Appendix 64

Whale Tail Migratory Bird Protection Plan Version 3

MEADOWBANK GOLD PROJECT

2020 Migratory Bird Protection Plan

In Accordance with NIRB Project Certificate No.008

Prepared by:
Agnico Eagle Mines Limited – Meadowbank Division

March, 2020

IMPLEMENTATION SCHEDULE

The implementation schedule for this plan is effective immediately subject to any modifications proposed as a result of the review and approval process.

DISTRIBUTION LIST

Agnico Eagle - Environmental Superintendent

Agnico Eagle – Environmental Coordinator

DOCUMENT CONTROL

Document Control

Version	Date (YMD)	Section	Page	Revision
1	June, 2018	All	All	Initial document (TEMP Appendix F)
2	May 21, 2019	All	All	Golder Technical Memorandum - Document update following initial study year (2018) and discussion with ECCC.
3	March 31, 2020	2.2 2.3	-	Adapted format to Agnico Eagle monitoring plan layout. Update to sections on deterrent effectiveness study (2.2) and 2020 mitigation measures (2.3) based on 2019 study results.

Version 3

Prepared By: Meadowbank Environment Department

Approved By: ______________________________

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SECTION 1 • INTRODUCTION

Agnico Eagle has planned two water diversions as part of water management activities for the proposed Whale Tail Project (the Project) and the proposed Whale Tail Expansion Project (Expansion Project). The purpose of the Migratory Bird Protection Plan (Plan) is to present the anticipated flooding area and schedule during the Whale Tail Lake (South Basin) flooding and present appropriate mitigation measures to reduce impacts to nesting migratory birds.

The Whale Tail Lake (South Basin) diversion consists of construction of the Whale Tail Dike, from June 2018 to February 2019, to divert Whale Tail Lake (South Basin) and tributary lakes through Lake A45, just south of Lake A16 (Mammoth Lake). Flooded tributary lakes (light blue shading in Figure 1) include Lake A18, Lake A19, Lake A20, Lake A21, Lake A22, Lake A55, Lake A62, Lake A63, Lake A65, Pond A-P1, and Pond A-P43 (Figure 1). Active flooding from elevation 152.5 to 156.00 masl of the area will occur from 2018 until 2020 causing approximately 157 ha of flooding. The flooded area will remain at elevation 156.00 masl from June 2020 until 2026, during operations.

The flooding has the potential for incidental disturbance and destruction of migratory birds and their nests. As per Nunavut Impact Review Board (NIRB) Project Certificate No.008 Condition 34, this Plan describes how these impacts will be mitigated; the mitigation will be focused between 2018 to July 2020, or until water levels reach their maximum. This Plan revision has been updated to include results from 2018 and 2019 monitoring of migratory birds and the proposed monitoring design for 2020. The Plan revision also includes an additional section on monitoring of flooded areas (added in Version 2).

The *Migratory Birds Convention Act* (1994) (*MBCA*) prohibits the harm of migratory birds and the disturbance or destruction of nests and eggs. The original aim of this legislation in the early 1900s was to conserve migratory bird populations from overharvest (CWS 2007). Inadvertent disturbance or destruction of migratory birds has been termed “Incidental Take” and Environment and Climate Change Canada (ECCC) currently lacks legal mechanisms to regulate Incidental Take (CWS 2007).

This Plan describes the likely effects pathways that may harm migratory birds (based on the Whale Tail FEIS, Agnico Eagle 2016), the mitigation options to reduce these impacts, and Agnico Eagle’s preferred option for proceeding.

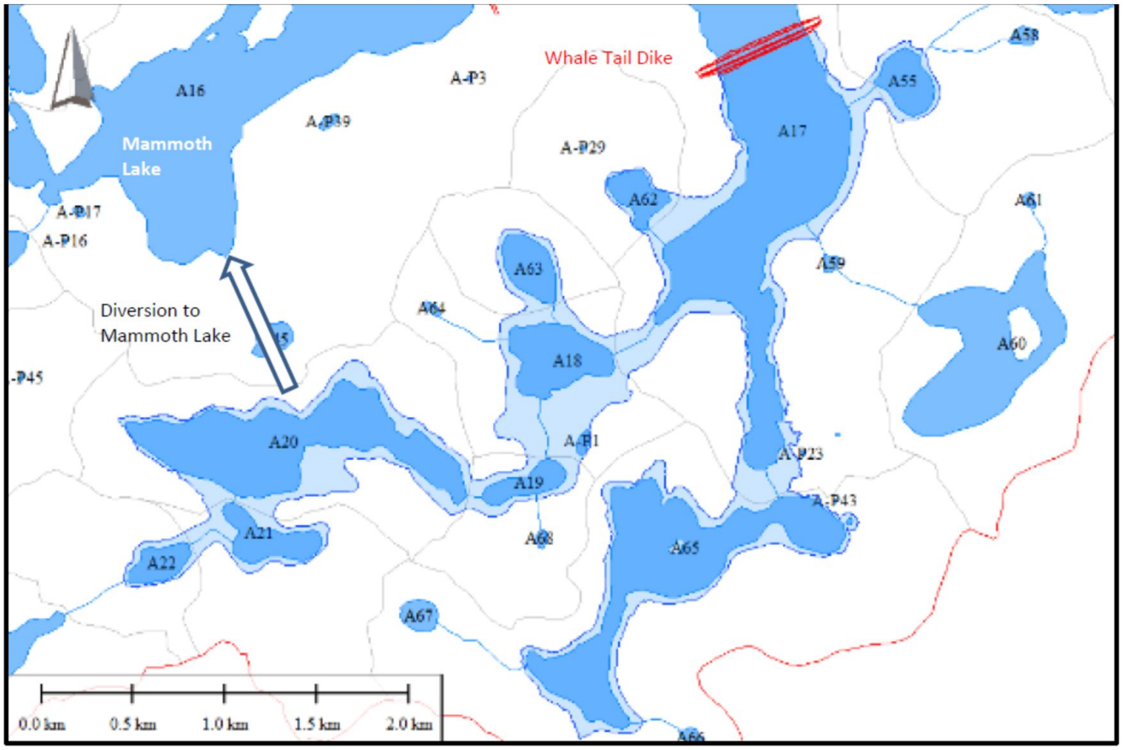

Figure 1: Whale Tail Lake (South Basin) Diversion Flooding occurring between June 2018 to July 2020, and during operation (July 2020 to 2026). Light blue shading shows flooded areas.

SECTION 2 • EFFECTS PATHWAYS AND MITIGATION

The flooding resulting from the Whale Tail Project and proposed Whale Tail Expansion Project water diversions will lead to incidental disturbance and destruction of migratory birds and their nests. There is less flooding predicted for the Expansion Project than for the Approved Project.

