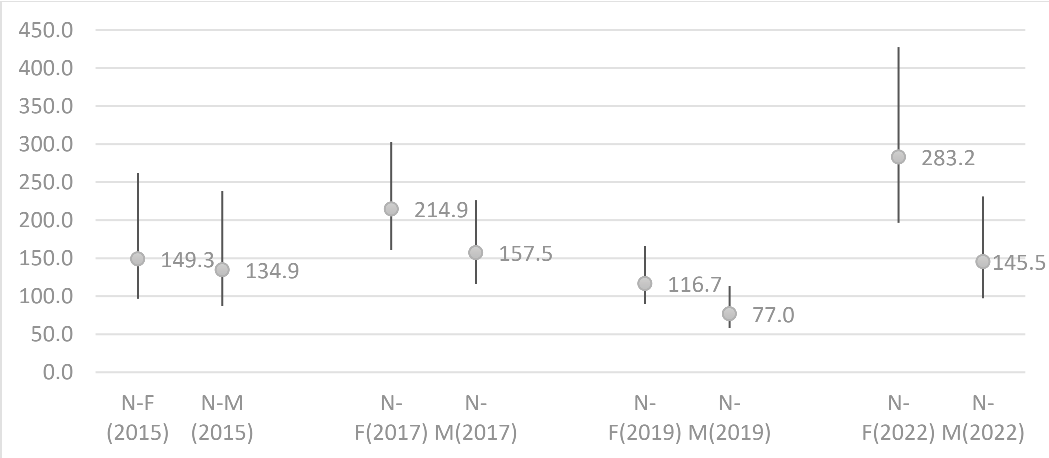
Appendix 1, Figure 2: Capture Rate p(time) vs Survey Year for the Bog Range



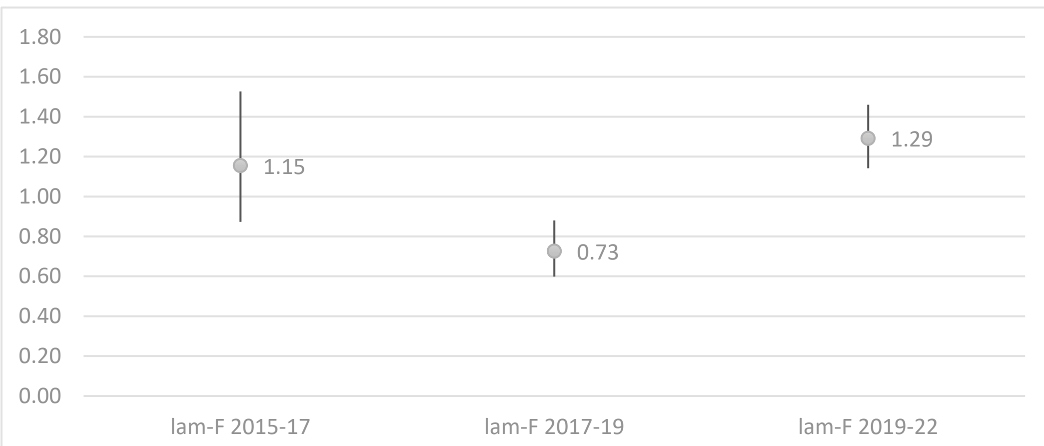
Appendix 1, Figure 3: Capture Rate, p(sex,time) vs Survey Year for Naosap-Reed Range



