NEW GOLD RAINY RIVER MINE
APPENDIX S
2018 WILDLIFE MONITORING REPORT

New Gold Inc. Rainy River Mine

2018 Wildlife Monitoring Report
Per Provincial Environmental Assessment Notice of Approval
Condition 5
TC111504

Prepared for:

New Gold Inc.

March 2019

New Gold Inc. Rainy River Mine

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Per Provincial Environmental Assessment Notice of Approval
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Prepared for:

New Gold Inc.
Rainy River Mine

Prepared by:

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Executive Summary

New Gold Inc. (New Gold) has constructed, is now operating, and will eventually reclaim a new open pit and underground gold mine, the Rainy River Mine (RRM), with processing plant and related infrastructure. The RRM site is located in the Township of Chapple, District of Rainy River, in northwestern Ontario, approximately 65 kilometres (km) northwest of Fort Frances, and 420 km west of Thunder Bay. Construction of the RRM began in the winter of 2015, normal operations and production began in 2017.

Regular baseline and monitoring studies have been undertaken since 2009 and have established a comprehensive understanding of the local environment. As part of the Federal environmental assessment process, New Gold committed to follow-up monitoring programs focusing on avian populations to verify the accuracy of the environmental assessment predictions. The current report provides the methods and results from the 2018 wildlife follow-up monitoring program and some initial statistical comparisons to baseline and construction years.

Avian morning point count stations were surveyed in 2014, 2015 (baseline), 2016 (construction) and 2018 (post-construction) to allow for comparisons across years, and the potential to assess any changes in the distribution, abundance, density and richness of species over time within the impact areas as well as areas outside the impact zone(control areas). Impact stations were located around the periphery of the mine site, whereas control stations were located at least 5 km from the mine site.

Data analysis of species distribution, abundance, density and richness were conducted to evaluate temporal and spatial effects of the RRM construction and operation on dominant avian species as well as to identify potential effects on primary avian guilds based on habitat preference.

The comparison of avian populations across survey years suggests that the RRM operations have not significantly adversely affected avian populations in the long term. Half of the most commonly occurring species evaluated experienced no interaction effects on abundance or density, suggesting that the RRM has not had an adverse effect on several of the most commonly occurring species. The other half of the most common species had interaction effects indicating the RRM had some effect on their populations. Some species appear to have been displaced temporarily during construction, either into control stations or further afield. The progression into mine operation activities and the decrease in intensive disturbances appears to have allowed these species to re-disperse evenly and for some, to move into optimal regenerating habitats created by the construction activities. Other species do not appear to have been adversely affected by construction activities but are showing preferential locations in post construction.

Mine related construction activities may provide increased habitat opportunities for some songbirds in the areas surrounding the RRM footprint. Species of Conservation Concern (SCC) Edge / Shrub / Successional birds increased specifically at impact stations. This indicates that construction activities have resulted in the creation of early successional habitat preferred by these species, causing a shift into these optimal habitats. Two species within this guild analysis, Chestnut-sided Warbler and Song Sparrow showed similar significant trends at the species level.

Forest birds (SCC and non-SCC) showed interaction effects whereby abundance and richness decreased at impact stations between 2014/15 and 2016, followed by an increase in these metrics in 2018 (i.e., post-construction). Conversely, these metrics increased at control station between 2014/15 and 2016, followed by a decrease in 2018. This indicates that these species may have been negatively impacted by construction activities being undertaken at the RRM impact stations. Individuals may have avoided impact

stations in 2016 and established breeding territories further away from construction activities. Individuals appear to be dispersing more evenly in 2018 (post-construction) now that habitats around impact stations are no longer undergoing active disturbance. Forest birds are frequently more common at control stations as compared to impact stations suggesting that there is more optimal (forested) habitat for these species further from the RRM. Black-and-white Warbler, Hermit Thrush, Red-eyed Vireo and White-throated Sparrow, species belonging to the Forest bird guild, showed similar results at the species level.

Grassland / Open Country birds are showing broad population increases, which could be attributed, at least in part, to the prevalence of optimal habitat provided by the Bobolink Overall Benefit lands and the work undertaken by New Gold to ensure these lands are maintained as high quality grassland bird habitat. Non-SCC Grassland birds had greater density and richness at impact stations. However, this may be a result of study design bias, since 32 stations were located within the Bobolink Overall Benefit areas (which provide preferred grassland habitat), as opposed to 11 control stations.

Overall, the data suggests that at this time most birds are not avoiding areas associated with mine activities, other than where habitats have been directly displaced by mine infrastructure. Abundance and density values which decreased in 2016 appear to be trending back towards baseline values, suggesting a lack of residual negative interaction effects on species and guilds. Ongoing monitoring studies will continue to identify longer term trends in avoidance and / or acclimatization of bird species to RRM activities.

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1.0 Introduction

1.1 Project Background

New Gold Inc. (New Gold) is constructing, operating and eventually reclaiming a new open pit and underground gold mine, the Rainy River Mine (RRM). The RRM will produce doré bars (gold with silver) for sale. Physical works related to the RRM consists primarily of:

- Open pit and underground mine;
- Overburden, mine rock and low grade ore stockpiles;
- Primary crusher and process plant;
- Tailings management area;
- 230 kilovolt transmission line;
- Relocation of a portion of gravel-surfaced Highway 600; and
- Associated buildings, facilities and infrastructure.

The RRM site is located in the Township of Chapple, District of Rainy River, in northwestern Ontario, approximately 65 kilometres (km) northwest of Fort Frances, and 420 km west of Thunder Bay (Figure 1-1). Lands in the immediate RRM site vicinity are typically gently rolling to flat, forested wetlands in low-lying areas, rounded bedrock outcrops and subcrops in upland areas and areas that have been cleared for agriculture. Local drainage systems are characterized by small creeks that flow to the Pinewood River which drains most of the RRM site area.

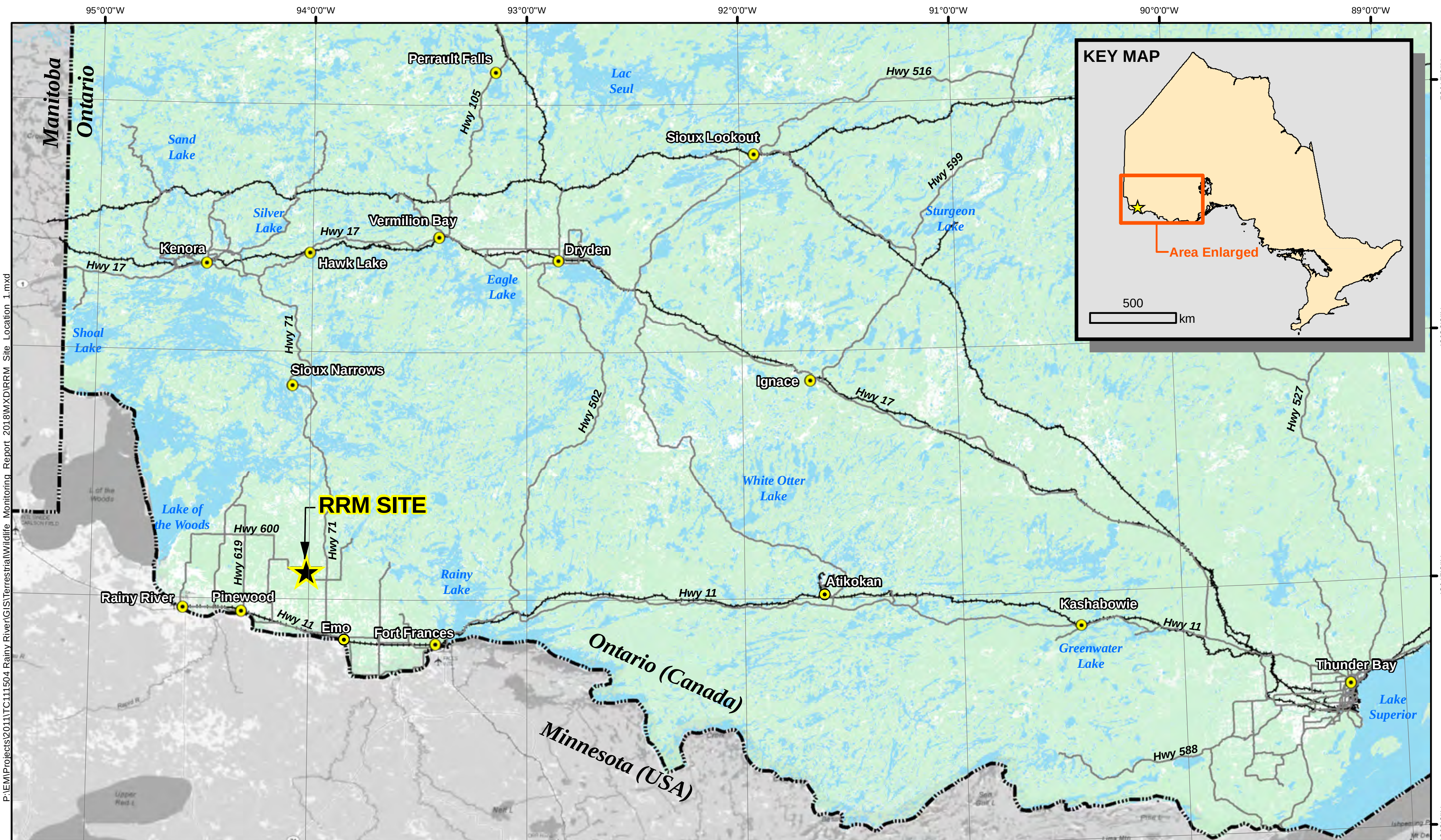
Environmental baseline studies for the RRM, initiated in 2009 and continued through development, established a comprehensive understanding of the composition of local plant and wildlife communities within the RRM footprint as well as surrounding lands. Regular baseline reports and wildlife monitoring reports have been produced in addition to annual Species at Risk (SAR) assessments (KCB 2011; AMEC 2011, 2012, 2014, 2015; Amec Foster Wheeler 2016a). The assessment of potential environmental impacts of the RRM was summarized in the RRP Final Environmental Assessment (EA) Report (Environmental Impact Statement) Version 2 (AMEC 2014), submitted to the Federal and Provincial Governments, including for Aboriginal and public review. A positive Federal EA Decision Statement was issued on January 12, 2015, and a favourable Provincial EA Notice of Approval was released on January 29, 2015. Construction of the RRM began in the winter of 2015, and normal operations and production began in 2017.

As a component of the Federal EA process, Wood Environment & Infrastructure Solutions, a Division of Wood Canada Limited (Wood; formerly Amec Foster Wheeler Environment & Infrastructure), was retained to create and implement a Follow-up Monitoring Plan (FMP; Amec Foster Wheeler 2016b). In accordance with the *Canadian Environmental Assessment Act, 2012* (CEAA 2012), the purpose of the FMP is to verify the accuracy of the predictions made in the EA about the potential impacts of the RRM on wildlife and wildlife habitat, and to monitor the effectiveness of rehabilitation efforts for wildlife habitat and terrestrial environments.

1.2 Objective and Scope

The RRP Final EA Report (AMEC 2014) estimated that approximately 2,170 hectares (ha) of terrestrial habitat would be directly impacted by the RRM. A total of 1,352 ha of woodland habitat would be cleared, of which 1,090 ha comprised second-growth aspen-birch hardwood forest, the dominant forest community type in the natural environment local study area (NLSA, as defined in AMEC 2014; Figure 1-2). Other affected community types include active agricultural lands (277 ha), open wetland habitat (261 ha), coniferous swamp (16.5 ha), and cultural meadows / fallow fields (10.8 ha). Portions of an additional 27 boreal community types were to be removed, with 11 of these community types expected to experience a loss of less than 10 ha. The NLSA supports a variety of wildlife species, including breeding populations of SAR and provincially rare species (AMEC 2014). The principal mitigation measures designed to limit adverse effects to terrestrial systems for the RRM include the development of a compact project footprint and the avoidance of SAR territories.

This *2018 Wildlife Monitoring Report* has been created to support the objectives of the FMP. The report presents the results of wildlife monitoring surveys undertaken in 2018 by Wood. Detailed monitoring results for SAR, including evening crepuscular bird surveys, are presented under a separate title, *2018 Species at Risk Monitoring Report* (Wood 2018).



LEGEND

- RRM Site
- Regional Communities
- Provincial / National Border
- Regional Road / Highway
- Railway

0 25 50 100 150 200 250 Kilometres

NOTES:
- Ontario base data extracted from Land Information Ontario (MNR) data warehouse, Queen's Printer for Ontario, 2011-2012
- Base data outside of Ontario extracted from ESRI DeLorme World Basemap

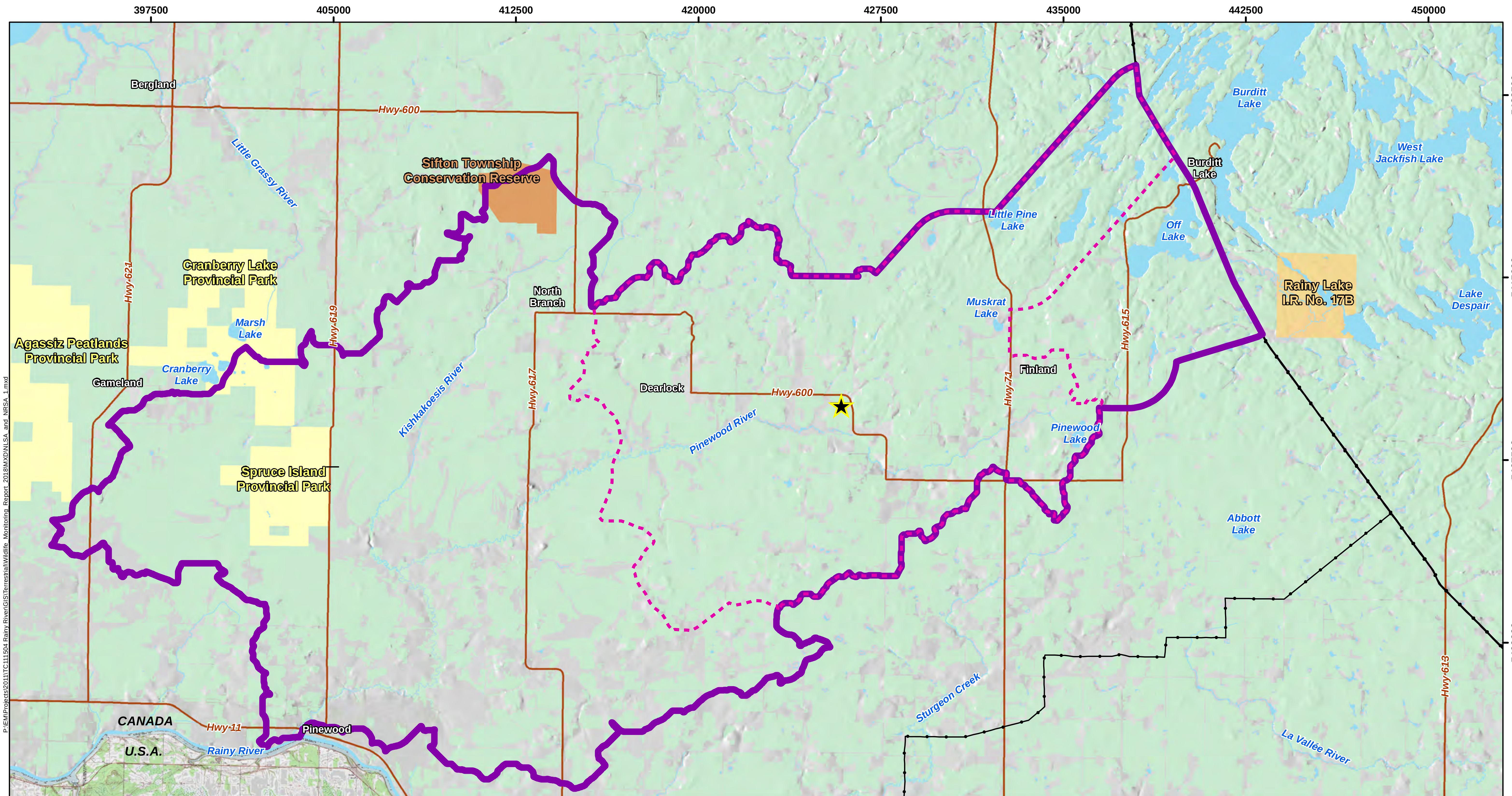
Datum: NAD83
Projection: UTM Zone 15N

newgold Rainy River Project wood.

RAINY RIVER MINE

Project Location

PROJECT N°: TC111504	**FIGURE: 1-1**
SCALE: 1:1,800,000	DATE: February 2019



LEGEND

- RRM Site
- Natural Environment Local Study Area Boundary (NLSA)
- Natural Environment Regional Study Area Boundary (NRSA)
- Transmission Line
- Regional Road / Highway
- Waterbody / Large Watercourse
- Wooded Area
- First Nation Reserve
- Conservation Reserve (Regulated)
- Provincial Park

NOTES:
- All base data on this map was extacted from Land Information Ontario (MNR), Queen's Printer for Ontario, 2011-2012
- USA land extracted from ESRI base map service, USGS Topo maps

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RAINY RIVER MINE

Local and Regional Natural Study Areas

Datum: NAD83
Projection: UTM Zone 15N

0 5 10 20 30 40 Kilometres

PROJECT N°: TC111504	FIGURE: 1-2
SCALE: 1:150,000	DATE: February 2019

2.0 Methodology

The following subsections outline the field methodology for completing the wildlife monitoring program, as well as the study design and analytical approach undertaken to evaluate project-related effects on avian communities.

The RRM FMP for breeding migratory birds and their habitats follows the Environment Canada (EC) guidelines for surveys as outlined in *Mining Project Baseline Desktop Assessment and Survey Requirements* (EC 2014a), *Incidental Take of Migratory Birds in Canada* (EC 2014b), and *General Nesting Periods of Migratory Birds in Canada* (EC 2018).

2.1 Avian Community

2.1.1 Morning Point Count Surveys

During the 2018 breeding bird season, morning point count surveys were undertaken at 185 long-term monitoring point count stations (Figure 2-1) distributed across available habitat types. All of these same point count stations were previously surveyed in 2016; however, only 181 of the 185 stations were surveyed in either 2014, 2015, or both. As such, statistical analyses on the temporal and/or spatial changes in the distribution, abundance, density and richness of avian species were only completed on the 181 stations surveyed across all monitoring years. High-level comparisons in avian community data between 2016 and 2018 were, however, evaluated using all 185 stations.

Magnolia Warbler (Photo: Wikimedia Commons)

Point count surveys were undertaken in accordance with standardized protocols (Fuller and Langslow 1994; OBBA 2001; EC 2014a) and were designed to target the majority of bird species that breed in proximity to the RRM site. The 2018 surveys were undertaken twice at each station during the breeding bird season by qualified biologists skilled in the identification of birds by sight and sound. During the second round of sampling, stations were surveyed in the reverse order from the first round (to the greatest extent possible) to reduce temporal sampling bias. Surveys were initiated prior to sunrise and extended to five hours after sunrise, depending on the weather conditions. Point count surveys were aborted or postponed if weather conditions were not optimal (e.g., light rain or high wind above 20 km/hour). Surveys were conducted for ten minutes at each listening station (an increase from the five minute listening period outlined in the OBBA 2001 guidelines) and all birds heard or observed were recorded at intervals of 0 to 50 metres (m), 50 to 100 m, > 100 m, and flyovers. In addition, birds were recorded at intervals of 0 to 3 minutes, 3 to 5 minutes, and 5 to 10 minutes. Each bird was recorded once and mapped on the field data sheets to minimize duplication of individual birds, as best feasible.

The first round of surveys was conducted between May 30 and June 5, 2018 and the second round of surveys was conducted between June 21 and 27, 2018. Incidental sightings were documented, particularly for SAR and species not detected during standardized point count surveys.

2.1.2 Analytical Methods

Morning point count survey stations are separated into impact and control stations. Impact stations were selected from point count stations surveyed at least once during the 2009 to 2014 baseline breeding bird studies and are located around the periphery of the RRM site (Figure 2-1), and in areas where noise from mine operation is expected to be greater than the average ambient noise level (approximately 40 decibels; dBA). Control stations are located at least 5 km from the RRM site (Figure 2-1), chosen to reflect a similar representation of ecosites found at impact stations, and where noise from mine operation is expected to be at or below the average ambient noise level. Additionally, the impact stations were positioned along the transmission line right-of-way (ROW), with control stations located at least 1 km from the ROW (Figure 2-1). Given the extent of previous anthropogenic disturbances and associated road networks throughout the area, it is recognized that birds at these control locations are likely experiencing and / or have experienced minor disturbance. As such these control stations serve as a reference with which to measure the effects of mine-related activities.

The purpose of separating stations into impact and control types was to allow for the application of a Before-After Control-Impact (BACI) study design, used to evaluate potential project-related effects on avian populations. The BACI design is statistically powerful, defensible, and allows for comparisons of the population metrics across years and between station types. The initial surveys were completed at 181 point count stations in 2014 and 2015, prior to the initiation of construction activities in the winter of 2015. These stations were re-surveyed over the years to allow for direct comparisons of the metrics during and after construction with baseline values. The paired nature of the design allows for an assessment of the potential adverse effects by the RRM on the avian population before and after construction activities.

The RRM FMP for breeding migratory birds and their habitats follows the EC guidelines for surveys as outlined in EC 2014a. As per this guideline, several metrics were applied to compare yearly changes in avian populations in an evaluation of potential project-related effects. The data and results are presented separately for impact and control stations. These metrics include:

- *Species Distribution (Percent Occurrence) Among Survey Stations:* a measure of the occurrence of individual species of birds at each point count station expressed as the percent occurrence. Percent occurrence was calculated by dividing the total number of species recorded by the total number of point count stations surveyed. This index of species prevalence does not take into account observation distance.

- *Species Abundance:* a measure of the maximum number of individuals recorded across all visits to a single point count station regardless of distance. The mean species abundance was calculated by dividing the sum of the maximum number of individuals recorded across all visits by the total number of point count stations. Species abundance is expressed as birds per station (birds/station).

- *Species Density:* a measure of the number of individual species present per unit area. Density was calculated at each survey station as the maximum number of birds per species recorded within a 100 m radius of the surveyor divided by the total area of the survey station (3.1416 ha), divided by the total number of count stations. Species density is expressed as birds per hectare (birds/ha).

- *Species Richness:* a measure of the total maximum number of species recorded across all visits to a single point count station regardless of distance. The mean species richness was calculated by dividing the sum of the maximum number of species recorded across all visits by the total number of count stations. Species richness is expressed as species per station (species/station).

The Ontario Landbird Conservation Plan has been created by Partners in Flight (PIF), through the collaboration of the Ontario Ministry of Natural Resources and Forestry (MNRF), Bird Studies Canada (BSC), and EC. In Ontario, plans have been developed for each of the three Bird Conservation Regions (BCR) occurring within the province. The purpose of these plans is to guide landbird conservation efforts so that the distribution, diversity and abundance of birds across this region are sustained within the estimated range of natural variability for this forest ecosystem. The Ontario Landbird Conservation Plan for the Boreal Hardwood Transition (North American BCR 12) overlaps with the NLSA (PIF 2008; EC 2014c).

For the purposes of this report, Species of Conservation Concern (SCC) include BCR 12 priority species as well as provincially and federally-listed SAR (PIF 2008, EC 2014c, ECCC 2018, MNRF 2018). The population metrics have been evaluated and results presented separately for SCC and non-SCC. This was done to highlight results for those species for which conservation has been prioritized.

For some analyses, bird species recorded were also grouped into one of four guilds based on habitat preferences. These four categories include:

- Edge / shrub / successional (species typical of shrubby and/or young habitats, including shrub swamps, bogs and fens);
- Forest (species typical of treed habitats, including treed swamp);
- Wetland / open water (species typical of large rivers, lakes and marshes); and
- Grassland / open country (species typical of open habitats).

Occasionally, observations were excluded from certain analyses. Observations of large flocks or groups of a single species can result in outliers in the statistical analyses and were consequently removed. Notations are made in each relevant results section when observations were excluded.

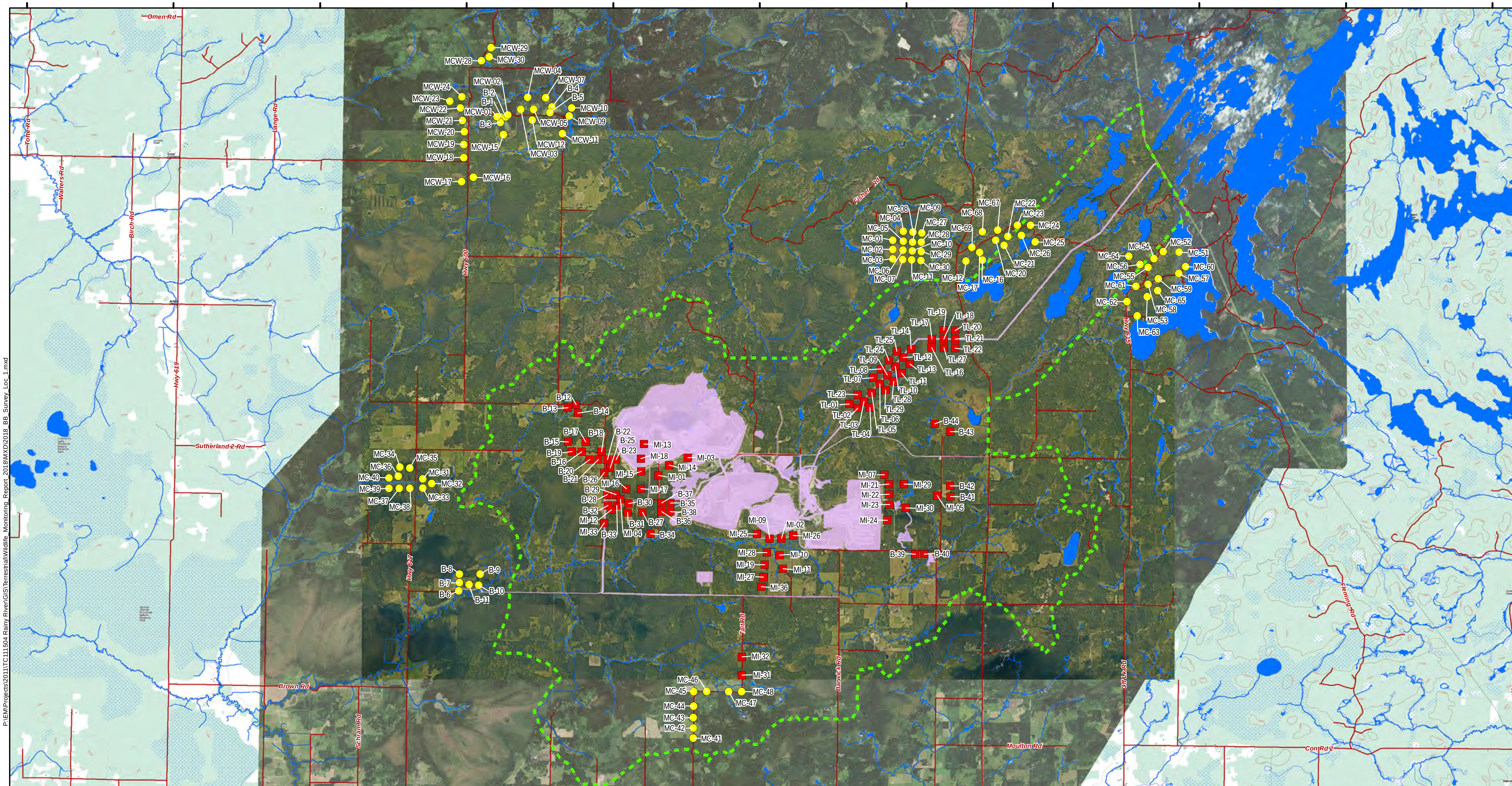
2.1.3 Statistical Analysis

Statistical analyses were completed using STATISTICA© software (StatSoft, Inc., 2009). A repeated measure analysis of variance (ANOVA) was applied to evaluate project-related effects on avian population metrics. Statistical analyses were completed on only those point count stations where monitoring was completed pre-construction (2014 or 2015), during construction (2016), and post-construction (2018). For pre-construction data, 2014 data was only included in the analysis when no 2015 data existed for a given point count station. Monitoring years (2014/15, 2016 and 2018) were inputted as the repeated dependent variables and station type (impact versus control station) was inputted as the categorical predictor. Assumptions of normality (normal distribution) were tested using Kolmogorov-Smirnov test and Shapiro-Wilk's test, as well as visually assessing quantile-quantile (Q-Q) plots and histograms. Some minor deviations from normality were detected within the analyses depending on the normality test applied; however, a graphical assessment of histograms and Q-Q plots suggested deviations were minor. Sphericity analysis, a measure of variance between all possible pairs of within-subject conditions, was also completed to verify the assumptions of repeated measures ANOVA; however, the assumption of sphericity was violated for several analyses. Nonetheless, as paired parametric analyses are highly robust to the presence of small deviations from normality and preferred over non-parametric analyses, the small deviations were considered acceptable to allow for the application of the parametric repeated measures ANOVA. Where sphericity was violated, a discussion on the influence of the violation relative to the analysis is provided in the results section below. Where the analyses revealed a significant interaction (i.e., one of the variables differs depending on the level of the other variable), the Fisher's Least Significant Difference (LSD) post-hoc test was utilized to detect differences between groups.

As the consequences of making Type II errors (false negative) may outweigh those associated with Type I errors (false positive) when evaluating environmental effects, a significance level of 0.10 (alpha = 0.10) was used to detect significant differences rather than 0.05 (Steidl et al. 1997).

2.2 Other Taxa

Incidental observations of other taxa, including mammal, reptile and amphibian species were collected opportunistically concurrently with the targeted avian surveys within the NLSA. The incidental observations included, but were not limited to: visual observations, vocalizations, and evidence such as tracks, scat, burrows and nests.



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LEGEND

- Approximate Principal RRM Facilities
- Natural Environment Local Study Area Boundary (NLSA)
- Road
- Watercourse
- Waterbody

Breeding Bird Point Count Survey Stations

- Monitoring Control Stations
- Monitoring Impact Stations

0 1 2 4 6 8 10 Kilometres

NOTES:
- Pleiades imagery Sept. 6, 2018 and July 20, 2014
- Road data extracted from Land Information Ontario, Ontario Road Network, MNRF

Datum: NAD83
Projection: UTM Zone 15N

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RAINY RIVER MINE

2018 Breeding Bird Point Count Survey Station Locations

PROJECT N°: TC111504	**FIGURE: 2-1**
SCALE: 1:125,000	DATE: February 2019

3.0 Results

The purpose of the RRM FMP is to evaluate potential project-related impacts on avian species in proximity to the RRM operations. Accordingly, this 2018 Wildlife Monitoring Report presents 2018 field results, high-level comparisons of the current results with those gathered at the same survey stations in 2016 (n=185), and a BACI statistical analysis to compare the current results with those gathered at the same survey stations in 2014/15 and 2016 (n=181).

Results for SAR listed as Threatened or Endangered under the *Endangered Species Act, 2007*, including Evening Crepuscular Bird Survey results are presented in the *2018 RRP Species at Risk Report* (Wood 2018) as required by Provincial and Federal legislation. As such, SAR are included in the following analyses but are not highlighted other than by grouping them with other SCC.

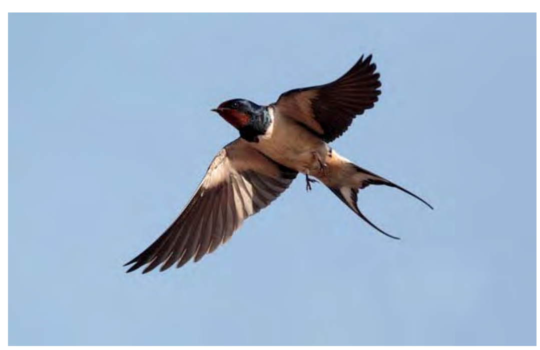
3.1 Avian Community

A total of 164 bird species have been recorded within the RRM monitoring area between 2009 and 2018, however, the number of bird species recorded has varied with each monitoring year. In 2018, 132 bird species and 4,309 individual birds were recorded during the morning point count surveys, which is an increase from the 115 species and 3,890 individual birds recorded in 2016 at the same 185 point count stations. A summary of all species recorded within each survey year (during standardized counts and incidentally) is provided in Appendix A.

3.1.1 Species of Conservation Concern

Morning point count surveys undertaken in 2018 recorded a total of 54 avian SCC, accounting for 40.9% of the total bird species recorded in 2018 (Appendix B). Forty-five (45) SCC were recorded at impact stations and 48 were recorded at control stations. These data indicate that there is currently little to no difference between the number of avian SCC at impact and control stations. The 54 species are all considered BCR 12 priority species with 12 further designated as SAR. Avian SAR are discussed further in the *2018 RRP Species at Risk Report* (Wood 2018).

Two SCC recorded in 2016 were not recorded during morning surveys in 2018 (Red Crossbill and Red-headed Woodpecker; Appendix C), whereas ten SCC recorded in 2018 had not been recorded in 2016 (American Woodcock, Black-throated Blue Warbler, Cliff Swallow, Evening Grosbeak, Herring Gull, Hooded Merganser, Northern Rough-winged Swallow, Purple Finch, Ring-necked Duck and Vesper Sparrow). Two additional SCC, Common Nighthawk and Eastern Whip-poor-will, were both frequently recorded during crepuscular surveys; one Common Nighthawk was recorded during morning surveys in 2016, and one Eastern Whip-poor-will was recorded during 2018 morning surveys but were otherwise not detected during morning point count surveys.



Barn Swallow (Photo: ThinkStock)

3.1.2 Species Distribution among Survey Stations

Of the 132 bird species identified within the monitoring area during the 2018 morning point count surveys, 113 species were recorded at impact stations and 120 species were recorded at control stations. Despite the slightly greater occurrence of species at control stations, the most widely occurring species were largely comparable.

Species of Conservation Concern

The five most widely occurring SCC recorded at impact stations in 2018, including the percentage of stations where presence was observed, were:

- Nashville Warbler (recorded at 73.3% of all impact stations);
- Common Yellowthroat (67.8%);
- Chestnut-sided Warbler (62.2%);
- White-throated Sparrow (54.4); and
- Song Sparrow (53.3).

Nashville Warbler (Photo: Bill Majoros/Wikimedia Commons)

These species were also the five most widely occurring SCC recorded at impact stations in 2016. The summary of dominant SCC occurrence between 2016 and 2018 is provided in Table 3-1 and presented in Illustration 1. Percent occurrence for all species from the 2018 surveys is presented in Appendix B and a multi-year comparison of population metrics is presented in Appendix C.

Four of these five species were also amongst the five most widely occurring species across the control stations. The five most widely occurring SCC recorded at control stations in 2018, including the percentage of stations where presence was observed, were:

- Nashville Warbler (81.1%);
- White-throated Sparrow (63.2%);
- Veery (46.3%);
- Chestnut-sided Warbler (43.2%); and
- Common Yellowthroat (34.7%).

Similar to the impact stations, these species were also the five most widely occurring SCC recorded at control stations in 2016. These results indicate that there is little difference in the dominant SCC species between the impact and control stations, as well as between survey years.

Non-Species of Conservation Concern

The five most widely occurring non-SCC recorded at impact stations in 2018, including the percentage of stations where presence was observed, were:

- Red-eyed Vireo (80.0%);
- Ovenbird (67.8%);
- American Robin (62.2%);
- Black-and-white Warbler (52.2%); and
- Blue Jay (42.2%).

These species were also the five most widely occurring non-SCC recorded at impact stations in 2016.

Four of these five species were also amongst the five most widely occurring species across the control stations. The six most widely occurring non-SCC recorded at control stations in 2018, including the percentage of stations where presence was observed, were:

- Red-eyed Vireo (91.6%);
- Ovenbird (70.5%);
- Black-and-white Warbler (50.5%);
- American Robin (48.4%);
- Hermit Thrush (41.1%); and
- Blue Jay (37.9%).

Red-eyed Vireo (Photo: Wikimedia Commons)

These species were also the six most widely occurring non-SCC recorded at control stations in 2016. These results indicate that there is little difference in the dominant non-SCC species between the impact and control stations, as well as between survey years.

The summary of dominant non-SCC occurrence is provided in Table 3-1 and presented in Illustration 2. Percent occurrence for all species from the 2018 surveys is presented in Appendix B and a multi-year comparison of population metrics is presented in Appendix C.

The slight differences within these species lists between impact and control stations indicate that impact stations may be attracting more species which adapt well to anthropogenic disturbances and prefer shrubby, regenerating and edge habitats (Song Sparrow and higher percent occurrence of Common Yellowthroat, Chestnut-sided Warbler and American Robin) while the control stations are attracting species which prefer forested habitats (Veery, Hermit Thrush and higher percent occurrence of Nashville Warbler, White-throated Sparrow, Red-eyed Vireo and Ovenbird).