2.1 EFFECT PATHWAY

Flooding at the Project and proposed Expansion Project site is anticipated due to the construction of new dikes in Whale Tail Lake (South Basin) and downstream of Lake A46 and Lake A50. Some of the flooding will occur during the nesting season and may lead to the loss of nests near the shoreline of the lakes.

Shoreline surveys during the Project baseline field work examined 62.8 km of shoreline along lakes and streams (Agnico Eagle 2016, Volume 5, Appendix 5-C). In total, 24 species of birds and eight nests were observed including three semipalmated sandpiper nests, two semipalmated plover nests, one dunlin nest, one herring gull nest, and one cackling goose nest. Assuming that observers recorded nests that were observed within a 20 m swath surveyed by two people, the nest density for the Project is 0.06 nests per ha. Given the area of flooding expected to occur at the Project and proposed Expansion Project, and assuming densities are the same as that observed during baseline studies, approximately seven nests in 2019 and three nests in 2020 of the shorebirds, gulls and waterfowl groups may be displaced by flooding if no mitigation is undertaken (Table 1).

Upland birds have been surveyed at Meadowbank from 2003 to 2015 using PRISM protocols. PRISM surveys found 3.8 pairs of breeding birds per plot during 2015. As PRISM plots are 16 ha in size this indicates a density of 0.24 pairs per ha. The average nests observed per PRISM plot was 0.6 nests, or 0.04 nests per ha. It is assumed that not all the nests or breeding pairs were detected during the 2015 baseline studies so a nest density of 0.5 nests per ha was used to calculate the number of nests displaced due to flooding. It is predicted that approximately 61 upland bird nests will be displaced in 2019 and approximately 27 nests in 2020 if no mitigation is undertaken at the Project and proposed Expansion Project (Table 1).

Table 1: Predicted Number of Bird Nests Displaced from Flooding

Nesting Period Year[a]	Whale Tail Lake (South Basin) Diversion			Northeast Diversion		
	Change in Flooded Terrestrial Area (ha)	Predicted Number of Nests Displaced		Change in Flooded Terrestrial Area (ha)	Predicted Number of Nests Displaced	
		Shoreline Survey	PRISM Survey		Shoreline Survey	PRISM Survey
2018	0.21	0.01	0.10	0	0	0
2019	115.96	6.96	57.98	6.58	0.42	3.29
2020	41.38	2.48	20.69	11.86	0.75	5.93
2021	0	0	0	0	0	0
2022	-64.94[b]	0	0	-18.45[b]	0	0

[a] The nesting period used included the months of May, June, July, and August.

[b] Between May and August 2020 the total flooded habitat area and the flooded terrestrial area is expected to decrease in size.

PRISM = Program for Regional and International Shorebird Monitoring; ha = hectare.

In 2018, 18 experimental low-lying wet sedge habitat plots (6 ha each) were monitored regularly to evaluate changes in breeding behavior associated with flash tap and effigy mitigation devices relative to control plots (Agnico Eagle 2018). Fifty-nine nests were detected at these 18 plots for a density of 0.54 nests per ha. The density of breeding birds was estimated to be 1.2 per ha.

In 2018, surveys for breeding migratory birds and nests were completed in areas predicted to be flooded (Agnico Eagle 2018). A total of 8 species of birds and 50 nests (0.28 nests per ha) were recorded, which is less than the 0.5 nests per ha assumed in the FEIS. Based on the nests found, monitoring completed in 2018 indicates impacts may be less than predicted in the FEIS (Agnico Eagle 2018).

The density of breeding birds measured at the Whale Tail Project have varied through time and ranged from 1.4 per ha in 2016 to 3.4 per ha in 2018, although areas and observers have changed during this time (Dougan and Associates 2017; Agnico Eagle 2018). For example, in 2015 and 2016 PRISM methods at 16 ha plots and shoreline surveys were completed by subcontractors, whereas 2018 surveys included different 6 ha plots and more extensive searches in the areas predicted to be flooded completed by Trent University. Predictions of absolute birds impacted by Project-related flooding used area extrapolation of the highest mean observed density during baseline (1.41 observed in 2015). While monitoring in 2018 estimated a higher density of breeding birds, application through area extrapolation will only increase the absolute numbers of birds impacted while the relative magnitude will remain the same as predicted in the FEIS because the area does not change.

2.2 DETERRENT EFFECTIVENESS STUDY

While it is recognized that mitigation should be implemented to reduce impacts of flooding on migratory birds as much as possible, little is known about the effectiveness of commonly recommended bird deterrents for nesting species in this region. As a result, and in support of Condition 34 of the NIRB Project Certificate, Agnico Eagle is currently collaborating with Trent University and Environment and Climate Change Canada on studies to monitor impacts to nesting migratory birds and deterrent mitigation effectiveness.

In 2018, the field team assessed nesting behaviour at 21 plots along the Whale Tail Haul Road between the Amaruq Camp and kilometer 163 (originally km 48) over a 6-week period, beginning June 4, 2018. Plots were chosen with the use of Ecological Land Classification maps and ground truthing. Plots are 200 x 300 meters (6 ha), covering a mix of low-lying wet sedge habitat types representative of the habitats that will be flooded around Whale Tail Lake. The purpose of the plots was to allow spatially-independent samples in which to test deterrents. However, delays in the arrival of deterrents onsite meant they were not erected until late June, and 2018 was treated as a "before" year in the eventual before-after-control-impact study design.

At the beginning of the 2019 study season (June 5 – 14), audio and visual deterrents were placed in the same experimental plots established in 2018 along the Whale Tail Haul Road (n = 15 plots). Experimental plots (300 m x 200 m) were divided into two types of treatment and control plots. Treatment 1 consisted of audio deterrents playing a mix of predatory and distress calls paired with a 20 x 20 m grid of Mylar® flash tape and a Jackite© hawk kite effigy. Treatment 2 consisted of audio deterrents with the use of Jackite© (a hawk kite effigy) only. Control plots had no deterrents present.

Nest and territory densities were compared between 2018 and 2019 using a before-after control-impact design.

Results to date demonstrate that deterrents were not effective at deterring birds from nesting. In addition, deployment and maintenance of the deterrents was extremely time consuming. As a result, the study authors do not recommend the use of the tested deterrents for mitigating nest loss due to disturbance such as flooding. Further discussion is provided in Appendix A.

2.3 MITIGATION

Based on field studies completed in the summer of 2017 and discussions with ECCC, the following mitigation options were initially selected for use in flood zones (Migratory Bird Protection Plan, Version 1, June 2018):

- Deploying visual and audio bird deterrents.
- Regular sweeps to discourage nesting through human activity, and to move the visual and audio deterrents.