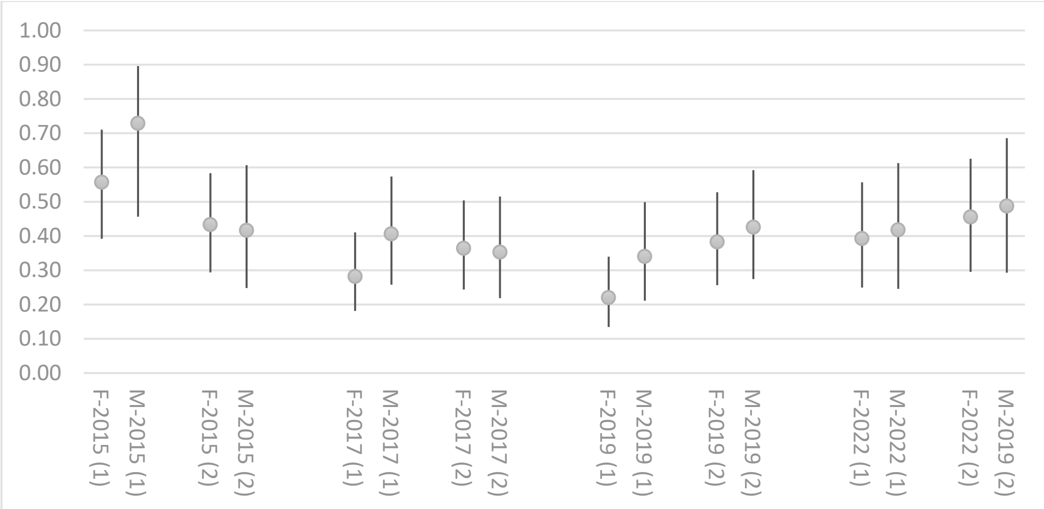
Appendix 1, Figure 4: Capture Rate p(time) vs Survey Year for Naosap-Reed Range



Appendix 1, Figure 5: Abundance Estimates from Robust Design Model for Naosap-Reed Range

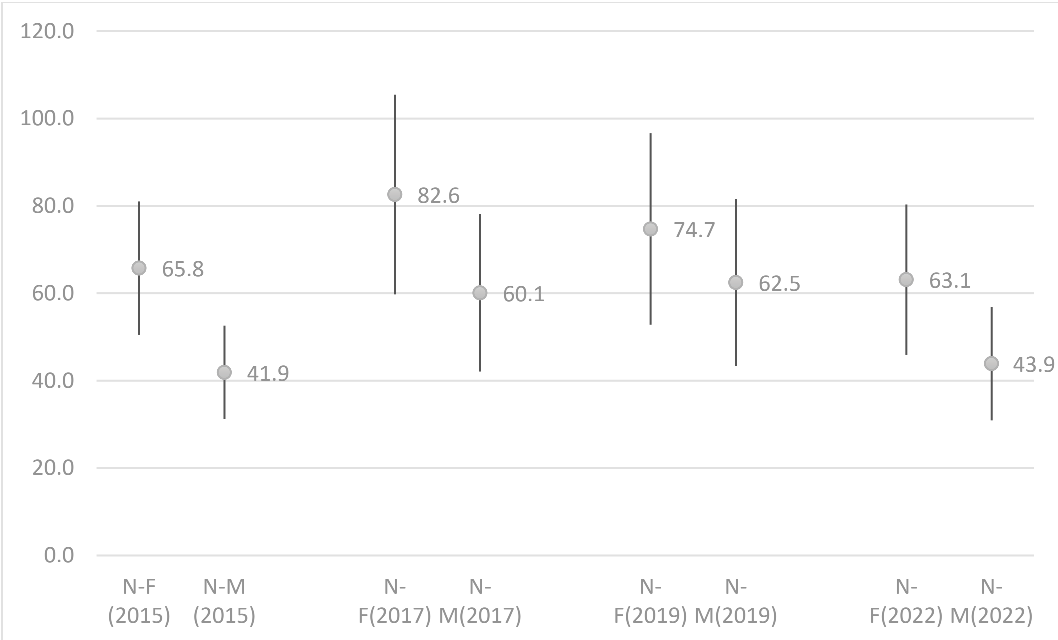


Appendix 1, Figure 6: Lambda (Per Year) Estimates from Robust Desing Model for Naosap-Reed Range