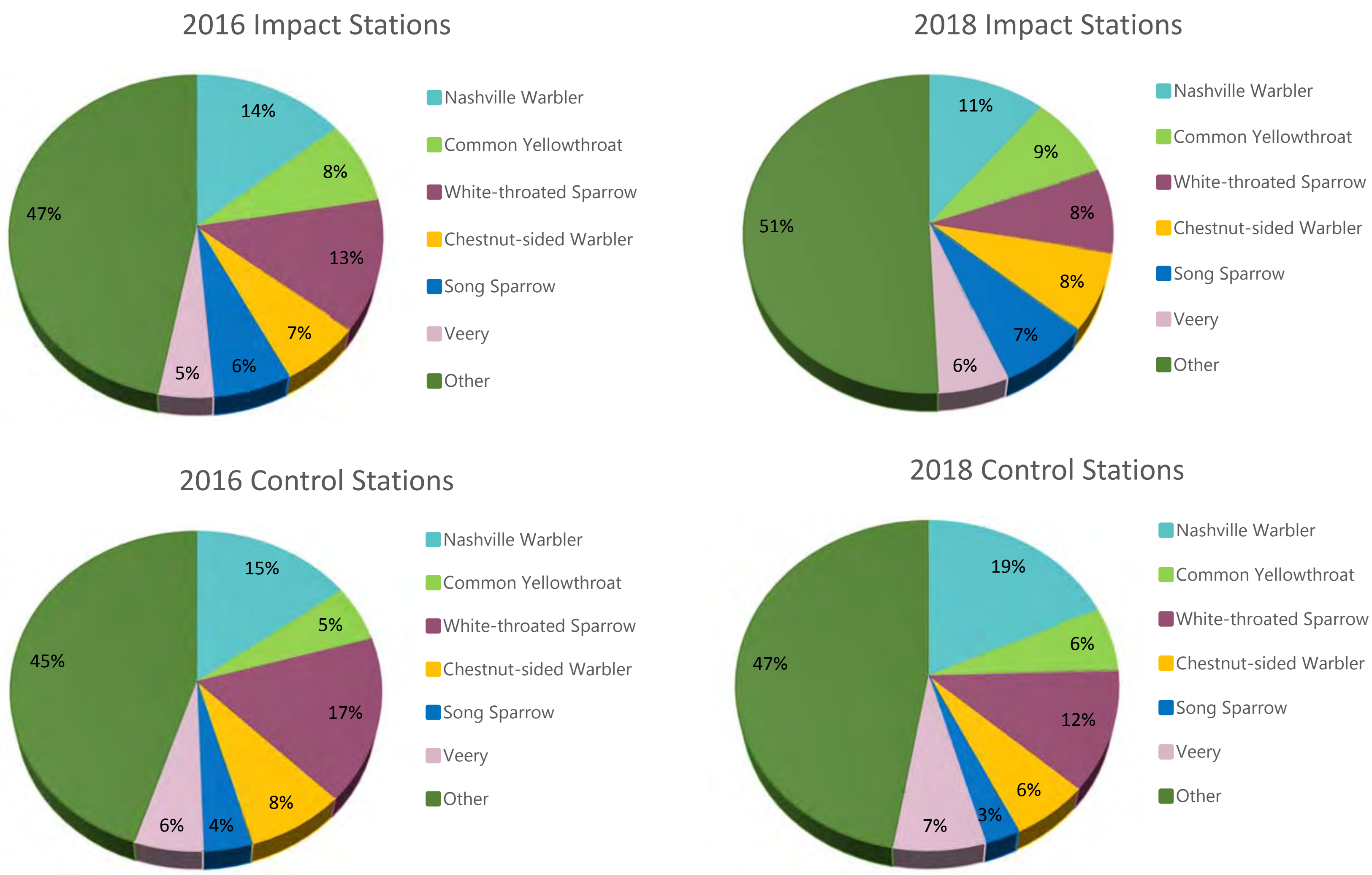


Illustration 1: Abundance of Dominant SCC Birds

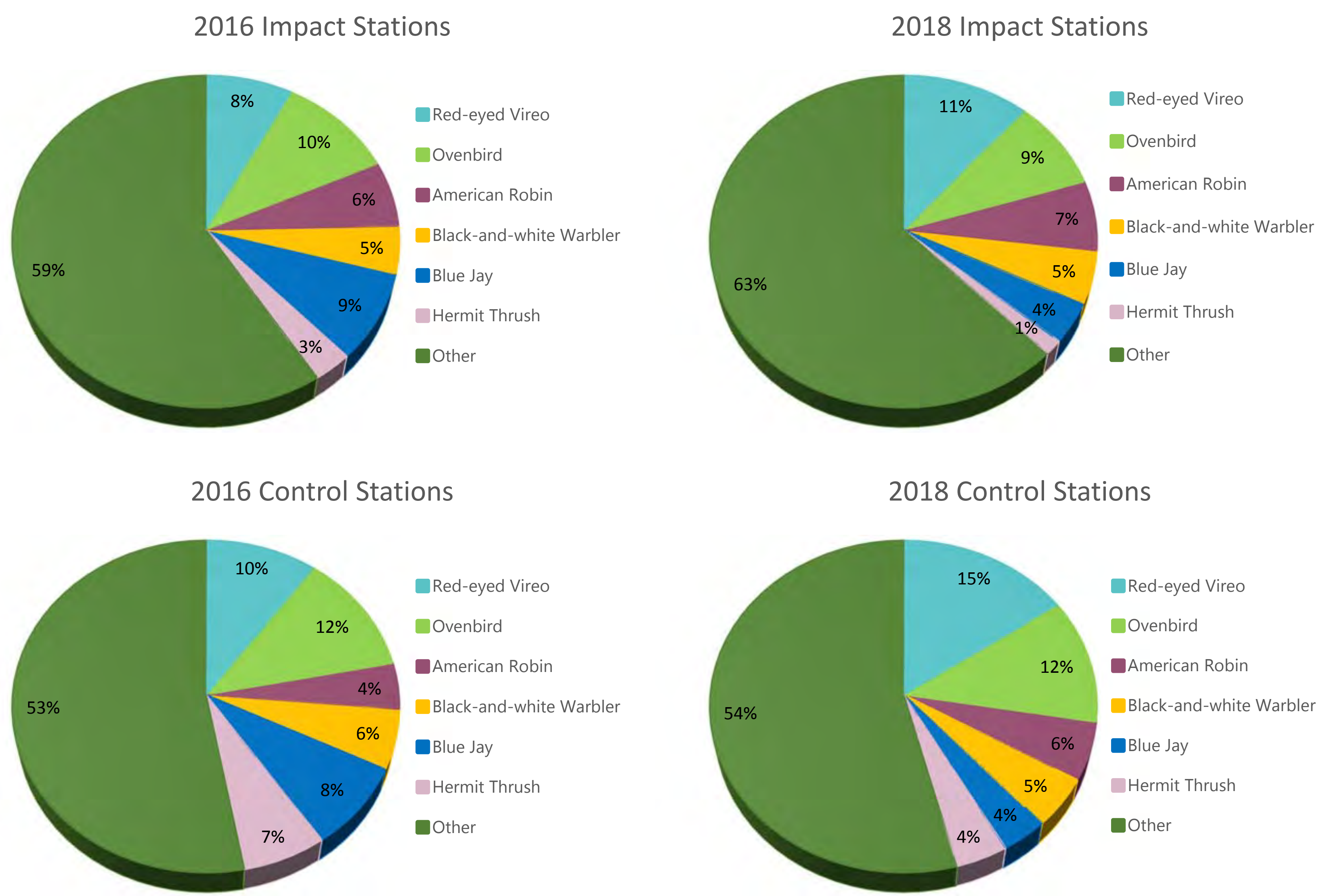


Illustration 2: Abundance of Dominant non-SCC Birds

3.1.3 Species Abundance

3.1.3.1 2018 Results

The most abundant birds were considered to be those with the highest abundance coupled with a relatively high (>25%) percent occurrence. Several species were identified in flocks or large groups and these bulk observations were excluded from the lists of dominant species and analyses as they can represent outliers in the statistical analyses.

During the 2018 morning point count surveys, 2,197 individual birds were recorded at impact stations and 2,112 individual birds were recorded at control stations. Despite the slightly greater abundance of individual birds at impact stations, the lists of most abundant species were largely comparable.

The five most abundant SCC recorded at impact stations in 2018, including their mean abundance, were:

- Nashville Warbler (average 1.28 birds/point count station across all impact stations);
- Common Yellowthroat (1.00 birds/point count station);
- White-throated Sparrow (0.99 birds/point count station);
- Chestnut-sided Warbler (0.94 birds/point count station); and
- Bobolink (0.89 birds/point count station).

These species were also the five most abundant SCC recorded at impact stations in 2016. Abundances for all species from the 2018 surveys are presented in Appendix B and a multi-year comparison of population metrics is presented in Appendix C.

Four of these five species were also amongst the five most abundant SCC across the control stations. Consequently, the five most abundant SCC recorded at control stations in 2018, including their mean abundance, were:

- Nashville Warbler (1.66 birds/point count station);
- White-throated Sparrow (1.07 birds/point count station);
- Veery (0.66 birds/point count station);
- Common Yellowthroat (0.57 birds/point count station); and
- Chestnut-sided Warbler (0.57 birds/point count station).

Common Yellowthroat (Photo: Matt Tillett/Wikimedia Commons)

These species were also the five most abundant SCC recorded at control stations in 2016.

Canada Goose was excluded from this 2018 list of SCC at control stations. While this species had an abundance value of 0.86 birds/point count station, it was observed at only four point count stations. In one instance a flock of 65 individuals was recorded flying over a single survey station.

The five most abundant non-SCC recorded at impact stations in 2018, including their mean abundance, were:

- Red-eyed Vireo (1.41 birds/point count station);
- Ovenbird (1.10 birds/point count station);
- Savannah Sparrow (0.88 birds/point count station);
- American Robin (0.84 birds/point count station); and
- Black-and-white Warbler (0.64 birds/point count station).

Four of these five species were also the most abundant non-SCC recorded at impact stations in 2016. In 2016, Blue Jay was one of the most abundant non-SCC at impact stations in 2016, replacing Black-and-white Warbler in the list above.

Four of these five species were also amongst the five most abundant species across the control stations. The five most abundant non-SCC recorded at control stations in 2018, including their mean abundance, were:

- Red-eyed Vireo (1.84 birds/point count station);
- Ovenbird (1.44 birds/point count station);
- American Robin (0.67 birds/point count station);
- Black-and-white Warbler (0.58 birds/point count station); and
- Hermit Thrush (0.48 birds/point count station).

Four of these five species were also the most abundant non-SCC recorded at control stations in 2016. In 2016, Blue Jay was one of the most abundant non-SCC recorded at control stations, replacing American Robin in the list above.

There is substantial overlap between the most abundant species and the most widely distributed species. Further statistical analyses were conducted on the abundances of the most widely occurring SCC and non-SCC recorded in 2018 (as described in Section 3.1.2). Summaries of these analyses are provided in Table 3-2 and Table 3-3.

3.1.3.2 BACI Analysis Results

Hermit Thrush (Photo: Matt MacGillivray/Wikimedia Commons)

The BACI analysis revealed no significant interaction effect between station type (impact or control) and year relative to the abundance of some of the most widely occurring SCC (Nashville Warbler, Common Yellowthroat and Veery), and some of the most widely occurring non-SCC (Red-eyed Vireo, Ovenbird, American Robin and Blue Jay), suggesting that RRM construction and operations have not adversely affected the abundance of these species since baseline conditions (2014/15; Table 3-2 and Table 3-3).

However, this trend was not universal among the SCC and non-SCC birds evaluated. Analysis of SCC Chestnut-sided Warbler ($F_{2,266} = 10.2023$, $p < 0.0001$), Song Sparrow ($F_{2,196} = 5.9626$, $p = 0.0031$), White-throated Sparrow ($F_{2,340} = 2.5024$, $p = 0.0834$), and non-SCC Black-and-white Warbler ($F_{2,282} = 2.8318$, $p = 0.0606$) and Hermit Thrush ($F_{2,232} = 2.6775$, $p = 0.0709$) showed significant interaction effects indicating that abundance at control and impact stations differs depending on the year.

Further analysis revealed that the abundance of Chestnut-sided Warbler significantly increased at impact stations between 2014/15 and 2016, and again between 2016 and 2018 (p = 0.0035 and p = 0.0154, respectively). Abundance of this species significantly increased at control stations between 2014/15 and 2016 (p = 0.0234), and then significantly decreased between 2016 and 2018 (p = 0.0051). Chestnut-sided Warbler abundance was significantly greater at control stations compared to impact stations in 2014/15 and 2016 (p = 0.0083 and p = 0.0279). However, in 2018 this pattern was reversed with abundance significantly greater at impact stations (p = 0.0100). The significant increases in population at both control and impact stations in 2016 may indicate this species is experiencing broad population increases across the overall monitoring area which did not appear to be adversely impacted by the construction activities being undertaken at the RRM impact stations. The continued increase in abundance at impact stations in 2018 and the concurrent drop in abundance at control stations may indicate that the construction activities have resulted in disturbed areas which have begun regenerating into preferred successional habitat for this species causing a shift into these new optimal habitats. The assumption of sphericity was violated for the Chestnut-sided Warbler abundance analysis (p = 0.0497) resulting in an increased chance of Type I error, as such results should be interpreted with some caution. In this instance there is a clear trend in the mean abundances with non-overlapping standard errors and relatively low p-values (not approaching the limit of 0.10), therefore, it is likely that these assertions are significant despite the violation of sphericity.

Further evaluation of Song Sparrow revealed a decrease in abundance at impact stations between 2014/15 and 2016 (not significant; p = 0.2057) before significantly increasing between 2016 and 2018 (p = 0.0522). Concurrently, abundance of this species decreased significantly at control stations between 2014/15 and 2016 (p = 0.0521), and again between 2016 and 2018 (p = 0.0888). This resulted in Song Sparrow abundance being significantly greater at impact stations compared to control stations in 2018 (p = 0.0017), a difference that was not significant in the previous monitoring years. The decreases between 2014/15 and 2016 at both the control and impact stations indicate broad population declines across the overall monitoring and did not appear to be further impacted by the construction activities being undertaken at the RRM. The increase in population abundance at impact stations in 2018 and concurrent drop in abundance at control stations may indicate that the construction activities have resulted in the creation of early successional habitat, preferred by Song Sparrow, in the disturbed areas which and that the birds are shifting into these optimal habitats.

Further analysis revealed the abundance of SCC White-throated Sparrow significantly decreased at impact stations between 2014/15 and 2016 (p = 0.0932), and again between 2016 and 2018 (p = 0.0045). Abundance at control stations showed an increase between 2014/15 and 2016 (not significant; p = 0.1443), followed by a significant decrease between 2016 and 2018 (p < 0.0001). The overall abundances for this species in 2014/15 and 2016 were similar, suggesting that the significant decrease in abundance at impact stations and the (non-significant) increase at control stations is potentially due to individuals avoiding impact stations in 2016 and breeding further away from construction activities.

White-throated Sparrow abundance in 2018 was similar between impact and control stations, potentially due to individuals dispersing more evenly post-construction once habitats around impact stations were no longer undergoing active disturbance. There also appears to be a broad population decrease in 2018 across the overall monitoring areas, demonstrated by the significant decreases at both impact and control stations.

Further evaluation of Black-and-white Warbler revealed a significant increase in abundance at control stations between 2014/15 and 2016 ($p = 0.0057$) and remained significantly higher in 2018 than it was in 2014/15 ($p = 0.0773$). In 2016, the control stations had significantly higher abundance of this species than impact stations ($p = 0.0253$). A subsequent significant increase in abundance of this species occurred at impact stations between 2016 and 2018 ($p = 0.0836$) and, as such, there was no longer a significant difference in Black-and-white Warbler abundance between impact and control stations in 2018. This could be explained by individuals choosing control stations further away from construction activities in 2016 and dispersing more evenly in post-construction once habitats around impact stations were no longer undergoing active disturbance.

Further analysis revealed the abundance of Hermit Thrush decreased at impact stations between 2014/15 and 2016 (not significant; $p = 0.1244$), followed by a significant decrease between 2016 and 2018 ($p = 0.0961$). Concurrently, the abundance at control stations increased between 2014/15 and 2016 (not significant; $p = 0.1989$), and then decreased significantly between 2016 and 2018 ($p = 0.0302$). This could be explained by population decreases across the overall monitoring area coupled with individuals preferentially using control stations in 2016, either to distance themselves from construction activities or due to preferred habitat loss. This utilization appears to be maintained in 2018 (post-construction) once the optimal forested habitats preferred by this species was removed near the impact stations. The assumption of sphericity was violated for the Hermit Thrush abundance analysis ($p = 0.0002$) resulting in an increased chance of Type I error, as such results should be interpreted with some caution. In this instance there is limited overlap of standard errors of the mean abundances and some of the p-values are relatively high, therefore, it is possible some of the significant interactions could be false positives. Regardless of significance, this is still a clear and notable trend despite the violation of sphericity, and the assertions and explanations are still valid.

The analysis of yearly effects (inclusive of impact and control stations) showed a significant increase in abundance of Veery ($F_{2,248} = 3.1774$, $p = 0.0434$), American Robin ($F_{2,298} = 3.0311$, $p = 0.0498$), and Red-eyed Vireo ($F_{2,348} = 30.0890$, $p < 0.0001$) in 2018 compared with the abundance in 2014/15 and 2016, indicating that these species may have experienced broad increases within the overall monitoring area between 2016 and 2018. All three of these species also experienced decreases in abundance between 2014/15 and 2016, although only the decrease in Red-eyed Vireo abundance was found to be significant. This indicates that these species may be experiencing broad population fluctuations between years within the overall monitoring area. Non-SCC Blue Jay ($F_{2,306} = 19.6596$, $p < 0.0001$) showed opposite effects, Blue Jay abundance significantly increased between 2014/15 and 2016 ($p < 0.0001$), followed by a significant decrease in abundance between 2016 and 2018 ($p < 0.0001$). This suggests that this species may be experiencing broad population fluctuations within the overall monitoring area. No yearly changes in abundance were observed for the other species analyzed (Table 3-3). The assumption of sphericity was violated for Blue Jay and Red-eyed Vireo abundance analyses ($p = 0.0057$ and $p = 0.0029$) resulting in an increased chance of Type I error, as such results should be interpreted with some caution. In the instance of both these species, there are clear trends in the mean abundances with non-overlapping standard errors and most p-values of < 0.0001, therefore, it is likely that these assertions are significant despite the violation of sphericity.

The analysis of location effects (inclusive of 2014/15, 2016 and 2018) showed Common Yellowthroat ($F_{1,125}$ = 2.8626, p = 0.0932) was significantly more abundant at impact stations compared to control stations indicating that habitat for these species was more prevalent within the impact areas. Conversely, Red-eyed Vireo ($F_{1,174}$ = 8.8833, p = 0.0033) and Ovenbird ($F_{1,155}$ = 5.0001, p = 0.0268) were significantly more abundant at control stations compared to impact stations indicating that habitat for these species was more prevalent within the control areas. No changes in abundance between impact and control stations were observed for the other species analyzed (Table 3-3). The assumption of sphericity was violated for the Common Yellowthroat abundance analysis (p = 0.0382) resulting in an increased chance of Type I error, as such results should be interpreted with some caution. In the instance of this species, there is no overlap of standard errors of the mean abundances however the p-value is relatively high, therefore, it is possible that this significant interaction could be a false positive. This is still a clear and notable trend despite the violation of sphericity and the explanations are still valid.

3.1.4 Species Density

3.1.4.1 2018 Results

The species with the highest densities were considered to be those with the highest density coupled with a relatively high (>25%) percent occurrence. Several species were identified in flocks or large groups and these bulk observations were excluded from the lists of dominant species and analyses as they represent outliers in the statistical analyses.

The five SCC recorded with the highest densities across all impact stations in 2018 were:

- Nashville Warbler (average 0. 350 birds/ha across all impact stations);
- Chestnut-sided Warbler (0.251 birds/ha);
- Common Yellowthroat (0.237 birds/ha);
- White-throated Sparrow (0.223 birds/ha); and
- Bobolink (0.209 birds/ha).

White-throated Sparrow (Photo: Pixabay)

These species were also the five SCC with the highest densities recorded at impact stations in 2016. Densities for all species from the 2018 surveys are presented in Appendix B and a multi-year comparison of population metrics is presented in Appendix C.

Four of these five species were also amongst the five SCC with the highest densities across the control stations. The five SCC with the highest densities at control stations were:

- Nashville Warbler (average 0.503 birds/ha across all control stations);
- White-throated Sparrow (0.251 birds/ha);
- Chestnut-sided Warbler (0.168 birds/ha);
- Common Yellowthroat (0.168 birds/ha); and

- Veery (0.121 birds/ha).

All five of these species were also the SCC with the highest densities recorded at control stations in 2016.

Barn Swallow was excluded from this 2018 list of SCC at control stations. While this species had a density value of 0.137 birds/ha, it was observed at only four point count stations.

The five non-SCC with the highest densities recorded at impact stations in 2018 were:

- Red-eyed Vireo (0.255 birds/ha);
- Savannah Sparrow (0.248 birds/ha);
- Ovenbird (0.202 birds/ha);
- LeConte's Sparrow (0.191 birds/ha); and
- Black-and-white Warbler (0.159 birds/ha).

Four of these five species also had the highest non-SCC densities recorded at impact stations in 2016. In the 2016 survey year, Blue Jay had the one of the highest densities of the non-SCC recorded at impact stations in 2016, replacing Black-and-white Warbler in the list above.

Three of these five species listed above were also amongst the five non-SCC with the highest densities across the control stations. The five non-SCC with the highest densities recorded at control stations in 2018 were:

- Red-eyed Vireo (0.456 birds/ha);
- Ovenbird (0.328 birds/ha);
- Black-and-white Warbler (0.171 birds/ha);
- American Robin (0.161 birds/ha); and
- Magnolia Warbler (0.134 birds/ha).

Three of these five species also had the highest non-SCC densities recorded at control stations in 2016. In the 2016 survey year, Golden-crowned Kinglet and Blue Jay had some of the highest densities recorded for non-SCC at the control stations, replacing American Robin and Magnolia Warbler in the list above.

Despite some differences, there is substantial overlap between the most abundant species and those with the highest densities. Further statistical analyses were conducted on the densities of the most widely occurring SCC and non-SCC recorded in 2018 (as described in Section 3.1.2). Summaries of these analyses are provided in Table 3-4 and Table 3-5.

3.1.4.2 BACI Analysis Results

The BACI analysis revealed no significant interaction effect between survey station type and year relative to the density of half of the most widely occurring SCC (Nashville Warbler, Common Yellowthroat and Veery), and half of the non-SCC (Ovenbird, American Robin and Blue Jay), suggesting that RRM construction and operations have not affected the densities of these species (Table 3-4 and Table 3-5).


American Robin (Photo: Ken Thomas/Wikimedia Commons)

However, this trend was not universal amongst the SCC and non-SCC birds evaluated. Analysis of SCC Chestnut-sided Warbler ($F_{2,266}$ = 7.9714, p = 0.0004), Song Sparrow ($F_{2,196}$ = 3.6906, p = 0.0267), White-throated Sparrow ($F_{2,340}$ = 3.9998, p = 0.0192), and non-SCC Red-eyed Vireo ($F_{2,348}$ = 3.8922, p = 0.0213), Black-and-white Warbler ($F_{2,282}$ = 2.7627, p = 0.0648) and Hermit Thrush ($F_{2,232}$ = 2.8269, p = 0.0612) showed significant interaction effects indicating that abundance at control and impact stations differs depending on the year.

Further analysis revealed the density of Chestnut-sided Warbler followed the same pattern as was seen for abundance. Density significantly increased at impact stations between 2014/15 and 2016 and again between 2016 and 2018 (p = 0.0176 and p = 0.0400). Density significantly increased at control stations between 2014/15 and 2016 (p = 0.0154) and significantly decreased between 2016 and 2018 (p = 0.0040). Chestnut-sided Warbler density was significantly greater at control stations compared to impact stations in 2014/15 and 2016 (p = 0.0137 and p = 0.0082). However, in 2018 this reversed with density significantly greater at impact stations (p = 0.0936). The significant increases in densities at both control and impact stations in 2016 indicate that this species is experiencing broad population increases across the overall monitoring area and did not appear to be adversely affected by the construction activities undertaken at the RRM impact stations. The continued increase in density at impact stations in 2018 and concurrent drop in density at control stations may indicate that the construction activities have created early successional habitat, preferred by Chestnut-sided Warbler, causing a shift into these optimal habitats. As with abundance, the assumption of sphericity was violated for the Chestnut-sided Warbler (p = 0.0329) resulting in an increased chance of Type I error, as such results should be interpreted with some caution. In this instance there are non-overlapping standard errors of the mean densities, all but one of the p-values are relatively low and there is a clear trend in the mean densities, therefore, it is likely that these assertions are significant despite the violation of sphericity.

Further evaluation of Song Sparrow revealed a similar pattern as was seen for abundance. Density significantly decreased (p = 0.0373) at impact stations between 2014/15 and 2016 before significantly increasing between 2016 and 2018 (p = 0.0111). Concurrently, density of this species decreased significantly between 2014/15 and 2016 (p = 0.0208) and continued to decrease slightly between 2016 and 2018 (not significant; p = 0.5608). Song Sparrow density was therefore significantly greater at impact stations compared to control stations in 2018 (p = 0.0216), a difference that was not significant in the previous monitoring years. The significant decreases between 2014/15 and 2016 at both control and impact stations could be due to broad population decreases across the overall monitoring area which did not appear to be adversely impacted further by the construction activities being undertaken at the RRM impact stations. The significant increase in density at impact stations in 2018 and concurrent non-significant decrease at control stations may indicate that the construction activities have resulted in the creation of early successional habitat, preferred by Song Sparrow, causing a shift into these optimal habitats. The assumption of sphericity was violated for the Song Sparrow density analysis ($p = 0.0179$) resulting in an increased chance of Type I error, as such results should be interpreted with some caution. In this instance there is a clear trend in the mean densities with non-overlapping standard errors and relatively low p-values, therefore, it is likely that these assertions are significant despite the violation of sphericity.

Further analysis revealed that the density of White-throated Sparrow significantly decreased at impact stations between 2014/15 and 2016 ($p = 0.0035$) and increased at impact stations between 2016 and 2018 (not significant; $p = 0.2559$). The density at control stations showed an increase between 2014/15 and 2016 (not significant; $p = 0.3144$), followed by a decrease between 2016 and 2018 (not significant; $p = 0.2346$). White-throated Sparrow density was significantly greater at control stations than impact stations in 2016. Similar to the patterns observed for the abundance of this species, this is potentially due to individuals avoiding impact stations in 2016 and breeding further away from construction activities. Density in 2018 does not show a significant difference between impact and control stations, potentially due to individuals dispersing more evenly in 2018 post-construction once habitats around impact stations were no longer undergoing active disturbance. The assumption of sphericity was again violated for the White-throated Sparrow density analysis ($p = 0.0530$) resulting in an increased chance of Type I error, as such results should be interpreted with some caution. There is again a clear trend in the mean densities with non-overlapping standard errors and all the significant p-values are relatively low, therefore, it is likely that these assertions are significant despite the violation of sphericity.

Further evaluation of Red-eyed Vireo revealed a significant decrease in abundance between 2014/15 and 2016 at both the impact and control stations ($p = 0.0037$ and $p = 0.0954$). Subsequently, density significantly increased between 2016 and 2018 at both the impact and control stations ($p = 0.0026$ and $p < 0.0001$). Density was significantly greater at control stations than at impact stations in all monitoring years with the greatest difference in densities between the two station types in 2018. These results are likely in part due to broad population fluctuations across the overall monitoring area, combined with some avoidance of impact stations in 2016 due to increased construction activities. The increase in density at control stations in 2018 is likely because habitats around impact stations no longer support as much optimal (forested) habitat for this species. The assumption of sphericity was violated for the Red-eyed Vireo density analysis ($p = 0.0382$) resulting in an increased chance of Type I error, as such results should be interpreted with some caution. In the instance of this species, there is a clear trend in the mean densities with non-overlapping standard errors and most p-values are relatively low, therefore, it is likely that these assertions are significant despite the violation of sphericity and the assertions and explanations are valid regardless due to the clear trend in the data.

Further analysis revealed the density of Black-and-white Warbler once again followed the same pattern as was seen for abundance. Density significantly increased at control stations between 2014/15 and 2016 ($p = 0.0086$) and remained significantly higher in 2018 than it was in 2014/15 ($p = 0.0352$). As such, control stations in 2016 had significantly higher Black-and-white Warbler densities than impact stations ($p = 0.0503$). No significant changes in densities occurred between 2016 and 2018 at either the control or the impact stations. However, there was no significant difference in Black-and-white Warbler density between control and impact stations in 2018 ($p = 0.6040$). These results suggest that individuals may have preferentially used control stations further away from construction activities in 2016 and dispersed more evenly in post-construction once habitats around impact stations were no longer undergoing active disturbance.

Further analysis revealed the density of Hermit Thrush followed a similar pattern as was seen for abundance. Hermit Thrush density decreased significantly at impact stations between 2014/15 and 2016 ($p = 0.0323$), followed by a decrease in density between 2016 and 2018 (not significant; $p = 0.1863$). Concurrently, the density at control stations showed very minimal change across monitoring years. Hermit Thrush density was significantly greater ($p = 0.0556$) at control stations than impact stations in 2018. This suggests that individuals may have preferentially used control stations in 2016, either to distance themselves from construction activities or due to preferred habitat loss. This utilization appears to be maintained in 2018 (post-construction) with significantly greater density at control stations, potentially due the removal of optimal forested habitat, preferred by this species, near the impact stations. The assumption of sphericity was violated for the Hermit Thrush density analysis ($p < 0.0001$) resulting in an increased chance of Type I error, as such results should be interpreted with some caution. In this instance there is a clear trend in the mean densities with non-overlapping standard errors and the p-values are relatively low, therefore, it is likely that these assertions are significant despite the violation of sphericity.

The analysis of yearly effects (inclusive of impact and control stations) showed significant decreases in the density of Common Yellowthroat ($F_{2,250} = 5.2972$, $p = 0.0056$) between 2014/15 and 2016 ($p = 0.0041$), followed by a significant increase in the density of this species between 2016 and 2018 ($p = 0.0067$), indicating that this species may be experiencing broad population fluctuations within the overall monitoring area. No significant change in density was observed for Veery ($F_{2,248} = 3.8761$, $p = 0.0220$) and non-SCC Blue Jay ($F_{2,306} = 3.4179$, $p = 0.0340$) between 2014/15 and 2016. However, both species experienced significant changes in density between 2016 and 2018. Veery densities increased significantly ($p = 0.0131$) while Blue Jay densities decreased significantly ($p = 0.0220$). This suggests that these species may be experiencing broad increases and decreases (respectively) within the overall monitoring area. No yearly changes in density were observed for the other species analyzed (Table 3-5). The assumption of sphericity was violated for the Common Yellowthroat ($p = 0.0006$), Veery ($p = 0.0088$) and Blue Jay density analyses ($p = 0.0076$) resulting in increased chances of Type I error, as such results should be interpreted with some caution. In the instance of all three species, there are clear trends in the mean densities with non-overlapping standard errors and relatively low p-values, therefore, it is likely that these assertions are significant despite the violation of sphericity.

The analysis of location effects (inclusive of 2014/15, 2016 and 2018) showed Ovenbird ($F_{1,155} = 8.5917$, $p = 0.0039$) had a significantly greater density at control stations compared to impact stations suggesting that the less disturbed forest habitat preferred by this species, is more prevalent within the control areas. No changes in density between impact and control stations was observed for the other species analyzed (Table 3-5).

3.1.5 Species Abundance by Guild

Statistical comparisons of SCC and non-SCC by guild were conducted to detect significant differences in abundance between monitoring year (2014/15, 2016 and 2018) and survey station type (impact versus control) as summarized in Table 3-6 and Table 3-7. The total abundance of birds between monitoring years and station types was also evaluated, which was inclusive of all four guilds.

Several species were identified in flocks or large groups and these bulk observations were excluded from the guild analyses as they represent outliers in the statistical analyses. Within the abundance data, these species included: American White Pelican, Barn Swallow, Canada Goose, European Starling and Sharp-tailed Grouse.

Species of Conservation Concern

The SCC analysis revealed a significant interaction effect between survey station type and year relative to the abundance of the SCC Edge / Shrub / Successional birds ($F_{2,332} = 9.5154$, $p < 0.0001$), Forest birds ($F_{2,358} = 4.6350$, $p = 0.0103$), Grassland / Open Country birds ($F_{2,136} = 2.5805$, $p = 0.0794$ and Total birds ($F_{2,358} = 7.1600$, $p = 0.0009$) indicating that abundance at control and impact stations differs depending on the year.

Further analysis revealed the abundance of the SCC Edge / Shrub / Successional birds was relatively unchanged between 2014/15 and 2016. The abundance of birds in this guild significantly increased at impact stations between 2016 and 2018 ($p = 0.0021$), while decreasing significantly at control stations ($p = 0.0358$; Table 3-6 and Table 3-7). The abundance of SCC Edge / Shrub / Successional birds was also significantly greater at impact stations in 2018 ($p < 0.0001$) as compared to control stations. The lack of notable change in abundance at both impact and control stations between 2014/15 and 2016 indicates this guild of species was not adversely impacted by the construction activities being undertaken at the RRM impact stations. Additionally, the increase in population abundance at impact stations in 2018 and concurrent drop at control stations indicates that the construction activities have resulted in the creation of early successional habitat preferred by SCC Edge / Shrub / Successional birds, causing a shift into these optimal habitats. This result aligns with the similar species-level trends observed for Chestnut-sided Warbler and Song Sparrow, both of which are included in this habitat guild. The assumption of sphericity was violated for the SCC Edge / Shrub / Successional abundance analysis ($p = 0.0975$) resulting in an increased chance of Type I error, as such results should be interpreted with some caution. In this instance, there is a clear trend in the mean abundances with non-overlapping standard errors and relatively low p-values, therefore, it is likely that these assertions are significant despite the violation of sphericity.


Black-and-white Warbler (Photo: National Park Service)

Further analysis revealed the abundance of the SCC Forest birds to be similar at both impact and control stations in 2014/15. The abundance of these birds then significantly increased at control stations ($p = 0.0200$) between 2014/15 and 2016, while concurrently decreasing significantly at impact stations ($p = 0.0610$). As such, abundance was significantly greater at control stations than impact stations in 2016 ($p < 0.0001$). Between 2016 and 2018, the abundance of the SCC Forest birds significantly decreased ($p = 0.0579$) at control stations while showing increasing abundances at impact stations (not significant; $p = 0.3311$). Despite this, the significantly greater abundance of SCC Forest birds recorded at control stations as compared to impact was sustained in 2018 ($p = 0.0858$). These results indicate this guild may have been temporarily adversely affected by increased disturbance and habitat loss from the RRM construction activities. Disturbance typically experienced at impact stations may have included increased noise levels beyond tolerance thresholds and/or habitat degradation due to mine construction activities (e.g., road construction, tree removals) to a point where individuals of these species found alternative nesting territories at control stations in 2016. The subsequent decrease in abundance of SCC Forest birds at control stations, coupled with non-significant increase at impact stations in 2018 may indicate that effects from disturbances at these locations have decreased now that the RRM has entered the operations phase and these species are able to disperse more evenly. However, the continued significantly greater abundance at control stations indicates habitats around impact stations likely no longer support as much optimal (forested) habitat for these species.

Further evaluation of SCC Grassland / Open Country birds revealed a significant increase in abundance at both control and impact stations ($p = 0.0103$ and $p = 0.0571$) between 2016 and 2018. This appears to indicate a broad population increase across the overall monitoring area. This could be attributed to the work undertaken by New Gold to ensure protected Bobolink Overall Benefit lands are maintained as high quality grassland bird habitat or the clearing of previously woody vegetated land into anthropogenically open areas introducing new habitat for certain species. A non-significant decrease in abundance at impact stations between 2014/15 and 2016 may indicate these species were temporarily adversely affected by construction activities to a point where individuals of these species found alternative nesting territories. However, the subsequent increase in abundance at all stations in 2018 may indicate that disturbances at these locations have decreased now that the RRM has entered the operations phase and these species are able to again increase their utilization of habitats at these sites. The assumption of sphericity was violated for the SCC Grassland / Open Country abundance analysis ($p < 0.0001$) resulting in an increased chance of Type I error, as such results should be interpreted with some caution. In this instance there is a clear trend in the mean abundances and relatively low p-values, however, there is some overlap of the standard errors. Despite this the trends in the data are clear and notable it is likely that these assertions are significant despite the violation of sphericity.

Further analysis revealed total SCC bird abundance trends are similar to those observed in the two largest guilds showing interaction effects, SCC Edge / Shrub / Successional birds and SCC Forest birds. Total SCC abundance decreased (not significant; $p = 0.2918$) at impact stations between 2014/15 and 2016, followed by a significant increase ($p = 0.0010$) in abundance at impact stations between 2016 and 2018. Concurrently, Total SCC bird abundance significantly increased ($p = 0.0344$) at control stations between 2014/15 and 2016, followed by a significant decrease ($p = 0.0481$) between 2016 and 2018 (Table 3-6 and Table 3-7). These results support the theory that birds may have been temporarily adversely affected by construction activities to a point where individuals found alternative nesting territories (resulting in an increase in abundance at control stations), however, the subsequent increase in abundance at impact stations in 2018 corroborates the theory that disturbances at these locations have decreased now that the RRM has entered the operations phase and that new optimal habitat may have been created through these construction activities to support numerous species across the guilds.

The analysis for SCC revealed no significant interaction effects were observed for SCC Wetland / Open Water birds which would imply that the RRM construction and operations have not adversely affected the abundance of this guild. As well, the analysis of yearly effects (inclusive of impact and control stations) showed no changes in abundance between monitoring years for SCC Wetland / Open Water birds (Table 3-6 and Table 3-7).

The analysis of location effects (using pooled abundances for all years of study) showed that SCC Wetland / Open Water bird abundance was significantly greater at impact stations compared to control stations ($F_{1,134} = 5.2195$, $p = 0.0239$). This suggests that there may be more suitable habitats within the impact areas for these species. The assumption of sphericity was violated for the SCC Wetland / Open Water abundance analysis ($p < 0.0001$) resulting in an increased chance of Type I error, as such results should be interpreted with some caution. In this instance there is a clear trend in the mean abundances with non-overlapping standard errors and a low p-value, therefore, it is likely these assertions are significant despite the violation of sphericity.

Non-Species of Conservation Concern

The analysis for non-SCC revealed significant interaction effects between survey station type and year relative to the abundance of non-SCC Forest birds ($F_{2,358}$ = 3.7810, p = 0.0237) and Wetland / Open Water birds ($F_{2,198}$ = 2.7580, p = 0.0659) indicating that abundance at control and impact stations differs depending on the year.

Further evaluation of non-SCC Forest revealed a decrease in abundance at impact stations between 2014/15 and 2016 (not significant; p = 0.2790), followed by a significant increase in abundance between 2016 and 2018 (p = 0.0778). At control stations, non-SCC Forest bird abundance significantly increased between 2014/15 and 2016 (p = 0.0057) and demonstrated no notable change between 2016 and 2018. Abundance at control stations was significantly greater than at impact stations for all monitoring years with the largest differences in mean abundance occurring in 2016 followed by 2018. These results indicate this guild may have been temporarily adversely affected by increased disturbance and habitat loss from the RRM construction activities. Disturbance typically experienced at impact stations may have included increased noise levels beyond tolerance thresholds and/or habitat degradation due to mine construction activities (e.g., road construction, tree removals) to a point where individuals of these species found alternative nesting territories at control stations in 2016. The subsequent non-significant increase at impact stations in 2018 may indicate that disturbances at these locations have decreased now that the RRM has entered the operations phase and that these species are able to disperse more evenly. However, the continued significantly greater abundance at control stations indicates habitats around impact stations likely no longer support as much optimal (forested) habitat for these species.

Further analysis revealed the abundance of the non-SCC Wetland / Open Water birds increased at control stations between 2014/15 and 2016 (not significant; p = 0.2535), followed by a significant increase in the abundance of these birds between 2016 and 2018 (p = 0.0874). Abundance at impact stations showed no significant trend between years. In 2014/15, the abundance of non-SCC Wetland / Open water species was significantly greater at impact stations than at control stations (p = 0.0300). However, this trend was not found in 2016 and 2018. Instead, abundance was slightly greater (although not significantly) at control stations in 2018. These results suggest that these species were not adversely affected by the active construction in 2016. However, the current trends could indicate that habitat for these species was diminished at impact stations resulting in higher abundance of these species at control site post-construction in 2018. Further years of surveys will be needed to determine conclusive trends in abundance for these species.

The analysis of non-SCC guilds revealed no significant interaction effects between survey station type and year relative to the abundance of non-SCC Edge / Shrub / Successional birds, Grassland / Open Country birds or Total non-SCC birds. This would imply that the RRM construction and operations have not adversely affected the abundance of these guilds (Table 3-6 and Table 3-7). As well, the analysis of yearly effects (inclusive of impact and control stations) showed significant effects on the abundance of non-SCC Edge / Shrub / Successional birds ($F_{2,354}$ = 6.2746, p = 0.0021), Grassland / Open Country birds ($F_{2,122}$ = 13.2407, p < 0.0001) and Total non-SCC birds ($F_{2,358}$ = 10.4110, p < 0.0001).

Non-SCC Edge / Shrub / Successional bird abundance significantly decreased between 2014/15 and 2016 (p = 0.0624), followed by a significant increase in abundance between 2016 and 2018 (p = 0.0005), which indicates that these species are experiencing broad population fluctuations within the overall monitoring area. For non-SCC Grassland / Open Country birds, abundance significantly increased between 2014/15 and 2016 (p = 0.0002) and again between 2016 and 2018 (p = 0.0296), indicating that these species are experiencing broad population increases within the overall monitoring area. The total combined non-SCC bird abundance also increased significantly between 2016 and 2018, which is mainly a result of the increase observed for non-SCC Edge / Shrub / Successional birds. The non-SCC Total birds showed an increase between 2014/15 and 2016 as well, although it was not significant. These results indicate that non-SCC birds overall are experiencing broad populations increases within the overall monitoring area. The assumption of sphericity was violated for the non-SCC Grassland / Open Country abundance analysis ($p = 0.0071$) resulting in an increased chance of Type I error, as such results should be interpreted with some caution. In this instance there is a clear trend in the mean abundances with minimal standard error overlap and relatively low p-values, therefore, it is likely that these assertions are significant despite the violation of sphericity.

The analysis of location effects (inclusive of 2014/15, 2016 and 2018) showed that non-SCC Edge / Shrub / Successional bird abundance was significantly greater at impact stations compared to control stations ($F_{1,177} = 5.1531$, $p = 0.0244$). This result is potentially due to a greater prevalence of suitable habitats within impact areas. Similarly, non-SCC Grassland / Open Country bird abundance was significantly greater at the impact stations compared to the control stations ($F_{1,61} = 12.8638$, $p = 0.0007$). This result is potentially due to the greater prevalence of impact stations located within Bobolink Overall Benefit lands (32 stations as opposed to 11 control stations) which provide suitable habitat.

3.1.6 Species Density by Guild

Statistical comparisons of SCC and non-SCC by guild were conducted to detect significant differences in density between monitoring year (2014/15, 2016 and 2018) and survey station type (impact versus control) as summarized in Table 3-8 and Table 3-9. The total density of birds between monitoring years and station types was also evaluated, which is inclusive of all four guilds.

Several species were identified in flocks or large groups and these bulk observations were excluded from the guild analyses as they represent outliers in the statistical analyses. Within the density data, these species included: Barn Swallow and Sharp-tailed Grouse.

Species of Conservation Concern

Similar to the results for abundance, the SCC analysis revealed a significant interaction effect between survey station type and year, relative to the density of the SCC Edge / Shrub / Successional birds ($F_{2,332} = 5.8382$, $p = 0.0032$), Forest birds ($F_{2,358} = 3.9912$, $p = 0.0193$), Grassland / Open Country birds ($F_{2,136} = 2.5455$, $p = 0.0822$) and Total birds ($F_{2,358} = 5.4810$, $p = 0.0045$) indicating that density at control and impact stations differs depending on the year.