2.3.1 2018 Mitigation

In the 2018 nesting season, no flooding had yet occurred, so deterrents were not required.

2.3.2 2019 Mitigation

In 2019, flooding of the Whale Tail South flood zone began prior to the nesting season. The research crew from Trent University deployed audio and visual deterrents throughout selected plots within this area (Figure 3) between June 16 and 17. These were the earliest dates logistically feasible, based on weather conditions (primarily the need to wait for snowmelt). At this time, water levels were at 154.68 masl in Whale Tail South Basin, or approximately 2 m above baseline levels.

Deterrents consisted of 20 x 20 m flash tape grids, and audio deterrents. Flood-zone plots were surveyed every four days between June 16 and July 14, for a total of 148 hours of sweeps within the flood zone during the 2019 nesting season.

No deterrents were deployed within the Northeast flood zone, since water levels were already near their maximum predicted elevation (156.6 masl) at the beginning of the nesting season (first measured at 156.3 masl on June 14, 2019).

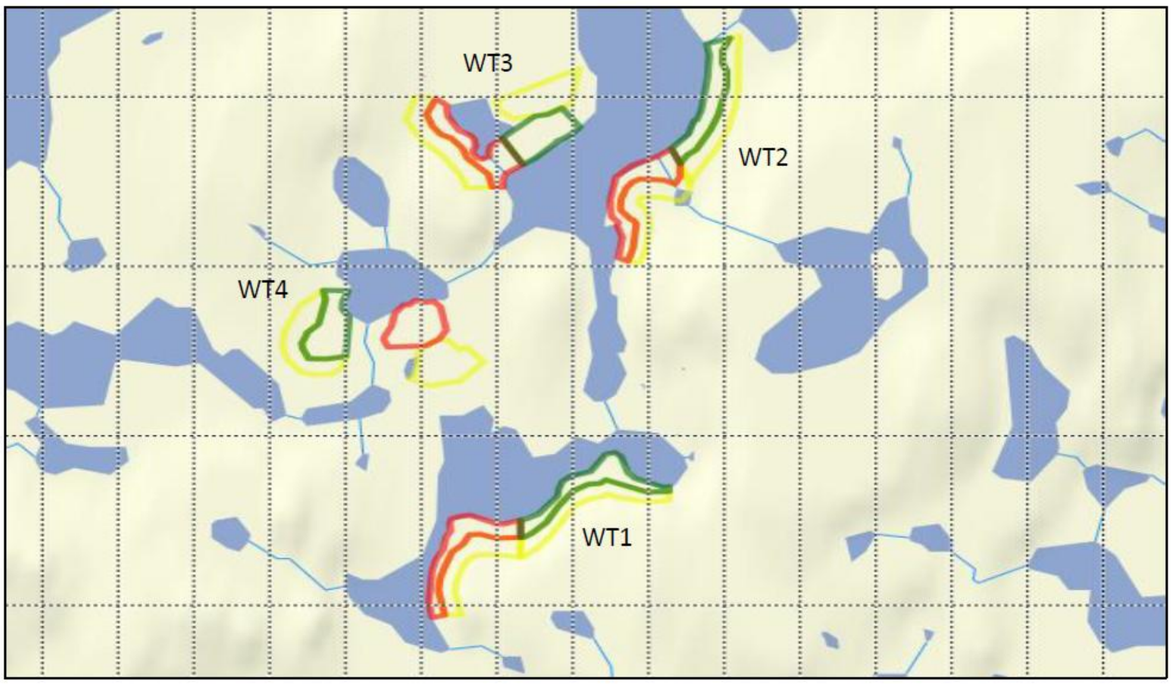

Figure 3: Map of the four main study sites (WT1, WT2, WT3, WT4) around Whale Tail Lake and its connecting lakes and tributaries. The Flood plots (red) and Treatment plots (green) are within the proposed flood zone, and the Control (yellow) plots are adjacent to the proposed flood zone.

2.3.3 2020 Mitigation

Based on results of studies by the University of Trent and ECCC in 2018 – 2019 (Section 2.2), and associated recommendations as described in Appendix A, no deterrents will be specifically implemented in 2020 for Whale Tail area flooding. This decision is supported by the relatively small increase in water levels predicted to occur during the 2020 breeding season compared to 2019. Researchers from the University of Trent will be conducting weekly nest surveys in two flood-zone plots however, resulting in some intermittent presence in those areas.

SECTION 3 • EVALUATION OF FLOODING PREDICTIONS

The FEIS predicted that the Whale Tail Lake (South Basin) diversion would flood 148.5 ha of terrestrial habitat (Table 1). The predictions were derived from a mean annual water balance modeling as described in Appendix 6-F. A monitoring program was developed to monitor and compare the actual water levels resulting from the diversion, to those estimated by the mean annual water balance.

Agnico Eagle has committed to weekly monitoring (i.e. water level measurement) in water bodies where flooding will occur. As stated previously, the following 12 water bodies were expected to be impacted by the Whale Tail Lake (South Basin) diversion: A17, A18, A19, A20, A21, A22, A55, A62, A63, A65, A-P1, A-P43 (Figure 1) beginning in 2019.

In 2019 and 2020, the water level in Whale Tail Lake (South Basin) was predicted to range from 155.1 masl to 156.0 masl. At these elevations, all the water bodies listed above are expected to be inundated. Therefore, weekly monitoring will be required throughout. However, the frequency of monitoring may be adapted depending on actual conditions. For example, if there is little change recorded at the weekly frequency, then the monitoring frequency may be reduced following discussion with ECCC.

Surveys will be performed in the lakes and ponds to determine the water levels. Staff gauges or data loggers (or both) will be installed in all 12 water bodies to allow visual confirmation of water levels. Care should be taken to ensure the gauges do not move (due to wind or wave action, or poor installation). The staff gauges will be referenced to fixed benchmarks (at wadable locations) references to the geodetic datum to maintain consistency in water level readings. Given the potential range of water levels during the Expansion Project life (approximately 152.5 masl to 156.0 masl), multiple, staggered staff gauges will be required in order to measure the full range of flows.

If regular access to any of the lakes and/or ponds proves difficult, Agnico may choose to supplement the staff gauges with remotely accessible data loggers in these water bodies. However, these loggers must be installed to prevent freezing or should be removed prior to winter (potentially missing water levels during the spring freshet).

The readings will be plotted with the predicted water levels (Appendix 6-F) and will include historical water levels for each lake or pond. This will allow Agnico Eagle to react quickly if water levels deviate from expected levels and provide input to the mitigation measures described in Section 2.3.