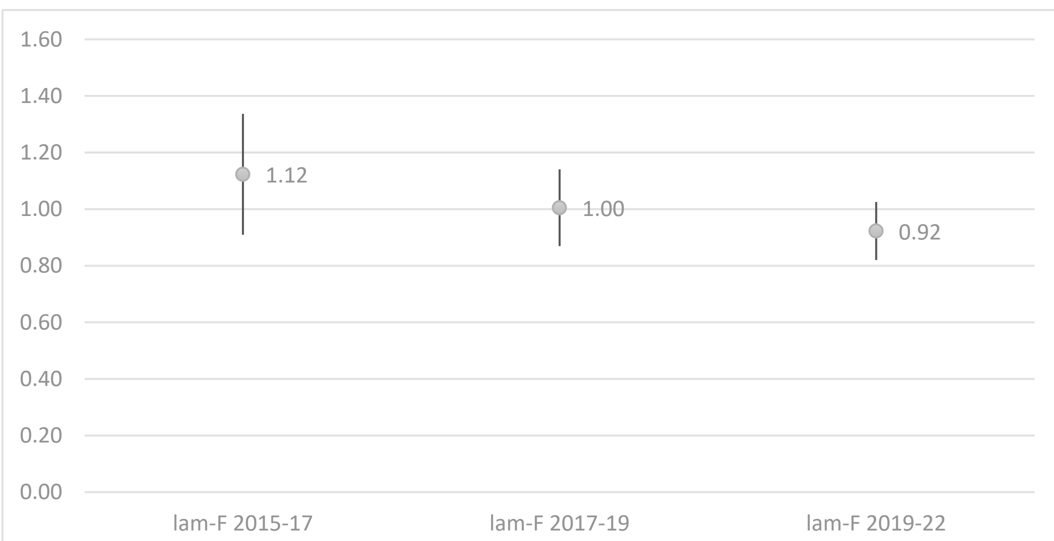


Appendix 1, Figure 7: Capture Rate, p(sex,time) vs Survey Year for Wabowden Range

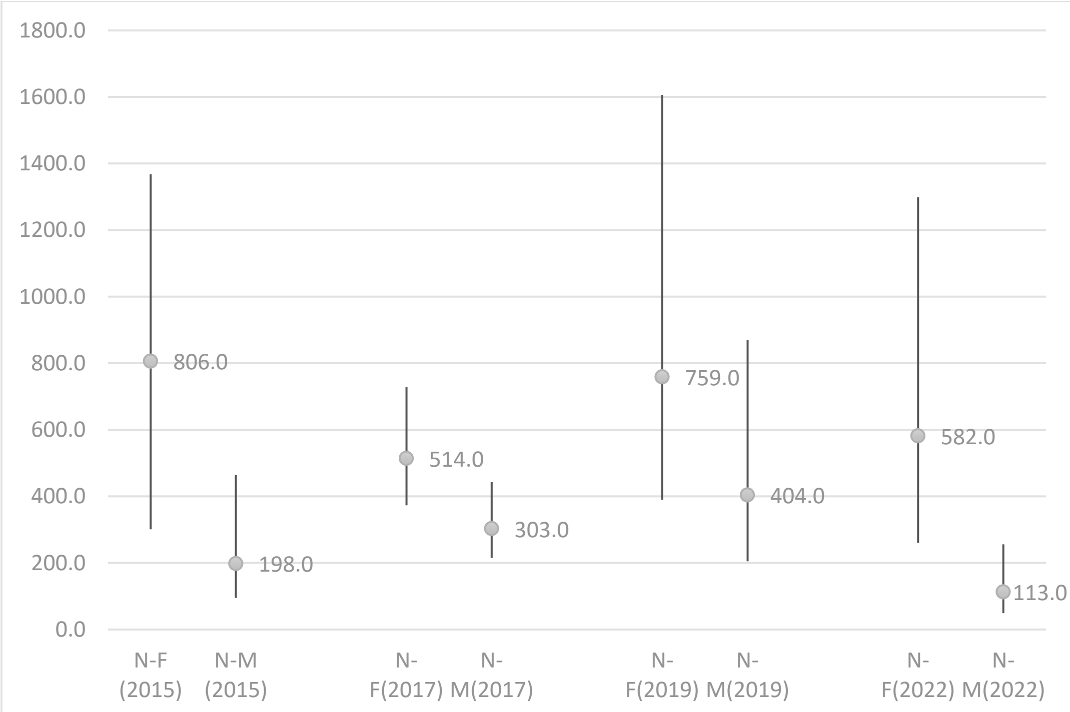
Appendix 1, Figure 8: Capture Rate p(time) vs Survey Year for Wabowden Range



Appendix 1, Figure 9: Abundance Estimates from Robust Design Model for Wabowden Range



Appendix 1, Figure 10: Lambda (per year) Estimates from Robust Design Model for Wabowden Range



Appendix 1, Figure 11: Abundance Estimates from Robust Design Model and only Lincoln-Peterson Estimates for 2022 for Charron Lake Range