Further analysis revealed that the density of the SCC Edge / Shrub / Successional birds followed a similar trend to that seen for abundance. Density was relatively unchanged between 2014/15 and 2016, then significantly increased at impact stations between 2016 and 2018 ($p = 0.0002$), while decreasing slightly at control stations (not significant; $p = 0.4965$; Table 3-8 and Table 3-9). The density of SCC Edge / Shrub / Successional birds was therefore significantly greater at impact stations in 2018 ($p = 0.0005$) as compared to control stations. The lack of notable change in density at both impact and control stations between 2014/15 and 2016 indicates this guild of species was not adversely impacted by the construction activities being undertaken at the RRM impact stations. The increase in density at impact stations in 2018 and concurrent slight decrease at control stations may indicate that the construction activities have resulted in disturbed areas which have begun regenerating into preferred edge / shrub / successional habitat for these species causing a shift into these optimal habitats.

Further analysis revealed that the density of the SCC Forest birds followed a similar trend to that seen for abundance. Density was similar at both impact and control stations in 2014/15, then increased at control stations (not significant; $p = 0.3882$) between 2014/15 and 2016, while concurrently decreasing significantly at impact stations ($p = 0.0047$). As such, there was a significantly greater density at control stations than impact stations in 2016 ($p = 0.0004$). Between 2016 and 2018, the density of the SCC Forest birds significantly increased ($p = 0.0381$) at both control and impact stations ($p = 0.0085$). A significantly greater density was maintained at control stations as compared to impact stations in 2018 ($p = 0.0017$). These results indicate that SCC Forest birds may have been adversely affected by increased disturbance and habitat loss from the RRM construction activities. Disturbance typically experienced at impact stations may have included increased noise levels beyond tolerance thresholds and/or habitat degradation due to mine construction activities (e.g., road construction, tree removals) to a point where individuals of these species found alternative nesting territories at control stations in 2016. The subsequent increase in density at both control and impact stations in 2018 may indicate that disturbances at impact stations have decreased now that the RRM has entered the operations phase, and that these species are able to disperse more evenly. However, the sustained significantly greater abundance at control stations indicates habitats around impact stations no longer support as much optimal (forested) habitat for these species.

Further analysis revealed that the density of the SCC Grassland / Open Country birds followed a similar trend to that seen for abundance. Density significantly increased at both the control and impact stations ($p = 0.0086$ and $p = 0.0109$) between 2016 and 2018. This appears to indicate a broad population increase across the overall monitoring area. This could be attributed to the work undertaken by New Gold to maintain high quality grassland bird habitat within the protected Bobolink Overall Benefit lands or the clearing of previously woody vegetated land into anthropogenically open areas introducing new habitat for certain species. In 2014/15, density of SCC Grassland / Open Country birds was significantly greater at impact stations than at control stations ($p = 0.0527$), this could have been due to the greater prevalence of impact stations located within Bobolink Overall Benefit lands (32 stations as opposed to 11 control stations), which provide suitable habitat for birds in this guild. The decrease in abundance at impact stations between 2014/15 and 2016, whilst not significant, may indicate that these species were temporarily adversely affected by construction activities to a point where individuals of these species found alternative nesting territories. The subsequent increase in density at all stations in 2018 may indicate that disturbances at these locations have decreased now that the RRM has entered the operations phase and these species are able to again increase their utilization of habitats at these sites. The assumption of sphericity was violated for the SCC Grassland / Open Country density analysis ($p < 0.0001$) resulting in an increased chance of Type I error, as such results should be interpreted with some caution. In this instance there is a clear trend in the mean densities with non-overlapping standard errors and most of the p-values are relatively low, therefore, it is likely that these assertions are significant despite the violation of sphericity and regardless of significance there is a clear trend in the data and the explanations are still valid.

Further analysis revealed the density of the Total SCC birds followed a similar trend to those observed in the two largest guilds showing interaction effects, SCC Edge / Shrub / Successional birds and SCC Forest birds. Total SCC bird density significantly decreased ($p = 0.0001$) at impact stations between 2014/15 and 2016, followed by a significant increase ($p < 0.0001$) between 2016 and 2018. Total SCC density also slightly (non-significantly) increased ($p = 0.7093$) at control stations between 2014/15 and 2016, followed by a significant increase ($p = 0.0337$) between 2016 and 2018. (Table 3-8 and Table 3-9). These results corroborate the theory that birds may have been temporarily adversely affected by construction activities at impact stations to a point where individuals found alternative nesting territories (resulting in an increase in density at control stations), however, the subsequent increase in density at impact stations in 2018 supports the theory that disturbances at these locations have decreased now that the RRM has entered the operations phase and that new optimal habitat may have been created through these construction activities to support numerous species across the guilds. The assumption of sphericity was violated for the Total SCC density analysis ($p = 0.0028$) resulting in an increased chance of Type I error, as such results should be interpreted with some caution. In this instance there is a clear trend in the mean densities with non-overlapping standard errors and low p-values, therefore, it is likely that these assertions are significant despite the violation of sphericity.

The analysis for SCC revealed no significant interaction effect between survey station type and year relative to the density of SCC Wetland / Open Water birds. This suggests that the RRM construction and operations have not adversely affected the density of this guild (Table 3-8 and Table 3-9).

The analysis of yearly effects (inclusive of impact and control stations) showed significant fluctuations in the density of SCC Wetland / Open Water birds ($F_{2,268} = 3.445$, $p = 0.0333$) between monitoring years. The density significantly decreased between 2014/15 and 2016 ($p = 0.0276$), followed by a significant increase between 2016 and 2018 ($p = 0.0089$). These results indicate that species within this guild are experiencing broad population fluctuations within the overall monitoring area. The assumption of sphericity was violated for the SCC Wetland / Open Water density analysis ($p < 0.0001$) resulting in an increased chance of Type I error, as such results should be interpreted with some caution. In this instance there is a clear trend in the mean densities with non-overlapping standard errors and low p-values, therefore, it is likely that these assertions are significant despite the violation of sphericity.

The analysis of location effects (inclusive of 2014/15, 2016 and 2018) showed no changes in density between impact and control stations was observed for SCC Wetland / Open Water birds.

Non-Species of Conservation Concern

The analysis for non-SCC revealed significant interaction effects between survey station type and year relative to the density of non-SCC Forest birds ($F_{2,358} = 5.0312$, $p = 0.0070$) and Total non-SCC birds ($F_{2,358} = 3.5550$, $p = 0.0296$) indicating that density at control and impact stations differs depending on the year.

Ruby-crowned Kinglet (Photo: Cephas/Wikimedia Commons)

Further analysis revealed that the density of the non-SCC Forest birds followed similar trends to those described for abundance. Density slightly increased at control stations between 2014/15 and 2016 (not significant; $p = 0.4568$), followed by a significant increase in density between 2016 and 2018 ($p = 0.0562$). At impact stations non-SCC Forest bird density significantly decreased between 2014/15 and 2016 ($p = 0.0009$), followed by a significant increase in density between 2016 and 2018 ($p = 0.0174$). Abundance at control stations was significantly greater than at impact stations for all monitoring years with the largest differences occurring in 2016 followed by 2018. These results indicate this guild may have been adversely affected by increased disturbance and habitat loss from the RRM construction activities. Disturbance typically experienced at impact stations may have included increased noise levels beyond tolerance thresholds and/or habitat degradation due to mine construction activities (e.g., road construction, tree removals) to a point where individuals of these species found alternative nesting territories in 2016. The subsequent significant increase in density at impact stations in 2018 may indicate that disturbances at these locations have decreased now that the RRM has entered the operations phase and these species are able to disperse more evenly. The sustained significantly greater abundance at control stations indicates habitats around impact stations likely no longer support as much optimal (forested) habitat for these species.

Further analysis revealed that the density of the Total non-SCC birds displays trends similar to those observed for the non-SCC Forest birds. Total non-SCC bird density slightly decreased at control stations between 2014/15 and 2016 (not significant; $p = 0.8085$), followed by a significant increase in density between 2016 and 2018 ($p = 0.0001$). At impact stations Total non-SCC bird density significantly decreased between 2014/15 and 2016 ($p = 0.0012$), followed by a significant increase in density between 2016 and 2018 ($p = 0.0005$). Density at control stations increased from (non-significantly) lower in 2014/15, to (non-significantly) greater in 2016, to significantly greater ($p = 0.0493$) than at impact stations in 2018. These results corroborate the theory that birds may have been temporarily adversely affected by construction activities at impact stations to a point where individuals found alternative nesting territories. The subsequent significant increase in density at impact and control stations in 2018 show a broad increase in birds across the overall monitoring area as well as corroborating the theory that species are able to disperse more evenly now that disturbances at impact stations have decreased with the RRM entering the operations phase. The significantly greater density at control stations in 2018 indicates some species may have been displaced permanently from impact stations due to loss of forest habitat. The assumption of sphericity was violated for the Total non-SCC density analysis ($p = 0.0038$) resulting in an increased chance of Type I error, as such results should be interpreted with some caution. In this instance there is a clear trend in the mean densities with non-overlapping standard errors and low p-values, therefore, it is likely that these assertions are significant despite the violation of sphericity.

The analysis of non-SCC guilds revealed no significant interaction effects between survey station type and year relative to the density of non-SCC Edge / Shrub / Successional birds, Grassland / Open Country birds or Wetland / Open Water birds. This would imply that the RRM construction and operations have not adversely affected the densities of these guilds (Table 3-8 and Table 3-9).

The analysis of yearly effects (inclusive of impact and control stations) showed significant fluctuations in the density of non-SCC Edge / Shrub / Successional birds ($F_{2,354} = 6.5819$, $p = 0.0016$). The density significantly decreased between 2014/15 and 2016 ($p = 0.0047$), followed by a significant increase between 2016 and 2018 ($p = 0.0008$). These results indicate species within this guild are experiencing broad population fluctuations within the overall monitoring area. Additionally, non-SCC Grassland / Open Country birds ($F_{2,122} = 13.6516$, $p < 0.0001$) showed significant increases in density between 2014/15 and 2016 ($p = 0.0054$) and again between 2016 and 2018 ($p = 0.0015$). These results indicate species within this guild are experiencing broad increases within the overall monitoring area. No changes in density between monitoring years were observed for non-SCC Wetland / Open Water birds. The assumption of sphericity was violated for the non-SCC Grassland / Open Country density analysis ($p = 0.0008$) resulting in an increased chance of Type I error, as such results should be interpreted with some caution. In this instance there is a clear trend in the mean densities with non-overlapping standard errors and low p-values, therefore, it is likely that these assertions are significant despite the violation of sphericity.

The analysis of location effects (inclusive of 2014/15, 2016 and 2018) showed that the density of non-SCC Edge / Shrub / Successional birds ($F_{1,177} = 2.8900$, $p = 0.0909$) and non-SCC Grassland / Open Country birds ($F_{1,61} = 12.0017$, $p = 0.0010$) was significantly greater at impact stations compared to control stations. This result is potentially due to a greater prevalence of suitable habitats within the impact areas.

No significant changes in density between impact and control stations were observed for non-SCC Wetland / Open Water birds.

3.1.7 Species Richness by Guild

Statistical comparisons of SCC and non-SCC by guild were conducted to detect significant differences in species richness between monitoring year (2014/15, 2016 and 2018) and survey station type (impact versus control) as summarized in Table 3-10 and Table 3-11. The total species richness of birds between monitoring years and station types was also evaluated, which is inclusive of all four guilds.

Species of Conservation Concern

The SCC analysis revealed a significant interaction effect between survey station type and year relative to the richness of the SCC Edge / Shrub / Successional birds ($F_{2,332}$ = 8.7981, p = 0.0002), Forest birds ($F_{2,358}$ = 4.2230, p = 0.0154), Grassland / Open Country birds ($F_{2,132}$ = 2.9229, p = 0.0573), and Total birds ($F_{2,358}$ = 7.6580, p = 0.0006; Table 3-10 and Table 3-11) indicating that species richness at control and impact stations differs depending on the year.

Further analysis revealed that the richness of the SCC Edge / Shrub / Successional birds follows similar trends to those described for abundance. Richness increased at impact stations between 2014/15 and 2016 (not significant; p = 0.2286), followed by a significant increase in species richness between 2016 and 2018 (p = 0.0062). Concurrently, richness decreased at control stations between 2014/15 and 2016 (not significant; p = 0.5324) and again between 2016 and 2018 (not significant; p = 0.2122). Despite the decreases being non-significant, the richness at control stations in 2018 was significantly lower (p = 0.0.0617) than in 2014/15. The richness of SCC Edge / Shrub / Successional species in 2014/15 was similar at impact and control stations, however, in both 2016 and 2018 richness was significantly greater at impact stations compared to control stations (p = 0.8987 and p < 0.0001). The increase in richness at impact stations between 2014/15 and 2016 substantiates the theory that this guild of species was not adversely impacted by the construction activities being undertaken at the RRM. The increase in richness at impact stations in 2018 and concurrent decrease at control stations supports the theory that the construction activities have resulted in disturbed areas which have begun regenerating into preferred edge / shrub / successional habitat for these species causing a shift into these optimal habitats.

Further analysis revealed that the richness of the SCC Forest birds follows similar trends to those described for abundance. Richness significantly increased at control stations (p = 0.0244) between 2014/15 and 2016 while concurrently decreasing at impact stations (not significant; p = 0.3044). As such, richness was significantly greater at control stations than at impact stations in 2016 (p < 0.0001). Between 2016 and 2018 the richness of SCC Forest birds significantly decreased (p = 0.0858) at control stations while significantly increasing at impact stations (p = 0.0404). These results corroborate the theory that this guild may have been adversely affected by increased disturbance and habitat loss from the RRM construction activities. The subsequent decrease in richness at control stations, coupled with the increase at impact stations in 2018 supports the theory that disturbances at these locations have decreased now that the RRM has entered the operations phase and these species are able to disperse more evenly.

Further analysis revealed the richness of the SCC Grassland / Open Country birds was significantly greater at impact stations compared to control stations in 2014/15 (p = 0.0740). Between 2014/15 and 2016, richness at control stations significantly increased (p = 0.0764) while decreasing at impact stations (not significant; p = 0.1706). Richness increased slightly at both impact and control stations between 2016 and

2018 (not significant; $p = 0.2859$ and $p = 0.7990$, respectively), with species richness being similar between the impact stations and control stations in 2018 (1.32 and 1.33, respectively). These results further corroborate the theory that these species were temporarily adversely affected by construction activities to a point where individuals of these species found alternative nesting territories in 2016.The subsequent slight increase in richness between 2016 and 2018 supports the theory that disturbances at the impact locations have decreased now that the RRM has entered the operations phase and these species are able to again increase their utilization of habitats at these sites.

The richness of Total SCC showed trends similar to those observed in the two largest guilds showing interaction effects; SCC Edge / Shrub / Successional birds and SCC Forest birds. Total SCC bird richness significantly increased at control stations between 2014/15 and 2016 ($p = 0.0069$), followed by a significant decrease in richness between 2016 and 2018 ($p = 0.0021$). At impact stations there was no notable change in richness between 2014/15 and 2016, however a significant increase in richness occurred between 2016 and 2018. Richness values were similar at impact and control stations (mean richness 6.58 and 6.60, respectively) in 2016, however, richness was significantly greater at impact stations compared with control stations in both 2014/15 and 2018. This further supports the theory that some species were temporarily adversely affected by construction activities to a point where individuals of these species found or chose alternative nesting territories in 2016. The subsequent increase in richness at impact stations between 2016 and 2018, coupled with the decrease in richness at control stations supports the theory that disturbances at the impact locations have decreased now that the RRM has entered the operations phase and species are able to disperse more evenly and again increase their utilization of habitats at these sites.

No significant interaction effect between survey station type and year was observed relative to the richness of SCC Wetland / Open Water birds (Table 3-10 and Table 3-11); however, the analysis of yearly effects (inclusive of impact and control stations) showed a significant fluctuation in the richness of SCC Wetland / Open Water birds between monitoring years ($F_{2,268} = 5.7960$, $p = 0.0034$). Richness significantly increased between 2014/15 and 2016 ($p = 0.0095$), followed by a significant decrease in richness between 2016 and 2018 ($p = 0.0024$). This result indicates SCC Wetland / Open Water species are experiencing broad fluctuations of richness within the overall monitoring area.

The analysis of location effects (inclusive of 2014/15, 2016 and 2018) showed no changes in richness between impact and control stations for SCC Wetland / Open Water birds (Table 3-10 and Table 3-11).

Non-Species of Conservation Concern

The analysis for non-SCC revealed significant interaction effects between survey station type and year relative to the richness of non-SCC Forest birds ($F_{2,358} = 4.6000$, $p = 0.0107$) and Total non-SCC birds ($F_{2,358} = 4.3820$, $p = 0.0132$; Table 3-10 and Table 3-11) indicating that species richness at control and impact stations differs depending on the year.

Further analysis revealed the richness of non-SCC Forest species follows similar trends to those described for abundance. Richness significantly increased at control stations ($p = 0.0118$) between 2014/15 and 2016 while concurrently decreasing at impact stations (not significant; $p = 0.1499$). Richness was consistently significantly greater at control stations than impact stations across all monitoring years. This difference was most pronounced in 2016 ($p < 0.0001$). Between 2016 and 2018, the richness of non-SCC Forest birds decreased (not significant; $p = 0.1295$) at control stations while significantly increasing at impact stations ($p = 0.0627$). These results corroborate the theory that this guild may have been adversely affected by increased disturbance and habitat loss from the RRM construction activities. The subsequent decrease (non-significant) in richness at control stations, coupled with the increase at impact stations in 2018 supports the theory that disturbances at these locations have decreased now that the RRM has entered the operations phase and these species are able to disperse more evenly.

Further analysis revealed Total non-SCC bird richness trends are similar to those observed for non-SCC Forest birds. Total non-SCC bird richness significantly increased at control stations ($p = 0.0716$) between 2014/15 and 2016 while concurrently decreasing at impact stations (not significant; $p = 0.1192$). Richness was therefore significantly greater at control stations than at impact stations in 2016 ($p = 0.0920$). Between 2016 and 2018, richness decreased (not significant; $p = 0.8741$) at control stations while significantly increasing at impact stations ($p < 0.0001$). These results support the theory that some species have been adversely affected by increased disturbance and habitat loss from the RRM construction activities. However, disturbances at these locations have decreased now that the RRM has entered the operations phase and these species are able to disperse more evenly.

No significant interaction effect between survey station type and year was observed relative to the richness of non-SCC Edge / Shrub / Successional, Grassland / Open Country or Wetland / Open Water species (Table 3-10 and Table 3-11).

The analysis of yearly effects (inclusive of impact and control stations) showed a significant fluctuation in the richness of non-SCC Edge / Shrub / Successional birds ($F_{2,354} = 7.4605$, $p = 0.0007$) between monitoring years. Richness decreased significantly between 2014/15 and 2016 ($p = 0.0098$) and increased significantly between 2016 and 2018 ($p = 0.0002$). Similar to the results for abundance and density, these results indicate that species within this guild are experiencing broad fluctuations within the overall monitoring area. The analysis of yearly effects also showed significant increases in the richness of non-SCC Grassland / Open Country birds ($F_{2,122} = 9.5910$, $p = 0.0001$) and non-SCC Wetland / Open Water birds ($F_{2,198} = 6.3257$, $p = 0.0022$). Non-SCC Grassland / Open Country bird richness significantly increased between 2014/15 and 2016 ($p = 0.0090$) and again between 2016 and 2018 ($p = 0.0422$). Similarly, non-SCC Wetland / Open water bird richness significantly increased between 2014/15 and 2016 ($p = 0.0457$) and again between 2016 and 2018 ($p = 0.0004$). Similar to the results for abundance and density, this indicates that these species are experiencing broad population increases within the overall monitoring area.

The analysis of location effects (inclusive of 2014/15, 2016 and 2018) revealed that the richness of non-SCC Edge / Shrub / Successional species ($F_{1,177} = 5.8888$, $p = 0.0162$) and non-SCC Grassland / Open Country species ($F_{1,61} = 16.5067$, $p = 0.0001$) were significantly greater at impact stations compared to control stations. This result suggests that habitat for non-SCC Edge / Shrub / Successional species and non-SCC Grassland / Open Country species may be more prevalent at impact stations. No significant differences between impact and control stations were observed for non-SCC Wetland / Open Water species (Table 3-10 and Table 3-11).

3.2 Other Taxa (Incidental Observations)

White-tailed Deer (*Odocoileus virginianus*) were commonly observed throughout the NLSA as were their tracks and droppings, indicating a high level of local habitat use by this species. Similarly, evidence of Beaver (*Castor canadensis*) activity such as dams, lodges and chewed stumps were widespread throughout the NLSA.

The only avian species documented incidentally which was not also recorded during morning point count surveys was Common Nighthawk (Appendix A).

Table 3-1: Summary of Percent Occurrence of Dominant Species between 2016 and 2018 Monitoring Years

Species	Year	Impact (n = 90)			Control (n = 95)		
		Max. Birds Observed	No. of Stations Observed	Percent of Stations Observed	Max. Birds Observed	No. of Stations Observed	Percent of Stations Observed
SCC Birds							
Nashville Warbler	2016	129	64	71.1	141	79	83.2
	2018	115	66	73.3	158	70	81.1
Common Yellowthroat	2016	76	54	60.0	53	38	40.0
	2018	90	61	67.8	54	27	34.7
Chestnut-sided Warbler	2016	61	43	47.8	76	45	47.4
	2018	85	56	62.2	54	34	43.2
White-throated Sparrow	2016	122	71	78.9	158	76	80.0
	2018	89	49	54.4	102	54	63.2
Song Sparrow	2016	58	37	41.1	38	23	24.2
	2018	78	48	53.3	24	12	21.1
Veery	2016	41	32	35.6	53	41	43.2
	2018	61	40	44.4	63	39	46.3
Non-SCC Birds							
Red-eyed Vireo	2016	74	57	63.3	105	73	76.8
	2018	127	72	80.0	175	77	91.6
Ovenbird	2016	101	65	72.2	125	73	76.8
	2018	99	61	67.8	137	60	70.5
American Robin	2016	61	44	48.9	47	39	41.1
	2018	76	56	62.2	64	37	48.4
Black-and-white Warbler	2016	44	38	42.2	61	52	54.7
	2018	58	47	52.2	55	42	50.5
Blue Jay	2016	83	49	54.4	87	58	61.1
	2018	44	38	42.2	41	30	37.9
Hermit Thrush	2016	29	21	23.3	69	49	51.6
	2018	16	14	15.6	46	37	41.1

Table 3-2: Summary of Abundance of Commonly Occurring Species between Monitoring Years

Species	Station Type	No. of Survey Stations (n)*	2014/15 Mean Abundance ±SE	2016 Mean Abundance ±SE	2018 Mean Abundance ±SE
SCC Birds					
Nashville Warbler	Impact	81	1.43 ± 0.13	1.59 ± 0.12	1.42 ± 0.14
	Control	88	1.52 ± 0.12	1.56 ± 0.12	1.75 ± 0.13
Common Yellowthroat	Impact	71	1.17 ± 0.12	1.07 ± 0.10	1.27 ± 0.12
	Control	56	1.11 ± 0.13	0.89 ± 0.11	0.93 ± 0.13
White-throated Sparrow	Impact	83	1.72 ± 0.14	1.48 ± 0.14	1.07 ± 0.13
	Control	89	1.49 ± 0.13	1.70 ± 0.13	1.10 ± 0.12
Chestnut-sided Warbler	Impact	72	0.44 ± 0.09	0.85 ± 0.12	1.18 ± 0.10
	Control	63	0.86 ± 0.10	1.19 ± 0.13	0.78 ± 0.11
Song Sparrow	Impact	61	1.16 ± 0.13	0.95 ± 0.14	1.28 ± 0.12
	Control	39	1.38 ± 0.16	0.97 ± 0.17	0.62 ± 0.15
Veery	Impact	59	0.81 ± 0.11	0.69 ± 0.11	1.03 ± 0.12
	Control	67	0.73 ± 0.10	0.73 ± 0.10	0.91 ± 0.11
non-SCC Birds					
Red-eyed Vireo	Impact	88	1.19 ± 0.10	0.85 ± 0.08	1.44 ± 0.11
	Control	88	1.28 ± 0.10	1.14 ± 0.08	1.91 ± 0.11
Ovenbird	Impact	80	1.33 ± 0.12	1.26 ± 0.11	1.24 ± 0.12
	Control	77	1.57 ± 0.12	1.47 ± 0.11	1.62 ± 0.12
American Robin	Impact	81	0.75 ± 0.09	0.75 ± 0.08	0.94 ± 0.09
	Control	70	0.73 ± 0.10	0.64 ± 0.09	0.89 ± 0.10
Black-and-white Warbler	Impact	73	0.63 ± 0.07	0.60 ± 0.08	0.79 ± 0.08
	Control	70	0.53 ± 0.07	0.84 ± 0.08	0.73 ± 0.08
Blue Jay	Impact	77	0.71 ± 0.08	1.08 ± 0.11	0.57 ± 0.07
	Control	78	0.55 ± 0.08	1.09 ± 0.11	0.49 ± 0.07
Hermit Thrush	Impact	44	0.93 ± 0.13	0.66 ± 0.13	0.36 ± 0.10
	Control	74	0.72 ± 0.10	0.89 ± 0.10	0.59 ± 0.07

Note:

* Unlike the abundances provided above and in Appendix B and C, those presented in this table are over the total number of point counts where the species was observed (n) across both survey years (rather than the total number of overall point counts).

Table 3-3: Results of Repeated Measures ANOVA on Species Abundance

Species	Effect	DF	F	P*
SCC Birds				
Nashville Warbler	Station Type	1,167	0.9257	0.3374
	Year	2,334	0.6499	0.5228
	Station Type * Year	2,334	1.5953	0.2044
Common Yellowthroat	**Station Type**	**1,125**	**2.8626**	**0.0932**
	Year	2,250	1.2130	0.2990
	Station Type * Year	2,250	0.8897	0.4121
White-throated Sparrow	Station Type	1,170	0.0012	0.9729
	Year	**2,340**	**17.6935**	**<0.0001**
	Station Type * Year	**2,340**	**2.5024**	**0.0834**
Chestnut-sided Warbler	Station Type	1,133	1.2813	0.2597
	Year	**2,266**	**8.1483**	**0.0004**
	Station Type * Year	**2,266**	**10.2023**	**<0.0001**
Song Sparrow	Station Type	1,98	0.9854	0.3233
	Year	**2,196**	**3.7745**	**0.0246**
	Station Type * Year	**2,196**	**5.9626**	**0.0031**
Veery	Station Type	1,124	0.4003	0.5281
	Year	**2,248**	**3.1774**	**0.0434**
	Station Type * Year	2,248	0.2971	0.7432
non-SCC Birds				
Red-eyed Vireo	**Station Type**	**1,174**	**8.8833**	**0.0033**
	Year	**2,348**	**30.0890**	**<0.0001**
	Station Type * Year	2,348	2.2169	0.1105
Ovenbird	**Station Type**	**1,155**	**5.0001**	**0.0268**
	Year	2,310	0.4592	0.6322
	Station Type * Year	2,310	0.5369	0.5851
American Robin	Station Type	1,149	0.7396	0.3912
	Year	**2,298**	**3.0311**	**0.0498**
	Station Type * Year	2,298	0.1129	0.8933
Black-and-white Warbler	Station Type	1,141	0.1867	0.6663
	Year	**2,282**	**2.9574**	**0.0536**
	Station Type * Year	**2,282**	**2.8318**	**0.0606**
Hermit Thrush	Station Type	1,116	1.0382	0.3104
	Year	**2,232**	**5.5932**	**0.0042**
	Station Type * Year	**2,232**	**2.6775**	**0.0709**
Blue Jay	Station Type	1,153	1.4131	0.2364
	Year	**2,306**	**19.6596**	**<0.0001**
	Station Type * Year	2,306	0.4334	0.6487

Note:

* Bolded values represent statistically significant at $p < 0.10$

Table 3-4: Summary of Densities of Commonly Occurring Species between Monitoring Years

Species	Station Type	No. of Survey Stations (n)*	2014/15 Mean Density ±SE (per ha)	2016 Mean Density ±SE (per ha)	2018 Mean Density ±SE (per ha)
SCC Birds					
Nashville Warbler	Impact	81	1.21 ± 0.12	1.30 ± 0.12	1.22 ± 0.14
	Control	88	1.26 ± 0.12	1.39 ± 0.11	1.66 ± 0.13
Common Yellowthroat	Impact	71	0.96 ± 0.11	0.69 ± 0.08	0.94 ± 0.11
	Control	56	0.88 ± 0.12	0.57 ± 0.09	0.86 ± 0.12
White-throated Sparrow	Impact	83	0.99 ± 0.12	0.61 ± 0.11	0.76 ± 0.12
	Control	89	0.84 ± 0.12	0.97 ± 0.11	0.82 ± 0.11
Chestnut-sided Warbler	Impact	72	0.42 ± 0.09	0.72 ± 0.12	0.99 ± 0.10
	Control	63	0.79 ± 0.10	1.13 ± 0.13	0.73 ± 0.11
Song Sparrow	Impact	61	0.90 ± 0.12	0.61 ± 0.09	0.97 ± 0.11
	Control	39	1.08 ± 0.15	0.67 ± 0.12	0.56 ± 0.14
Veery	Impact	59	0.32 ± 0.09	0.27 ± 0.09	0.61 ± 0.10
	Control	67	0.45 ± 0.08	0.43 ± 0.09	0.54 ± 0.10
non-SCC Birds					
Red-eyed Vireo	Impact	88	0.81 ± 0.10	0.49 ± 0.08	0.82 ± 0.10
	Control	88	1.03 ± 0.10	0.85 ± 0.08	1.47 ± 0.10
Ovenbird	Impact	80	0.73 ± 0.11	0.65 ± 0.10	0.71 ± 0.11
	Control	77	1.03 ± 0.10	0.85 ± 0.08	1.47 ± 0.10
American Robin	Impact	81	0.58 ± 0.08	0.57 ± 0.08	0.51 ± 0.08
	Control	70	0.57 ± 0.09	0.43 ± 0.08	0.66 ± 0.09
Black-and-white Warbler	Impact	73	0.59 ± 0.07	0.52 ± 0.07	0.62 ± 0.08
	Control	70	0.44 ± 0.07	0.73 ± 0.08	0.67 ± 0.08
Blue Jay	Impact	77	0.51 ± 0.08	0.36 ± 0.09	0.22 ± 0.06
	Control	78	0.35 ± 0.08	0.50 ± 0.08	0.29 ± 0.06
Hermit Thrush	Impact	44	0.61 ± 0.12	0.32 ± 0.09	0.14 ± 0.08
	Control	74	0.45 ± 0.09	0.39 ± 0.07	0.38 ± 0.06

Note:

* Unlike the densities provided above and in Appendix B and C, those presented in this table are over the total number of point counts where the species was observed (n) across both survey years (rather than the total number of overall point counts).

Table 3-5: Results of Repeated Measure ANOVA on Species Density

Species	Effect	DF	F	P*
SCC Birds				
Nashville Warbler	Station Type	1,167	2.1566	0.1438
	Year	2,334	2.1488	0.1182
	Station Type * Year	2,334	2.3017	0.1017
Common Yellowthroat	Station Type	1,125	0.8990	0.3449
	Year	**2,250**	**5.2972**	**0.0056**
	Station Type * Year	2,250	0.0201	0.9801
White-throated Sparrow	Station Type	1,170	0.5163	0.4734
	Year	2,340	1.3431	0.2624
	Station Type * Year	**2,340**	**3.9998**	**0.0192**
Chestnut-sided Warbler	Station Type	1,133	2.6730	0.1044
	Year	**2,266**	**6.4865**	**0.0018**
	Station Type * Year	**2,266**	**7.9714**	**0.0004**
Song Sparrow	Station Type	1,98	0.2313	0.6316
	Year	**2,196**	**5.0147**	**0.0075**
	Station Type * Year	**2,196**	**3.6906**	**0.0267**
Veery	Station Type	1,124	0.7341	0.3932
	Year	**2,248**	**3.8761**	**0.0220**
	Station Type * Year	2,248	1.0797	0.3413
non-SCC Birds				
Red-eyed Vireo	**Station Type**	**1,174**	**19.0390**	**<0.0001**
	Year	**2,348**	**18.8345**	**<0.0001**
	Station Type * Year	**2,348**	**3.8922**	**0.0213**
Ovenbird	**Station Type**	**1,155**	**8.5917**	**0.0039**
	Year	2,310	1.2446	0.2895
	Station Type * Year	2,310	0.3817	0.6830
American Robin	Station Type	1,149	0.0002	0.9887
	Year	2,298	0.5973	0.5509
	Station Type * Year	2,298	1.4553	0.2350
Black-and-white Warbler	Station Type	1,141	0.4199	0.5181
	Year	2,282	1.6663	0.1908
	Station Type * Year	**2,282**	**2.7627**	**0.0648**
Hermit Thrush	Station Type	1,116	0.4142	0.5211
	Year	**2,232**	**5.0789**	**0.0069**
	Station Type * Year	**2,232**	**2.8269**	**0.0612**
Blue Jay	Station Type	1,153	0.0710	0.7903
	Year	**2,306**	**3.4179**	**0.0340**
	Station Type * Year	2,306	2.1381	0.1196

Note:
Bolded values represent statistically significant at $p < 0.10$

Table 3-6: Bird Species Abundance by Guild between Monitoring Years

Guild	Station Type	No. of Survey Stations (n)*	2014/15 Mean Abundance ±SE	2016 Mean Abundance ±SE	2018 Mean Abundance ±SE
SCC Birds					
Edge / Shrub / Successional Birds	Impact	87	2.49 ± 0.22	2.48 ± 0.18	3.15 ± 0.20
	Control	81	2.32 ± 0.23	2.25 ± 0.19	1.78 ± 0.20
Forest Birds	Impact	90	5.42 ± 0.29	4.80 ± 0.30	5.12 ± 0.31
	Control	91	5.70 ± 0.28	6.47 ± 0.30	5.85 ± 0.31
Grassland / Open Country Birds	Impact	50	2.84 ± 0.37	2.44 ± 0.39	3.14 ± 0.55
	Control	20	1.65 ± 0.58	2.00 ± 0.61	3.50 ± 0.88
Wetland / Open Water Birds	Impact	76	1.38 ± 0.17	1.78 ± 0.20	2.07 ± 0.31
	Control	60	1.10 ± 0.19	1.43 ± 0.22	1.10 ± 0.35
Total Birds	Impact	90	10.58 ± 0.45	10.08 ± 0.43	11.66 ± 0.53
	Control	91	8.86 ± 0.45	9.86 ± 0.43	8.92 ± 0.52
Non-SCC Birds					
Edge / Shrub / Successional Birds	Impact	89	3.79 ± 0.29	3.31 ± 0.28	4.15 ± 0.35
	Control	90	2.94 ± 0.29	2.58 ± 0.28	3.33 ± 0.35
Forest Birds	Impact	90	5.93 ± 0.33	5.51 ± 0.33	6.20 ± 0.33
	Control	91	6.85 ± 0.33	7.92 ± 0.33	7.70 ± 0.32
Grassland / Open Country Birds	Impact	45	1.82 ± 0.20	2.87 ± 0.26	3.42 ± 0.32
	Control	18	0.72 ± 0.31	1.39 ± 0.42	1.89 ± 0.50
Wetland / Open Water Birds	Impact	49	0.92 ± 0.20	1.02 ± 0.16	0.84 ± 0.15
	Control	52	0.40 ± 0.19	0.67 ± 0.15	1.08 ± 0.15
Total Birds	Impact	90	11.09 ± 0.47	10.78 ± 0.36	12.47 ± 0.53
	Control	91	10.13 ± 0.46	11.13 ± 0.36	11.99 ± 0.53

Note:

* Unlike the abundances provided above and in Appendix B and C, those presented in this table are over the total number of point count stations *where the species was observed* (n) across both survey years (rather than the total number of overall point counts stations).

Table 3-7: Repeated Measures ANOVA of Bird Species Abundance by Guild

Guild	Effect	DF	F	P*
SCC Birds				
Edge / Shrub / Successional Birds	**Station Type**	**1,166**	**6.6590**	**0.0107**
	Year	2,332	0.2052	0.8146
	Station Type * Year	**2,332**	**9.5154**	**< 0.0001**
Forest Birds	**Station Type**	**1,179**	**7.6580**	**0.0062**
	Year	2,358	0.2120	0.8089
	Station Type * Year	**2,358**	**4.6350**	**0.0103**
Grassland / Open Country Birds	Station Type	1,68	0.3347	0.5648
	Year	**2,136**	**6.7752**	**0.0016**
	Station Type * Year	**2,136**	**2.5805**	**0.0794**
Wetland / Open Water Birds	**Station Type**	**1,134**	**5.2195**	**0.0239**
	Year	2,268	1.5512	0.2139
	Station Type * Year	2,268	1.3335	0.2653
Total Birds	**Station Type**	**1,179**	**8.2620**	**0.0045**
	Year	2,358	1.4740	0.2304
	Station Type * Year	**2,358**	**7.1600**	**0.0009**
Non-SCC Birds				
Edge / Shrub / Successional Birds	**Station Type**	**1,177**	**5.1531**	**0.0244**
	Year	**2,354**	**6.2746**	**0.0021**
	Station Type * Year	2,354	0.0294	0.9711
Forest Birds	**Station Type**	**1,179**	**22.6020**	**< 0.0001**
	Year	2,358	2.1120	0.1225
	Station Type * Year	**2,358**	**3.7810**	**0.0237**
Grassland / Open Country Birds	**Station Type**	**1,61**	**12.8638**	**0.0007**
	Year	**2,122**	**13.2407**	**<0.0001**
	Station Type * Year	2,122	0.3776	0.6863
Wetland / Open Water Birds	Station Type	1,99	2.4294	0.1223
	Year	2,198	1.5685	0.2109
	Station Type * Year	**2,198**	**2.7580**	**0.0659**
Total Birds	Station Type	1,179	0.5600	0.4551
	Year	**2,358**	**10.4110**	**< 0.0001**
	Station Type * Year	2,358	1.5780	0.2078

Note:
Bolded values represent statistically significant at $p < 0.10$

Table 3-8: Bird Species Density by Guild between Monitoring Years

Guild	Station Type	No. of Survey Stations (n)*	2014/15 Mean Abundance ±SE	2016 Mean Abundance ±SE	2018 Mean Abundance ±SE
SCC Birds					
Edge / Shrub / Successional Birds	Impact	87	1.92 ± 0.19	1.75 ± 0.16	2.47 ± 0.18
	Control	81	1.81 ± 0.19	1.73 ± 0.16	1.59 ± 0.18
Forest Birds	Impact	90	3.63 ± 0.26	2.83 ± 0.25	3.58 ± 0.30
	Control	91	3.95 ± 0.26	4.19 ± 0.24	4.77 ± 0.29
Grassland / Open Country Birds	Impact	50	1.88 ± 0.24	1.36 ± 0.19	2.34 ± 0.47
	Control	20	0.70 ± 0.38	1.15 ± 0.30	2.75 ± 0.74
Wetland / Open Water Birds	Impact	76	0.67 ± 0.12	0.25 ± 0.07	0.83 ± 0.21
	Control	60	0.47 ± 0.14	0.30 ± 0.08	0.40 ± 0.23
Total Birds	Impact	90	7.10 ± 0.34	5.50 ± 0.27	7.97 ± 0.43
	Control	91	6.02 ± 0.34	6.18 ± 0.27	7.05 ± 0.43
Non-SCC Birds					
Edge / Shrub / Successional Birds	Impact	89	3.07 ± 0.24	2.31 ± 0.23	2.76 ± 0.30
	Control	90	2.21 ± 0.24	1.81 ± 0.22	2.72 ± 0.29
Forest Birds	Impact	90	3.92 ± 0.29	2.88 ± 0.30	3.62 ± 0.30
	Control	91	4.98 ± 0.29	5.21 ± 0.29	5.80 ± 0.29
Grassland / Open Country Birds	Impact	45	1.62 ± 0.18	2.33 ± 0.23	3.11 ± 0.30
	Control	18	0.61 ± 0.29	1.11 ± 0.36	1.78 ± 0.47
Wetland / Open Water Birds	Impact	49	0.43 ± 0.12	0.33 ± 0.08	0.35 ± 0.11
	Control	52	0.23 ± 0.12	0.15 ± 0.08	0.42 ± 0.11
Total Birds	Impact	90	8.00 ± 0.34	6.51 ± 0.32	8.10 ± 0.40
	Control	91	7.42 ± 0.34	7.31 ± 0.32	9.09 ± 0.40

Note:

* Unlike the densities provided above and in Appendix B and C, those presented in this table are over the total number of point count stations *where the species was observed* (n) across both survey years (rather than the total number of overall point count stations).