SECTION 4 • REPORTING

Results of Plan monitoring and mitigation effectiveness will be reported in the annual Terrestrial Ecosystem Monitoring Report including any adaptive management required. As per Project Certificate No.008 Condition 34, Agnico Eagle will report the results of the Migratory Birds Protection Plan to NIRB on an annual basis.

SECTION 5 • REFERENCES

Agnico Eagle (Agnico Eagle Mines Limited). 2016. Whale Tail Pit Final Environmental Impact Statement. Submitted to Nunavut Impact Review Board and Nunavut Water Board. June 2016.

Agnico Eagle. 2018. Meadowbank Gold Project: 2018 Migratory Bird Protection Plan Report. March 2019.

CWS (Canadian Wildlife Service). 2007. Environment Canada Background Document on the Management of Incidental Take of Migratory Birds: Towards and updated Regulatory Approach. Available at: https://www.ec.gc.ca/. Accessed May 2017.

De Beers. 2016. Gahcho Kué Mine 2015 Annual Wildlife Report. March 2016.

Dougan and Associates. 2017. Whale Tail Pit, V-Zone & Whale Tail Haul Road Project Area Comprehensive Terrestrial Baseline Characterization Report. Prepared for Agnico Eagle Mines Limited by Dougan and Associates, Guelph, ON. December 2017.

Environment Canada. 2013. Planning ahead to Reduce the Risk of detrimental effects to migratory Birds, and their nests and eggs. Available at: http://www.ec.gc.ca/paom-itmb/. Accessed May 2015.

Environment Canada. 2014. General Nesting Periods of Migratory Birds in Canada. Available at: https://www.ec.gc.ca/. Accessed May 2015.

Environment and Climate Change Canada (ECCC). Unpublished. Guidelines for deterrence and bird dispersal techniques used during pollution and non-pollution incidents in Canada. Appendix 1. Technical Overview of Recommended Hazing Devices.

APPENDIX A

2019 University of Trent/ECCC Study Summary Report

Waterbird Mitigation Project, Agnico Eagle Mines Ltd

2019 Field Season and Research Report

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Introduction

Mining and other forms of resource development frequently result in disturbance to wildlife that is difficult to avoid. Technological options to mitigate these impacts are therefore of great interest to resource developers and conservationists alike. Mining is an important economic driver in the north by providing jobs for people living in northern communities (Cameron and Levitan 2014; Belayneh et al. 2018). In Nunavut alone, 18% of the gross domestic product in 2014 was associated with resource extraction (AMAP 2017). Mineral, oil and gas exploration is expected to increase throughout the Arctic landscape (A.T. Kearney Inc. 2015), leading to land use changes and disturbance of critical habitat for wildlife (Wilson et al. 2013). Resource extraction can have detrimental impacts on habitat quality through the modification of landscapes, increased pollutants, human traffic and infrastructure (Reijnen et al. 1997; Johnson et al. 2005; Hassan 2016). Studies from Hof et al. (2017) have demonstrated that arctic-nesting birds are especially vulnerable to climate change; with the increase of resource extraction in arctic landscapes leading to additional loss in nesting habitat, there is an even greater probability of future species loss (Gajera et al. 2013; Bernath-Plaisted and Koper 2016). Finding a balance between conservation and economic growth is crucial in vulnerable landscapes such as the Arctic, particularly when faced with climatic change (Wauchope 2016).

The following report will outline the objectives fulfilled during the 2019 field season, the next steps for data analysis and plans for the 2020 field season.

Project Overview

Agnico Eagle Mines Ltd. proposed, and has now built, the Whale Tail Project, approximately 130km North of Baker Lake, NU. The project included the construction of two dykes within the northern portion of Whale Tail Lake that diverted water from the Whale Tail mining pit into the surrounding lakes and tributaries. This resulted in flooding that elevated the water levels by 4 m above current levels over two year between 2019 and 2020, causing approximately 157 ha of flooded tundra during the time of birds' nest initiation. The Migratory Birds Convention Act (1994) prohibits the harm of migratory birds and the disturbance or destruction of nests and eggs. Therefore, the company is committed to avoiding or minimizing this harm and developing mitigation strategies.

As part of a collaboration between Trent University, Environment and Climate Change Canada and Agnico Eagle Mines Ltd., this project explored mitigation options for flooding during the construction phase of the Whale Tail Pit. Mitigation options sought to deter birds from nesting in high risk areas, so that the impacts from mining-induced flooding or other localized disturbances could be minimized.

Through experimentation with the use of deterrents, the objectives of the research were to (1) determine the most effective bird deterrents and the method in which these deterrents should be applied, (2) assess the degree of risk posed to nesting migratory birds by mining-induced flooding and estimate the number of nests and the species composition lost due to the flooding and (3) examine the behavioural response of flooding by birds to determine whether birds re-nested or moved after the flooding events.

Year Two - 2019 Overview

The 2019 field season began on May 23rd with the arrival of Gill Holmes (MSc. Candidate) and technician, Sophie Roy. Late May tasks included the assemblage the audio deterrents and troubleshooting any problems that may arise in the field, testing visual deterrents in the field and gathering equipment used for deterrents and nest monitoring. Three more technicians arrived on the 1st of June and 3rd of June, Amy Wilson, Joanne Hamilton and Sarah Bonnett.

Figure 1: Examples of the shoreline flooding due to the diversion into the southern basin of Whale Tail Lake. Top: A view ground view of the flooding at WT3 site, Amaruq Camp in the background. Bottom: An above view of the flooding at WT3 site.

When the crew arrived on site, flooding had already occurred. Although Whale Tail Lake was frozen, there was a change in the riparian zone due to the late winter flooding of Whale Tail Lake southern basin. Snow melt occurred between the first week of June, with an unexpected snowstorm on the 9th of June, blanketing the landscape with an estimated 8 cm of snow. Whale Tail Lake began to thaw between early June to mid-June, showing more obvious signs of water level changes on the land (Figure 1). Deterrent deployment was delayed due to late arrival of gear and the heavy snow fall. All deterrents were deployed between 6th and 17th of June. The field season ended on 19th of July with the entire Waterbird Mitigation Project crew, departing Meadowbank. The field season was a total of 57 days.