Table 3-9: Repeated Measures ANOVA of Bird Species Density by Guild

Guild	Effect	DF	F	P*
SCC Birds				
Edge / Shrub / Successional Birds	**Station Type**	**1,166**	**3.0143**	**0.0844**
	Year	2,332	2.2631	0.1056
	Station Type * Year	**2,332**	**5.8382**	**0.0032**
Forest Birds	**Station Type**	**1,179**	**10.0757**	**0.0018**
	Year	**2,358**	**5.6371**	**0.0039**
	Station Type * Year	**2,358**	**3.9912**	**0.0193**
Grassland / Open Country Birds	Station Type	1,68	0.5396	0.4651
	Year	**2,136**	**8.5620**	**0.0003**
	Station Type * Year	**2,136**	**2.5455**	**0.0822**
Wetland / Open Water Birds	Station Type	1,134	1.7848	0.1838
	Year	**2,268**	**3.4447**	**0.0333**
	Station Type * Year	2,268	1.4567	0.2348
Total Birds	Station Type	1,179	1.4030	0.2377
	Year	**2,358**	**16.4650**	**< 0.0001**
	Station Type * Year	**2,358**	**5.4810**	**0.0045**
Non-SCC Birds				
Edge / Shrub / Successional Birds	**Station Type**	**1,177**	**2.8900**	**0.0909**
	Year	**2,354**	**6.5819**	**0.0016**
	Station Type * Year	2,354	2.0440	0.1310
Forest Birds	**Station Type**	**1,179**	**31.6478**	**< 0.0001**
	Year	**2,358**	**4.7098**	**0.0096**
	Station Type * Year	**2,358**	**5.0312**	**0.0070**
Grassland / Open Country Birds	**Station Type**	**1,61**	**12.0017**	**0.0010**
	Year	**2,122**	**13.6516**	**< 0.0001**
	Station Type * Year	2,122	0.2069	0.8134
Wetland / Open Water Birds	Station Type	1,99	0.8500	0.3588
	Year	2,198	1.2449	0.2902
	Station Type * Year	2,198	1.3363	0.2652
Total Birds	Station Type	1,179	1.4140	0.2359
	Year	**2,358**	**13.7540**	**< 0.0001**
	Station Type * Year	**2,358**	**3.5550**	**0.0296**

Note:

Bolded values represent statistically significant at $p < 0.10$

Table 3-10: Summary of Bird Species Richness by Guild

Guild	Station Type	No. of Survey Stations (n)*	2014/15 Mean Richness ±SE	2016 Mean Richness ±SE	2018 Mean Richness ±SE
SCC Birds					
Edge / Shrub / Successional Birds	Impact	87	1.60 ± 0.12	1.76 ± 0.11	2.13 ± 0.12
	Control	81	1.56 ± 0.13	1.47 ± 0.11	1.30 ± 0.13
Forest Birds	Impact	90	3.44 ± 0.16	3.23 ± 0.16	3.66 ± 0.19
	Control	91	3.82 ± 0.16	4.29 ± 0.16	3.93 ± 0.19
Grassland / Open Country Birds	Impact	50	1.36 ± 0.14	1.18 ± 0.14	1.32 ± 0.13
	Control	18	0.89 ± 0.23	1.28 ± 0.23	1.33 ± 0.22
Wetland / Open Water Birds	Impact	76	0.95 ± 0.11	1.17 ± 0.11	0.92 ± 0.12
	Control	60	0.77 ± 0.12	1.15 ± 0.13	0.68 ± 0.14
Total Birds	Impact	90	6.54 ± 0.27	6.58 ± 0.24	7.22 ± 0.26
	Control	91	5.89 ± 0.27	6.60 ± 0.24	5.79 ± 0.26
Non-SCC Birds					
Edge / Shrub / Successional Birds	Impact	89	2.63 ± 0.18	2.25 ± 0.17	2.93 ± 0.20
	Control	90	2.20 ± 0.18	1.89 ± 0.16	2.21 ± 0.20
Forest Birds	Impact	90	4.47 ± 0.23	4.09 ± 0.22	4.58 ± 0.22
	Control	91	5.01 ± 0.23	5.67 ± 0.22	5.27 ± 0.22
Grassland / Open Country Birds	Impact	45	1.20 ± 0.12	1.51 ± 0.13	1.80 ± 0.12
	Control	18	0.50 ± 0.19	0.94 ± 0.20	1.17 ± 0.19
Wetland / Open Water Birds	Impact	49	0.51 ± 0.08	0.55 ± 0.08	0.69 ± 0.10
	Control	52	0.29 ± 0.08	0.62 ± 0.08	0.77 ± 0.10
Total Birds	Impact	90	7.91 ± 0.31	7.37 ± 0.25	8.76 ± 0.33
	Control	91	7.45 ± 0.31	8.08 ± 0.25	8.13 ± 0.33

Note:

* Unlike the species richness values provided in Appendix B and C, those presented in this table are over the total number of point count stations *where the species was observed* (n) across both survey years (rather than the total number of overall point count stations).

Table 3-11: Repeated Measures ANOVA of Bird Species Richness by Guild

Guild	Effect	DF	F	P*
	SCC Birds			
Edge / Shrub / Successional Birds	**Station Type**	**1,166**	**8.9902**	**0.0031**
	Year	2,332	1.0490	0.3514
	Station Type * Year	**2,332**	**8.7981**	**0.0002**
Forest Birds	**Station Type**	**1,179**	**10.4880**	**0.0014**
	Year	2,358	0.6790	0.5077
	Station Type * Year	**2,358**	**4.2230**	**0.0154**
Grassland / Open Country Birds	Station Type	1,66	0.3072	0.5813
	Year	2,132	1.2688	0.2846
	Station Type * Year	**2,132**	**2.9229**	**0.0573**
Wetland / Open Water Birds	Station Type	1,134	1.7380	0.1896
	Year	**2,268**	**5.7960**	**0.0034**
	Station Type * Year	2,268	0.4906	0.6128
Total Birds	**Station Type**	**1,179**	**5.5590**	**0.0195**
	Year	2,358	2.2130	0.1108
	Station Type * Year	**2,358**	**7.6580**	**0.0006**
	Non-SCC Birds			
Edge / Shrub / Successional Birds	**Station Type**	**1,177**	**5.8888**	**0.0162**
	Year	**2,354**	**7.4605**	**0.0007**
	Station Type * Year	2,354	1.0402	0.3545
Forest Birds	**Station Type**	**1,179**	**16.1650**	**< 0.0001**
	Year	2,358	0.5590	0.5724
	Station Type * Year	**2,358**	**4.6000**	**0.0107**
Grassland / Open Country Birds	**Station Type**	**1,61**	**16.5067**	**0.0001**
	Year	**2,122**	**9.5910**	**0.0001**
	Station Type * Year	2,122	0.1050	0.9004
Wetland / Open Water Birds	Station Type	1,99	0.1899	0.6640
	Year	**2,198**	**6.3257**	**0.0022**
	Station Type * Year	2,198	1.6200	0.2005
Total Birds	Station Type	1,179	0.1610	0.6886
	Year	**2,358**	**6.0960**	**0.0025**
	Station Type * Year	**2,358**	**4.3820**	**0.0132**

Note:
Bolded values represent statistically significant at $p < 0.10$

4.0 Conclusions

A total of 132 bird species were recorded during the 2018 morning point count surveys, of which 113 species were recorded at impact stations and 120 species were recorded at control stations. A total of 54 bird SCC were documented, of which 45 species were recorded at impact stations and 48 species were recorded at control stations. These 54 species are all considered BCR 12 priority species with 12 of them further designated as SAR. The SAR are discussed further in the *2018 RRP Species at Risk Report* (Wood 2018).

Based on the percent occurrence, abundance and density there was significant overlap of the overall dominant species between impact and control stations and between monitoring years.

Based on the analyses undertaken for the most commonly occurring species, abundance and density values followed similar trends for each species, especially for those species with significant interaction effects present (i.e., interaction between station type and year indicating the RRM is having some effect).

Based on the analyses of the most widely occurring SCC, Chestnut-sided Warbler, Song Sparrow and White-throated Sparrow all showed significant interaction effects between site type and year, indicating that the RRM has had an effect on these species. Neither Chestnut-sided Warbler nor Song Sparrow showed a negative effect at impact stations in 2016 (construction), indicating that these species did not appear to have been adversely impacted by the construction activities being undertaken at the RRM impact stations. Both species experienced increases in abundance and density at impact stations in 2018 with concurrent decreases at control stations, suggesting that the construction activities may have resulted in the creation of early successional habitat preferred by species belonging to the Edge / Shrub / Successional habitat guild, causing some species to shift into these new optimal habitats. White-throated Sparrow showed a significant decrease in abundance and density at impact stations between 2014/15 and 2016 but not at control stations. This suggests that this species may have been negatively impacted by construction activities being undertaken at the RRM impact stations. Individuals may have avoided impact stations in 2016 and established breeding territories further away from construction activities. Abundance and density of White-throated Sparrow in 2018 appear similar between impact and control stations, potentially due to individuals dispersing more evenly in 2018 (post-construction) once habitats around impact stations were no longer undergoing active disturbance (Table 4-1).

Based on the analyses of the most widely occurring non-SCC, Red-eyed Vireo, Black-and-white Warbler and Hermit Thrush all showed significant interaction effects between location type and year, indicating the RRM has had some effect on these species. Black-and-white Warbler abundance and density were slightly higher at impact stations than control stations in 2014/15. Both metrics were significantly higher at control stations in 2016 and then returned to similar values between station types in 2018. This indicates individuals may have been preferentially choosing control stations in 2016 to be further away from construction activities. Additionally, these species may have been dispersing more evenly in 2018 (post-construction), once habitats around impact stations were no longer undergoing active disturbance. Hermit Thrush showed overall population declines. Density of this species was slightly higher at impact stations in 2014/15, then decreasing at impact stations in 2016 and 2018. In 2018, the density of this species was greater at control stations than at the impact stations. This indicates that, in addition to the overall decreases in density, this species may be preferentially choosing control stations as optimal forested habitat was removed near the impact stations. Red-eyed Vireo density was significantly lower in 2016 at both the impact and control stations when compared with 2014/2015and 2018. Density of this species was significantly greater at control stations than at impact stations in all monitoring years, with the greatest difference between station types observed in 2018. These results are likely in part due to population fluctuations across the overall monitoring area, combined with some avoidance of impact stations in 2016 due to increased construction activities. The increase in density at control stations in 2018 is likely because habitats around impact stations no longer support as much optimal (forested) habitat for this species (Table 4-1).

Based on the analysis of the most commonly occurring SCC, there was a significant increase in the abundance and density of Veery between 2016 and 2018. This implies that this species may be experiencing a population increase within the overall monitoring area. A significantly greater abundance of Common Yellowthroat was recorded at impact stations than control stations, though this trend was not observed for density. This increased abundance of Common Yellowthroat may be due to a prevalence of suitable habitat for this species at the impact stations.

Based on the analysis of the most commonly occurring non-SCC, abundance fluctuated across years for several species. Red-eyed Vireo abundance initially decreased between 2014/15 and 2016 followed by an increase between 2016 and 2018. Conversely, Blue Jay showed the opposite trend with an increase in abundance between 2014/2015 and 2016 followed by a decrease between 2016 and 2018. The density of Blue Jay also significantly decreased between 2016 and 2018. American Robin abundance increased between 2016 and 2018. This implies that these species may be experiencing population changes within the overall monitoring area. Red-eyed Vireo and Ovenbird showed significantly greater abundance (Ovenbird also showed greater density) at control stations than at impact stations, which may be due to the prevalence of forested habitat at locations further removed from mine activities.

Half of the most widely occurring species experienced no interaction effects between station type and year for either abundance or density, suggesting the RRM has not had an adverse effect on several of the most widely occurring species. Additionally, the recurring trend of these metrics increasing for several species at impact stations post-construction (2018) indicates that any disturbance effects of mine construction were likely temporary and reversible and, in some cases, possibly beneficial in providing optimal habitat for some species (especially those preferring successional habitats).

Based on the analysis of guilds, species abundance, density and richness followed similar trends for both SCC and non-SCC birds, although the level of significance for these trends varied between the guilds. Overall, the RRM operations did appear to have some effect on species abundance or density for several guilds. Decreases in abundance and density were noted for some guilds, particularly in 2016 (construction). However, the abundance and density of several guilds subsequently increased between 2016 and 2018 (Table 4-1). This suggests that some species may be less sensitive to disturbance from the RRM operations and / or habitats for these species are either still available or enhanced at the impact stations post-construction.

SCC Edge / Shrub / Successional bird population metrics remained relatively unchanged between 2014/15 and 2016, indicating that this guild of species was not adversely impacted by the construction activities being undertaken at the RRM impact stations. Between 2016 and 2018, abundance, density and richness increased at impact stations while decreasing at control stations. This may indicate that construction activities resulted in the creation of edge / shrub / successional habitat preferred these species, causing them to shift into these optimal habitats.

No change in abundance was detected between location types over time (interaction effect) for Non-SCC Edge / Shrub / Successional birds, implying that the RRM construction and operations have not affected the abundance of this guild. Abundance and density of these species was greater at impact stations compared with control stations, potentially due to a greater prevalence of suitable habitats within impact areas. Abundance, density and richness for these species did vary over time, a decrease in these metrics for these species was recorded in 2016 followed by a subsequent increase in 2018. This would suggest that these species are experiencing population fluctuations within the overall monitoring area.

Both SCC and non-SCC Forest birds exhibited similar differences in population metrics between location types and year. Abundance and richness increased at control stations between 2014/15 and 2016, and decreased between 2016 and 2018. Conversely, at impact stations, these metrics decreased between 2014/15 and 2016 and increased between 2016 and 2018. This indicates that these species may have been negatively impacted by construction activities being undertaken at the RRM impact stations. Individuals may have avoided impact stations in 2016 and established breeding territories further away from construction activities (causing increases at control stations). Population metrics were similar at impact and control stations in 2018, potentially due to individuals dispersing more evenly post-construction, once habitats around impact stations were no longer undergoing active disturbance. Forest birds are frequently more common at control stations as compared to impact stations indicating that there is more optimal (forested) habitat for these species further from the RRM.

Birds belonging to the SCC Grassland / Open Country guild showed some non-significant trends in abundance and density between 2014/15 and 2016. These metrics decreased at impact stations while increasing at control stations, indicating that these species may have been temporarily adversely affected by construction activities, thereby temporarily displacing individuals of these species to alternative nesting territories. Between 2016 and 2018 abundance and density significantly increased at both control and impact stations, indicating a population increase across the overall monitoring area. This could be partly attributed to the work undertaken by New Gold to maintain high quality grassland bird habitat within the protected Bobolink Overall Benefit lands. Since disturbances at these locations have decreased and the RRM has entered the operations phase, populations of these species have increased, suggesting that they are once again able to fully utilize these habitats.

No change in abundance was detected between location types and year for Non-SCC Grassland / Open Country birds, implying that the RRM construction and operations have not affected the abundance of this guild. Abundance, density and richness of these species were higher at impact stations than control stations, which is likely a result of the higher number of impact stations located within Bobolink Overall Benefit lands. Thirty-two (32) impact stations are located in the Bobolink Overall Benefit lands, compared with only 11 control stations. An increase in these same population metrics was recorded across monitoring years, indicating that these species are experiencing population increases within the overall monitoring area.

No change in abundance was detected between location types and year for SCC Wetland / Open Water birds, implying that the RRM construction and operations have not affected the abundance of this guild. The abundance of these species was higher at impact stations compared with control stations, potentially due to a prevalence of suitable habitats within impact areas. Density and richness showed an inverse relationship over time, whereby density decreased between 2014/15 and 2016, followed by an increase between 2016 and 2018. Conversely, richness increased between 2014/2015 and 2016, followed by a decrease between 2016 and 2018. This suggests that these species are experiencing population fluctuations within the overall monitoring area. As there is limited wetland habitat within the NLSA, it is possible that these trends have been magnified based on limited sample sizes as no explanation is apparent. Future monitoring could identify potential sources of these changes.

The abundance of Non-SCC Wetland / Open water birds in 2014/15 was significantly greater at impact stations than at control stations. In 2016, abundance increased slightly at both impact and control stations, indicating that these species did not seem to be negatively impacted by construction activities being undertaken at the RRM impact stations. In 2018, abundance decreased slightly at impact stations, while increasing significantly at control stations, potentially indicating that these species are preferentially choosing control stations. Further years of surveys will be needed to confirm and explain this trend.

Total SCC birds showed similar trends to those noted above for the larger guilds contained within it. This group showed clear decreases in abundance at impact stations in 2016, while concurrently showing marked increases at control stations. This may indicate that some species may have been negatively impacted by construction activities undertaken at impact stations. Individual SCC birds may have avoided impact stations in 2016 and established breeding territories further away from construction activities either at control stations or further afield. An opposite trend was observed in 2018 when abundances increased at impact stations and simultaneously decreased at control stations. This may potentially be due to individuals dispersing more evenly in 2018 (post-construction), when habitats around impact stations were no longer undergoing active disturbance.

No significant differences in the abundance of total non-SCC birds were recorded between location types and year, implying that the RRM construction and operations did not affect the majority of non-SCC species. An increase in the abundance of non-SCC birds was recorded across all monitoring years. Decreases in Total non-SCC bird density and richness were recorded at impact stations in 2016, followed by increases in these metrics in 2018. This trend supports the theory that some species may have been temporarily negatively impacted by construction activities undertaken at impact stations in 2016. However, individuals appear to be dispersing more evenly in 2018 (post-construction) now that habitats around impact stations are no longer undergoing active disturbance.

The culmination of results suggests that the RRM activities (i.e., construction activities and operations) have not significantly adversely affected avian populations in the long term. The progression into mine operation activities and the decrease in intensive disturbances appears to have allowed these species to re-disperse evenly and for some, to move into optimal regenerating habitats created by the construction activities (Table 4-1).

Despite the apparent lack of long-term adverse effects on avian populations, it is unclear whether productivity (e.g., clutch size and fledgling rate) or rates of depredation have been affected by the RRM operations. In cases where bird abundance, density and richness increase, yet productivity decreases, and depredation increases, a 'sink' population may be produced in which immigration rates are higher that emigration rates (or death rates are greater than birth rates), resulting in a population decline. A 'sink' population is in contrast to a 'source' population, in which populations grow due to greater emigration than immigration (or birth rates are greater than death rates). Further studies that include productivity measures in addition to the population metrics may provide further insight into the effect of mining operations on bird populations.

Table 4-1: Summary of Significant Yearly, Location and Interaction Effects on Avian Community

Species / Guild	Abundance	Density	Richness
Species Effects – SCC			
Nashville Warbler	Nil	Nil	N/A
Common Yellowthroat	Impact > Control	Nil	N/A
White-throated Sparrow	Impact 2015-2016: Decrease Impact 2016-2018: Decrease Control 2016-2018: Decrease	Impact 2015-2016: Decrease 2016: Control > Impact	N/A
Chestnut-sided Warbler	Impact 2015-2016: Increase Impact 2016-2018: Increase Control 2015-2016: Increase Control 2016-2018: Decrease 2015: Control > Impact 2016: Control > Impact 2018: Impact > Control	Impact 2015-2016: Increase Impact 2016-2018: Increase Control 2015-2016: Increase 2015: Control > Impact 2016: Control > Impact 2018: Impact > Control	N/A
Song Sparrow	Impact 2016-2018: Increase Control 2015-2016: Decrease Control 2016-2018: Decrease 2018: Impact > Control	Impact 2015-2016: Decrease Impact 2016-2018: Increase Control 2015-2016: Decrease 2018: Impact > Control	N/A
Veery	2016-2018: Increase	2016-2018: Increase	N/A
Species Effects – non-SCC			
Red-eyed Vireo	2015-2016: Decrease 2016-2018: Increase Control > Impact	Impact 2015-2016: Decrease Impact 2016-2018: Increase Control 2015-2016: Decrease Control 2016-2018: Increase	N/A
Ovenbird	Control > Impact	Control > Impact	N/A
American Robin	2016-2018: Increase	Nil	N/A
Black-and-white Warbler	Impact 2016-2018: Increase Control 2015-2016: Increase 2016: Control > Impact	Control 2015-2016: Increase 2016: Control > Impact	N/A
Blue Jay	2015-2016: Increase 2016-2018: Decrease	2016-2018: Decrease	N/A
Hermit Thrush	Impact 2016-2018: Decrease Control 2016-2018: Decrease	Impact 2015-2016: Decrease 2018: Control > Impact	N/A
Guild Effects – SCC			
Edge / Shrub / Successional Birds	Impact 2016-2018: Increase Control 2016-2018: Decrease 2018: Impact > Control	Impact 2016-2018: Increase 2018: Impact > Control	Impact 2016-2018: Increase 2016: Impact > Control 2018: Impact > Control
Forest Birds	Impact 2015-2016: Decrease Control 2015-2016: Increase Control 2016-2018: Decrease 2016: Control > Impact 2018: Control > Impact	Impact 2015-2016: Decrease Impact 2016-2018: Increase Control 2016-2018: Increase 2016: Control > Impact 2018: Control > Impact	Impact 2016-2018: Increase Control 2015-2016: Increase Control 2016-2018: Decrease 2016: Control > Impact
Grassland / Open Country Birds	Impact 2016-2018: Increase Control 2016-2018: Increase	Impact 2016-2018: Increase Control 2016-2018: Increase 2015: Impact > Control	Control 2015-2016: Increase 2015: Impact > Control
Wetland / Open Water Birds	Impact > Control	2015-2016: Decrease 2016-2018: Increase	2015-2016: Increase 2016-2018: Decrease
Total Combined Birds	Impact 2016-2018: Increase Control 2015-2016: Increase Control 2016-2018: Decrease	Impact 2015-2016: Decrease Impact 2016-2018: Increase Control 2016-2018: Increase	Impact 2016-2018: Increase Control 2015-2016: Increase Control 2016-2018: Decrease 2015: Impact > Control 2018: Impact > Control

Species / Guild	Abundance	Density	Richness
Guild Effects – Non-SCC			
Edge / Shrub / Successional Birds	2015-2016: Decrease 2016-2018: Increase Impact > Control	2015-2016: Decrease 2016-2018: Increase Impact > Control	2015-2016: Decrease 2016-2018: Increase Impact > Control
Forest Birds	Impact 2016-2018: Increase Control 2015-2016: Increase 2015: Control > Impact 2016: Control > Impact 2018: Control > Impact	Impact 2015-2016: Decrease Impact 2016-2018: Increase Control 2016-2018: Increase 2015: Control > Impact 2016: Control > Impact 2018: Control > Impact	Impact 2016-2018: Increase Control 2015-2016: Increase 2015: Control > Impact 2016: Control > Impact 2018: Control > Impact
Grassland / Open Country Birds	2015-2016: Increase 2016-2018: Increase Impact > Control	2015-2016: Increase 2016-2018: Increase	2015-2016: Increase 2016-2018: Increase Impact > Control
Wetland / Open Water Birds	Control 2016-2018: Increase 2015: Impact > Control	Nil	2015-2016: Increase 2016-2018: Increase
Total Combined Birds	2016-2018: Increase	Impact 2015-2016: Decrease Impact 2016-2018: Increase Control 2016-2018: Increase 2018: Impact > Control	Impact 2016-2018: Increase Control 2015-2016: Increase 2016: Control > Impact

Notes:

Highlighted cells represent interaction effects
Nil denotes no significant trend revealed
Increase/Decrease denotes change between specified years
> denotes location effect showing metric greater at either control or impact stations across all monitoring years
N/A – not applicable
2015 = 2014/15 combined baseline survey years

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6.0 Closing

This report has been developed based on information gathered from field surveys.

We trust that this report is sufficient for your needs. Should additional information be required, please contact the undersigned at (905) 568-2929.

Regards,
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Appendix A

Compiled Bird Species List by Survey Year

Appendix A: Compiled Bird Species List by Survey Year

Common Name	Latin Name	2018	2016	2015	2014	2012	2011	2010	2009	Guild	S-Rank	ESA / SARA Status	BCR 12 Priority Species
Alder Flycatcher	*Empidonax alnorum*	✓	✓	✓	✓	✓	✓	✓	✓	Edge/Shrub/Successional	S5B	--	--
American Bittern	*Botaurus lentiginosus*	✓	✓	✓	✓	✓	✓	✓	✓	Wetland/Open Water	S4B	--	--
American Crow	*Corvus brachyrhynchos*	✓	✓	✓	✓	✓	✓	✓	✓	Forest	S5B	--	--
American Golden Plover	*Pluvialis dominica*	--	--	--	--	--	✓	--	--	Wetland/Open Water	S2B, S4N	--	--
American Goldfinch	*Carduelis tristis*	✓	✓	✓	✓	✓	✓	✓	✓	Edge/Shrub/Successional	S5B	--	--
American Kestrel	*Falco sparverius*	✓	✓	✓	--	✓	✓	✓	✓	Grassland/Open Country	S4	--	✓
American Pipit	*Anthus rubescens*	✓	--	--	--	--	--	--	--	Grassland/Open Country	S4	--	--
American Redstart	*Setophaga ruticilla*	✓	✓	✓	✓	✓	✓	✓	✓	Edge/Shrub/Successional	S5B	--	--
American Robin	*Turdus migratorius*	✓	✓	✓	✓	✓	✓	✓	✓	Edge/Shrub/Successional	S5B	--	--
American Three-toed Woodpecker	*Picoides dorsalis*	--	--	--	--	✓	--	--	--	Forest	S4	--	--
American Tree Sparrow	*Spizella arborea*	--	--	--	✓	--	--	--	--	Edge/Shrub/Successional	S4B	--	--
American White Pelican	*Pelecanus erythrorhynchos*	✓	✓	✓	✓	✓	✓	--	✓	Wetland/Open Water	S2B	THR/--	✓
American Woodcock	*Scolopax minor*	✓	--	✓	--	✓	✓	--	✓	Edge/Shrub/Successional	S4B	--	✓
Bald Eagle	*Haliaeetus leucocephalus*	✓	✓	✓	--	✓	✓	--	--	Wetland/Open Water	S2N, S4B	SC/--	✓
Baltimore Oriole	*Icterus galbula*	✓	--	✓	--	✓	✓	✓	--	Edge/Shrub/Successional	S4B	--	--
Bank Swallow	*Riparia riparia*	--	✓	--	--	--	--	✓	✓	Wetland/Open Water	S4B	THR/THR	✓
Barn Swallow	*Hirundo rustica*	✓	✓	✓	✓	✓	✓	✓	✓	Grassland/Open Country	S4B	THR/THR	✓
Barred Owl	*Strix varia*	--	✓	✓	--	✓	✓	--	--	Forest	S5	--	--
Bay-breasted Warbler	*Setophaga castanea*	✓	✓	--	--	--	--	--	--	Forest	S5B	--	✓
Belted Kingfisher	*Ceryle alcyon*	✓	✓	✓	✓	✓	✓	✓	--	Wetland/Open Water	S4B	--	✓
Black-and-white Warbler	*Mniotilta varia*	✓	✓	✓	✓	✓	✓	✓	✓	Forest	S5B	--	--
Black-backed Woodpecker	*Picoides arcticus*	✓	--	✓	--	✓	--	--	--	Forest	S4B	--	--
Black-billed Cuckoo	*Coccyzus erythropthalmus*	✓	✓	✓	✓	✓	--	--	--	Edge/Shrub/Successional	S5B	--	✓
Black-billed Magpie	*Pica pica*	✓	✓	✓	✓	✓	✓	✓	--	Edge/Shrub/Successional	S3?	--	--
Blackburnian Warbler	*Setophaga fusca*	✓	✓	✓	✓	✓	✓	✓	--	Forest	S5B	--	✓
Black-capped Chickadee	*Poecile atricapillus*	✓	✓	✓	✓	✓	✓	✓	--	Forest	S5	--	--
Blackpoll Warbler[e]	*Setophaga striata*	✓	--	✓	--	--	--	--	--	Forest	S4B	--	--
Black-throated Blue Warbler	*Setophaga caerulescens*	✓	--	--	✓	✓	✓	--	--	Forest	S5B	--	✓
Black-throated Green Warbler	*Setophaga virens*	✓	✓	✓	✓	✓	✓	✓	--	Forest	S5B	--	✓
Blue Jay	*Cyanocitta cristata*	✓	✓	✓	✓	✓	✓	✓	✓	Forest	S5	--	--
Blue-headed Vireo	*Vireo solitarius*	✓	✓	✓	✓	✓	✓	--	--	Forest	S5B	--	--
Blue-winged Teal	*Anas discors*	--	--	--	--	--	--	✓	✓	Wetland/Open Water	S4	--	--
Bobolink	*Dolichonyx oryzivorus*	✓	✓	✓	✓	✓	✓	✓	✓	Grassland/Open Country	S4B	THR/THR	✓

Common Name	Latin Name	2018	2016	2015	2014	2012	2011	2010	2009	Guild	S-Rank	ESA / SARA Status	BCR 12 Priority Species
Boreal Chickadee	*Poecile hudsonica*	--	--	--	✓	✓	--	--	--	Forest	S5	--	--
Brewer's Blackbird	*Euphagus cyanocephalus*	✓	✓	--	✓	✓	✓	✓	✓	Edge/Shrub/Successional	S4B	--	--
Broad-winged Hawk	*Buteo platypterus*	✓	✓	✓	--	✓	--	✓	--	Forest	S5B	--	✓
Brown Creeper	*Certhia americana*	✓	✓	--	✓	✓	--	--	--	Forest	S5B	--	--
Brown Thrasher	*Toxostoma rufum*	✓	✓	--	--	✓	✓	✓	✓	Edge/Shrub/Successional	S4B	--	✓
Brown-headed Cowbird	*Molothrus ater*	✓	✓	✓	✓	✓	✓	✓	✓	Edge/Shrub/Successional	S4B	--	--
Canada Goose	*Branta canadensis*	✓	✓	✓	✓	✓	✓	✓	✓	Wetland/Open Water	S5	--	✓
Canada Warbler	*Cardellina canadensis*	✓	✓	✓	✓	✓	--	--	✓	Forest	S4B	SC/THR	✓
Cape May Warbler	*Setophaga tigrina*	✓	✓	✓	--	✓	--	--	--	Forest	S5B	--	--
Cedar Waxwing	*Bombycilla cedrorum*	✓	✓	✓	✓	✓	✓	✓	✓	Edge/Shrub/Successional	S5B	--	--
Chestnut-sided Warbler	*Setophaga pensylvanica*	✓	✓	✓	✓	✓	✓	✓	✓	Edge/Shrub/Successional	S5B	--	✓
Chipping Sparrow	*Spizella passerina*	✓	✓	✓	✓	✓	✓	✓	✓	Edge/Shrub/Successional	S5B	--	--
Clay-coloured Sparrow	*Spizella pallida*	✓	✓	✓	✓	✓	✓	✓	✓	Edge/Shrub/Successional	S4B	--	--
Cliff Swallow	*Petrochelidon pyrrhonota*	✓	--	✓	--	--	✓	✓	--	Wetland/Open Water	S4B	--	✓
Common Goldeneye	*Bucephala clangula*	--	--	--	--	✓	--	✓	✓	Wetland/Open Water	S5	--	✓
Common Grackle	*Quiscalus quiscula*	✓	✓	✓	--	✓	✓	✓	✓	Edge/Shrub/Successional	S5B	--	--
Common Loon	*Gavia immer*	✓	✓	✓	✓	✓	✓	✓	✓	Wetland/Open Water	S5B, S5N	--	--
Common Merganser	*Mergus merganser*	--	--	--	--	✓	--	--	--	Wetland/Open Water	S5B, S5N	--	✓
Common Nighthawk	*Chordeiles minor*	✓	✓	✓	--	✓	✓	--	✓	Grassland/Open Country	S4B	SC/THR	✓
Common Raven	*Corvus corax*	✓	✓	✓	✓	✓	✓	✓	✓	Forest	S5	--	--
Common Yellowthroat	*Geothlypis trichas*	✓	✓	✓	✓	✓	✓	✓	✓	Edge/Shrub/Successional	S5B	--	✓
Connecticut Warbler	*Oporornis agilis*	✓	✓	✓	✓	✓	✓	--	--	Forest	S4B	--	✓
Dark-eyed Junco	*Junco hyemalis*	✓	✓	✓	✓	✓	--	--	--	Forest	S5B	--	--
Double-crested Cormorant	*Phalacrocorax auritus*	--	--	--	--	--	✓	--	--	Wetland/Open Water	S5B	--	--
Downy Woodpecker	*Picoides pubescens*	✓	✓	✓	✓	✓	--	✓	--	Forest	S5	--	--
Eastern Bluebird	*Sialia sialis*	✓	--	--	--	--	✓	✓	--	Grassland/Open Country	S5B	--	--
Eastern Kingbird	*Tyrannus tyrannus*	✓	✓	✓	✓	✓	✓	✓	✓	Edge/Shrub/Successional	S4B	--	--
Eastern Phoebe	*Sayornis phoebe*	✓	✓	✓	✓	✓	✓	✓	✓	Edge/Shrub/Successional	S5B	--	--
Eastern Towhee	*Pilo erythrophthalmus*	--	--	✓	--	--	--	--	--	Edge/Shrub/Successional	S4B	--	✓
Eastern Whip-poor-will	*Antrostomus vociferous*	✓	✓	✓	✓	✓	✓	✓	--	Forest	S4B	THR/THR	✓
Eastern Wood-Pewee	*Contopus virens*	✓	✓	✓	✓	✓	✓	✓	--	Forest	S4B	SC/SC	✓
European Starling	*Sturnus vulgaris*	✓	✓	✓	--	✓	✓	✓	✓	Edge/Shrub/Successional	SNA	--	--
Evening Grosbeak	*Coccothraustes vespertinus*	✓	--	--	--	✓	--	--	--	Forest	S4B	SC/--	✓
Forster's Tern	*Sterna forsteri*	--	--	--	--	--	--	--	✓	Wetland/Open Water	S2B	--	--
Golden-crowned Kinglet	*Regulus satrapa*	✓	✓	✓	✓	✓	✓	✓	--	Forest	S5B	--	--

Common Name	Latin Name	2018	2016	2015	2014	2012	2011	2010	2009	Guild	S-Rank	ESA / SARA Status	BCR 12 Priority Species
Golden-winged Warbler	*Vermivora chrysoptera*	✓	✓	✓	✓	✓	✓	--	--	Edge/Shrub/Successional	S4B	SC/THR	✓
Gray Catbird	*Dumetella carolinensis*	✓	✓	✓	✓	✓	✓	✓	✓	Edge/Shrub/Successional	S4B	--	✓
Gray Jay	*Perisoreus canadensis*	✓	✓	✓	✓	✓	✓	✓	--	Forest	S5	--	--
Great Blue Heron	*Ardea herodias*	✓	✓	--	✓	✓	✓	--	✓	Wetland/Open Water	S4	--	--
Great Crested Flycatcher	*Myiarchus crinitus*	✓	✓	✓	✓	✓	✓	✓	--	Forest	S4B	--	--
Great Gray Owl	*Strix nebulosa*	--	--	--	--	✓	✓	✓	--	Forest	S4	--	✓
Great Horned Owl	*Bubo virginianus*	--	--	--	--	--	--	✓	--	Forest	S4	--	--
Greater Yellowlegs	*Tringa melanoleuca*	--	--	--	--	--	--	--	✓	Wetland/Open Water	S4B, S4N	--	--
Green Heron	*Butorides virescens*	--	--	✓	--	--	✓	--	--	Wetland/Open Water	S4B	--	✓
Green-winged Teal	*Anas crecca*	--	--	--	--	--	--	✓	--	Wetland/Open Water	S4	--	✓
Hairy Woodpecker	*Picoides villosus*	✓	✓	✓	✓	✓	✓	✓	✓	Forest	S5	--	--
Hermit Thrush	*Catharus guttatus*	✓	✓	✓	✓	✓	✓	✓	--	Forest	S5B	--	--
Herring Gull	*Larus argentatus*	✓	--	--	--	--	--	--	✓	Wetland/Open Water	S5B, S5N	--	✓
Hooded Merganser	*Lophodytes cucullatus*	✓	--	--	--	--	✓	--	--	Wetland/Open Water	S5B, S5N	--	✓
House Sparrow	*Passer domesticus*	--	--	--	--	✓	✓	✓	--	Edge/Shrub/Successional	SNA	--	--
House Wren	*Troglodytes aedon*	✓	✓	✓	✓	✓	✓	✓	✓	Edge/Shrub/Successional	S5B	--	--
Indigo Bunting	*Passerina cyanea*	✓	✓	✓	✓	✓	--	✓	--	Edge/Shrub/Successional	S4B	--	--
Killdeer	*Charadrius vociferus*	✓	✓	✓	--	✓	✓	✓	✓	Grassland/Open Country	S5B, S5N	--	✓
Least Flycatcher	*Empidonax minimus*	✓	✓	✓	✓	✓	✓	✓	✓	Forest	S4B	--	✓
Le Conte's Sparrow	*Ammodramus leconteii*	✓	✓	✓	✓	✓	✓	✓	✓	Grassland/Open Country	S4B	--	--
Lincoln's Sparrow	*Melospiza lincolnii*	✓	✓	✓	✓	--	--	✓	✓	Edge/Shrub/Successional	S5B	--	--
Long-eared Owl	*Asio otus*	--	✓	✓	--	✓	✓	--	--	Forest	S4	--	--
Magnolia Warbler	*Setophaga magnolia*	✓	✓	✓	✓	✓	✓	✓	--	Forest	S5B	--	--
Mallard	*Anas platyrhynchos*	✓	✓	--	--	✓	✓	✓	✓	Wetland/Open Water	S5	--	✓
Marbled Godwit	*Limosa fedoa*	✓	--	--	--	--	--	--	--	Wetland/Open Water	S3B	--	--
Marsh Wren	*Cistothorus palustris*	✓	--	✓	--	--	--	✓	--	Wetland/Open Water	S4B	--	--
Merlin	*Falco columbarius*	--	✓	--	--	✓	--	--	--	Forest	S5B	--	--
Mourning Dove	*Zenaida macroura*	✓	✓	✓	--	--	✓	--	--	Edge/Shrub/Successional	S5	--	--
Mourning Warbler	*Geothlypis philadelphia*	✓	✓	✓	✓	✓	--	✓	✓	Forest	S4B	--	✓
Nashville Warbler	*Oreothlypis ruficapilla*	✓	✓	✓	✓	✓	✓	✓	✓	Forest	S5B	--	✓
Northern Flicker	*Colaptes auratus*	✓	✓	✓	✓	✓	✓	✓	✓	Forest	S4B	--	✓
Northern Harrier	*Circus cyaneus*	✓	✓	✓	--	--	✓	✓	✓	Grassland/Open Country	S4B	--	--
Northern Parula	*Setophaga americana*	✓	✓	✓	✓	✓	✓	✓	--	Forest	S4B	--	--
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	✓	--	--	--	--	✓	✓	✓	Wetland/Open Water	S4B	--	✓
Northern Saw-whet Owl	*Aegolius acadicus*	--	--	--	--	--	✓	✓	--	Forest	S4	--	--