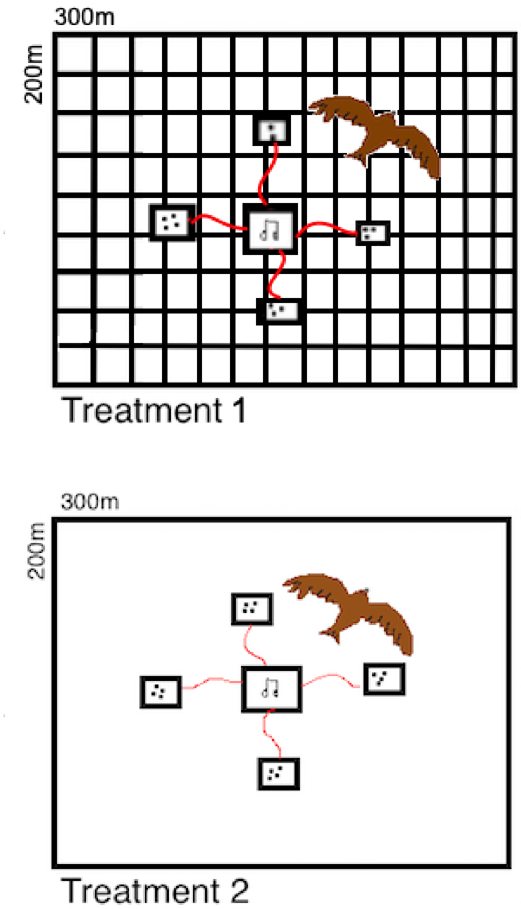

Figure 2: Illustrations of the two types of Treatment: Treatment 1 (top): audio deterrents, Jackite© predator effigy and 20 x 20 m grid of Flash Tape, and Treatment 2 (bottom): audio deterrents and Jackite© predator effigy. Used during the 2019 field season.

Methods

Objective 1. Efficacy of Deterrents

Deterrents were placed in experimental plots (300 m x 200 m, 6 ha) established during 2018 (n = 15). These plots were placed within 1 km of the Amaruq road between the 5th of June and 14th of June (Appendix 1). Experimental plots were divided into five sets of plots, with each set containing two treatment plots (Treatment 1 and 2) and one set of control plots. Treatment 1 consisted of audio deterrents playing a mix of predatory and distress calls paired with a Jackite© predator effigy placed in the centre of the plot, and Flash Tape covering the entire plot, with tape deployed every 20 m in both directions (Figure 1). Treatment 1 was chosen to potentially be the most effective at deterring breeding birds but was also the most labour-intensive. Treatment 2 consisted of audio deterrents and an effigy only and was selected as a less labour-intensive option (Figure 2). Control plots contained no deterrents.

As we did not set up deterrents in the plots in 2018 but we did obtain estimates of both territory and nest densities, we were able to use a before-after control-impact (BACI) statistical design. We compared nest and territory densities in control and treatment plots between years, using a general linear model, with Year and Treatment as factors, and testing for the interaction between these two factors. In this design, if there is a statistically significant interaction effect between the treatments and years, then the change in densities between 2018 (pre-treatment) and 2019 (post-treatment) should be greater in treatment plots than in controls. Because we analysed the same sites in both years, we also added a term to the model that represents random variation among sites (linear mixed-effects model, lmer in RStudio). We expected that both territory and nest densities would decline in the presence of the deterrent treatments, while there would be no change in either territory or nest densities between years in control plots. We also included hours spent nest searching and monitoring in the plots as an offset in the model to account for time spent in the plots. We spent substantially more time in plots assigned Treatment 1 than in other plots, while conducting maintenance of the deterrents. We conducted analyses on all birds, and the following subsets: terrestrial birds including Lapland Longspur (*Calcarius lapponicus*), Horned Lark (*Eremophila alpestris*), Savannah Sparrow (*Passerculus sandwichensis*), shorebirds including Semipalmated Sandpiper (*Calidris pusilla*), Least Sandpiper (*Calidris minutilla*), American Golden Plover (*Pluvialis dominica)*, and the two most common species, Lapland Longspur and Semipalmated Sandpiper.

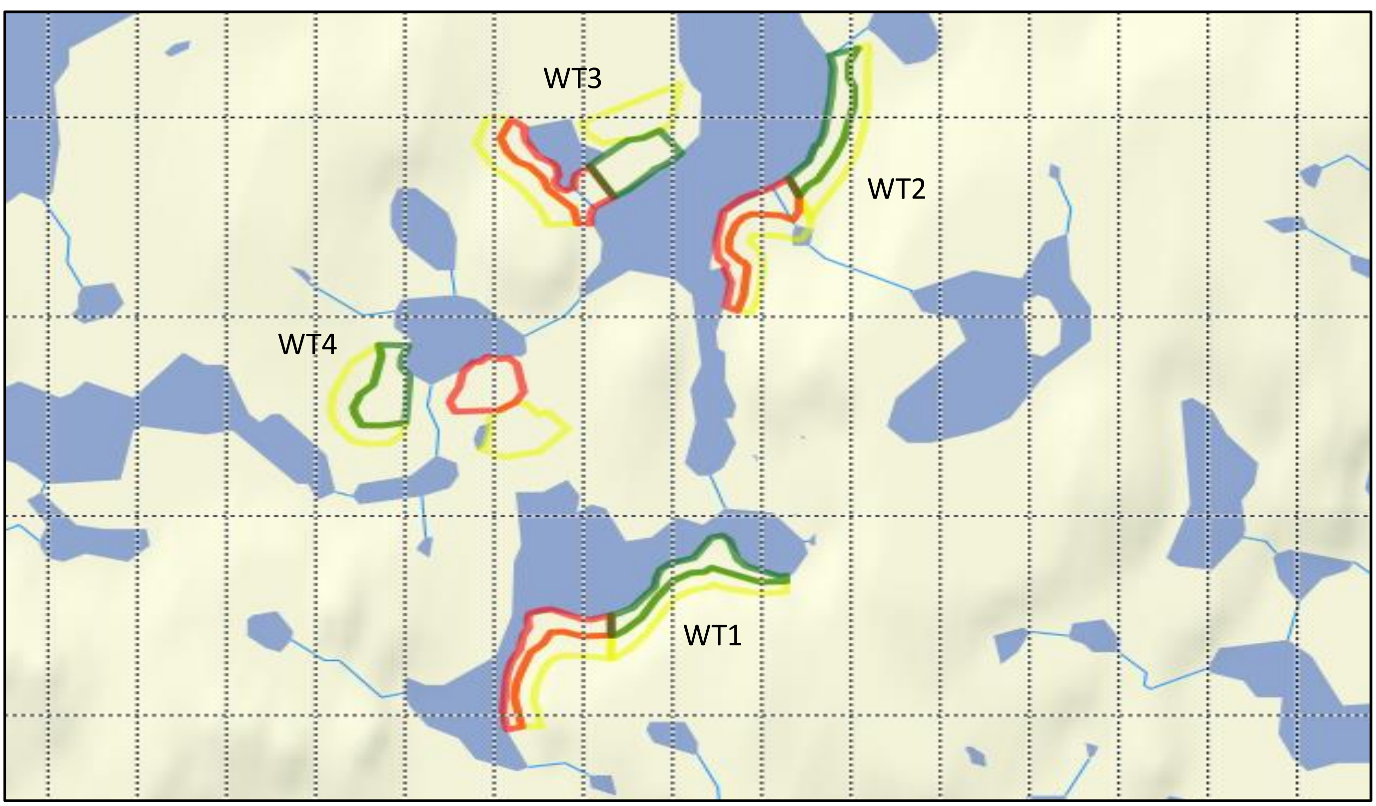

Figure 3: Map of the four main study sites (WT1, WT2, WT3, WT4) around Whale Tail Lake and its connecting lakes and tributaries. The Flood plots (red) and Treatment plots (green) are within the proposed flood zone, and the Control (yellow) plots are adjacent to the proposed flood zone.