Common Name	Latin Name	2018	2016	2015	2014	2012	2011	2010	2009	Guild	S-Rank	ESA / SARA Status	BCR 12 Priority Species
Northern Waterthrush	*Parkesia noveboracensis*	✓	✓	✓	✓	✓	--	✓	✓	Forest	S5B	--	--
Olive-sided Flycatcher	*Contopus cooperi*	✓	✓	✓	--	✓	✓	✓	--	Forest	S4B	SC/THR	✓
Orange-crowned Warbler	*Setophaga celata*	✓	--	✓	✓	--	--	--	--	Forest	S4B	--	--
Ovenbird	*Seiurus aurocapilla*	✓	✓	✓	✓	✓	✓	✓	✓	Forest	S4B	--	--
Palm Warbler	*Setophaga palmarum*	✓	✓	✓	✓	✓	✓	--	--	Edge/Shrub/Successional	S5B	--	--
Philadelphia Vireo	*Vireo philadelphicus*	✓	--	✓	✓	✓	✓	--	✓	Forest	S5B	--	--
Pied-billed Grebe	*Podilymbus podiceps*	✓	--	--	--	--	--	✓	--	Wetland/Open Water	S4B, S4N	--	--
Pileated Woodpecker	*Dryocopus pileatus*	✓	✓	✓	✓	✓	✓	✓	--	Forest	S5	--	--
Pine Siskin	*Spinus pinus*	✓	✓	--	--	✓	✓	✓	--	Forest	S4B	--	--
Pine Warbler	*Setophaga pinus*	✓	--	✓	--	✓	--	--	--	Forest	S5B	--	--
Purple Finch	*Haemorhous purpureus*	✓	--	✓	✓	✓	--	✓	✓	Forest	S4B	--	✓
Red-breasted Nuthatch	*Sitta canadensis*	✓	✓	✓	✓	✓	✓	✓	✓	Forest	S5	--	--
Red Crossbill	*Loxia curvirostra*	--	✓	--	--	✓	--	--	--	Forest	S4B	--	✓
Red-eyed Vireo	*Vireo olivaceus*	✓	✓	✓	✓	✓	✓	✓	✓	Forest	S5B	--	--
Redhead	*Aythya americana*	--	--	--	--	--	--	--	✓	Wetland/Open Water	S2B, S4N	--	--
Red-headed Woodpecker	*Melanerpes erythrocephalus*	--	✓	--	--	--	✓	--	--	Edge/Shrub/Successional	S4B	SC/THR	✓
Red-shouldered Hawk	*Buteo lineatus*	--	--	✓	--	--	✓	--	--	Forest	S4B	--	✓
Red-tailed Hawk	*Buteo jamaicensis*	✓	✓	✓	✓	--	✓	--	--	Forest	S5	--	--
Red-winged Blackbird	*Agelaius phoeniceus*	✓	✓	✓	✓	✓	✓	✓	✓	Wetland/Open Water	S4	--	--
Ring-billed Gull	*Larus delawarensis*	--	✓	✓	--	--	✓	--	--	Wetland/Open Water	S5B, S4N	--	--
Ring-necked Duck	*Aythya collaris*	✓	--	--	--	--	--	✓	✓	Wetland/Open Water	S5	--	✓
Rock Pigeon	*Columba livia*	✓	--	--	--	--	✓	✓	--	Grassland/Open Country	SNA	--	--
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	✓	✓	✓	✓	✓	✓	✓	✓	Forest	S4B	--	✓
Ruby-crowned Kinglet	*Regulus calendula*	✓	✓	✓	✓	✓	✓	✓	--	Forest	S4B	--	✓
Ruby-throated Hummingbird	*Archilochus colubris*	✓	✓	✓	✓	✓	✓	✓	--	Edge/Shrub/Successional	S5B	--	--
Ruffed Grouse	*Bonasa umbellus*	✓	✓	✓	✓	✓	✓	✓	✓	Forest	S4	--	✓
Rusty Blackbird	*Euphagus carolinus*	--	--	✓	--	--	--	--	--	Forest	S4B	SC/SC	✓
Sandhill Crane	*Grus canadensis*	✓	✓	✓	✓	✓	✓	✓	✓	Wetland/Open Water	S5B	--	✓
Savannah Sparrow	*Passerculus sandwichensis*	✓	✓	✓	✓	✓	✓	✓	✓	Grassland/Open Country	S4B	--	--
Scarlet Tanager	*Piranga olivacea*	✓	✓	✓	✓	✓	--	--	--	Forest	S4B	--	--
Sedge Wren	*Cistothorus platensis*	✓	✓	✓	✓	✓	✓	✓	✓	Grassland/Open Country	S4B	--	✓
Sharp-shinned Hawk	*Accipiter striatus*	✓	--	--	--	✓	--	--	--	Forest	S5	--	--
Sharp-tailed Grouse	*Tympanuchus phasianellus*	✓	✓	✓	--	✓	✓	✓	--	Grassland/Open Country	S4	--	--
Short-eared Owl	*Asio flammeus*	--	--	--	--	--	--	--	✓	Grassland/Open Country	S2N, S4B	SC/SC	✓
Song Sparrow	*Melospiza melodia*	✓	✓	✓	✓	✓	✓	✓	✓	Edge/Shrub/Successional	S5B	--	✓

Common Name	Latin Name	2018	2016	2015	2014	2012	2011	2010	2009	Guild	S-Rank	ESA / SARA Status	BCR 12 Priority Species
Sora	*Porzana carolina*	✓	✓	✓	✓		✓	✓	✓	Wetland/Open Water	S4B	--	--
Spotted Sandpiper	*Actitis macularia*	✓	✓	--	--	--	--	--	✓	Wetland/Open Water	S5	--	✓
Spruce Grouse	*Falcipennis canadensis*	--	--	--	--	✓	--	--	--	Forest	S5	--	--
Swainson's Thrush	*Catharus ustulatus*	✓	✓	✓	✓	✓	✓	✓	--	Forest	S4B	--	--
Swamp Sparrow	*Melospiza georgiana*	✓	✓	✓	✓	✓	✓	✓	✓	Wetland/Open Water	S5B	--	✓
Tennessee Warbler	*Oreothlypis peregrina*	✓	✓	✓	✓	✓	✓	--	--	Forest	S5B	--	✓
Tree Swallow	*Tachycineta bicolor*	✓	✓	--	✓	✓	✓	✓	✓	Wetland/Open Water	S4B	--	✓
Trumpeter Swan	*Cygnus buccinator*	✓	✓	✓	--	✓	✓	--	--	Wetland/Open Water	S4	--	--
Turkey Vulture	*Cathartes aura*	✓	✓	✓	✓	✓	✓	✓	✓	Edge/Shrub/Successional	S5B	--	--
Veery	*Catharus fuscescens*	✓	✓	✓	✓	✓	✓	✓	✓	Forest	S4B	--	✓
Vesper Sparrow	*Pooecetes* gramineus	✓	--	--	--	--	--	--	--	Grassland/Open Country	S4B	--	✓
Virginia Rail	*Rallus limicola*	✓	--	✓	--	--	--	✓	✓	Wetland/Open Water	S5B	--	--
Warbling Vireo	*Vireo gilvus*	✓	✓	✓	✓	✓	--	✓	✓	Edge/Shrub/Successional	S5B	--	--
Western Meadowlark	*Sturnella neglecta*	✓	--	✓	--	--	--	--	--	Grassland/Open Country	S3B	--	--
White-breasted Nuthatch	*Sitta carolinensis*	--	✓	✓	--	--	--	--	--	Forest	S5	--	--
White-throated Sparrow	*Zonotrichia albicollis*	✓	✓	✓	✓	✓	✓	✓	✓	Forest	S5B	--	✓
White-winged Crossbill	*Loxia leucoptera*	--	✓	--	✓	✓	--	--	--	Forest	S5B	--	--
Wilson's Snipe	*Gallinago delicata*	✓	✓	✓	✓	✓	✓	✓	✓	Wetland/Open Water	S5B	--	✓
Wilson's Warbler	*Cardellina pusilla*	✓	--	✓	--	✓	✓	✓	✓	Edge/Shrub/Successional	S4B	--	--
Winter Wren	*Troglodytes troglodytes*	✓	✓	✓	✓	✓	✓	✓	✓	Forest	S5B	--	--
Wood Duck	*Aix sponsa*	✓	✓	--	--	✓	✓	✓	✓	Wetland/Open Water	S5	--	✓
Wood Thrush	*Hylocichla mustelina*	✓	✓	✓	✓	✓	--	✓	--	Forest	S4B	SC/THR	✓
Yellow Warbler	*Setophaga petechia*	✓	✓	✓	✓	✓	✓	✓	✓	Edge/Shrub/Successional	S5B	--	--
Yellow-bellied Flycatcher	*Empidonax flaviventris*	✓	✓	✓	✓	✓	✓	✓	--	Forest	S5B	--	--
Yellow-bellied Sapsucker	*Sphyrapicus varius*	✓	✓	✓	✓	✓	--	✓	✓	Forest	S5B	--	✓
Yellow-rumped Warbler	*Setophaga coronata*	✓	✓	✓	✓	✓	✓	--	--	Forest	S5B	--	--

Appendix B

2018 Bird Population Metrics

Appendix B: 2018 Morning Bird Populations Metrics

Common Name	Distribution (Percent Occurrence) α		Abundance (birds/point count) α		Density (birds/ha) α	
	Impact	Control	Impact	Control	Impact	Control
Alder Flycatcher	36.7	21.1	0.56	0.36	0.120	0.101
American Bittern	2.2	5.3	0.02	0.05	0.000	0.000
American Crow	15.6	18.9	0.19	0.25	0.007	0.023
American Goldfinch	25.6	14.7	0.40	0.22	0.106	0.054
*American Kestrel	2.2	3.2	0.02	0.03	0.007	0.007
American Pipit	0.0	1.1	0.0	0.01	0.000	0.003
American Redstart	16.7	26.3	0.17	0.32	0.050	0.094
American Robin	62.2	48.4	0.84	0.67	0.145	0.161
*γAmerican White Pelican	3.3	2.1	0.08	0.16	0.007	0.003
*American Woodcock	1.1	1.1	0.01	0.01	0.000	0.003
*βBald Eagle	3.3	1.1	0.04	0.01	0.011	0.003
Baltimore Oriole	4.4	2.1	0.06	0.02	0.014	0.007
*γBarn Swallow	8.9	4.2	0.28	0.51	0.064	0.137
*Bay-breasted Warbler	1.1	5.3	0.01	0.06	0.004	0.017
*Belted Kingfisher	2.2	0.0	0.02	0.00	0.007	0.000
Black-and-white Warbler	52.2	50.5	0.64	0.58	0.159	0.171
Black-backed Woodpecker	3.3	4.2	0.03	0.05	0.007	0.013
*Black-billed Cuckoo	4.4	4.2	0.04	0.04	0.011	0.007
Black-billed Magpie	13.3	2.1	0.20	0.02	0.028	0.000
*Blackburnian Warbler	4.4	16.8	0.04	0.21	0.014	0.060
Black-capped Chickadee	26.7	21.1	0.30	0.28	0.071	0.087
Blackpoll Warbler	1.1	0.0	0.01	0.00	0.004	0.000
*Black-throated Blue Warbler	0.0	1.1	0.0	0.01	0.000	0.003
*Black-throated Green Warbler	12.2	26.3	0.14	0.33	0.028	0.094
Blue Jay	42.2	37.9	0.49	0.43	0.060	0.087
Blue-headed Vireo	0.0	1.1	0.00	0.01	0.000	0.003
*γBobolink	28.9	8.4	0.89	0.27	0.209	0.077
Brewer's Blackbird	3.3	2.1	0.07	0.06	0.007	0.010
*Broad-winged Hawk	0.0	1.1	0.00	0.01	0.000	0.003
Brown Creeper	3.3	3.2	0.03	0.03	0.011	0.010
*Brown Thrasher	1.1	0.0	0.01	0.00	0.000	0.000
Brown-headed Cowbird	6.7	4.2	0.13	0.04	0.039	0.013
*Canada Goose	15.6	4.2	0.77	0.86	0.099	0.000
*βCanada Warbler	6.7	6.3	0.08	0.06	0.025	0.020
Cape May Warbler	1.1	2.1	0.01	0.03	0.004	0.010
Cedar Waxwing	17.8	20.0	0.33	0.47	0.106	0.131
*Chestnut-sided Warbler	62.2	43.2	0.94	0.57	0.251	0.168
Chipping Sparrow	16.7	10.5	0.17	0.11	0.046	0.030

Common Name	Distribution (Percent Occurrence) α		Abundance (birds/point count) α		Density (birds/ha) α	
	Impact	Control	Impact	Control	Impact	Control
Clay-colored Sparrow	37.8	8.4	0.54	0.11	0.124	0.020
*Cliff Swallow	1.1	0.0	0.02	0.00	0.007	0.000
Common Grackle	4.4	4.2	0.04	0.06	0.007	0.010
Common Loon	3.3	7.4	0.03	0.07	0.000	0.003
Common Raven	15.6	8.4	0.27	0.15	0.025	0.000
*Common Yellowthroat	67.8	34.7	1.00	0.57	0.237	0.168
*Connecticut Warbler	2.2	1.1	0.03	0.01	0.007	0.003
Dark-eyed Junco	1.1	7.4	0.01	0.11	0.004	0.030
Downy Woodpecker	2.2	4.2	0.02	0.04	0.000	0.010
Eastern Bluebird	3.3	0.0	0.03	0.00	0.011	0.000
Eastern Kingbird	7.8	3.2	0.08	0.06	0.018	0.020
Eastern Phoebe	3.3	4.2	0.03	0.04	0.004	0.010
*[γ]Eastern Whip-poor-will	0.0	1.1	0.0	0.01	0.000	0.003
*[β]Eastern Wood-Pewee	5.6	7.4	0.06	0.08	0.007	0.020
European Starling	6.7	4.2	0.28	0.09	0.011	0.023
*[β]Evening Grosbeak	0.0	1.1	0.00	0.03	0.000	0.010
Golden-crowned Kinglet	3.3	5.3	0.04	0.05	0.014	0.017
*[β]Golden-winged Warbler	13.3	10.5	0.14	0.14	0.046	0.030
*Gray Catbird	2.2	1.1	0.02	0.01	0.007	0.003
Gray Jay	3.3	9.5	0.06	0.18	0.011	0.054
Great Blue Heron	3.3	2.1	0.03	0.03	0.004	0.000
Great Crested Flycatcher	4.4	1.1	0.04	0.01	0.011	0.000
Hairy Woodpecker	3.3	0.0	0.03	0.00	0.011	0.000
Hermit Thrush	15.6	41.1	0.18	0.48	0.021	0.094
*Herring Gull	0.0	1.1	0.00	0.01	0.000	0.003
*Hooded Merganser	0.0	1.1	0.00	0.01	0.000	0.003
House Wren	3.3	1.1	0.04	0.02	0.004	0.003
Indigo Bunting	1.1	0.0	0.01	0.00	0.004	0.000
*Killdeer	5.6	4.2	0.08	0.06	0.011	0.013
*Least Flycatcher	13.3	14.7	0.19	0.20	0.039	0.057
LeConte's Sparrow	35.6	8.4	0.62	0.14	0.191	0.044
Lincoln's Sparrow	0.0	6.3	0.00	0.08	0.000	0.027
Magnolia Warbler	10.0	31.6	0.10	0.44	0.028	0.134
*Mallard	3.3	0.0	0.07	0.00	0.004	0.000
Marbled Godwit	1.1	1.1	0.01	0.01	0.000	0.000
Marsh Wren	1.1	0.0	0.01	0.00	0.000	0.000
Mourning Dove	1.1	1.1	0.01	0.02	0.000	0.003
*Mourning Warbler	37.8	22.1	0.42	0.27	0.085	0.070
*Nashville Warbler	73.3	81.1	1.28	1.66	0.350	0.503
*Northern Flicker	11.1	11.6	0.11	0.14	0.021	0.034

Common Name	Distribution (Percent Occurrence) α		Abundance (birds/point count) α		Density (birds/ha) α	
	Impact	Control	Impact	Control	Impact	Control
Northern Harrier	0.0	1.1	0.00	0.01	0.000	0.003
Northern Parula	2.2	15.8	0.02	0.17	0.000	0.044
*Northern Rough-winged Swallow	1.1	0.0	0.02	0.00	0.007	0.000
Northern Waterthrush	10.0	8.4	0.10	0.09	0.014	0.023
*[β]Olive-sided Flycatcher	3.3	1.1	0.03	0.01	0.004	0.003
Orange-crowned Warbler	0.0	1.1	0.00	0.01	0.000	0.003
Ovenbird	67.8	70.5	1.10	1.44	0.202	0.328
Palm Warbler	2.2	7.4	0.02	0.13	0.004	0.040
Philadelphia Vireo	4.4	3.2	0.04	0.03	0.014	0.010
Pied-billed Grebe	0.0	1.1	0.00	0.01	0.000	0.000
Pileated Woodpecker	12.2	6.3	0.12	0.06	0.000	0.013
Pine Siskin	5.6	2.1	0.12	0.03	0.039	0.010
Pine Warbler	0.0	1.1	0.00	0.01	0.000	0.003
*Purple Finch	4.4	0.0	0.04	0.00	0.011	0.000
Red-breasted Nuthatch	23.3	23.2	0.24	0.25	0.060	0.064
Red-eyed Vireo	80.0	91.6	1.41	1.84	0.255	0.456
Red-tailed Hawk	7.8	2.1	0.09	0.02	0.004	0.003
Red-winged Blackbird	23.3	16.8	0.30	0.28	0.057	0.074
*Ring-necked Duck	0.0	1.1	0.00	0.01	0.000	0.003
Rock Pigeon	1.1	0.0	0.07	0.00	0.021	0.000
*Rose-breasted Grosbeak	26.7	15.8	0.32	0.18	0.064	0.050
*Ruby-crowned Kinglet	10.0	17.9	0.11	0.20	0.018	0.050
Ruby-throated Hummingbird	0.0	3.2	0.00	0.03	0.000	0.010
*Ruffed Grouse	20.0	23.2	0.20	0.24	0.032	0.047
*Sandhill Crane	18.9	10.5	0.34	0.14	0.039	0.003
Savannah Sparrow	42.2	10.5	0.88	0.19	0.248	0.054
Scarlet Tanager	0.0	1.1	0.00	0.01	0.000	0.003
*Sedge Wren	27.8	9.5	0.48	0.24	0.124	0.067
Sharp-shinned Hawk	1.1	3.2	0.01	0.04	0.000	0.013
Sharp-tailed Grouse	3.3	1.1	0.23	0.01	0.074	0.003
*Song Sparrow	53.3	21.1	0.87	0.25	0.209	0.074
Sora	0.0	1.1	0.00	0.01	0.000	0.000
*Spotted Sandpiper	2.2	1.1	0.02	0.01	0.004	0.000
Swainson's Thrush	2.2	8.4	0.02	0.11	0.004	0.010
*Swamp Sparrow	12.2	8.4	0.18	0.15	0.032	0.037
*Tennessee Warbler	11.1	16.8	0.12	0.21	0.035	0.060
*Tree Swallow	6.7	3.2	0.08	0.03	0.004	0.007
Trumpeter Swan	2.2	10.5	0.03	0.15	0.000	0.003
Turkey Vulture	1.1	1.1	0.01	0.01	0.000	0.003
*Veery	44.4	46.3	0.68	0.66	0.127	0.121

Common Name	Distribution (Percent Occurrence) α		Abundance (birds/point count) α		Density (birds/ha) α	
	Impact	Control	Impact	Control	Impact	Control
*Vesper Sparrow	0.0	1.1	0.00	0.01	0.000	0.003
Virginia Rail	1.1	1.1	0.01	0.01	0.000	0.000
Warbling Vireo	3.3	0.0	0.03	0.00	0.004	0.000
Western Meadowlark	4.4	1.1	0.04	0.01	0.004	0.003
*White-throated Sparrow	54.4	63.2	0.99	1.07	0.223	0.251
*Wilson's Snipe	7.8	13.7	0.10	0.22	0.004	0.030
Wilson’s Warbler	1.1	3.2	0.01	0.03	0.004	0.010
Winter Wren	7.8	7.4	0.08	0.08	0.011	0.023
*Wood Duck	0.0	2.1	0.00	0.02	0.000	0.000
*[β]Wood Thrush	14.4	13.7	0.17	0.15	0.028	0.030
Yellow Warbler	13.3	16.8	0.18	0.22	0.032	0.060
Yellow-bellied Flycatcher	14.4	24.2	0.19	0.28	0.050	0.077
*Yellow-bellied Sapsucker	8.9	2.1	0.09	0.02	0.018	0.007
Yellow-rumped Warbler	17.8	17.9	0.18	0.20	0.057	0.057

Notes:

α Distribution (Percent Occurrence) = number of point count stations at which a species was recorded divided by the total number of point counts surveyed
Abundance = maximum number of individuals per species divided by the total number of point count stations
Density = maximum number of individuals per species recorded within 100m radius of the surveyor divided by the area of the survey station (=3.1416 ha)

* BCR 12 Priority Species

β Species provincially-listed as Special Concern under the Endangered Species Act

γ Species provincially-listed as Threatened or Endangered under the Endangered Species Act

Appendix C

2014 – 2018 Bird Population Metrics

Appendix C1: Species Richness and Survey Stations by Year

	Species Richness for All Species			Species Richness for Species of Conservation Concern			Number of Survey Stations		
Year	**Impact**	**Control**	**Total**	**Impact**	**Control**	**Total**	**Impact**	**Control**	**Total**
2018	113	120	132	46	49	54	90	95	185
2016	99	101	115	43	38	47	90	95	185
2015	94	102	117	40	38	47	63	85	148
2014	74	85	95	27	33	36	32	75	107

Appendix C2: Distribution of All Species by Survey Year

Species	Distribution (Percent Occurrence)							
	2018		2016		2015		2014	
	Impact	Control	Impact	Control	Impact	Control	Impact	Control
Alder Flycatcher	36.7	21.1	16.9	29.5	44.4	22.4	34.4	16.7
American Bittern	2.2	5.3	0.0	3.2	1.6	2.4	3.1	1.4
American Crow	15.6	18.9	28.1	21.1	33.3	15.3	18.8	6.9
American Goldfinch	25.6	14.7	14.6	12.6	22.2	23.5	31.3	18.1
*American Kestrel	2.2	3.2	2.2	3.2	3.2	0.0	0.0	0.0
American Pipit	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0
American Redstart	16.7	26.3	4.5	10.5	9.5	9.4	25.0	6.9
American Robin	62.2	48.4	49.4	41.1	55.6	41.2	37.5	34.7
American Tree Sparrow	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4
*[γ]American White Pelican	3.3	2.1	3.4	0.0	4.8	0.0	0.0	1.4
*American Woodcock	1.1	1.1	0.0	0.0	0.0	0.0	0.0	0.0
*[β]Bald Eagle	3.3	1.1	0.0	1.1	3.2	1.2	0.0	0.0
Baltimore Oriole	4.4	2.1	0.0	0.0	3.2	2.4	0.0	0.0
*[γ]Barn Swallow	8.9	4.2	7.9	2.1	12.7	1.2	0.0	1.4
Barred Owl	0.0	0.0	0.0	2.1	0.0	0.0	0.0	0.0
*Bay-breasted Warbler	1.1	5.3	1.1	0.0	0.0	0.0	0.0	0.0
*Belted Kingfisher	2.2	0.0	0.0	1.1	0.0	3.5	3.1	0.0
Black-and-white Warbler	52.2	50.5	41.6	54.7	38.1	29.4	31.3	34.7
Black-backed Woodpecker	3.3	4.2	0.0	0.0	0.0	1.2	0.0	0.0
*Black-billed Cuckoo	4.4	4.2	4.5	8.4	19.0	7.1	53.1	9.7
Black-billed Magpie	13.3	2.1	14.6	0.0	22.2	2.4	6.3	1.4
*Blackburnian Warbler	4.4	16.8	4.5	18.9	3.2	11.8	0.0	6.9
Black-capped Chickadee	26.7	21.1	7.9	17.9	4.8	12.9	3.1	12.5
Blackpoll Warbler	1.1	0.0	0.0	0.0	0.0	4.7	0.0	0.0
*Black-throated Blue Warbler	0.0	1.1	0.0	0.0	0.0	0.0	0.0	1.4
*Black-throated Green Warbler	12.2	26.3	13.5	26.3	3.2	21.2	12.5	15.3
Blue Jay	42.2	37.9	53.9	61.1	50.8	44.7	37.5	31.9
Blue-headed Vireo	0.0	1.1	0.0	2.1	14.3	9.4	3.1	5.6
*[γ]Bobolink	28.9	8.4	32.6	10.5	49.2	10.6	21.9	5.6
Boreal Chickadee	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4
Brewer's Blackbird	3.3	2.1	2.2	2.1	0.0	0.0	6.3	1.4
*Broad-winged Hawk	0.0	1.1	3.4	0.0	3.2	4.7	0.0	0.0
Brown Creeper	3.3	3.2	3.4	4.2	0.0	0.0	6.3	2.8
*Brown Thrasher	1.1	0.0	4.5	0.0	0.0	0.0	0.0	0.0
Brown-headed Cowbird	6.7	4.2	2.2	3.2	9.5	1.2	25.0	6.9
*Canada Goose	15.6	4.2	11.2	11.6	12.7	5.9	0.0	1.4
*[β]Canada Warbler	6.7	6.3	5.6	5.3	0.0	3.5	3.1	0.0
Cape May Warbler	1.1	2.1	0.0	2.1	0.0	1.2	0.0	0.0
Cedar Waxwing	17.8	20.0	15.7	15.8	14.3	22.4	25.0	22.2
*Chestnut-sided Warbler	62.2	43.2	48.3	47.4	11.1	30.6	50.0	37.5
Chipping Sparrow	16.7	10.5	10.1	8.4	6.3	3.5	15.6	12.5
Clay-colored Sparrow	37.8	8.4	30.3	7.4	47.6	10.6	25.0	8.3
*Cliff Swallow	1.1	0.0	0.0	0.0	1.6	0.0	0.0	0.0
Common Grackle	4.4	4.2	2.2	3.2	3.2	3.5	0.0	0.0

Species	Distribution (Percent Occurrence)							
	2018		2016		2015		2014	
	Impact	Control	Impact	Control	Impact	Control	Impact	Control
Common Loon	3.3	7.4	2.2	8.4	0.0	4.7	0.0	2.8
*[β]Common Nighthawk	0.0	0.0	1.1	0.0	1.6	0.0	0.0	0.0
Common Raven	15.6	8.4	24.7	27.4	12.7	23.5	21.9	12.5
*Common Yellowthroat	67.8	34.7	60.7	40.0	55.6	43.5	62.5	43.1
*Connecticut Warbler	2.2	1.1	4.5	0.0	0.0	5.9	3.1	11.1
Dark-eyed Junco	1.1	7.4	2.2	1.1	4.8	8.2	0.0	8.3
Downy Woodpecker	2.2	4.2	1.1	9.5	1.6	3.5	6.3	2.8
Eastern Bluebird	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Eastern Kingbird	7.8	3.2	2.2	3.2	14.3	7.1	3.1	2.8
Eastern Phoebe	3.3	4.2	7.9	11.6	6.3	10.6	3.1	4.2
Eastern Towhee	0.0	0.0	0.0	0.0	0.0	2.4	0.0	0.0
*[γ]Eastern Whip-poor-will	0.0	1.1	0.0	0.0	1.6	1.2	0.0	2.8
*[β]Eastern Wood-Pewee	5.6	7.4	1.1	1.1	4.8	14.1	9.4	2.8
European Starling	6.7	4.2	2.2	2.1	1.6	5.9	0.0	0.0
*[β]Evening Grosbeak	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0
Golden-crowned Kinglet	3.3	5.3	0.0	11.6	0.0	8.2	0.0	9.7
*[β]Golden-winged Warbler	13.3	10.5	9.0	8.4	9.5	10.6	9.4	2.8
*Gray Catbird	2.2	1.1	1.1	2.1	3.2	0.0	6.3	1.4
Gray Jay	3.3	9.5	5.6	8.4	0.0	8.2	3.1	11.1
Great Blue Heron	3.3	2.1	0.0	1.1	0.0	0.0	3.1	0.0
Great Crested Flycatcher	4.4	1.1	5.6	1.1	1.6	2.4	9.4	2.8
Green Heron	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.0
Hairy Woodpecker	3.3	0.0	4.5	4.2	7.9	1.2	6.3	1.4
Hermit Thrush	15.6	41.1	22.5	51.6	23.8	43.5	37.5	47.2
*Herring Gull	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0
*Hooded Merganser	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0
House Wren	3.3	1.1	1.1	2.1	6.3	2.4	3.1	0.0
Indigo Bunting	1.1	0.0	2.2	1.1	1.6	0.0	9.4	0.0
*Killdeer	5.6	4.2	4.5	1.1	7.9	1.2	0.0	0.0
*Least Flycatcher	13.3	14.7	24.7	22.1	28.6	25.9	28.1	16.7
LeConte's Sparrow	35.6	8.4	30.3	8.4	34.9	3.5	9.4	0.0
Lincoln's Sparrow	0.0	6.3	1.1	7.4	3.2	10.6	0.0	5.6
Long-eared Owl	0.0	0.0	2.2	0.0	0.0	1.2	0.0	0.0
Magnolia Warbler	10.0	31.6	12.4	23.2	20.6	23.5	6.3	13.9
*Mallard	3.3	0.0	3.4	1.1	0.0	0.0	0.0	0.0
Marbled Godwit	1.1	1.1	0.0	0.0	0.0	0.0	0.0	0.0
Marsh Wren	1.1	0.0	0.0	0.0	1.6	1.2	0.0	0.0
Merlin	0.0	0.0	1.1	1.1	0.0	0.0	0.0	0.0
Mourning Dove	1.1	1.1	0.0	2.1	3.2	0.0	0.0	0.0
*Mourning Warbler	37.8	22.1	12.4	11.6	3.2	12.9	25.0	15.3
*Nashville Warbler	73.3	81.1	70.8	83.2	69.8	75.3	68.8	90.3
*Northern Flicker	11.1	11.6	23.6	20.0	22.2	24.7	12.5	18.1
Northern Harrier	0.0	1.1	4.5	1.1	0.0	1.2	0.0	0.0
Northern Parula	2.2	15.8	2.2	15.8	1.6	15.3	6.3	9.7
*Northern Rough-winged Swallow	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Species	Distribution (Percent Occurrence)							
	2018		2016		2015		2014	
	Impact	Control	Impact	Control	Impact	Control	Impact	Control
Northern Waterthrush	10.0	8.4	5.6	4.2	3.2	2.4	0.0	2.8
*[β]Olive-sided Flycatcher	3.3	1.1	0.0	2.1	1.6	0.0	0.0	0.0
Orange-crowned Warbler	0.0	1.1	0.0	0.0	0.0	1.2	0.0	1.4
Ovenbird	67.8	70.5	73.0	76.8	74.6	72.9	68.8	66.7
Palm Warbler	2.2	7.4	1.1	6.3	0.0	17.6	0.0	8.3
Philadelphia Vireo	4.4	3.2	0.0	0.0	0.0	2.4	6.3	0.0
Pied-billed Grebe	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0
Pileated Woodpecker	12.2	6.3	2.2	5.3	9.5	8.2	3.1	2.8
Pine Siskin	5.6	2.1	1.1	3.2	0.0	0.0	0.0	0.0
Pine Warbler	0.0	1.1	0.0	0.0	0.0	2.4	0.0	0.0
*Purple Finch	4.4	0.0	0.0	0.0	1.6	2.4	0.0	2.8
Red-breasted Nuthatch	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0
*Red Crossbill	23.3	23.2	15.7	25.3	12.7	23.5	3.1	12.5
Red-eyed Vireo	80.0	91.6	62.9	76.8	77.8	76.5	71.9	75.0
*[β]Red-headed Woodpecker	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0
*Red-shouldered Hawk	0.0	0.0	0.0	0.0	0.0	2.4	0.0	0.0
Red-tailed Hawk	7.8	2.1	2.2	2.1	3.2	3.5	0.0	1.4
Red-winged Blackbird	23.3	16.8	22.5	15.8	23.8	10.6	15.6	5.6
Ring-billed Gull	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0
*Ring-necked Duck	0.0	1.1	0.0	0.0	0.0	1.2	0.0	0.0
Rock Pigeon	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*Rose-breasted Grosbeak	26.7	15.8	27.0	32.6	14.3	25.9	25.0	20.8
*Ruby-crowned Kinglet	10.0	17.9	5.6	12.6	15.9	9.4	0.0	2.8
Ruby-throated Hummingbird	0.0	3.2	2.2	2.1	4.8	1.2	3.1	1.4
*Ruffed Grouse	20.0	23.2	5.6	32.6	6.3	14.1	18.8	4.2
*[β]Rusty Blackbird	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.0
*Sandhill Crane	18.9	10.5	19.1	20.0	23.8	11.8	18.8	2.8
Savannah Sparrow	42.2	10.5	38.2	8.4	38.1	5.9	21.9	8.3
Scarlet Tanager	0.0	1.1	3.4	3.2	0.0	2.4	6.3	2.8
*Sedge Wren	27.8	9.5	16.9	7.4	31.7	7.1	18.8	1.4
Sharp-shinned Hawk	1.1	3.2	0.0	0.0	0.0	0.0	0.0	0.0
Sharp-tailed Grouse	3.3	1.1	2.2	0.0	11.1	0.0	0.0	0.0
*Song Sparrow	53.3	21.1	40.4	24.2	66.7	34.1	56.3	27.8
Sora	0.0	1.1	0.0	2.1	1.6	1.2	3.1	1.4
*Spotted Sandpiper	2.2	1.1	3.4	0.0	0.0	0.0	0.0	0.0
Swainson's Thrush	2.2	8.4	0.0	1.1	0.0	7.1	3.1	1.4
*Swamp Sparrow	12.2	8.4	15.7	13.7	14.3	20.0	15.6	9.7
*Tennessee Warbler	11.1	16.8	2.2	6.3	11.1	7.1	6.3	0.0
*Tree Swallow	6.7	3.2	3.4	4.2	0.0	0.0	0.0	1.4
Trumpeter Swan	2.2	10.5	3.4	4.2	1.6	0.0	0.0	0.0
Turkey Vulture	1.1	1.1	4.5	2.1	1.6	3.5	3.1	0.0
*Veery	44.4	46.3	36.0	43.2	47.6	37.6	56.3	40.3
*Vesper Sparrow	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0
Virginia Rail	1.1	1.1	0.0	0.0	1.6	0.0	0.0	0.0
Warbling Vireo	3.3	0.0	6.7	0.0	0.0	1.2	6.3	0.0
Western Meadowlark	4.4	1.1	0.0	0.0	1.6	0.0	0.0	0.0

Species	Distribution (Percent Occurrence)							
	2018		2016		2015		2014	
	Impact	Control	Impact	Control	Impact	Control	Impact	Control
White-breasted Nuthatch	0.0	0.0	0.0	1.1	0.0	1.2	0.0	0.0
*White-throated Sparrow	54.4	63.2	78.7	80.0	74.6	71.8	59.4	72.2
White-winged Crossbill	0.0	0.0	0.0	1.1	0.0	0.0	0.0	1.4
*Wilson's Snipe	7.8	13.7	38.2	24.2	47.6	17.6	31.3	11.1
Wilson's Warbler	1.1	3.2	0.0	0.0	1.6	0.0	0.0	0.0
Winter Wren	7.8	7.4	10.1	16.8	1.6	16.5	9.4	16.7
*Wood Duck	0.0	2.1	0.0	1.1	0.0	0.0	0.0	0.0
*[β]Wood Thrush	14.4	13.7	1.1	21.1	0.0	7.1	6.3	2.8
Yellow Warbler	13.3	16.8	30.3	9.5	23.8	21.2	18.8	6.9
Yellow-bellied Flycatcher	14.4	24.2	4.5	6.3	6.3	16.5	0.0	8.3
*Yellow-bellied Sapsucker	8.9	2.1	1.1	11.6	11.1	20.0	9.4	8.3
Yellow-rumped Warbler	17.8	17.9	6.7	21.1	20.6	24.7	9.4	11.1

Notes:

α Distribution (Percent Occurrence) = number of point count stations at which a species was recorded divided by the total number of point counts surveyed;
Abundance = maximum number of individuals per species divided by the total number of point count stations;
Density = maximum number of individuals per species recorded within a 50 m radius of the surveyor divided by the area of the survey station (= 0.79 ha).