Objective 2. Flood Zone Impact Assessment

During the 2018 field season, diversion sites were surveyed for nests between 24^{th} and 25^{th} of June and 29^{th} June – 2^{nd} of July for a total of 40 search hours. These surveys were conducted to obtain an estimate of the densities of birds that would be exposed to the flooding event. The dates were limited due to limited access to the sites. After the initial 25^{th} of June survey of birds, and habitat composition across all of the Whale Tail Diversion site, we divided the Whale Tail diversion site into four main flood zone areas (WT1, WT2, WT3, and WT4). These areas were selected based on habitat quality (predominately sedge meadow), and low elevation, so most likely to support breeding birds that would be impacted by the flooding.

The 2018 survey consisted of walking a transect with four surveyors spread out every 10 m parallel to the edge of the lake and to the proposed high flood line (within the proposed flood zone), as described in Appendix 6-F - Flooding During Phases report by Golder Associates and AEM. Surveyors walked together, while watching the ground, to observe flushing birds or other breeding activity. When a bird was observed, all surveyors stopped, and one or more surveyors attempted to find the nest by waiting for the bird to return to its nest, or by searching the area where the bird was initially observed. A Garmin© GPS was used to mark each nest found, and observations and notes were written in a field notebook. Nest densities around Whale Tail Lake were estimated based on nests found during the 2018 surveys, with an estimated 3.4 territories per hectare, within the proposed flood zone of 157 ha.

During the 2019 field season, the four main flood zone areas were divided into 4 separate 6 ha plots, two within the flood zone and two outside the flood zone to be used as control plots (Figure 3). The two flood zone areas were further divided into treatment and flood zone. Treatments included the flash tape grid and audio deterrents similar to Treatment 1, but without a Jackite© predator effigy. Plots outside the flood zone were considered control plots with no deterrents or flooding occurring. Deterrents were placed in the treatment plots (n = 4) between the 16^{th} of June and 17^{th} of June. Plots were surveyed every four days, between the 16^{th} of June and 14^{th} of July for a total of 148 search hours within the proposed flood zone.

Objective 3. Bird Behavioural Reponses

Nest and Territory Monitoring

Monitoring of nesting birds occurred throughout the 2019 breeding season between the June 6th of - 14th of July, within the experimental plots and the flood zone sites. For the study, there were four main study species; Lapland Longspur (*Calcarius lapponicus*), Horned Lark (*Eremophila alpestris*), Semipalmated Sandpiper (*Calidris pusilla*) and Least Sandpiper (*Calidris minutilla*) (Figure 4). These species are the most abundant at the study sites and the easiest species for both locating and monitoring nests.

Figure 4: Four main study species, left to right; Lapland Longspur, Horned Lark, Semipalmated sandpiper, Least sandpiper.

Territorial mapping occurred primarily at the beginning of the breeding season once male birds arrived and began to sing and display. Mapping was done by observing the locations of displaying males and marking the location with a waypoint using a Garmin© GPS, for a minimum of 10 points per visit to the territory. The locations of each singing male were given a waypoint.

Nest searching occurred by systematically walking plots and observing behavioural cues of breeding adults (e.g. flushing, mate courtship, alarm calls). Upon discovery of a nest, it was marked with a tongue depressor 5m from the nest in a random direction, labeled with a nest name, along with the distance and bearing to the nest from the marker. Within a notebook, the observer recorded the exact coordinates of the nest using the "average waypoint" function within the GPS unit, the species, number of eggs present, and date found. Each plot, and nests within plots were visited on a 4-day schedule until fates were determined. Methods to assess nest fate depended on the life history of each target species. Nests occupied by species with precocial young (i.e., *Calidris sp*.) with at least one hatched egg were considered successful, whereas nests occupied by species with altricial young (i.e., Passerines) with at least one fledged young were determined successful. Signs of predation (loss of a whole clutch, nest disturbance, large eggshell fragments or yolk) or abandonment (no sign of adults or cold eggs) (Mabee 1997) indicated failed nesting attempts.

Twenty Lapland Longspur nests received a temperature logger after the clutch was completed (i.e., 5 eggs), with 10 loggers placed within nests located in Treatment plots and 10 loggers placed within nests located in Control Plots. Temperature loggers were used in this study to monitor incubating females to detect any changes in incubation duration between Treatment and Control nests that might be attributed to the presence of the deterrents.

Marking and Re-sighting

Birds of the four focal study species found within the flood zone areas (both Treatment and Control plots) were captured with the use of a bow net at the nest, and banded with individual colour markers. For nests found in the Treatment areas, banding was be done to determine whether the disturbance of the treatments caused birds to re-nest in adjacent sites. Additionally, we banded birds in 2018 from the tundra area that was flooded in 2019, and we used these data to determine whether birds dispersed to adjacent non-flooded sites, potentially increasing the densities of birds in these adjacent sites. We also plan to return to the study site in 2020 solely to re-sight previously banded individuals. Re-sighting of previously banded birds from 2018 and birds caught on the nest as they were found in 2019 occurred throughout the breeding season as nests were found and disturbed due to flooding, deterrents or predators. Resighting occurred during every visit (every four days).

We captured adults once a nest was in the incubation stage (i.e., the number of eggs in the nest does not increase each day). We attempted to capture both members of the pair for species where both adult birds incubate (i.e., *Calidris sp*.). For species where only one adult incubates (i.e., Passerines), we captured the incubating bird, although in a few cases both adults were captured. When a bird was captured, we measured the head-bill length, tarsus length, and wing length to the nearest mm and weight to the nearest dg. Birds were banded with a standard Canadian Wildlife Service issued stainless-steel metal band that has a unique 10-digit serial number. Semipalmated Sandpipers were banded with a metal band, a white flag with a 3-letter alpha code, and a single plastic coloured band. Least Sandpiper were banded with a metal band, a white flag and 2 colour bands. Lapland Longspurs and Horned Larks were given a unique colour band combination comprised of 1 metal band and 3 plastic colour bands. Band combinations are read from left to right as per standard protocol and were recorded when re-sighting a previously banded bird.