* BCR 12 Priority Species

β Species provincially-listed as *Special Concern* under the *Endangered Species Act*

γ Species provincially-listed as Threatened or Endangered under the *Endangered Species Act*

Appendix C3: Abundance of All Species by Survey Year

Species	Abundance (Birds / Point Count)							
	2018		2016		2015		2014	
	Impact	Control	Impact	Control	Impact	Control	Impact	Control
Alder Flycatcher	0.56	0.36	0.17	0.39	0.65	0.38	0.41	0.27
American Bittern	0.02	0.05	0.00	0.04	0.02	0.02	0.03	0.01
American Crow	0.19	0.25	0.33	0.25	0.43	0.26	0.19	0.08
American Goldfinch	0.40	0.22	0.19	0.16	0.35	0.36	0.47	0.19
*American Kestrel	0.02	0.03	0.02	0.03	0.03	0.00	0.00	0.00
American Pipit	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
American Redstart	0.17	0.32	0.04	0.15	0.13	0.09	0.34	0.07
American Robin	0.84	0.67	0.69	0.49	0.78	0.53	0.50	0.51
American Tree Sparrow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
*[γ]American White Pelican	0.08	0.16	0.09	0.00	0.06	0.00	0.00	0.03
*American Woodcock	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
*[β]Bald Eagle	0.04	0.01	0.00	0.01	0.03	0.01	0.00	0.00
Baltimore Oriole	0.06	0.02	0.00	0.00	0.03	0.02	0.00	0.00
*[γ]Barn Swallow	0.28	0.51	0.33	0.06	0.40	0.05	0.00	0.01
Barred Owl	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00
*Bay-breasted Warbler	0.01	0.06	0.01	0.00	0.00	0.00	0.00	0.00
*Belted Kingfisher	0.02	0.00	0.00	0.01	0.00	0.04	0.03	0.00
Black-and-white Warbler	0.64	0.58	0.48	0.64	0.38	0.36	0.41	0.39
Black-backed Woodpecker	0.03	0.05	0.00	0.00	0.00	0.01	0.00	0.00
*Black-billed Cuckoo	0.04	0.04	0.04	0.09	0.21	0.12	0.69	0.11
Black-billed Magpie	0.20	0.02	0.25	0.00	0.40	0.02	0.06	0.01
*Blackburnian Warbler	0.04	0.21	0.06	0.23	0.03	0.12	0.00	0.09
Black-capped Chickadee	0.30	0.28	0.11	0.26	0.06	0.16	0.03	0.15
Blackpoll Warbler	0.01	0.00	0.00	0.00	0.00	0.05	0.00	0.00
*Black-throated Blue Warbler	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.03
*Black-throated Green Warbler	0.14	0.33	0.13	0.35	0.03	0.22	0.13	0.20
Blue Jay	0.49	0.43	0.91	0.92	0.70	0.52	0.50	0.35
Blue-headed Vireo	0.00	0.01	0.00	0.03	0.14	0.09	0.03	0.05
*[γ]Bobolink	0.89	0.27	0.73	0.21	1.05	0.26	0.53	0.08
Boreal Chickadee	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Brewer's Blackbird	0.07	0.06	0.03	0.04	0.00	0.00	0.19	0.01
*Broad-winged Hawk	0.00	0.01	0.03	0.00	0.03	0.06	0.00	0.00
Brown Creeper	0.03	0.03	0.03	0.04	0.00	0.00	0.06	0.03
*Brown Thrasher	0.01	0.00	0.04	0.00	0.00	0.00	0.00	0.00
Brown-headed Cowbird	0.13	0.04	0.02	0.03	0.14	0.01	0.38	0.07
*Canada Goose	0.77	0.86	0.30	0.14	3.44	0.16	0.00	0.34
*[β]Canada Warbler	0.08	0.06	0.06	0.06	0.00	0.05	0.03	0.00
Cape May Warbler	0.01	0.03	0.00	0.02	0.00	0.01	0.00	0.00
Cedar Waxwing	0.33	0.47	0.43	0.31	0.27	0.27	0.41	0.31
*Chestnut-sided Warbler	0.94	0.57	0.69	0.80	0.14	0.42	0.78	0.57
Chipping Sparrow	0.17	0.11	0.10	0.11	0.06	0.04	0.16	0.14
Clay-colored Sparrow	0.54	0.11	0.51	0.16	0.76	0.15	0.50	0.15
*Cliff Swallow	0.02	0.00	0.00	0.00	0.05	0.00	0.00	0.00
Common Grackle	0.04	0.06	0.02	0.04	0.03	0.08	0.00	0.00

Species	Abundance (Birds / Point Count)							
	2018		2016		2015		2014	
	Impact	Control	Impact	Control	Impact	Control	Impact	Control
Common Loon	0.03	0.07	0.02	0.09	0.00	0.07	0.00	0.03
*βCommon Nighthawk	0.00	0.00	0.01	0.00	0.02	0.00	0.00	0.00
Common Raven	0.27	0.15	0.29	0.34	0.13	0.31	0.28	0.15
*Common Yellowthroat	1.00	0.57	0.85	0.56	1.10	0.61	1.06	0.73
*Connecticut Warbler	0.03	0.01	0.06	0.00	0.00	0.09	0.06	0.20
Dark-eyed Junco	0.01	0.11	0.02	0.01	0.05	0.09	0.00	0.14
Downy Woodpecker	0.02	0.04	0.01	0.11	0.02	0.04	0.06	0.03
Eastern Bluebird	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Eastern Kingbird	0.08	0.06	0.02	0.03	0.17	0.08	0.06	0.05
Eastern Phoebe	0.03	0.04	0.09	0.12	0.06	0.11	0.03	0.04
Eastern Towhee	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00
*γEastern Whip-poor-will	0.00	0.01	0.00	0.00	0.02	0.01	0.00	0.03
*βEastern Wood-Pewee	0.06	0.08	0.01	0.01	0.05	0.16	0.09	0.03
European Starling	0.28	0.09	0.29	0.07	0.24	0.44	0.00	0.00
*βEvening Grosbeak	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00
Golden-crowned Kinglet	0.04	0.05	0.00	0.24	0.00	0.12	0.00	0.14
*βGolden-winged Warbler	0.14	0.14	0.11	0.12	0.16	0.12	0.09	0.03
*Gray Catbird	0.02	0.01	0.01	0.02	0.03	0.00	0.06	0.01
Gray Jay	0.06	0.18	0.08	0.14	0.00	0.09	0.03	0.12
Great Blue Heron	0.03	0.03	0.00	0.01	0.00	0.00	0.03	0.00
Great Crested Flycatcher	0.04	0.01	0.06	0.02	0.03	0.02	0.09	0.03
Green Heron	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00
Hairy Woodpecker	0.03	0.00	0.04	0.04	0.10	0.02	0.06	0.03
Hermit Thrush	0.18	0.48	0.31	0.73	0.25	0.60	0.50	0.86
*Herring Gull	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
*Hooded Merganser	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
House Wren	0.04	0.02	0.01	0.02	0.08	0.02	0.03	0.00
Indigo Bunting	0.01	0.00	0.02	0.01	0.03	0.00	0.09	0.00
*Killdeer	0.08	0.06	0.06	0.01	0.08	0.01	0.00	0.00
*Least Flycatcher	0.19	0.20	0.33	0.28	0.51	0.32	0.34	0.19
LeConte's Sparrow	0.62	0.14	0.60	0.13	0.46	0.04	0.13	0.00
Lincoln's Sparrow	0.00	0.08	0.01	0.12	0.03	0.13		0.09
Long-eared Owl	0.00	0.00	0.02	0.00	0.00	0.01	0.00	0.00
Magnolia Warbler	0.10	0.44	0.12	0.32	0.21	0.27	0.06	0.15
*Mallard	0.07	0.00	0.04	0.01	0.00	0.00	0.00	0.00
Marbled Godwit	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Marsh Wren	0.01	0.00	0.00	0.00	0.02	0.04	0.00	0.00
Merlin	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
Mourning Dove	0.01	0.02	0.00	0.02	0.03	0.00	0.00	0.00
*Mourning Warbler	0.42	0.27	0.15	0.17	0.03	0.13	0.31	0.23
*Nashville Warbler	1.28	1.66	1.42	1.48	1.00	1.32	1.31	2.19
*Northern Flicker	0.11	0.14	0.27	0.23	0.29	0.29	0.22	0.26
Northern Harrier	0.00	0.01	0.04	0.02	0.00	0.01	0.00	0.00
Northern Parula	0.02	0.17	0.02	0.23	0.02	0.20	0.09	0.12
*Northern Rough-winged Swallow	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Species	Abundance (Birds / Point Count)							
	2018		2016		2015		2014	
	Impact	Control	Impact	Control	Impact	Control	Impact	Control
Northern Waterthrush	0.10	0.09	0.07	0.05	0.03	0.02	0.00	0.04
*[β]Olive-sided Flycatcher	0.03	0.01	0.00	0.02	0.02	0.00	0.00	0.00
Orange-crowned Warbler	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.01
Ovenbird	1.10	1.44	1.13	1.32	1.29	1.38	1.31	1.28
Palm Warbler	0.02	0.13	0.01	0.08	0.00	0.27	0.00	0.22
Philadelphia Vireo	0.04	0.03	0.00	0.00	0.00	0.04	0.06	0.00
Pied-billed Grebe	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Pileated Woodpecker	0.12	0.06	0.02	0.05	0.10	0.08	0.06	0.03
Pine Siskin	0.12	0.03	0.02	0.08	0.00	0.00	0.00	0.00
Pine Warbler	0.00	0.01	0.00	0.00	0.00	0.02	0.00	0.00
*Purple Finch	0.04	0.00	0.00	0.00	0.02	0.02	0.00	0.03
Red-breasted Nuthatch	0.24	0.25	0.16	0.29	0.13	0.27	0.03	0.14
*Red Crossbill	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Red-eyed Vireo	1.41	1.84	0.82	1.11	1.27	1.28	1.38	1.41
*[β]Red-headed Woodpecker	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00
*Red-shouldered Hawk	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00
Red-tailed Hawk	0.09	0.02	0.02	0.02	0.03	0.06	0.00	0.01
Red-winged Blackbird	0.30	0.28	0.38	0.18	0.54	0.20	0.22	0.05
Ring-billed Gull	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00
*Ring-necked Duck	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00
Rock Pigeon	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
*Rose-breasted Grosbeak	0.32	0.18	0.27	0.40	0.19	0.31	0.31	0.23
*Ruby-crowned Kinglet	0.11	0.20	0.06	0.14	0.19	0.11	0.00	0.03
Ruby-throated Hummingbird	0.00	0.03	0.02	0.02	0.05	0.01	0.03	0.01
*Ruffed Grouse	0.20	0.24	0.07	0.36	0.08	0.19	0.19	0.04
*[β]Rusty Blackbird	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00
*Sandhill Crane	0.34	0.14	0.26	0.31	0.41	0.15	0.38	0.03
Savannah Sparrow	0.88	0.19	0.73	0.12	0.68	0.11	0.69	0.18
Scarlet Tanager	0.00	0.01	0.06	0.04	0.00	0.02	0.09	0.03
*Sedge Wren	0.48	0.24	0.21	0.11	0.67	0.09	0.38	0.01
Sharp-shinned Hawk	0.01	0.04	0.00	0.00	0.00	0.00	0.00	0.00
Sharp-tailed Grouse	0.23	0.01	0.07	0.00	0.14	0.00	0.00	0.00
*Song Sparrow	0.87	0.25	0.63	0.40	1.05	0.64	1.03	0.51
Sora	0.00	0.01	0.00	0.02	0.02	0.01	0.03	0.01
*Spotted Sandpiper	0.02	0.01	0.08	0.00	0.00	0.00	0.00	0.00
Swainson's Thrush	0.02	0.11	0.00	0.01	0.00	0.07	0.03	0.03
*Swamp Sparrow	0.18	0.15	0.21	0.19	0.22	0.26	0.31	0.20
*Tennessee Warbler	0.12	0.21	0.03	0.14	0.11	0.09	0.06	0.00
*Tree Swallow	0.08	0.03	0.03	0.04	0.00	0.00	0.00	0.03
Trumpeter Swan	0.03	0.15	0.13	0.05	0.02	0.00	0.00	0.00
Turkey Vulture	0.01	0.01	0.08	0.02	0.02	0.04	0.03	0.00
*Veery	0.68	0.66	0.46	0.56	0.70	0.54	1.06	0.61
*Vesper Sparrow	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Virginia Rail	0.01	0.01	0.00	0.00	0.02	0.00	0.00	0.00
Warbling Vireo	0.03	0.00	0.08	0.00	0.00	0.01	0.06	0.00
Western Meadowlark	0.04	0.01	0.00	0.00	0.02	0.00	0.00	0.00

Species	Abundance (Birds / Point Count)							
	2018		2016		2015		2014	
	Impact	Control	Impact	Control	Impact	Control	Impact	Control
White-breasted Nuthatch	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00
*White-throated Sparrow	0.99	1.07	1.36	1.66	1.27	1.24	1.69	1.70
White-winged Crossbill	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01
*Wilson's Snipe	0.10	0.22	0.46	0.27	0.65	0.21	0.31	0.12
Wilson's Warbler	0.01	0.03	0.00	0.00	0.03	0.00	0.00	0.00
Winter Wren	0.08	0.08	0.11	0.17	0.02	0.16	0.13	0.23
*Wood Duck	0.00	0.02	0.00	0.01	0.00	0.00	0.00	0.00
*[β]Wood Thrush	0.17	0.15	0.01	0.24	0.00	0.08	0.06	0.03
Yellow Warbler	0.18	0.22	0.47	0.13	0.30	0.28	0.19	0.08
Yellow-bellied Flycatcher	0.19	0.28	0.07	0.12	0.06	0.20	0.00	0.08
*Yellow-bellied Sapsucker	0.09	0.02	0.01	0.13	0.13	0.22	0.09	0.12
Yellow-rumped Warbler	0.18	0.20	0.15	0.27	0.24	0.27	0.13	0.11

Notes:

- α Distribution (Percent Occurrence) = number of point count stations at which a species was recorded divided by the total number of point counts surveyed;
  Abundance = maximum number of individuals per species divided by the total number of point count stations;
  Density = maximum number of individuals per species recorded within a 50 m radius of the surveyor divided by the area of the survey station (= 0.79 ha).
- * BCR 12 Priority Species
- β Species provincially-listed as Special Concern under the Endangered Species Act
- γ Species provincially-listed as Threatened or Endangered under the Endangered Species Act

Appendix C4: Densities of All Species by Survey Year

Species	Density (birds/ha)							
	2018		2016		2015		2014	
	Impact	Control	Impact	Control	Impact	Control	Impact	Control
Alder Flycatcher	0.120	0.101	0.039	0.104	0.172	0.090	0.053	0.042
American Bittern	0.000	0.000	0.000	0.007	0.000	0.000	0.000	0.003
American Crow	0.007	0.023	0.011	0.007	0.040	0.037	0.003	0.008
American Goldfinch	0.106	0.054	0.050	0.017	0.101	0.101	0.030	0.033
*American Kestrel	0.007	0.007	0.004	0.007	0.010	0.000	0.000	0.000
American Pipit	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.000
American Redstart	0.050	0.094	0.011	0.040	0.040	0.030	0.042	0.011
American Robin	0.145	0.161	0.163	0.104	0.192	0.120	0.058	0.055
American Tree Sparrow	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000
*[γ]American White Pelican	0.007	0.003	0.000	0.000	0.000	0.000	0.019	0.006
*American Woodcock	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.000
*[β]Bald Eagle	0.011	0.003	0.000	0.000	0.005	0.004	0.000	0.000
Baltimore Oriole	0.014	0.007	0.000	0.000	0.005	0.004	0.000	0.000
*[γ]Barn Swallow	0.064	0.137	0.000	0.000	0.025	0.000	0.000	0.003
Barred Owl	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000
*Bay-breasted Warbler	0.004	0.017	0.004	0.000	0.000	0.000	0.000	0.000
*Belted Kingfisher	0.007	0.000	0.000	0.003	0.000	0.004	0.003	0.000
Black-and-white Warbler	0.159	0.171	0.134	0.178	0.106	0.101	0.080	0.055
Black-backed Woodpecker	0.007	0.013	0.000	0.000	0.000	0.004	0.000	0.000
*Black-billed Cuckoo	0.011	0.007	0.000	0.010	0.020	0.004	0.022	0.000
Black-billed Magpie	0.028	0.000	0.018	0.000	0.081	0.007	0.003	0.003
*Blackburnian Warbler	0.014	0.060	0.014	0.074	0.005	0.037	0.006	0.019
Black-capped Chickadee	0.071	0.087	0.032	0.077	0.020	0.045	0.008	0.028
Blackpoll Warbler	0.004	0.000	0.000	0.000	0.000	0.015	0.000	0.000
*Black-throated Blue Warbler	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.000
*Black-throated Green Warbler	0.028	0.094	0.039	0.077	0.010	0.060	0.028	0.025
Blue Jay	0.060	0.087	0.099	0.137	0.141	0.094	0.061	0.053
Blue-headed Vireo	0.000	0.003	0.000	0.010	0.040	0.026	0.008	0.011
*[γ]Bobolink	0.209	0.077	0.191	0.044	0.217	0.034	0.028	0.011
Boreal Chickadee	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.003
Brewer's Blackbird	0.007	0.010	0.011	0.010	0.000	0.000	0.014	0.003
*Broad-winged Hawk	0.000	0.003	0.004	0.000	0.010	0.007	0.011	0.000
Brown Creeper	0.011	0.010	0.011	0.013	0.000	0.000	0.006	0.006
*Brown Thrasher	0.000	0.000	0.004	0.000	0.000	0.000	0.000	0.000
Brown-headed Cowbird	0.039	0.013	0.007	0.007	0.025	0.004	0.022	0.011
*Canada Goose	0.099	0.000	0.000	0.000	0.000	0.015	0.003	0.000
*[β]Canada Warbler	0.025	0.020	0.011	0.017	0.000	0.015	0.014	0.000
Cape May Warbler	0.004	0.010	0.000	0.007	0.000	0.004	0.000	0.000
Cedar Waxwing	0.106	0.131	0.103	0.070	0.051	0.056	0.042	0.039
*Chestnut-sided Warbler	0.251	0.168	0.184	0.241	0.035	0.120	0.116	0.089
Chipping Sparrow	0.046	0.030	0.021	0.017	0.010	0.004	0.019	0.022
Clay-colored Sparrow	0.124	0.020	0.117	0.047	0.222	0.030	0.025	0.011
*Cliff Swallow	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Common Grackle	0.007	0.010	0.007	0.007	0.010	0.022	0.000	0.000

Species	Density (birds/ha)							
	2018		2016		2015		2014	
	Impact	Control	Impact	Control	Impact	Control	Impact	Control
Common Loon	0.000	0.003	0.000	0.000	0.000	0.011	0.000	0.000
*ᵝCommon Nighthawk	0.00	0.00	0.000	0.000	0.005	0.000	0.000	0.000
Common Raven	0.025	0.000	0.018	0.013	0.010	0.049	0.000	0.003
*Common Yellowthroat	0.237	0.168	0.173	0.117	0.278	0.146	0.089	0.108
*Connecticut Warbler	0.007	0.003	0.011	0.000	0.000	0.026	0.011	0.033
Dark-eyed Junco	0.004	0.030	0.004	0.003	0.005	0.022	0.008	0.022
Downy Woodpecker	0.000	0.010	0.004	0.034	0.005	0.011	0.006	0.006
Eastern Bluebird	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Eastern Kingbird	0.018	0.020	0.007	0.003	0.045	0.015	0.008	0.011
Eastern Phoebe	0.004	0.010	0.018	0.027	0.010	0.019	0.000	0.008
Eastern Towhee	0.00	0.00	0.000	0.000	0.000	0.004	0.000	0.000
*ᵞEastern Whip-poor-will	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.003
*ᵝEastern Wood-Pewee	0.007	0.020	0.004	0.000	0.005	0.037	0.006	0.006
European Starling	0.011	0.023	0.000	0.003	0.000	0.026	0.000	0.000
*ᵝEvening Grosbeak	0.000	0.010	0.000	0.000	0.000	0.000	0.000	0.000
Golden-crowned Kinglet	0.014	0.017	0.000	0.077	0.000	0.037	0.008	0.025
*ᵝGolden-winged Warbler	0.046	0.030	0.032	0.030	0.040	0.037	0.006	0.003
*Gray Catbird	0.007	0.003	0.004	0.007	0.010	0.000	0.006	0.003
Gray Jay	0.011	0.054	0.025	0.034	0.000	0.030	0.011	0.022
Great Blue Heron	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Great Crested Flycatcher	0.011	0.000	0.011	0.003	0.000	0.007	0.008	0.006
Green Heron	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hairy Woodpecker	0.011	0.000	0.007	0.007	0.015	0.007	0.011	0.000
Hermit Thrush	0.021	0.094	0.050	0.101	0.020	0.097	0.080	0.113
*Herring Gull	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.000
*Hooded Merganser	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.000
House Wren	0.004	0.003	0.000	0.003	0.015	0.004	0.003	0.000
Indigo Bunting	0.004	0.000	0.007	0.003	0.010	0.000	0.006	0.000
*Killdeer	0.011	0.013	0.007	0.000	0.010	0.000	0.000	0.000
*Least Flycatcher	0.039	0.057	0.064	0.067	0.116	0.097	0.039	0.036
LeConte's Sparrow	0.191	0.044	0.170	0.040	0.147	0.011	0.006	0.000
Lincoln's Sparrow	0.000	0.027	0.004	0.037	0.005	0.030	0.000	0.017
Long-eared Owl	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000
Magnolia Warbler	0.028	0.134	0.035	0.094	0.045	0.071	0.017	0.022
*Mallard	0.004	0.000	0.004	0.000	0.000	0.000	0.000	0.000
Marbled Godwit	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Marsh Wren	0.000	0.000	0.000	0.000	0.005	0.011	0.000	0.000
Merlin	0.00	0.00	0.004	0.000	0.000	0.000	0.000	0.000
Mourning Dove	0.000	0.003	0.000	0.000	0.010	0.000	0.000	0.000
*Mourning Warbler	0.085	0.070	0.039	0.030	0.010	0.022	0.072	0.033
*Nashville Warbler	0.350	0.503	0.371	0.422	0.243	0.352	0.208	0.318
*Northern Flicker	0.021	0.034	0.032	0.027	0.045	0.034	0.033	0.028
Northern Harrier	0.000	0.003	0.004	0.000	0.000	0.000	0.000	0.000
Northern Parula	0.000	0.044	0.004	0.064	0.005	0.041	0.008	0.019
*Northern Rough-winged Swallow	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Species	Density (birds/ha)							
	2018		2016		2015		2014	
	Impact	Control	Impact	Control	Impact	Control	Impact	Control
Northern Waterthrush	0.014	0.023	0.007	0.010	0.010	0.004	0.000	0.003
*$^{\beta}$Olive-sided Flycatcher	0.004	0.003	0.000	0.003	0.000	0.000	0.000	0.000
Orange-crowned Warbler	0.000	0.003	0.000	0.000	0.000	0.004	0.000	0.003
Ovenbird	0.202	0.328	0.184	0.278	0.177	0.292	0.138	0.158
Palm Warbler	0.004	0.040	0.004	0.027	0.000	0.071	0.008	0.036
Philadelphia Vireo	0.014	0.010	0.000	0.000	0.000	0.011	0.008	0.000
Pied-billed Grebe	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Pileated Woodpecker	0.000	0.013	0.004	0.007	0.005	0.015	0.000	0.006
Pine Siskin	0.039	0.010	0.000	0.017	0.000	0.000	0.003	0.000
Pine Warbler	0.000	0.003	0.000	0.000	0.000	0.004	0.000	0.000
*Purple Finch	0.011	0.000	0.000	0.000	0.005	0.007	0.000	0.006
Red-breasted Nuthatch	0.060	0.064	0.035	0.070	0.015	0.071	0.019	0.025
*Red Crossbill	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000
Red-eyed Vireo	0.255	0.456	0.152	0.261	0.263	0.333	0.113	0.147
*$^{\beta}$Red-headed Woodpecker	0.00	0.00	0.007	0.000	0.000	0.000	0.000	0.000
*Red-shouldered Hawk	0.00	0.00	0.000	0.000	0.000	0.007	0.000	0.000
Red-tailed Hawk	0.004	0.003	0.004	0.003	0.005	0.000	0.000	0.000
Red-winged Blackbird	0.057	0.074	0.057	0.020	0.086	0.034	0.025	0.003
Ring-billed Gull	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000
*Ring-necked Duck	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.000
Rock Pigeon	0.021	0.000	0.000	0.000	0.000	0.000	0.000	0.000
*Rose-breasted Grosbeak	0.064	0.050	0.032	0.084	0.051	0.060	0.036	0.042
*Ruby-crowned Kinglet	0.018	0.050	0.014	0.027	0.015	0.030	0.000	0.006
Ruby-throated Hummingbird	0.000	0.010	0.007	0.007	0.010	0.004	0.003	0.003
*Ruffed Grouse	0.032	0.047	0.011	0.044	0.005	0.034	0.019	0.008
*$^{\beta}$Rusty Blackbird	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000
*Sandhill Crane	0.039	0.003	0.007	0.000	0.061	0.000	0.000	0.000
Savannah Sparrow	0.248	0.054	0.177	0.027	0.192	0.030	0.044	0.030
Scarlet Tanager	0.000	0.003	0.007	0.013	0.000	0.004	0.003	0.003
*Sedge Wren	0.124	0.067	0.039	0.027	0.202	0.026	0.033	0.003
Sharp-shinned Hawk	0.000	0.013	0.000	0.000	0.000	0.000	0.000	0.000
Sharp-tailed Grouse	0.074	0.003	0.021	0.000	0.030	0.000	0.000	0.000
*Song Sparrow	0.209	0.074	0.131	0.087	0.253	0.161	0.061	0.069
Sora	0.000	0.000	0.000	0.000	0.000	0.004	0.003	0.003
*Spotted Sandpiper	0.004	0.000	0.011	0.000	0.000	0.000	0.000	0.000
Swainson's Thrush	0.004	0.010	0.000	0.000	0.000	0.015	0.006	0.006
*Swamp Sparrow	0.032	0.037	0.035	0.037	0.061	0.064	0.028	0.036
*Tennessee Warbler	0.035	0.060	0.011	0.023	0.030	0.026	0.003	0.000
*Tree Swallow	0.004	0.007	0.000	0.000	0.000	0.000	0.000	0.000
Trumpeter Swan	0.000	0.003	0.000	0.007	0.000	0.000	0.000	0.000
Turkey Vulture	0.000	0.003	0.007	0.000	0.000	0.004	0.000	0.000
*Veery	0.127	0.121	0.057	0.107	0.086	0.097	0.058	0.075
*Vesper Sparrow	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.000
Virginia Rail	0.000	0.000	0.000	0.000	0.005	0.000	0.000	0.000
Warbling Vireo	0.004	0.000	0.021	0.000	0.000	0.000	0.006	0.000
Western Meadowlark	0.004	0.003	0.000	0.000	0.000	0.000	0.000	0.000

Species	Density (birds/ha)							
	2018		2016		2015		2014	
	Impact	Control	Impact	Control	Impact	Control	Impact	Control
White-breasted Nuthatch	0.00	0.00	0.000	0.003	0.000	0.004	0.000	0.000
*White-throated Sparrow	0.223	0.251	0.180	0.308	0.136	0.172	0.227	0.197
White-winged Crossbill	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.003
*Wilson's Snipe	0.004	0.030	0.000	0.030	0.096	0.026	0.025	0.017
Wilson's Warbler	0.004	0.010	0.011	0.000	0.000	0.000	0.000	0.000
Winter Wren	0.011	0.023	0.014	0.034	0.005	0.022	0.030	0.028
*Wood Duck	0.000	0.000	0.000	0.003	0.000	0.000	0.000	0.000
*[β]Wood Thrush	0.028	0.030	0.004	0.020	0.000	0.019	0.006	0.006
Yellow Warbler	0.032	0.060	0.127	0.027	0.076	0.079	0.028	0.017
Yellow-bellied Flycatcher	0.050	0.077	0.018	0.034	0.015	0.064	0.006	0.017
*Yellow-bellied Sapsucker	0.018	0.007	0.004	0.017	0.020	0.041	0.019	0.014
Yellow-rumped Warbler	0.057	0.057	0.046	0.080	0.045	0.079	0.033	0.022

Notes:

α Distribution (Percent Occurrence) = number of point count stations at which a species was recorded divided by the total number of point counts surveyed;
Abundance = maximum number of individuals per species divided by the total number of point count stations;
Density = maximum number of individuals per species recorded within a 100 m radius of the surveyor divided by the area of the survey station (= 3.1416 ha).

* BCR 12 Priority Species

β Species provincially-listed as Special Concern under the Endangered Species Act

γ Species provincially-listed as Threatened or Endangered under the Endangered Species Act

New Gold Inc. Rainy River Mine

2015 - 2018 Bat Acoustic Monitoring Report
Per Provincial Environmental Assessment Notice of Approval Condition 6
TC111504

Prepared for:

New Gold Inc.

March 2019

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March 20, 2019

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Yours truly,

Wood Environment & Infrastructure
a Division of Wood Canada Limited

New Gold Inc. Rainy River Mine

2015 - 2018 Bat Acoustic Monitoring Report
TC111504

Prepared for:

New Gold Inc.
Rainy River Project

Prepared by:

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March 2019

Executive Summary

Environmental baseline studies and wildlife monitoring for the RRM have been undertaken annually since 2009. These studies have established a comprehensive understanding of the composition of local plant and wildlife communities within the Project footprint as well as on surrounding lands. Environmental baseline studies for bats were undertaken at the RRM by Wood (formerly AMEC) in 2012 and 2013. As part of the federal environmental assessment process, New Gold committed to follow-up wildlife monitoring programs to verify the accuracy of the environmental assessment predictions. This current report provides the methods and results from the 2015 to 2018 bat acoustic monitoring program.

Annual bat acoustic monitoring was conducted at five monitoring stations between 2015 and 2018 during the maternal brood rearing period in June and early July. Bat acoustic surveys were designed to target two bat SAR whose ranges overlap with the study area and have previously been identified within the Project footprint: Little Brown Myotis and Northern Myotis. Recordings were identified to species using SonoBat^{TM} software and were verified manually using parameters such as frequency of maximum energy, minimum and maximum frequency, call duration, slope of the call, and other qualitative parameters.

Acoustic monitoring has consistently recorded all six species of bat anticipated to be present, based on current known ranges: Little Brown Myotis, Northern Myotis, Eastern Red Bat, Silver-Haired Bat, Hoary Bat and Big Brown Bat. Little Brown Myotis and Northern Myotis are both designated as Endangered Species under Ontario's ESA, which prohibits harming, destroying or disturbing habitat for this species under Sections 9 and 10 of the Act.

Little Brown Myotis and Silver-haired Bats have been consistently detected at the highest frequencies and widest distributions followed by Hoary Bat. Eastern Red Bat and Big Brown Bat are both widespread and have been consistently detected at relatively low frequencies while Northern Myotis has the lowest level of detection and the smallest consistent distribution.

During the spring maternal brood rearing period surveys, Northern Myotis made up 0.16% and 0.06% (2 passes) of all recorded passes in 2015 and 2016 respectively. Despite this low sample size, it appears Detector 23 may have slightly higher activity levels for this species than the other detector locations. This is consistent with the wooded habitat present at this location.

Little Brown Myotis was recorded at all five survey locations within the RRM study area at relatively high levels, particularly in 2015 and 2017. In 2015, 52% of all passes were by Little Brown Myotis or Myotis species and in 2017 these species represented 34% of all passes. Little Brown Myotis and Myotis species passes appear to have their highest detection rate consistently at Detector 21. Between 2015 and 2017 detections of these species at Detector 21 made up between 68% to 93% of their overall detections. The same pattern was present for Silver-haired Bat with the highest number of passes per night for this species recorded at this detector during each maternal brood rearing survey period.

Due to issues with the acoustic surveys during the maternal brood rearing period in 2018 a survey was undertaken in early fall. During this survey period several activity levels for non-SAR bat species survey were the highest of the entire study. Silver-haired Bat numbers (passes per night) were relatively high at every detector location during this survey period and Detector 25 had the highest number of nightly passes over the entire study for Eastern Red Bat, Hoary Bat, Big Brown Bat and the second highest number of nightly passes for Silver-haired Bat.

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1.0 Introduction

1.1 Project Background

New Gold Inc. (New Gold) is constructing, operating and eventually reclaiming a new open pit and underground gold mine, the Rainy River Mine (RRM; the Project). The RRM will produce doré bars (gold with silver) for sale. Physical works related to the RRM will consist primarily of:

- Open pit and underground mine;
- Overburden, mine rock and low grade ore stockpiles;
- Primary crusher and process plant;
- Tailings management area;
- 230 kilovolt transmission line;
- Relocation of a portion of gravel-surfaced Highway 600; and
- Associated buildings, facilities and infrastructure.

The RRM site is located in the Township of Chapple, District of Rainy River, in northwestern Ontario, approximately 65 kilometres (km) northwest of Fort Frances, and 420 km west of Thunder Bay (Figure 1-1). Lands immediately adjacent to the RRM are typically gently rolling to flat, forested wetlands in low-lying areas, rounded bedrock outcrops and subcrops in upland areas and areas that have been cleared for agriculture. Local drainage systems are characterized by small creeks that flow to the Pinewood River which drains most of the RRM site area.

Environmental baseline studies and wildlife monitoring for the RRM have been undertaken annually since 2009 within the Natural Environment Local Study Area (NLSA) and the wider Regional Study Area (as defined in AMEC 2014; Figure 1-2). These studies have established a comprehensive understanding of the composition of local plant and wildlife communities within the Project footprint as well as on surrounding lands (i.e., the Study Area). Environmental baseline studies for bats were undertaken at the RRM by Wood Environment & Infrastructure Solutions, a Division of Wood Canada Limited (Wood; formerly AMEC) in 2012 and 2013. Initial acoustic surveys during these baseline studies revealed the presence of six bat species within the proposed RRM footprint, including two species designated as Endangered: Little Brown Myotis (*Myotis lucifugus*) and Northern Myotis (*Myotis septentrionalis*).

The assessment of potential environmental impacts for the RRM was summarized in the RRM Final Environmental Assessment Report (Environmental Impact Statement) Version 2 (AMEC 2014) submitted to the Federal and Provincial Governments, including for Aboriginal and public review. A positive federal Environmental Assessment (EA) Decision Statement was issued on January 12, 2015 and a favourable provincial EA Notice of Approval was released on January 29, 2015.

As a component of the federal EA process, Amec Foster Wheeler Environment & Infrastructure (currently Wood Environment & Infrastructure), was retained to create and implement a Follow-up Monitoring Plan (FMP). In accordance with the *Canadian Environmental Assessment Act, 2012* (CEAA 2012) the purpose of the FMP is to verify the accuracy of the predictions made in the EA about the potential impacts of the

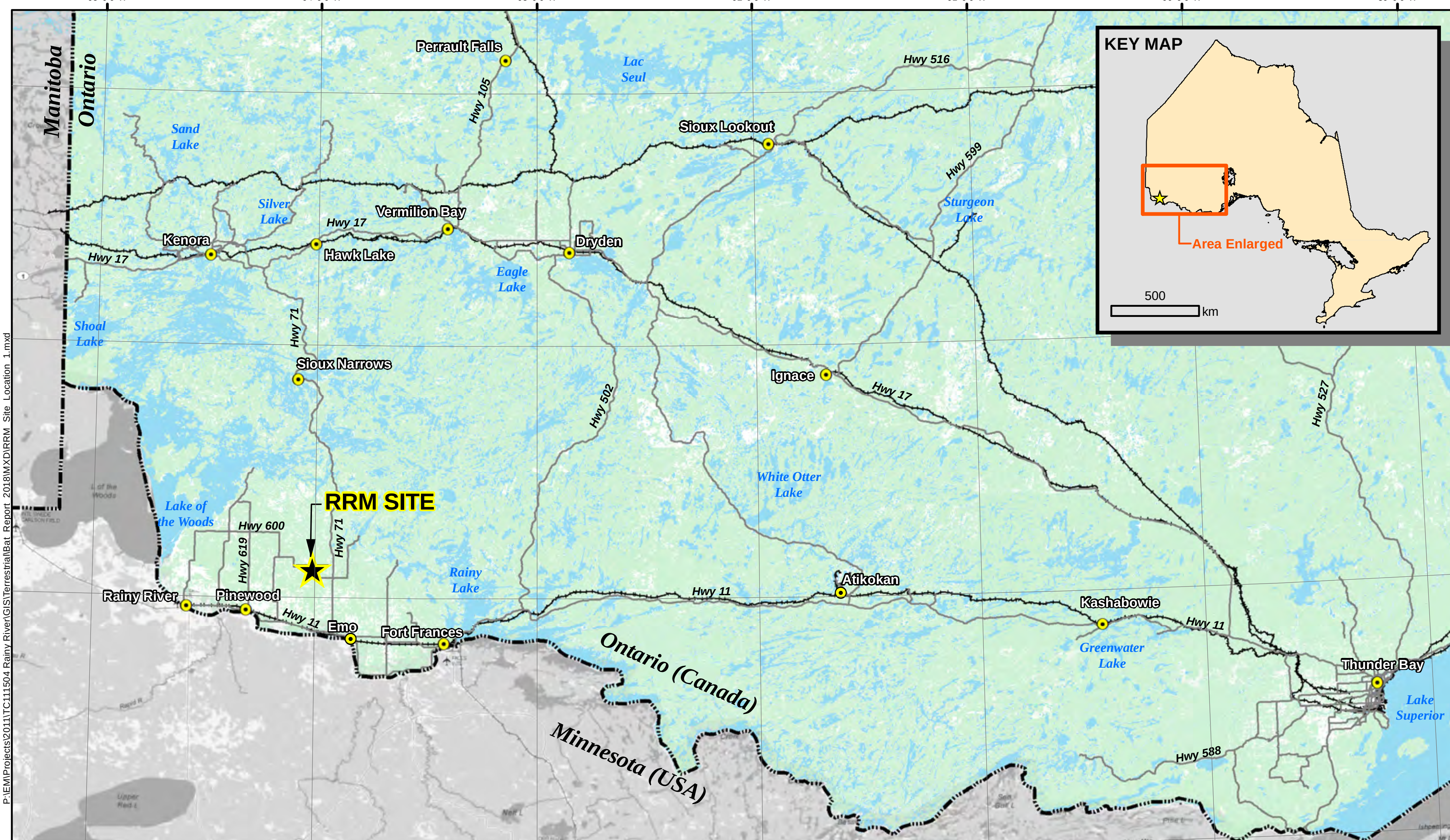
Project on wildlife and wildlife habitat, and to monitor the effectiveness of rehabilitation efforts for wildlife habitat and terrestrial environments. This bat acoustic monitoring report has been created to support the objectives of the FMP and presents the results of bat acoustic monitoring surveys undertaken between 2015 and 2018.

1.2 Objective and Scope

Noise disturbance can cause adverse effects on wildlife, particularly bats, in a variety of ways, most notably interference with acoustic signals. Bats rely heavily on vocal and auditory feedback for foraging and navigation. Anthropogenic noise can interfere with these signals and deter bats (Schaub et al. 2008, Arnett et al. 2013, Bunkley et al. 2015). Additionally, bats rely on, and are relatively faithful to specific habitat features with particular conditions for roosting, mating and hibernation, the latter two being relatively uncommon in the landscape, and anthropogenic disturbance may drive bats to abandon these areas. Chronic noise disturbance can decrease breeding success, increase mortality rates and lead to an overall decrease in population density and/or species diversity (USFWS 2012).

Bat acoustic studies were undertaken annually between 2015 and 2018 to fulfill the following objectives:

- Provide an annual reassessment of bat acoustic survey results;
- Monitor current bat populations as compared to baseline bat acoustic surveys at the RRM;
- Confirm the continued presence or absence of Endangered Little Brown Myotis and Northern Myotis within the RRM Natural Environment Local Study Area (NLSA; as shown in Figure 1-2);
- Begin to identify any long-term population changes and implications of any such changes.



LEGEND

- RRM Site
- Regional Communities
- Provincial / National Border
- Regional Road / Highway
- Railway

0 25 50 100 150 200 250 Kilometres

NOTES:
- Ontario base data extracted from Land Information Ontario (MNR) data warehouse, Queen's Printer for Ontario, 2011-2012
- Base data outside of Ontario extracted from ESRI DeLorme World Basemap

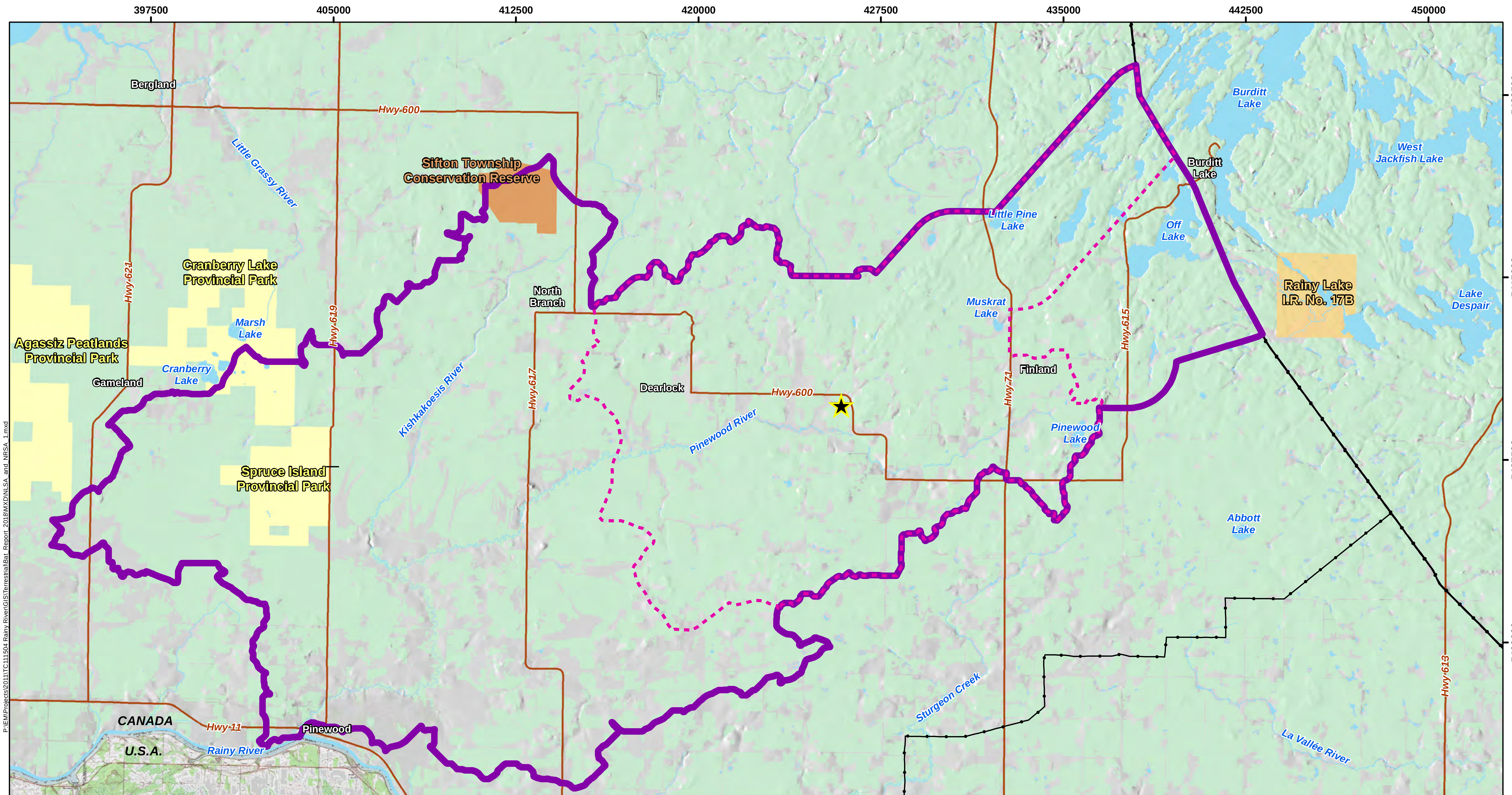
Datum: NAD83
Projection: UTM Zone 15N

newgold Rainy River Project wood.

RAINY RIVER MINE

Project Location

PROJECT N°: TC111504	**FIGURE: 1-1**
SCALE: 1:1,800,000	DATE: February 2019



LEGEND

- RRM Site
- Natural Environment Local Study Area Boundary (NLSA)
- Natural Environment Regional Study Area Boundary (NRSA)
- Transmission Line
- Regional Road / Highway
- Waterbody / Large Watercourse
- Wooded Area
- First Nation Reserve
- Conservation Reserve (Regulated)
- Provincial Park

NOTES:
- All base data on this map was extacted from Land Information Ontario (MNR), Queen's Printer for Ontario, 2011-2012
- USA land extracted from ESRI base map service, USGS Topo maps

Datum: NAD83
Projection: UTM Zone 15N

0 5 10 20 30 40 Kilometres

newgold Rainy River Project wood.

RAINY RIVER MINE

Local and Regional Natural Study Areas

PROJECT N°: TC111504	FIGURE: 1-2
SCALE: 1:150,000	DATE: February 2019

2.0 Methodology

2.1 Existing Information Review

A list of bat species likely to occur within the RRM Study Area was generated from inventory maps in the Atlas of the Mammals of Ontario (Dobbyn 1994) and up-to-date range maps provided by Bat Conservation International (BCI 2018). Six bat species, including two SAR, were found to potentially occur in the vicinity of the RRM: Little Brown Myotis, Northern Myotis, Big Brown Bat (*Eptesicus fuscus*), Silver-Haired Bat (*Lasionycteris noctivagans*), Hoary Bat (*Lasiurus cinereus*) and Eastern Red Bat (*Lasiurus borealis*). All six species were confirmed to occur within the RRM footprint during the baseline studies in 2012 and 2013.

2.2 Bat Acoustic Surveys

To support the objectives of the FMP and to monitor RRM-induced effects on bats, Wood conducted annual bat acoustic monitoring at five monitoring stations between 2015 and 2018. Bat acoustic surveys were designed to target two bat SAR whose ranges overlap with the study area and have previously been identified within the Project footprint: Little Brown Myotis and Northern Myotis. Both species are designated provincially and federally as Endangered. The program focused on confirming the continued presence of these SAR and other bat species and to monitor the level of activity and relative abundance of all bat species at representative locations around the periphery of the mine site and in nearby compensatory property (Figure 2-1).

Bat acoustic surveys were conducted annually between 2015 and 2018 to detect nocturnal bat activity, generally during the maternal brood rearing period in June and early July. All nocturnal bat activity was recorded from 30 minutes before sunset to 30 minutes after sunrise. During each annual recording period, five ultrasonic recording detectors were deployed throughout the study area (Figure 2-1). From 2015-2017, Songmeter SM2Bat+ (Wildlife Acoustics Inc.) recorders paired with SMX-US and SMX-UT microphones were used, while in 2018, a combination of SM2Bat+ recorders with SMX-UT microphones and SM4BAT recorders with SMM-U1 microphones were used. Details of the yearly bat detector deployment dates are provided in Table 2-1. Whenever possible, based on other RRM field program schedules, two rounds of acoustic monitoring were conducted.

Prior to deployment, an ultrasonic calibrator (Wildlife Acoustics Inc.) that emitted a 40 kilohertz (kHz) pure tone was used to verify the sensitivity and proper functioning of the bat detector microphones. Detectors were positioned 2 to 4 metres (m) above ground at representative locations with characteristics likely to result in higher levels of bat activity, such as the edges of wetlands and woodlands and / or near natural corridors to potential feeding areas (Furlonger et al. 1987). Bat detectors were configured to begin recording when ultrasonic signals greater than 18 decibels (dB) above the noise floor rolling average were detected. Upon trigger, a 2 to 5 second recording was saved. A signal process then filtered recorded signals and retained those files resembling bat echolocation. All recordings were made in .wav format with a 384 kHz sampling frequency and 16 bit resolution, producing real time, full spectrum data that afford greater accuracy and confidence when identifying recordings of bat calls to species.

Recordings were identified to species using SonoBat 3.2.0 NE.vi (Sonobat™) automated processing software (for Ontario and United States, north and northeast). Recordings were also classified manually because, while automated classification can provide accurate classifications for clear recordings that have a high signal to noise ratio, most field recordings contain some level of noise which can limit the accuracy of automated software and its ability to detect echolocation calls within recordings. Recordings were first examined for saturated calls (calls with a noise level that surpassed the limits of the recording equipment). Saturated calls were removed from recordings with Audacity software to ensure better identification of calls by the species identification software. If all calls within a recording were saturated, the volume of the recording was reduced, and the clipped sections of the calls were digitally corrected with Audacity software. For these calls, amplitude information was not used to identify the calls to species. While automated classification provides efficient classification of large numbers of echolocation recordings, studies on the accuracy of automated classification caution on relying solely on this method (Menon et al. 2018, Rydell et al. 2017, Lemen et al. 2015). Therefore, a subset of the recordings for each year was also classified manually. While poor recording quality or call feature overlap can lead to inaccurate classifications by the software, the software is able to accurately distinguish between High-frequency bats and Low-frequency bats. The former group emits calls with a minimum frequency above 35 kHz and includes all SAR species as well as the Eastern Red Bat, while the latter, emits calls with a minimum frequency below 35 kHz. Since we were confident that all classifications by the software to a low-frequency species were unlikely to be an inaccurately classified SAR species, recordings selected for manual vetting included only those classified to SAR species. Due to the volume of recordings, we also limited the manual vetting to 200 passes for a given species at a given detector.

Automated classification used the mean classification decision method in Sonobat. Individual calls within a recording were classified based on over 30 acoustic parameters. The software used a discriminant analysis to provide an accuracy probability for each classification and only calls with a probability greater than 90% were accepted. The calls within a sequence are sorted hierarchically and processed to generate a mean classification decision. Manual classification was accomplished by comparing qualitative and quantitative parameters of recorded bat calls to a library of known species parameters. Parameters used for species identification included: frequency of maximum energy, minimum frequency, maximum frequency, call duration, slope of the call, and other more qualitative parameters such as the time-frequency shape of the call, the position of the knee, presence of inflections and terminal curvatures (see diagram in Appendix A). Less importance was placed on maximum frequency due to its susceptibility to atmospheric attenuation. Calls that could not be classified to a single species were placed in a group named after the two or more species most likely to have produced the call.

2.2.1 Exceptions to Standard Methodology

In 2016 microphone sensitivity was found to be extremely variable during routine calibration testing, likely due to the age of the microphones and different weathering conditions attained through use in previous seasons. In an attempt to determine qualitative differences in detectability, bat detectors were 'paired' at the RRM in 2016 to allow a comparison of recorded data. This involved deploying two bat detectors at each location, one with a known 'good condition' microphone with high sensitivity (>17 dB) paired with a known 'poor condition' microphone with lower sensitivity (<30 dB). The results of this comparison are provided in Appendix B. The data used in this report was that obtained from the detector with higher sensitivity to ensure the most accurate results are presented.

In 2018 two bat detectors failed to collect data for unknown reasons and the other three detectors had suspicious gaps in the recorded data. Factors could have included inclement weather, natural bat population fluctuations, microphone sensitivity, detector faults, human error or a combination of these factors. As only three of the five detectors collected data during the maternal brood rearing period, a second round of monitoring was undertaken in early fall to supplement the study program.

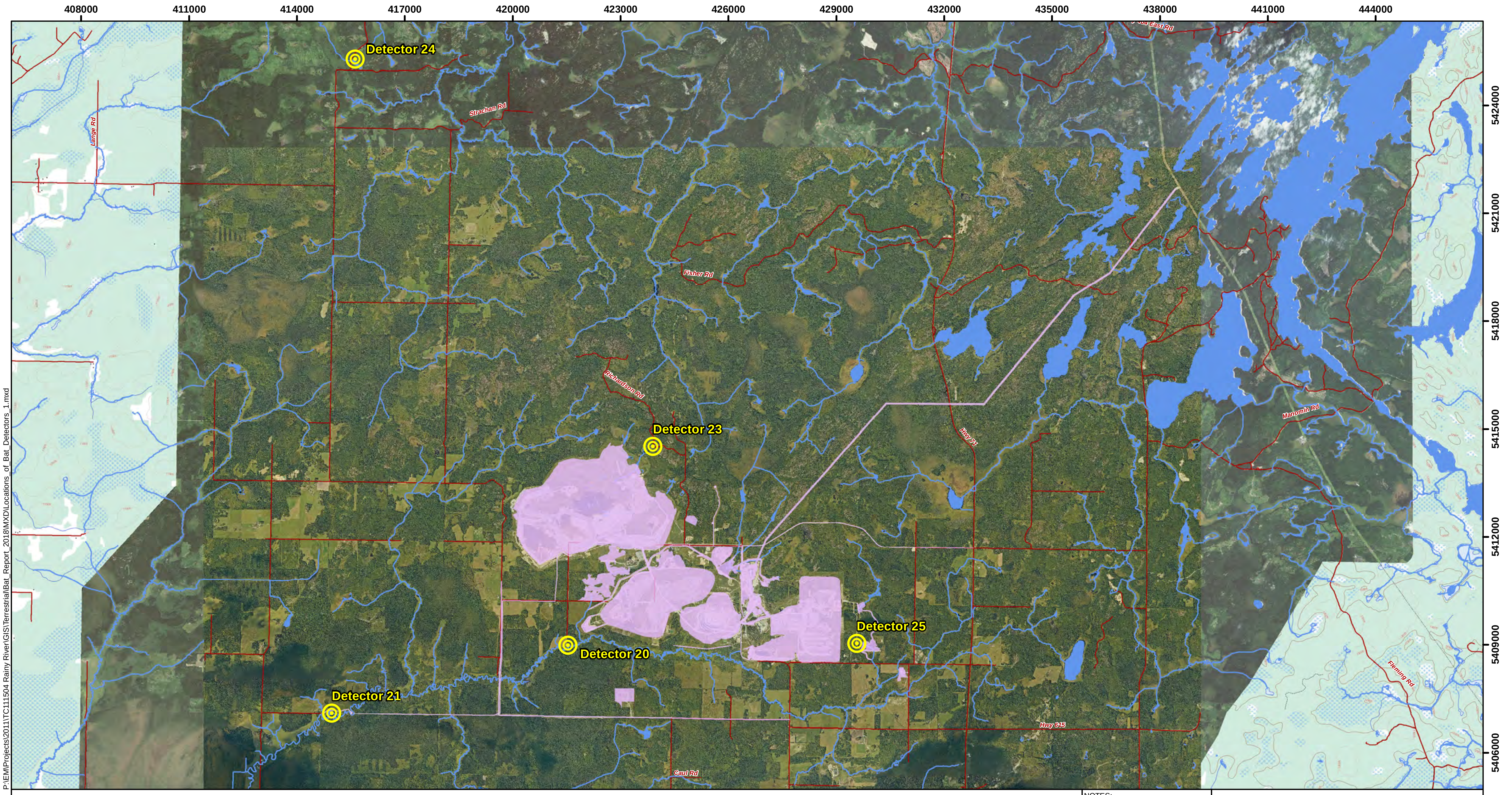
Table 2-1: Details of Bat Acoustic Surveys Completed

Year	Detector	Round 1		Round 2		Combined
		Recording Dates	Recording Period (nights)	Recording Dates	Recording Period (nights)	Recording Period (nights)
2015	Detector 20	June 7 – June 20	14	June 26 – July 10	15	29
	Detector 21	June 7 – June 18	12	June 26 – July 9	14	26
	Detector 23	June 7 – June 17	11	June 26 – July 9	14	25
	Detector 24	June 7 – June 22	16	June 27 – July 11	15	31
	Detector 25	June 7 – June 21	15	June 26 – July 10	15	30
2016[1]	Detector 20	June 25 – July 9	15	--	--	15
	Detector 21	June 19 – June 30	12	--	--	12
	Detector 23	June 20 – July 4	15	--	--	15
	Detector 24	June 19 – July 1	13	--	--	13
	Detector 25	June 20 – July 3	14	--	--	14
2017	Detector 20	June 3 – June 16	14	July 1 – July 17	17	31
	Detector 21	June 1 – June 6	6	July 2 – July 15	14	20
	Detector 23	June 2 – June 16	15	July 1 – July 15	15	30
	Detector 24	June 1 – June 15	15	July 2 – July 15	14	29
	Detector 25	June 2 – June 16	15	July 1 – July 16	16	31
2018[2]	Detector 20	--	--	Aug 12 – Sept 6	26	N/A
	Detector 21	June 21 – June 27	7	Aug 12 – Sept 7	27	N/A
	Detector 23	June 2 – July 2	31	Aug 12 – Sept 7	27	N/A
	Detector 24	June 1 – June 27	27	Aug 12 – Sept 6	26	N/A
	Detector 25	--	--	Aug 12 – Sept 6	26	N/A

Notes:

Detectors were only deployed for one round in 2016.

Detector failures in 2018 led to minimal data collected during maternal brood rearing period and a later round 2 of collection in early fall, as such a total recording period was used for each round rather than the entire season.



LEGEND

- Bat Detector Locations (labelled with ID)
- Approximate Principal RRM Facilities
- Watercourse
- Waterbody
- Road

0 2 4 8 12 16 20 Kilometres

NOTES:
- Pleiades imagery Sept. 6, 2018 and July 20, 2014
- Road data extracted from Land Information Ontario, Ontario Road Network, MNRF

Datum: NAD83
Projection: UTM Zone 15N

newgold Rainy River Project wood.

RAINY RIVER MINE

Bat Detector Locations

PROJECT N°: TC111504 | **FIGURE: 2-1**

SCALE: 1:100,000 | DATE: February 2019

3.0 Results

Subsequent to the baseline surveys undertaken in 2012 and 2013, acoustic bat monitoring was conducted annually between 2015 and 2018. A compiled species list with respective provincial rank, SAR status, relevant protective acts and details on the years species have been detected is provided in Table 3-1.

Calls that could not be classified to a single species were placed into separate paired classes (e.g., Myotis species, LANO/EPFU) if possible and where this level of classification was not possible, calls were placed into high-frequency, low-frequency or unknown groupings.

3.1 Bat Acoustic Surveys

2015 Bat Acoustic Surveys

Acoustic bat monitoring during 2015 produced records of all six bat species anticipated to be present in the RRM area based on existing data sources: Little Brown Myotis, Northern Myotis, Big Brown Bat, Silver-Haired Bat, Hoary Bat and Eastern Red Bat. A total of 13,958 passes were recorded during the maternal brood rearing period (June to early July) over a total of 141 recording nights. Little Brown Myotis were recorded at all five survey locations and had the highest frequency of occurrence (35.3%; 4,921 passes). Another 17.3% of the total recorded passes were classified as Myotis species (either Little Brown Myotis or Northern Myotis) (Table 3-2). Silver-haired Bats, Hoary Bats and Eastern Red Bats were recorded at all five survey locations, with the next highest frequencies of occurrence (18.4%, 5.5% and 2.8% of the total recorded passes, respectively). Big Brown Bat and Northern Myotis had low frequencies of occurrence (0.3%; 37 passes and 0.2%; 22 passes, respectively) with Big Brown Bat recorded at all five survey stations and Northern Myotis at four of the five survey locations. The combination of Silver-haired Bat or Big Brown Bat had an occurrence frequency of 0.3% of the total recorded passes while the combination of Little Brown Bat or Eastern Red Bat had a very low frequency of occurrence with less than 0.01% of total recorded passes.

A total of 2,801 passes could not be classified to species or species pair; 2,450 of these were from high-frequency species, 350 were from low-frequency species, and one could not be classified, likely as a result of poor recording quality.

The acoustic activity of bats during the first recording period (early June to late June) averaged 125.29 passes per night (passes/night) at Detector 20 (D20), 529.25 passes/night at D21, 43.09 passes/night at D23, 45.31 passes/night at D24 and 14.53 passes/night at D25. The acoustic monitoring of bats during the second recording period (late June to mid-July) recorded less passes than the first round and averaged 26.33 passes/night at D20, 203.79 passes/night at D21, 14.86 passes/night at D23, 44.40 passes/night at D24 and 20.93 passes/night at D25 (Table 3-2). Several species, particularly Little Brown Myotis, showed a substantial decrease in activity during the later survey period.

2016 Bat Acoustic Surveys

Acoustic bat monitoring during 2016 produced records of all six bat species anticipated to be present in the RRM area based on existing data sources: Little Brown Myotis, Northern Myotis, Big Brown Bat, Silver-Haired Bat, Hoary Bat and Eastern Red Bat. A total of 3,591 passes were recorded during the maternal brood rearing period (June to early July) over a total of 69 recording nights. Silver-haired Bats and Hoary Bats were recorded at all five surveys stations with the two highest frequencies of occurrence (32.4% and

25.3% of the total passes recorded, respectively). Little Brown Myotis were also recorded at all five survey locations and with a relatively high frequency of occurrence (10.6%; 330 passes). Another 12.8% of the total passes were classified as Myotis species (either Little Brown Myotis or Northern Myotis) (Table 3-3). Eastern Red Bats and Big Brown Bats were both recorded at low frequencies of occurrence (1.3%; 46 passes and 0.4%; 22 passes respectively) with Eastern Red Bat recorded at all five survey stations and Big Brown Bat at four of the five survey locations. Northern Myotis were recorded twice at a single survey station, representing 0.06% of the total passes recorded. The combination of Silver-haired Bat or Big Brown Bat had a frequency of occurrence of 0.6% of the total passes recorded while the combination of Little Brown Bat or Eastern Red Bat had an even lower frequency of occurrence making up 0.2% of the total passes recorded.

A total of 591 passes could not be classified to species or species pair; 370 of these were from high-frequency species and 221 were from low-frequency species.

The acoustic activity of bats during the recording period (mid-late June to early June) averaged 49.73 passes/night at D20, 116.17 passes/night at D21, 7.20 passes/night at D23, 79.92 passes/night at D24 and 21.71 passes/night at D25. This level of activity is lower than that of 2015 and corroborates the idea noted in 2015 that activity may be lower in this area by late June.

2017 Bat Acoustic Surveys

Acoustic bat monitoring during 2017 produced records of five of the six bat species anticipated to be present in the RRM area based on existing data sources: Little Brown Myotis, Big Brown Bat, Silver-Haired Bat, Hoary Bat and Eastern Red Bat. Although no Northern Myotis were identified during this survey year, ambiguous recordings classified as Myotis species may include passes by Northern Myotis as this species is known to occur in the RRM area as it has been recorded in previous survey years (Table 3-4). A total of 9,004 passes were recorded during the maternal brood rearing period (June to early July) over a total of 141 recording nights. Silver-haired Bats were recorded at all five surveys stations with the highest frequency of occurrence (30.4% of the total passes recorded). Little Brown Myotis were also recorded at all five survey locations with a high frequency of occurrence (30.1%; 2,709 passes), with another 3.2% of the total recorded passes being classified as Myotis species (Table 3-4). Hoary Bats and Eastern Red Bats were both recorded at all five survey stations with relatively low frequencies of occurrence of 12.8% and 1.8% of the total recorded passes respectively, while Big Brown Bats were recorded at two survey stations with a low frequency of occurrence (0.06%; 5 passes). Four pairs of species occurred in low frequencies; the combination of Little Brown Bat or Eastern Red Bat had a frequency of 6.4% of the total recorded passes, Silver-haired Bat or Hoary Bat had a frequency of 0.87% of the total recorded passes, Silver-haired Bat or Big Brown Bat had a frequency of 0.14% of the total recorded passes and the combination of Eastern Red Bat or Big Brown Bat had a frequency of 0.01% of the total recorded passes.

A total of 1,061 passes could not be classified to species or species pair; 222 of these were from high-frequency species, 647 were from low-frequency species and 414 could not be classified, likely as a result of poor recording quality.

The acoustic activity of bats during the first recording period (early June to late June) averaged 45.43 passes/night at D20, 634.67 passes/night at D21, 10.07 passes/night at D23, 19.67 passes/night at D24 and 5.53 passes/night at D25. The acoustic activity of bats during the second recording period (late June to mid-July) was higher than the first round and averaged 58.18 passes/night at D20, 95.71 passes/night at D21, 31.20 passes/night at D23, 66.00 passes/night at D24 and 19.38 passes/night at D25 (Table 3-4). Most species occurrences increased in this second survey period, which may indicate a late arrival from wintering areas. Once again, Little Brown Myotis showed a substantial decrease in activity during the later survey period which corroborates the idea noted in 2015 and 2016 that activity of this species may decrease in this area by late June.

2018 Bat Acoustic Surveys

Acoustic bat monitoring during 2018 was not undertaken with the same methodology as the previous survey years (further details in Section 2.2.1). As such the results cannot be directly compared and should be interpreted with caution. Minimal data of unknown quality was collected during the maternal brood rearing period and an additional full survey program was undertaken in the early fall.

Despite the anomalies in data collection, five of the six bat species anticipated to be present in the RRM area based on existing data sources were detected: Little Brown Myotis, Big Brown Bat, Silver-Haired Bat, Hoary Bat and Eastern Red Bat. Although no Northern Myotis were identified during this survey year, ambiguous recordings classified as Myotis species may include passes by Northern Myotis as this species is known to occur in the RRM area as it has been recorded in previous survey years (Table 3-5).

During the spring survey period a total of 1,825 passes were recorded during the maternal brood rearing period (June to early July) over a total of 65 recording nights. Only three detectors collected data for various recording periods (Table 2-1). No Little Brown Myotis were detected during this survey period. Silver-haired Bats and Hoary Bats were recorded at all three surveys stations with the two highest frequencies of occurrence (57.4% and 15.5% of the total recorded passes). Big Brown Bats and Eastern Red Bats were both recorded at two of the three survey stations with low frequencies of occurrence (0.8% and 0.2% of the total recorded passes, respectively). Five passes (0.3% of the total recorded passes) classified as Myotis species (either Little Brown Myotis or Northern Myotis) were recorded at a single station (Table 3-5).

A total of 472 (25.8%) passes could not be classified to species or species pair; 63 of these were from high-frequency species and 409 were from low-frequency species.

The acoustic activity of bats during the spring recording period (June to July) averaged 14.48 passes/night at D21, 10.11 passes/night at D23 and 157.57 passes/night at D24. Due to the various issues with bat detectors it is unclear whether the low numbers of Myotis species recorded is due to an actual paucity of individuals or due to faults with the recording equipment. Results from the next monitoring year will be key to determining current trends for these species.

During the fall survey period (late August to early September) a total of 12,975 passes were recorded over a total of 132 recording nights. Silver-haired Bats and Hoary Bats were recorded at all five surveys stations with the two highest frequencies of occurrence (60.3% and 20.6% of the total recorded passes, respectively). Eastern Red Bat and Big Brown Bat were also both recorded at all five survey stations with lower frequencies of occurrence (4.1% and 1.8% of the total recorded passes, respectively). Little Brown Myotis were recorded at three of the five survey locations while Myotis species were recorded at four of the five locations and each had a low frequency of occurrence (0.1% of the total recorded passes each; 17 and 13 passes, respectively) (Table 3-5).

A total of 1,690 passes could not be classified to species or species pair; 636 of these were from high-frequency species and 1,054 were from low-frequency species.

The acoustic activity of bats during the fall recording period (late August to early September) averaged 217.15 passes/night at D20, 83.26 passes/night at D21, 97.15 passes/night at D23, 44.73 passes/night at D24 and 139.81 passes/night at D25. Little Brown Myotis and unknown Myotis species were identified among the recorded passes, indicating they were present within the RRM study area during 2018. However, these values do not give an indication of their level of activity during the maternal brood rearing period. This fall survey has recorded the highest number of passes from both Silver-haired and Hoary Bats across all survey years. Silver-haired, Hoary and Eastern Red Bats are migratory species. Migration occurs in the spring and late summer/fall, with this latter period also coinciding with the mating period. Except for the mating period, at all other times of the year, these species are generally solitary so it is therefore not uncommon to see increases in acoustic activity of these species during late summer and fall (Jameson and Willis 2014).

3.2 Bat Species at Risk

In January 2013, the Little Brown Myotis and the Northern Myotis were afforded Endangered Species Status in Ontario and are now protected under the ESA and the federal *Fish and Wildlife Conservation Act, 1997* (FWCA). Since it first appeared in upstate New York in 2006, the fungal disease known as White Nose Syndrome has decimated millions of bats throughout eastern North America and is rapidly spreading westward (Frick et al. 2010). Little Brown Myotis and Northern Myotis are the two species most impacted by White Nose Syndrome (White-Nose Syndrome Response Team 2018). The natural histories of these two species are very similar in that both rely on old growth forest stands where they form maternity colonies in tree cavities. Both also rely on caves and abandoned mines as hibernacula and staging points for reproductive activities (Norquay et al. 2013). This section presents acoustic survey results specific to the two SAR known to occur within the RRM study area.

3.2.1 Little Brown Myotis

Since the Northern Myotis is generally less abundant than the Little Brown Myotis (Caceres and Barclay 2000), the majority of calls classified as Myotis species were likely produced by the Little Brown Myotis.

During spring maternal brood rearing period surveys in 2015 Little Brown Myotis and the Myotis species group made up 52% (7,334 out of 13,958) of all recorded passes, of which 70% of these (5,152 out of 7,334) were at D21 (Table 3-6). In 2016, these species made up less of the overall passes, with 23% (839 out of 3591) of all recorded passes, however, 68% of these (573 out of 839) were again at D21. Similarly, in 2017 these species made up 33% (2,999 out of 9,004) of all recorded passes, and again, 93% of these (2,778 out of 2,999) were at D21. While there appears to be variation in the activity levels of this species between years, the majority of the activity is consistently at Detector D21.

The average activity of the Little Brown Myotis and Myotis group throughout the study area was 52.01 passes/night in 2015, 12.16 passes/night in 2016, 21.27 passes/night in 2017, dropping to 0.08 passes/night in 2018. There appears to be high variability in average number of passes/night between survey years. While this decrease does seem to correspond with the approximate arrival of White Nose Syndrome in the area (White-Nose Syndrome Response Team 2018), the data from 2018 is of relatively questionable quality, so the next round of survey data will be key to predicting ongoing population dynamics for this species.

3.2.2 Northern Myotis

Northern Myotis was recorded in the RRM study area in 2015 and 2016 with a low detection rate. This species was not confidently identifiable to species in 2017 or 2018. This species may have been recorded more often but could not be distinguished from the Little Brown Myotis. Both species commonly produce echolocation calls that are difficult to distinguish from each other and so the Northern Myotis may have been recorded more often and at more locations than could be determined.

During spring maternal brood rearing period surveys in 2015, Northern Myotis made up 0.16% of all recorded passes (22 out of 13958) of which 18% were recorded at D20, 50% at D23, 23% at D24 and 9% at D25 (Table 3-6). In 2016, only two passes were detected, and both were at D23. It is not possible to make broad conclusions with the paucity of data currently available for this species, however, it appears D23 may have slightly higher activity levels of this species in comparison with the other detectors.

Average activity of Northern Myotis throughout the study area was 0.16 passes/night in 2015 and 0.03 passes/night in 2016.

Table 3-1: Bat Species Confirmed Present by Survey Year

Common Name	Scientific Name	Observed in 2012	Observed in 2013	Observed in 2015	Observed in 2016	Observed in 2017	Observed in 2018	Provincial S-Rank 1	ESA / SARA Status 2	Other Protective Acts 3
Big Brown Bat	*Eptesicus fuscus*	--	✓	✓	✓	✓	✓	S4	--	FWCA
Silver-haired Bat	*Lasionycteris noctivagans*	✓	✓	✓	✓	✓	✓	S4	--	FWCA
Eastern Red Bat	*Lasiurus borealis*	✓	--	✓	✓	✓	✓	S4	--	FWCA
Hoary Bat	*Lasiurus cinereus*	✓	✓	✓	✓	✓	✓	S4	--	FWCA
Little Brown Myotis	*Myotis lucifugus*	✓	✓	✓	✓	✓	✓	S3	END/END	FWCA
Northern Myotis	*Myotis septentrionalis*	✓	✓	✓	✓	--	--	S3	END/END	FWCA

Notes:

S-Rank: S3 Uncommon or vulnerable species; S4 Apparently Secure Species; S5 Secure Species

ESA: Endangered Species Act; SARA: Species at Risk Act – Schedule 1: Full protection under SARA. END: Endangered

FWCA: Fish and Wildlife Conservation Act

Table 3-2: Bat Passes Recorded at Acoustic Detectors during the 2015 Maternal Brood Rearing Period

Detector ID	Round	MYLU	MYSE	Myotis	MYLU / LABO	LABO	LABO / EPFU	HiF Species	LACI	LANO	EPFU	LANO / EPFU	LANO / LACI	LoF Species	Unknown	Total Passes	Passes/Night
D20	1	348	4	482	5	32	--	330	133	387	8	2	--	23	--	**1754**	**125.29**
D20	2	70	--	147	--	2	--	71	19	81	1	--	--	4	--	**395**	**26.33**
D21	1	2988	--	779	--	330	--	1354	25	788	10	9	--	67	1	**6,351**	**529.25**
D21	2	892	--	493	--	4	--	505	48	699	8	25	--	179	--	**2853**	**203.79**
D23	1	72	8	171	--	2	--	43	40	122	2	--	--	14	--	**474**	**43.09**
D23	2	18	3	53	--	1	--	24	37	57	--	2	--	13	--	**208**	**14.86**
D24	1	307	3	121	--	2	--	42	153	87	--	--	--	10	--	**725**	**45.31**
D24	2	203	2	128	--	13	--	50	176	79	1	2	--	12	--	**666**	**44.40**
D25	1	11	0	20	--	0	--	11	84	74	6	--	--	12	--	**218**	**14.53**
D25	2	12	2	19	--	0	--	20	49	195	1	--	--	16	--	**314**	**20.93**
TOTAL		**4921**	**22**	**2413**	**5**	**386**	**--**	**2450**	**764**	**2569**	**37**	**40**	**--**	**350**	**1**	**13,958**	**98.99**
Total Passes / Night		**34.90**	**0.16**	**17.11**	**0.04**	**2.74**	**--**	**17.38**	**5.42**	**18.22**	**0.26**	**0.28**	**--**	**2.48**	**0.01**	**--**	**--**

Notes:

Four letter codes are derived from scientific names; combinations refer to passes with characteristics from both species

HiF = high-frequency bat species
LoF = low-frequency bat species
MYLU = Little Brown Myotis
MYSE = Northern Myotis
LABO = Eastern Red Bat
LACI = Hoary Bat
LANO = Silver-haired Bat
EPFU = Big Brown Bat
MYLU/LABO = Little Brown Myotis or Eastern Red Bat
LABO / EPFU = Eastern Red Bat or Big Brown Bat
LANO/EPFU = Silver-haired Bat or Big Brown Bat
LANO/LACI = Silver-haired Bat or Hoary Bat

Table 3-3: Bat Passes Recorded at Acoustic Detectors during the 2016 Maternal Brood Rearing Period

Detector ID	Round	MYLU	MYSE	Myotis	MYLU / LABO	LABO	LABO / EPFU	HiF Species	LACI	LANO	EPFU	LANO / EPFU	LANO / LACI	LoF Species	Unknown	Total Passes	Passes/Night
D20	1	7	--	111	1	2	--	109	263	241	1	1	--	10	--	**746**	**49.73**
D21	1	330	--	243	4	6	--	210	27	425	7	10	--	132	--	**1,394**	**116.17**
D23	1	10	2	19	--	4	--	6	11	49	--	3	--	4	--	**108**	**7.20**
D24	1	23	--	69	--	29	--	40	703	97	4	5	--	69	--	**1,039**	**79.92**
D25	1	10	--	17	3	5	--	5	160	96	1	1	--	6	--	**304**	**21.71**
TOTAL		**380**	**2**	**459**	**8**	**46**	**--**	**370**	**1164**	**908**	**13**	**20**	**--**	**221**	**--**	**3591**	**52.04**
Total Passes / Night		**5.51**	**0.03**	**6.65**	**0.12**	**0.67**	**--**	**5.36**	**16.87**	**13.16**	**0.19**	**0.29**	**--**	**3.20**	**--**	**--**	**--**

Notes:

Four letter codes are derived from scientific names; combinations refer to passes with characteristics from both species

HiF = high-frequency bat species
LoF = low-frequency bat species
MYLU = Little Brown Myotis
MYSE = Northern Myotis
LABO = Eastern Red Bat
LACI = Hoary Bat
LANO = Silver-haired Bat
EPFU = Big Brown Bat
MYLU/LABO = Little Brown Myotis or Eastern Red Bat
LABO / EPFU = Eastern Red Bat or Big Brown Bat
LANO/EPFU = Silver-haired Bat or Big Brown Bat
LANO/LACI = Silver-haired Bat or Hoary Bat

Table 3-4: Bat Passes Recorded at Acoustic Detectors during the 2017 Maternal Brood Rearing Period

Detector ID	Round	MYLU	MYSE	Myotis	MYLU / LABO	LABO	LABO / EPFU	HiF Species	LACI	LANO	EPFU	LANO / EPFU	LANO / LACI	LoF Species	Unknown	Total Passes	Passes/Night
D20	1	6	--	1	--	--	--	3	152	374	--	--	2	44	54	**636**	**45.43**
D20	2	5	--	5	2	8	--	1	361	427	--	--	15	96	69	**989**	**58.18**
D21	1	2669	--	109	562	127	--	168	28	114	--	--	6	17	8	**3,808**	**634.67**
D21	2	23	--	137	1	9	--	34	172	644	3	9	20	159	129	**1,340**	**95.71**
D23	1	1	--	--	--	1	--	--	30	94	--	--	--	12	13	**151**	**10.07**
D23	2	3	--	1	--	14	--	5	123	269	2	3	7	15	26	**468**	**31.20**
D24	1	--	--	4	--	--	--	--	107	71	--	--	2	70	41	**295**	**19.67**
D24	2	--	--	30	--	2	1	9	90	514	--	1	21	202	54	**924**	**66.00**
D25	1	1	--	--	--	--	--	--	29	47	--	--	--	2	4	**83**	**5.53**
D25	2	1	--	3	--	2	--	2	65	186	--	--	5	30	16	**310**	**19.38**
TOTAL		**2709**	**--**	**290**	**565**	**163**	**1**	**222**	**1157**	**2740**	**5**	**13**	**78**	**647**	**414**	**9,004**	**63.86**
Total Passes / Night		**19.21**	**--**	**2.06**	**4.01**	**1.16**	**0.01**	**1.57**	**8.21**	**19.43**	**0.04**	**0.09**	**0.55**	**4.59**	**2.94**	**--**	**--**

Notes:

Four letter codes are derived from scientific names; combinations refer to passes with characteristics from both species

HiF = high-frequency bat species
LoF = low-frequency bat species
MYLU = Little Brown Myotis
MYSE = Northern Myotis
LABO = Eastern Red Bat
LACI = Hoary Bat
LANO = Silver-haired Bat
EPFU = Big Brown Bat
MYLU/LABO = Little Brown Myotis or Eastern Red Bat
LABO / EPFU = Eastern Red Bat or Big Brown Bat
LANO/EPFU = Silver-haired Bat or Big Brown Bat
LANO/LACI = Silver-haired Bat or Hoary Bat

Table 3-5: Bat Passes Recorded at Acoustic Detectors during the 2018 Survey Period

Detector ID[2]	Round	MYLU	MYSE	Myotis	MYLU / LABO	LABO	LABO / EPFU	HiF Species	LACI	LANO	EPFU	LANO / EPFU	LANO / LACI	LoF Species	Unknown	Total Passes	Passes/Night[1]
Maternal Roosting Period Surveys																	
D21	1	--	--	5	--	1	--	50	151	589	7	--	--	300	--	**449**	**14.48**
D23	1	--	--	--	--	2	--	7	59	301	7	--	--	73	--	**273**	**10.11**
D24	1	--	--	--	--	--	--	6	73	158	--	--	--	36	--	**1103**	**157.57**
TOTAL		**--**	**--**	**5**	**--**	**3**	**--**	**63**	**283**	**1048**	**14**	**--**	**--**	**409**	**--**	**1,825**	**28.08**
Total Passes / Night[1]		--	--	0.08	--	0.05	--	0.97	4.35	16.12	0.22	--	--	6.29	--	--	--
Early Fall Surveys																	
D20	2	3	--	1	--	115	--	58	516	2352	16	--	--	245	--	**3,306**	**127.15**
D21	2	--	--	4	--	105	--	244	458	1257	4	--	--	176	--	**2,248**	**83.26**
D23	2	--	--	--	--	60	--	196	537	1550	8	--	--	272	--	**2,623**	**97.15**
D24	2	5	--	2	--	15	--	32	198	806	13	--	--	92	--	**1,163**	**44.73**
D25	2	9	--	6	--	235	--	106	963	1855	192	--	--	269	--	**3,635**	**139.81**
TOTAL		**17**	**--**	**13**	**--**	**530**	**--**	**636**	**2672**	**7820**	**233**	**--**	**--**	**1054**	**--**	**12,975**	**98.30**
Total Passes / Night[1]		**0.13**	**--**	**0.10**	**--**	**4.02**	**--**	**4.82**	**20.24**	**59.24**	**1.77**	**--**	**--**	**7.98**	**--**	**--**	**--**

Notes:

Detector failures in 2018 led to minimal data collected during maternal brood rearing period and a later round 2 of collection in early fall, as such passes/night were calculated for each round rather than the entire season.

Four letter codes are derived from scientific names; combinations refer to passes with characteristics from both species

HiF = high-frequency bat species
LoF = low-frequency bat species
MYLU = Little Brown Myotis
MYSE = Northern Myotis
LABO = Eastern Red Bat
LACI = Hoary Bat
LANO = Silver-haired Bat
EPFU = Big Brown Bat
MYLU/LABO = Little Brown Myotis or Eastern Red Bat
LABO / EPFU = Eastern Red Bat or Big Brown Bat
LANO/EPFU = Silver-haired Bat or Big Brown Bat
LANO/LACI = Silver-haired Bat or Hoary Bat.

Table 3-6: SAR Bat Passes by Year

Year	Detector ID	MYLU		MYSE		Myotis	
		Total Passes	Passes/Night	Total Passes	Passes/Night	Total Passes	Passes/Night
2015	D20	418	14.41	4	0.14	629	21.69
	D21	3880	149.23	0	0.00	1272	48.92
	D23	90	3.60	11	0.44	224	8.96
	D24	510	16.45	5	0.16	249	8.03
	D25	23	0.77	2	0.07	39	1.30
	Total	4921	34.90	22	0.16	2413	17.11
2016	D20	7	0.47	0	0	111	7.40
	D21	330	27.5	0	0	243	20.25
	D23	10	0.67	2	0.136	19	1.27
	D24	23	1.77	0	0	69	5.31
	D25	10	0.71	0	0	17	1.21
	Total	380	5.51	2	0.03	459	6.65
2017	D20	11	0.35	0	0	6	0.19
	D21	2692	134.6	0	0	246	12.3
	D23	4	0.13	0	0	1	0.03
	D24	0	0	0	0	34	1.17
	D25	2	0.06	0	0	3	0.1
	Total	2709	19.21	0	0	290	2.06
2018 S	D21	0	0	0	0	5	0.08
	D23	0	0	0	0	0	0
	D24	0	0	0	0	0	0
	Total	0	0	0	0	5	0.08
2018 F	D20	3	0.12	0	0	1	0.04
	D21	0	0	0	0	4	0.15
	D23	0	0	0	0	0	0
	D24	5	0.19	0	0	2	0.08
	D25	9	0.35	0	0	6	0.23
	Total	17	0.13	0	0	13	0.1

Notes:

Yellow highlighted squares are those with relatively high values worthy of note. This was considered to be > 8 passes/night

Four letter codes are derived from scientific names; MYLU = Little Brown Myotis, MYSE = Northern Myotis

Table 3-7: SAR Bat Passes by Detector

Detector ID	Year	MYLU		MYSE		Myotis	
		Total Passes	Passes/Night	Total Passes	Passes/Night	Total Passes	Passes/Night
D20	2015	418	14.41	4	0.14	629	21.69
	2016	7	0.47	0	0	111	7.40
	2017	11	0.35	0	0	6	0.19
	2018 F	3	0.12	0	0	1	0.04
D21	2015	3880	149.23	0	0	1272	48.92
	2016	330	27.50	0	0	243	20.25
	2017	2692	134.60	0	0	246	12.3
	2018 S	0	0	0	0	5	0.08
	2018 F	0	0	0	0	4	0.15
D23	2015	90	3.60	11	0.44	224	8.96
	2016	10	0.67	2	0.13	19	1.27
	2017	4	0.13	0	0	1	0.03
	2018 S	0	0	0	0	0	0
	2018 F	0	0	0	0	0	0
D24	2015	510	16.45	5	0.16	249	8.03
	2016	23	1.77	0	0	69	5.31
	2017	0	0	0	0	34	1.17
	2018 S	0	0	0	0	0	0
	2018 F	17	0.13	0	0	13	0.10
D25	2015	23	0.77	2	0.07	39	1.3
	2016	10	0.71	0	0	17	1.21
	2017	2	0.06	0	0	3	0.10
	2018 F	9	0.35	0	0	6	0.23

Notes:

Yellow highlighted squares are those with relatively high values worthy of note. This was considered to be > 8 passes/night

Four letter codes are derived from scientific names; MYLU = Little Brown Myotis, MYSE = Northern Myotis

Table 3-8: Non-SAR Bat Passes by Year

Year	Detector ID	LABO		LACI		LANO		EPFU	
		Total Passes	Passes/Night	Total Passes	Passes/Night	Total Passes	Passes/Night	Total Passes	Passes/Night
2015	D20	34	1.17	152	5.24	468	16.14	9	0.31
	D21	334	12.85	73	2.81	1487	57.19	18	0.69
	D23	3	0.12	77	3.08	179	7.16	2	0.08
	D24	15	0.48	329	10.61	166	5.35	1	0.03
	D25	0	0.00	133	4.43	269	8.97	7	0.23
	Total	386	2.74	764	5.42	2569	18.22	37	0.26
2016	D20	2	0.13	263	17.53	241	16.07	1	0.07
	D21	6	0.50	27	2.25	425	35.42	7	0.58
	D23	4	0.27	11	0.73	49	3.27	0	0.00
	D24	29	2.23	703	54.08	97	7.46	4	0.31
	D25	5	0.36	160	11.43	96	6.86	1	0.07
	Total	46	0.67	1164	16.87	908	13.16	13	0.19
2017	D20	8	0.26	513	16.55	801	25.84	0	0.00
	D21	136	6.80	200	10.00	758	37.90	3	0.15
	D23	15	0.50	153	5.10	363	12.10	2	0.07
	D24	2	0.07	197	6.79	585	20.17	0	0.00
	D25	2	0.06	94	3.03	233	7.52	0	0.00
	Total	163	1.16	1157	8.21	2740	19.43	5	0.04
2018 S	D21	1	0.14	151	21.57	589	84.14	7	1.00
	D23	2	0.06	59	1.90	301	9.71	7	0.23
	D24	0	0.00	73	2.70	158	5.85	0	0.00
	Total	3	0.05	283	4.35	1048	16.12	14	0.22
2018 F	D20	115	4.42	516	19.85	2352	90.46	16	0.62
	D21	105	3.89	458	16.96	1257	46.56	4	0.15
	D23	60	2.22	537	19.89	1550	57.41	8	0.30
	D24	15	0.58	198	7.62	806	31.00	13	0.50
	D25	235	9.04	963	37.04	1855	71.35	192	7.38
	Total	530	4.02	2672	20.24	7820	59.24	233	1.77

Notes:

Yellow highlighted squares are those with relatively high values worthy of note. For species with lower frequency of detection (LABO and EPFU) this was considered to be 9 passes/night and for species with high frequency of detection (LACI and LANO) this was considered to be > 30 passes/night.