Results

Objective 1. Efficacy of Deterrents

Our results suggested that deterrents did not significantly impact nest densities of all species, nor the subsets of terrestrial or shorebird species (Figure 5) as there were no significant interaction terms for any of these three analyses (P's > 0.05). Similarly, there was no significant impact of the deterrents on either of Semipalmated Sandpiper or Lapland Longspur nest densities (Figure 6). In most cases, plots exposed to Treatment 1 had double the nest density of that of control and Treatment 2 in 2019, the year of deterrent deployment, a result that was opposite to our expectation. These results demonstrate that deterrents were likely not effective at deterring birds from nesting in possible at-risk areas.

Cost and Maintenance of Deterrents

Deterrent deployment occurred over multiple days, with up to 200 person hours to deploy, not including the extra 120 hours to assemble and trouble shoot before deployment. In most cases, a crew of 6 – 8 people spent 4 hours deploying the flash tape grid, within a single Treatment 1 6-ha plot. Deterrent maintenance was done every 4 days, with the time spent in the plot ranging from 20 mins to 4 hours, depending on damage and needs. Examples of maintenance were ensuring that the hawk kite effigy poles were erect and that the kite was still intact, ensuring the fishing line holding together the flash tape grid was taut, ensuring flash tape was not tangled around hummocks or brush. In some cases, deterrents were completely destroyed, taking hours to fix or so damaged that we could not fix them. An

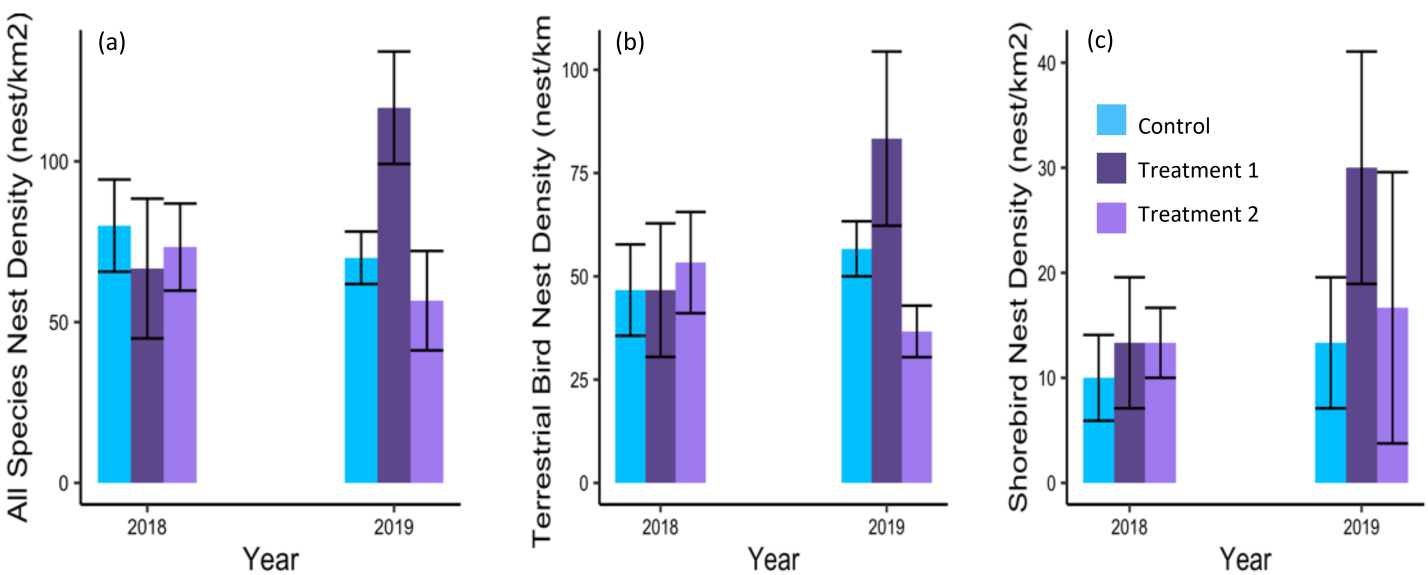

Figure 5: Nest densities (nests/km² ± SE) before (2018) and after (2019) deterrent deployment of two deterrents treatments, for all species present at the study site (a), only terrestrial bird species (b), only shorebird species (c) only.

example of this is where the Flash tape grid was dismantled due to disturbance by caribou or muskoxen, causing the entire grid to collapse and requiring maintenance and re-deployment. This re-deployment took hours and also demonstrated a possible risk to large arctic mammals who may have become entangled in the flash tape.

Financial costs for audio and visual deterrents and accessories included each Bird-X Super Bird X-peller Pro audio unit of $509.99 CAD, with 14 purchased in 2019, for a total of $7,139.06 CAD. This cost included audio chips for each audio unit ($60.00 CAD each). To keep the batteries charged so the audio deterrents would run for up to 6 weeks, we purchased 14 solar panels, $89.99 CAD each, for a total of $1259.86 CAD. The 12V car batteries used to run the audio deterrents and hold the solar panel charge, were donated by Environment and Climate Change Canada. Visual deterrent costs came to a total of $5,131.25 CAD, with Hawk Kite Effigies costing $524.75 CAD for 12 Hawk Kites, with Fiber glass poles (10) totaling $517.50 CAD and replacement strings (7) $42.00 CAD. Flash tape rolls were $5.40 CAD per roll, accounting to $1,917.00 CAD for 355 roles. Fishing line was used to string the flash tape grid together, costing $850.00 for 34 rolls of 100lb Hercules PE Braided Fishing Line 4 Strands. Lastly, the Aluminum Angle used to erect the flash tape grid, with 640 pieces of 1 m long angles, cost $1,280.00 CAD. The complete cost of deterrents for this project was $13,529.17 CAD.