Four letter codes are derived from scientific names; LABO = Eastern Red Bat, LACI = Hoary Bat, LANO = Silver-haired Bat, EPFU = Big Brown Bat.

Table 3-9: Non-SAR Bat Passes by Detector

Detector ID	Year	LABO		LACI		LANO		EPFU	
		Total Passes	Passes/Night	Total Passes	Passes/Night	Total Passes	Passes/Night	Total Passes	Passes/Night
D20	2015	34	1.17	152	5.24	468	16.14	9	0.31
	2016	2	0.13	263	17.53	241	16.07	1	0.07
	2017	8	0.26	513	16.55	801	25.84	0	0.00
	2018 F	115	4.42	516	19.85	2352	90.46	16	0.62
D21	2015	334	12.85	73	2.81	1487	57.19	18	0.69
	2016	6	0.50	27	2.25	425	35.42	7	0.58
	2017	136	6.80	200	10.00	758	37.90	3	0.15
	2018 S	1	0.14	151	21.57	589	84.14	7	1.00
	2018 F	105	3.89	458	16.96	1257	46.56	4	0.15
D23	2015	3	0.12	77	3.08	179	7.16	2	0.08
	2016	4	0.27	11	0.73	49	3.27	0	0.00
	2017	15	0.50	153	5.10	363	12.10	2	0.07
	2018 S	2	0.06	59	1.90	301	9.71	7	0.23
	2018 F	60	2.22	537	19.89	1550	57.41	8	0.30
D24	2015	15	0.48	329	10.61	166	5.35	1	0.03
	2016	29	2.23	703	54.08	97	7.46	4	0.31
	2017	2	0.07	197	6.79	585	20.17	0	0.00
	2018 S	0	0.00	73	2.70	158	5.85	0	0.00
	2018 F	15	0.58	198	7.62	806	31.00	13	0.50
D25	2015	0	0.00	133	4.43	269	8.97	7	0.23
	2016	5	0.36	160	11.43	96	6.86	1	0.07
	2017	2	0.06	94	3.03	233	7.52	0	0.00
	2018 F	235	9.04	963	37.04	1855	71.35	192	7.38

Notes:

Yellow highlighted squares are those with relatively high values worthy of note. For species with lower frequency of detection (LABO and EPFU) this was considered to be 9 passes/night and for species with high frequency of detection (LACI and LANO) this was considered to be > 30 passes/night.

Four letter codes are derived from scientific names; LABO = Eastern Red Bat, LACI = Hoary Bat, LANO = Silver-haired Bat, EPFU = Big Brown Bat.

4.0 Discussion

4.1 Species at Risk

Little Brown Myotis

The Little Brown Myotis is designated as Endangered under both the ESA and SARA. Ontario's ESA prohibits harming, destroying or disturbing habitat for this species under Sections 9 and 10 of the Act. The Little Brown Myotis is at risk of population decline due to their low reproduction rates, communal hibernating behaviour and recent declines due to White Nose Syndrome, a fungal infection that has been devastating bat populations across eastern North America. More information about White Nose Syndrome is provided in Section 4.5.

Little Brown Myotis roost in small spaces or crevices found in loose bark, hollow trees, rock faces and human structures such as walls and bat boxes. Colony numbers may range from a few to a few hundred individuals (Ministry of Natural Resources [MNR] 2011, Environment and Climate Change Canada [ECCC] 2018). This species forages over open areas such as water, forest trails and meadows. During the winter months the Little Brown Myotis will hibernate in caves and abandoned mines shafts, underground foundations and karst (MNR 2011, ECCC 2018). Hibernacula sites are characterized by remote and restricted openings with sufficient space for entry and with interior air temperatures slightly above freezing, relative humidity levels above 90% and sufficient space for roosting (Raesly and Gates 1987, MNR 2000, ECCC 2018).

Little Brown Myotis was recorded at all five survey locations within the RRM study area at high levels, particularly in 2015 and 2017 (Table 3-6). In 2015 35% of all passes were by Little Brown Myotis with an additional 17% by Myotis species (4,921 and 2,413 passes, respectively). In 2017, 30% of all passes were by Little Brown Myotis with an additional 4% by Myotis species (2,709 and 290 passes, respectively).

Little Brown Myotis and Myotis species passes appear to have a consistently high detection rate at Detector 21 (Table 3-7). In 2015, detections of these species at D21 made up 70% of their overall detections and in 2017 this value increased to 93%. Despite the 2016 survey period having a smaller sample size for these species, 68% of their overall detections were at D21.

Detector 21 is situated beside the Pinewood River with agriculture to the north and forest to the south of the river. During 2013 vegetation and habitat assessments for bat critical habitat no maternity roost sites were identified and no habitat meeting the Ministry of Natural Resources and Forestry (MNRF) criteria for significant bat habitat was detected around the RRM site (AMEC 2013). However, with the high levels of activity and detection rates at Detector 21 it is possible a maternity roost is located in the adjacent forest habitat and further bat habitat surveys should be considered.

There is not enough repetition in survey periods yet to indicate clear trends. However, it appears that Little Brown Myotis and Myotis species show higher activity levels in earlier sampling periods (beginning in early June). In 2015 and 2017 when two rounds of surveys were undertaken, the second round in both years had lower numbers of Little Brown Myotis and Myotis detections. While only one survey was undertaken in 2016, it was completed later in June than surveys completed in 2015 and 2017 (Table 2-1). While it could be at least partly a yearly effect, the levels of Little Brown Myotis and Myotis activity were lower in this survey than they had been for those performed earlier in 2015 and 2017.

Northern Myotis

The Northern Myotis is designated as Endangered under both the ESA and SARA. Ontario's ESA prohibits harming, destroying or disturbing habitat for this species under Sections 9 and 10 of the Act. The Northern Myotis is at risk of population decline due to their low reproduction rates, communal hibernating behaviour and recent declines due to White Nose Syndrome, discussed below in Section 4.5.

The habitat requirements of the Northern Myotis are similar to those of the Little Brown Myotis. The Northern Myotis is also a cavity roosting bat species that resides year-round in Ontario. Roost sites include small spaces or crevices found in loose bark, hollow trees, rock faces and human structures such as walls and bat boxes. Northern Myotis roost singly or in small groups (ECCC 2018). This species forages along and within forests including forested stream corridors. During the winter months the Northern Myotis will hibernate in caves and abandoned mines shafts, underground foundations and karst (MNR 2011, ECCC 2018). Hibernacula sites are characterized by remote and restricted openings with sufficient space for entry and with interior air temperatures slightly above freezing, relative humidity levels above 90% and sufficient space for roosting (Raesly and Gates 1987, MNR 2000, ECCC 2018).

Northern Myotis was recorded in 2015 and 2016 with a low detection rate and no Northern Myotis were specifically identified in 2017 or 2018 (Table 3-6). Since the recordings of Northern Myotis are difficult to distinguish from Little Brown Myotis, identification of this species may have been underrepresented. The presence of calls classified to genus (Myotis species) suggests it is possible that Northern Myotis may be present at higher levels than currently reported within the study area.

Northern Myotis have been detected at four of the five survey stations, indicating the population may be widespread though at very low numbers. During spring maternal brood rearing period surveys Northern Myotis made up 0.16% and 0.06% of all recorded passes in 2015 and 2016 respectively. Within the passes recorded for this species, 50% of the detections were at Detector 23 in 2015 and 100% (2 passes) were at D23 in 2016. It appears D23 may have slightly higher activity levels of this species than the other detector locations (Table 3-7). However, further data are required to confirm this apparent trend.

Detector 23 is situated in a wooded area with rock barren habitat, forest clearings, trails, and roads present in close proximity. These habitats provide ample preferred foraging habitat for this species. During the 2013 vegetation and habitat assessments for bat critical habitat, no maternity roost sites or hibernacula were identified and no habitat meeting the MNRF criteria for significant bat habitat was detected around the RRM site and nearby compensatory habitats (AMEC 2013). The low levels of activity and detection rates of this species indicate that while it may be using some of these nearby habitats to carry out its life processes, it is unlikely that critical habitat is present within the RRM site.

4.2 Non-Species at Risk

Some interesting patterns were observed in the data across the survey years. As stated in Section 4.1, Detector 21 appeared to have consistently high activity levels of Little Brown Myotis. The same pattern was present for Silver-haired Bat with the highest passes/night for this species, in each maternal brood rearing survey period, recorded at this detector (Table 3-8). The highest passes/night for Eastern Red Bat across the study, recorded in 2015, were recorded at this survey location. As suggested for Little Brown Myotis, further bat habitat surveys should be considered in the forest habitat adjacent to this survey location.

Due to the issues with the acoustic surveys during the maternal brood rearing period in 2018, a unique survey was undertaken in early fall (late August to early September). The activity levels for several non-SAR bat species were detected at the highest levels for the entire study during this survey period. Silver-haired Bat detections were high at every detector location (Table 3-9) during this survey period and Detector 25 had the highest passes/night of the entire study for Eastern Red Bat, Hoary Bat, Big Brown Bat and the second highest passes/night for Silver-haired Bat. Silver-haired, Hoary and Eastern Red Bats are migratory species. Migration occurs in the spring and late summer and fall, with this latter period also coinciding with the mating period. Except for the mating period, at all other times of the year, these species are generally solitary, therefore it is not uncommon to see increases in acoustic activity of these species during late summer and fall (Jameson and Willis 2014). Detector 25 is on the edge of a large wetland complex and may represent an ideal foraging site for migrating bats. Migratory species rely on large trees for roosting and potentially as landmarks for mating (Jameson and Willis 2014). However, the 2013 vegetation and habitat assessments for bat critical habitat found no habitat meeting the MNRF criteria for significant bat habitat around the RRM site and nearby compensatory habitats (AME 2013) which supports the hypothesis that the area at D25 may serve more as a foraging stop-over site.

4.3 Results Relative to 2012 and 2013 Data

The 2012 and 2013 detectors were deployed in different locations to the detectors in 2015 through 2018. Additionally, survey periods were much shorter (5 nights) which can cause species with low detection levels to be missed or misrepresented. As such, direct comparisons are not recommended with the current analysis. These early acoustic surveys coupled with habitat assessments are considered a pilot run to determine the best locations for long term bat acoustic monitoring.

Species presence/absence, as well as relative detection levels from the current analysis are consistent with the results obtained from the 2012 and 2013 surveys periods. The 2012 survey period recorded five of the six species, with Big Brown Bat not confirmed to the species level. The 2013 survey period likewise recorded five of the six species, with Eastern Red Bat not confirmed to the species level.

Little Brown Myotis and Silver-haired Bat have been consistently detected at the highest frequencies of occurrence and widest distributions followed by Hoary Bat. Eastern Red Bat and Big Brown Bat are widespread and have been consistently detected at relatively low frequencies of occurrence while Northern Myotis has the lowest level of detection and the smallest consistent distribution.

Average activity of the Little Brown Myotis and Myotis group can be compared across the study area; in 2012 these species averaged 11.9 passes/night, in 2013 10.4 passes/night, in 2015 this value escalated to 52.0 passes/night, in 2016 5.5 passes/night, in 2017 19.21 passes/night and only 0.08 passes/night in 2018. The high degree of variability in species occurrences may be explained by multiple factors and/or combinations thereof, such as: actual population fluctuations, the arrival of White Nose Syndrome in the area in 2017/2018, weather during survey periods, various errors during detector deployment, equipment sensitivity, and/or the timing of surveys.

4.4 Critical Habitat

The RRM Final EA Report (AMEC 2014) estimated that approximately 2,170 hectares (ha) of terrestrial habitat would be directly impacted by RRM. A total of 1,352 ha of woodland habitat will be cleared, of which 1,090 ha comprise second-growth aspen-birch hardwood forest, the dominant forest community type in the NLSA. This older deciduous or mixed wood habitat type can also potentially support bat maternal roost colonies and foraging habitat for local bat species including two SAR. In addition, approximately 261 ha of open wetland habitat and other habitats potentially used as foraging habitat will be directly impacted.

During the spring and early summer, most Ontario bat species rely on forest habitat, typically mature (dominant trees over 80 years old) deciduous or mixed stands, that support a healthy density of large-diameter cavity trees. Little Brown Myotis, Northern Myotis, Silver-haired Bat and Big Brown Bat utilize maternity roosts consisting of cavities or crevices provided by loose bark, hollow trees, woodpecker holes and rock faces, whereas Eastern Red Bat and Hoary Bat are foliage-roosting species (Fenton 1970, MNR 2011). Preferred roost trees of forest-dwelling bats are generally in early stages of decay, but may be alive, are relatively tall with large trunks, are situated in areas of low density canopy and are in proximity to other suitable roost trees (Kunz and Lumsden 2003). Females form maternity colonies of single individuals to hundreds of individuals in cavities that provide a warm, humid microclimate that optimizes gestation and growth of offspring (Kunz and Anthony, 1982).

In August and September, bats congregate at the entrance of caves or mine shafts which are used as hibernacula during the winter (Norquay et al. 2013). Hibernacula sites are characterized by remote and restricted openings with sufficient space for entry and with interior air temperatures slightly above freezing, consistent air flow, relative humidity levels above 90% and sufficient space for roosting (Raesly and Gates 1987, MNR 2000, ECCC 2018).

Thorough vegetation and habitat surveys undertaken in 2013 did not identify any maternity roost or hibernacula sites within the NLSA and nearby compensatory properties.

The density of potential maternity roosting trees in forest stands impacted by the RRM footprint ranged from 0 to 6.67 trees per ha (trees/ha) with an average of 3.6 trees/ha. The density of candidate roost trees in forest stands within prospective compensatory properties near the RRM ranged from 0 trees/ha to 8.9 trees/ha with an average of 5.2 trees/ha. Both values are below the 10 trees/ha minimum threshold specified by the MNR (MNR 2011) for identifying candidate significant bat maternity roosting habitat. Therefore, areas impacted by project activities and those in nearby compensatory properties do not contain significant maternity roosting habitat for bats, particularly of the genus Myotis.

Six areas of exposed bedrock were thoroughly examined, and none contained features such as cracks, crevices or other openings that might provide suitable habitat for hibernation. Rock piles at these sites were also unsuitable. No abandoned mines occurred near or within the RRM.

While no areas met the criteria of candidate bat maternity roost habitat or hibernacula, the detection of bats within the study area indicates several species are utilizing the habitats within the study area to carry out their life processes. The relatively high levels of activity observed in certain locations and at certain times of year as described in Sections 4.1 and 4.2 above may indicate these critical habitats are present and undetected. Future acoustic programs and bat habitat assessment could be considered as described above.

4.5 White Nose Syndrome

Little Brown Myotis and Northern Myotis species have recently experienced dramatic population declines in Ontario and across northeastern North America due to White Nose Syndrome. White Nose Syndrome is a fungus which grows optimally in the same conditions under which bats hibernate and has killed up to 99% of bats in infected hibernacula (Frick et al. 2010). White Nose Syndrome grows on the muzzle, ears and wings of hibernating bats and spreads quickly between hibernating bats which huddle together to thermoregulate during the winter. In doing so, infected individuals may pass the fungus to neighbouring bats. White Nose Syndrome causes bats to prematurely arouse from torpor (hibernation) in the winter and subsequently, leads to death from starvation due to excessive activity without a readily available food source (MNR 2011).

5.0 Conclusion

Acoustic monitoring has consistently recorded all six species of bat anticipated to be present, based on current known ranges. These species are: Little Brown Myotis, Northern Myotis, Eastern Red Bat, Silver-Haired Bat, Hoary Bat and Big Brown Bat. The Little Brown Myotis and Northern Myotis are both designated as Endangered Species protected under Ontario's ESA, which prohibits harming, destroying or disturbing habitat for these species under Sections 9 and 10 of the Act.

Detection levels for all species are variable though some patterns are apparent. Little Brown Myotis and Silver-haired Bats have been consistently detected at the highest frequencies of occurrence and widest distributions, followed by Hoary Bat. Eastern Red Bat and Big Brown Bat are widespread and have been consistently detected at relatively low frequencies of occurrence, while Northern Myotis has the lowest level of detection and the smallest consistent distribution.

Northern Myotis was recorded in 2015 and 2016, although with a low detection rate, and this species was not confidently identifiable to species in 2017 or 2018. Since the recordings of Northern Myotis are difficult to distinguish from Little Brown Myotis, identification of this species may have been underrepresented. The presence of calls classified to genus (Myotis species) suggests it is possible that Northern Myotis may be present at higher levels than currently reported within the study area. During spring maternal brood rearing period surveys Northern Myotis made up 0.16% and 0.06% of all recorded passes in 2015 and 2016, respectively. Within the passes recorded for this species, 50% of the detections were at D23 in 2015 and 100% (2 passes) were at D23 in 2016. While it is not possible to confirm apparent trends with the level of data currently collected, it appears D23 may have slightly higher activity levels of this species than the other detector locations.

Little Brown Myotis was frequently recorded at all five survey locations within the RRM study area at relatively high levels, particularly in 2015 and 2017. In 2015, 52% of the total passes recorded were by Little Brown Myotis or Myotis species and in 2017 these species represented 34% of all passes.

Little Brown Myotis and Myotis species passes appear to have a consistently high detection rate at Detector D21. Between 2015 and 2017 detections of these species at D21 made up 68% to 93% of their overall detections. The same pattern was present for Silver-haired Bat, where D21 consistently recorded the highest passes/night for this species throughout all of the survey periods.

Due to the issues with the acoustic surveys during the maternal brood rearing period in 2018, a unique survey was undertaken in early fall (late August to early September). Interestingly, activity levels for several non-SAR bat species were recorded at their highest levels for the entire study area during this survey period. Silver-haired Bat detections were relatively high at every detector location during this survey period and Detector 25 had the highest passes/night of the entire study for Eastern Red Bat, Hoary Bat, Big Brown Bat. Detector 25 is on the edge of a large wetland complex and may represent an ideal foraging stop-over site for migrating bats.

Most of Ontario's bats, including the two SAR, Little Brown Myotis and Northern Myotis, use mature forests with a high density of large diameter cavity trees as maternity colonies (MNR 2011). Use of maternity colony stands generally occurs between June and July, thus tree clearing of potential bat habitat should be undertaken outside of this period to avoid harming or disrupting roosting bats. If tree clearing must be undertaken between the months of May and August, consultation with the MNRF should be undertaken prior to clearing activities to confirm other seasonal restrictions (such as the breeding bird season) and surveys should be undertaken to confirm the presence of significant roosting habitat. Should roosting colonies be located within these areas, consultation with the MNRF and ECCC will be required to establish whether clearing activities may continue, whether SAR permitting is required and whether habitat compensation will be required.

During thorough vegetation surveys and bat habitat assessments in 2013 no candidate maternity roosting habitat or hibernacula were identified. However, acoustic surveys demonstrate that these species are consistently active, with some species having relatively high activity levels within the RRM study area. This suggests that at least some roosts or other critical habitat may be present nearby.

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7.0 Closing

This report has been developed based on information gathered from field and acoustic surveys.

We trust that this report is sufficient for your needs. Should additional information be required, please contact the undersigned at (905) 568-2929.

Regards,
Wood Environment & Infrastructure
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Appendix A
Bat Acoustic Analysis Sample

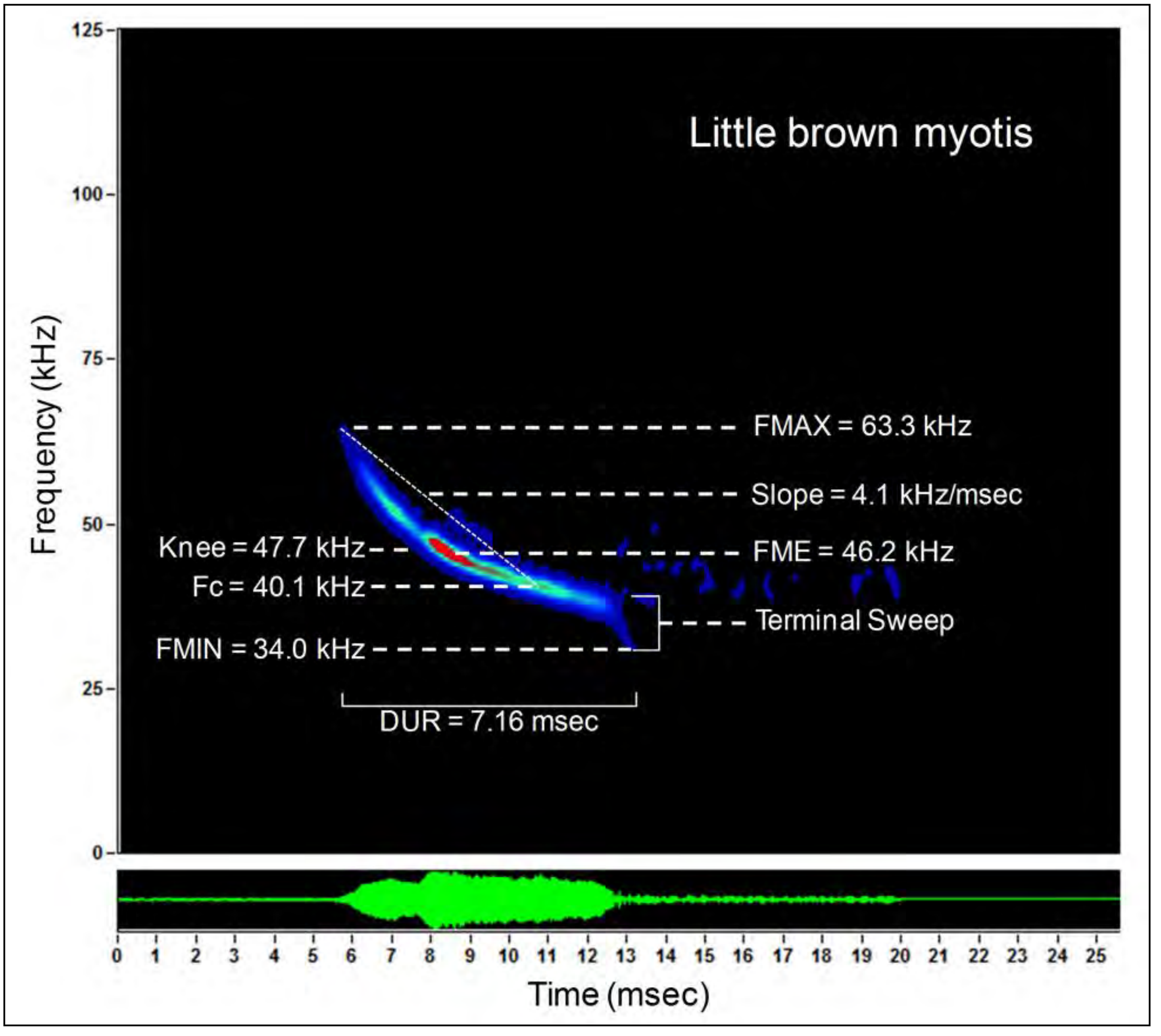

Figure 1: Spectrogram (above) and oscillogram (below) of a search-phase echolocation pulse from a Little Brown Myotis (Myotis lucifugus). Parameters displayed are those used to identify which species emitted the call: FMAX = Maximum frequency, FMIN = Minimum frequency, FME = Frequency with maximum energy, Knee = Frequency of most abrupt change in slope, Fc = Main frequency at the end of the call, DUR = Duration.

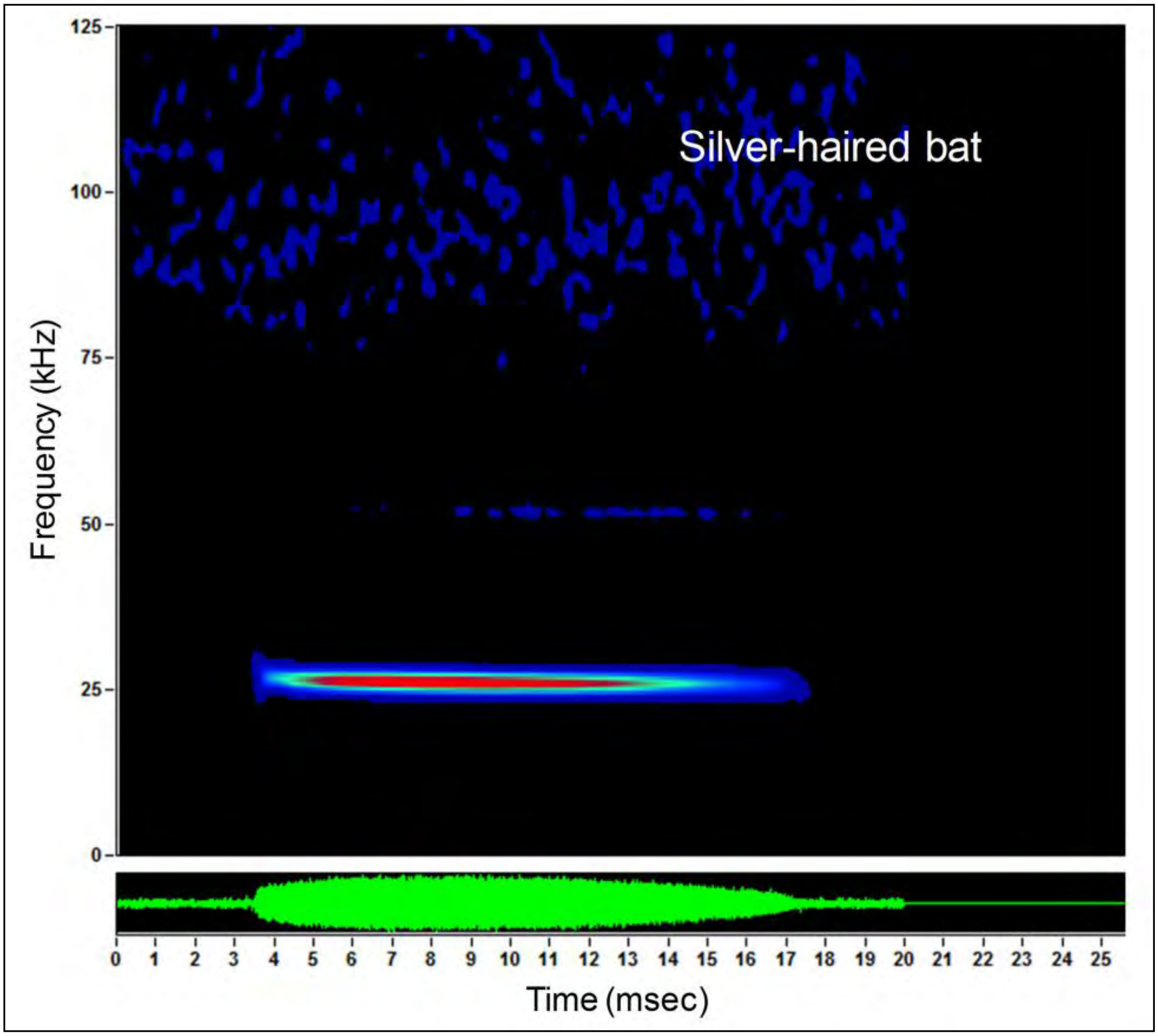

Figure 2: Spectrogram (above) and oscillogram (below) of a search-phase (constant frequency variant) echolocation pulse from a Silver-haired Bat (Lasionycteris noctivagans).

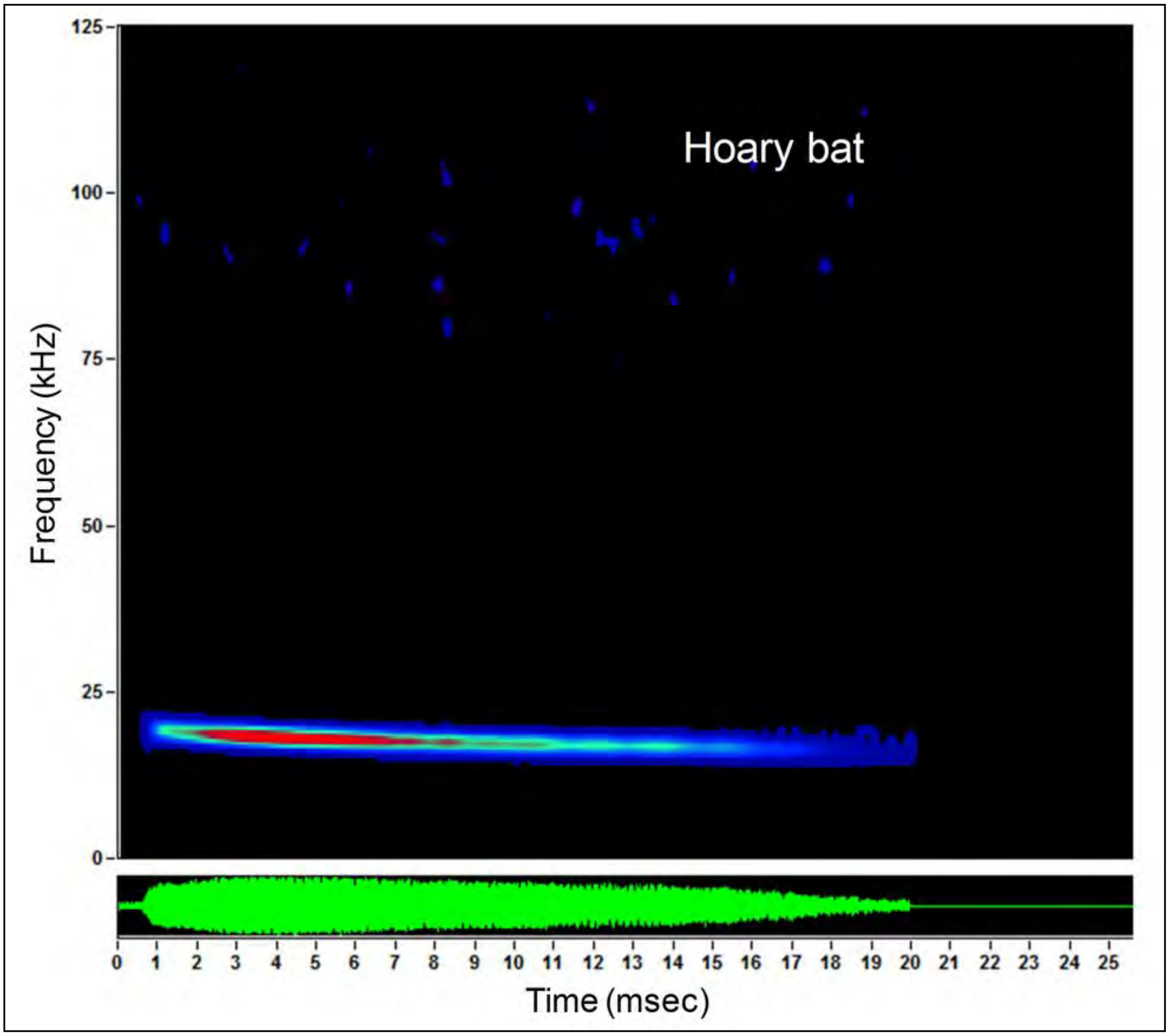

Figure 3: Spectrogram (above) and oscillogram (below) of a search-phase echolocation pulse from a Hoary Bat (Lasiurus cinereus).

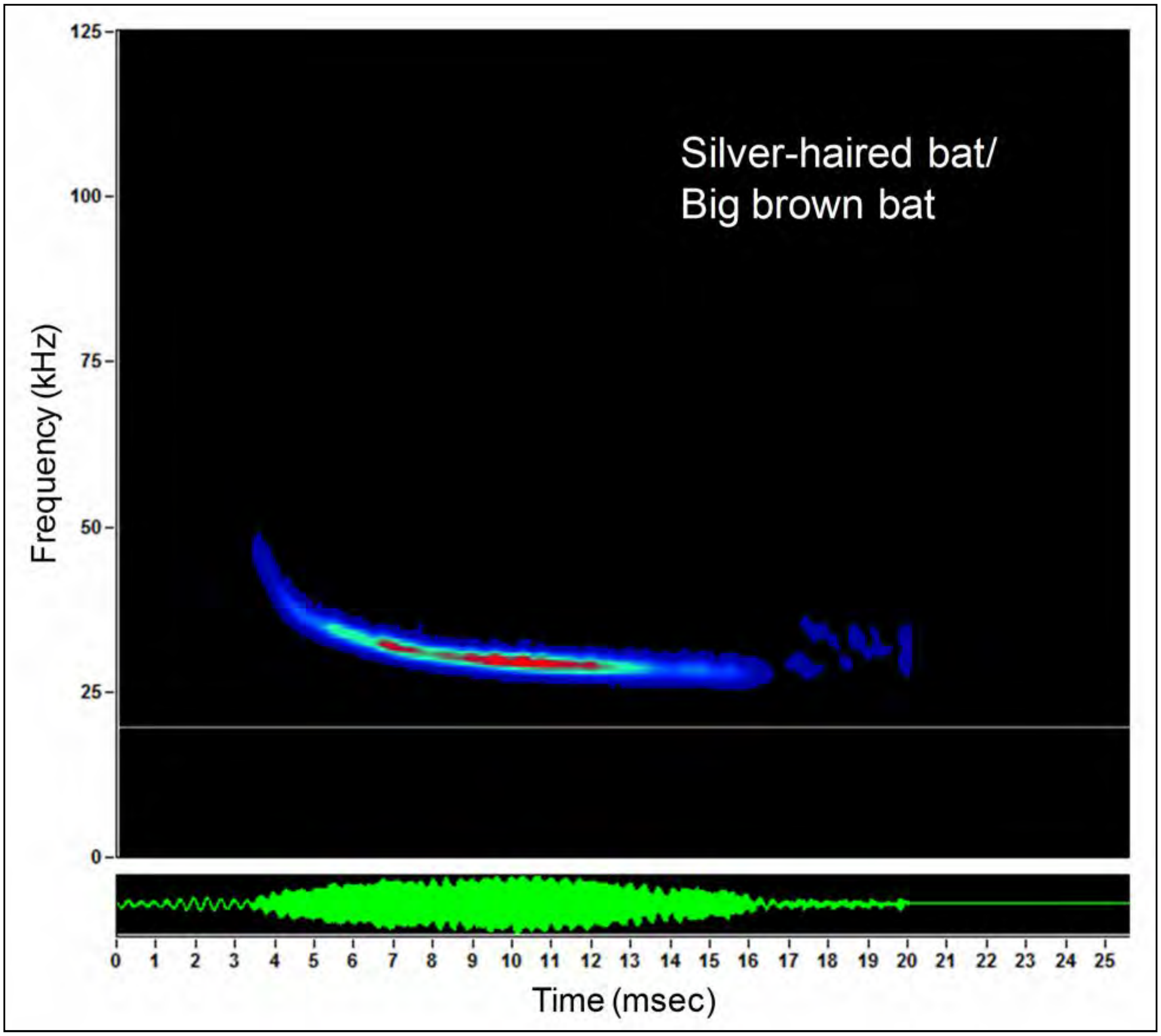

Figure 4: Spectrogram (above) and oscillogram (below) of a search-phase echolocation pulse from either a Silver-haired Bat (Lasionycteris noctivagans) or a Big Brown Bat (Eptesicus fuscus). These two species produce certain variants of echolocation that are similar to each other. This often makes it nearly impossible to accurately distinguish between these species using echolocation.

Appendix B

Microphone Sensitivity Report

Bat Detector Pair Testing in 2016

In 2016 microphone sensitivity was found to be extremely variable during routine calibration testing; likely due to the age of the microphones and different weathering conditions attained through use in previous seasons. In an attempt to determine qualitative differences in detectability bat detectors were 'paired' at the RRM in 2016 to allow a comparison of recorded data. This involved deploying two bat detectors at each location, one with a known 'good condition' microphone with a high sensitivity (< -17 dB) with a known 'poor condition' microphone with lower sensitivity (>19 dB).

As shown in the table below the qualitative differences in detectability are quite variable. A microphone pairing that had a 50.30% decrease in sensitivity resulted in an increase of 10.19% passes recorded while another pairing with a 38.78% decrease in sensitivity resulted in a 62.46% reduction in passes recorded.

There are other factors which could be influencing this variability such as recording environment, background noise, microphone positioning, the quality and distance from the source sound and whether there is a clear path between the source and the microphone.

High microphone sensitivity is clearly integral to the quality of data produced however there appears to be high variability in this relationship. This variability makes setting an acceptable sensitivity threshold difficult and implications may need to be addressed on a case by case basis.

Table 1: Appendix Microphone Sensitivity Data

Detector ID	Microphone Condition1	Microphone Sensitivity (dB)	MYLU	MYSE	Myotis	MYLU / LABO	LABO	HiF Species	LACI	LANO	EPFU	LANO / EPFU	LoF Species	UNKN	Total Passes	Passes / Night
D21	Good	-15.9	330	--	243	4	6	210	27	425	7	10	132	--	**1394**	**116.17**
D21	Poor	-23.5	--	--	200	--	1	182	15	182	1	12	108	1	**702**	**58.50**
Difference		***-47.80%***	*(-330)*	--	*(-43)*	*(-4)*	*(-5)*	*(-28)*	*(-12)*	*(-243)*	*(-6)*	*(-2)*	*(-24)*	*+1*	***(-692)***	***-49.64%***
D23	Good	-16.9	10	2	19	--	4	6	11	49	--	3	4	--	**108**	**7.20**
D23	Poor	-25.4	15	4	13	--	4	13	13	52	--	--	5	--	**119**	**7.93**
Difference		***-50.30%***	*+5*	*+4*	*(-6)*	--	*0*	*+7*	*+2*	*+3*	--	*(-3)*	*+1*	--	***+11***	***+10.19%***
D24	Good	-14.7	23	--	69	--	29	40	703	97	4	5	69	--	**1039**	**79.92**
D24	Poor	-20.4	63	--	75	2	23	34	124	53	--	1	15	--	**390**	**30.00**
Difference		***-38.78%***	*+40*	--	*+6*	*+2*	*(-6)*	*(-6)*	*(-579)*	*(-44)*	*(-4)*	*(-4)*	*(-54)*	--	***(-649)***	***-62.46%***
D25	Good	-17.0	10	--	17	3	5	5	160	96	1	1	6	--	**304**	**21.71**
D25	Poor	-19.9	5	--	4	--	1	6	25	22	--	--	4	--	**67**	**4.79**
Difference		***-17.06%***	*(-5)*	--	*(-13)*	*(-3)*	*(-4)*	*+1*	*(-135)*	*(-74)*	*(-1)*	*(-1)*	*(-2)*	--	***(-237)***	***-22.04%***

Notes:

Positive differences for unidentified species (HiF, LoF, Unknown or combinations e.g., MYLU / LABO) for microphone with poor sensitivity could indicate these calls were able to be identified to the species level with good quality microphone.

Four letter codes are derived from scientific names; combinations refer to passes with characteristics from both species.

HiF = high-frequency bat species
LoF = low-frequency bat species
MYLU = Little Brown Myotis
LABO = Eastern Red Bat
LACI = Hoary Bat
LANO = Silver-haired Bat
EPFU = Big Brown Bat
MYLU/LABO = Little Brown Myotis or Eastern Red Bat
LANO/EPFU = Silver-haired Bat or Big Brown Bat.