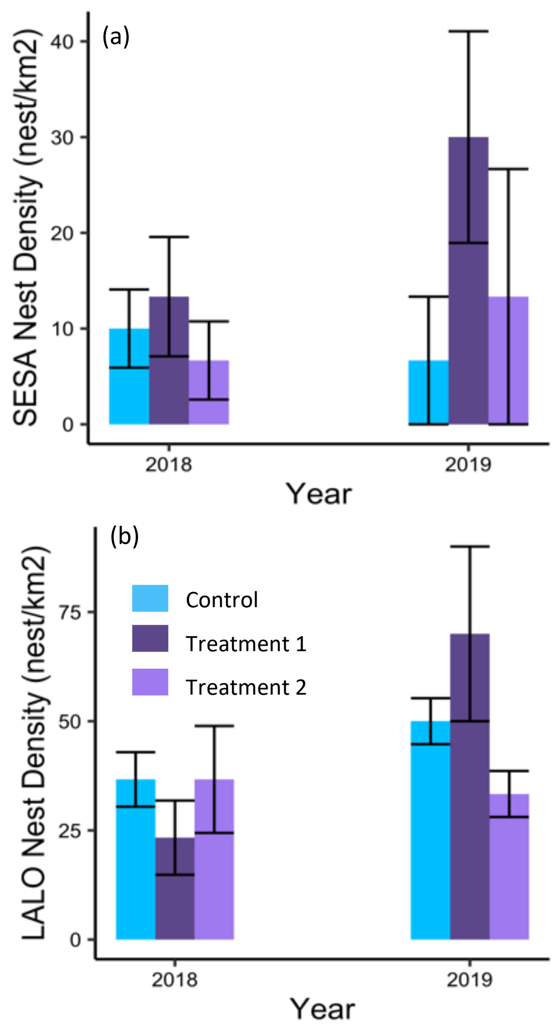

Figure 6: Nest densities (nests/km² ± SE) before (2018) and after (2019) deterrent deployment of two deterrents treatments for Lapland Longspur (a) or Semipalmated Sandpiper (b) only.

Objective 2. Flood Zone Impact Assessment

During the 2018 Whale Tail Study survey we estimated 31 bird territories per km^2, with an average initiation date of the 16th June. Given these dates, we concluded that the proposed flooding timeline outline in Terrestrial Ecosystem Management Plan - Version 4, by Golder Associates, would flood nests along the shore of

Whale Tail Lake. When we arrived at the Whale Tail Flood zone in 2019, we estimated a shoreline loss of 40 m, which occurred when Agnico Eagle Mines Ltd. flooded in late winter. Because of this loss, about half of the proposed flood area plots where under water. Despite this, birds continued to nest within the flood area with an average territory density of 21.9 territories per km^2, while control plots surrounding the proposed flood zone within the Whale Tail Study area had an average territory density of 15.6 territories per km^2. The densities surrounding Whale Tail Lake decreased by 10.9 territories per km^2 between 2018 (pre-flooding) and 2019 (post-flooding).

During the flooding, we documented 6 nests of 3 species that were lost due to direct impacts of the high water (Figure 7). We estimate an average loss of 3.8 nests per km^2 by taking the number of nests observed to be lost and dividing it by the total proposed flood zone of Whale Tail Lake (1.575 km^2). The species that lost nests were Lapland Longspur (4), Semipalmated Sandpiper (1) and Herring Gull (1). Despite nest loss due to flooding and a significant amount of habitat loss, nests in the proposed flood zone had an estimated success rate of 56%.

Objective 3. Bird Behavioural Responses

Birds nesting within the flood zone were captured and banded with unique band combinations. A total of 15 female Lapland Longspur were banded, while 8 Semipalmated Sandpipers were banded within the flood zone. Out of these 23 individuals, a single Lapland Longspur female re-nested after nest loss due to flooding, nesting approximately 125 m from the original nest and between 50 to 100 m away from the proposed flood zone. The original nest was estimated to be lost during the nestling stage due to flooding between July 1st - 3rd and we estimated that the bird initiated a new nest on the July 3rd.

Figure 7: A Lapland Longspur nest with four eggs that was found within the Whale Tail Lake flood zone. It was found active, but later in the season became flooded.

Discussion

Based on the results of the deterrent experiment, we conclude that our deterrents were not able to prevent birds from nesting.

Therefore, we do not recommend their use in future mitigations for nest loss of arctic-nesting birds. We are confident that the deterrents we used failed to deter birds from nesting in at risk areas, resulting in the loss of nests due to mining-induced flooding. There may be several possible reasons why the deterrents did not work, such as a bird's life history and the timing of deployment, and the risk that may be posed to other wildlife who occupy the same landscape.

Figure 8: An extremely concealed Lapland Longspur nest with a piece of flash tape draped over it.

Our sample is dominated by small, short-lived species such as Lapland Longspur. These species may be especially reluctant to abandon or forgo a breeding attempt in the presence of novel objects such as our deterrents, as they have fewer breeding opportunities compared to long-lived species. Previous studies have demonstrated the ability to deter birds from nesting with the use of a flash tape grid and other visual deterrents, such as done by Marcus et al. (2007) where these authors were successful in deterring Piping Plover and Least Tern from nesting within gravel pits. In the case of our study, Lapland Longspur showed no signs of obvious distress or disturbance during deterrent use. There were multiple occasions where a nest was found within 5 m of an audio deterrent speaker or directly under a piece of flash tape (Figure 8).

Treatments were applied during the early nest initiation period with an average nest initiation date of 13th of June, with the earliest initiation date estimated as the 3rd of June and as late as the 25th of June in 2019. Arctic-breeding birds nest very synchronously, due to their contracted breeding season. Delaying initiation or abandonment to establish a new territory could compromise reproductive success (Smith et al. 2010). Deploying deterrents before territories are established may be more effective but is logistically challenging. The challenges of deploying deterrents in a timely manner refers to the ability to erect deterrents during the late winter and early spring, when the ground is still frozen and there is still snow present on the landscape. These conditions made it difficult to travel with equipment on foot and the frozen ground made it difficult to hammer the aluminum angle in the ground, as well as making it difficult to ensure that the audio deterrent speakers stayed upright.

During the experiment there were a few instances where deterrents were damaged or destroyed due to mammals. In some plots where we found Arctic ground squirrels (*Spermophilus parryii*) or Arctic hare (*Lepus arcticus*) we anticipated that there might be some damage to the wires associated with the audio deterrent units. Damage by Arctic ground squirrels occurred on one occasion when a speaker cord was chewed, but we noticed and replaced the cord quickly. A more concerning issue arose as there was some noticeable impact on large ungulate species such as caribou and muskoxen. There were multiple occasions where visual deterrents were destroyed by caribou or muskoxen walking through the treatment plots, causing aluminum poles to be ripped out of ground and carried away. There was a case where fishing line was found to have blood on it, possibly from a caribou who may have gotten the fishing line caught around their mouth. This is a major concern, as we did not want to cause harm to wildlife.

The outcome of the project exhibited that arctic-nesting birds are not easily discouraged from nesting, especially in the case of visual and audio deterrent use. Based on the outcomes of the research, the amount labour and cost of deterrents, we would not recommend these methods for mitigating nest loss in the future.

Next Steps

Objective 2: Flood Zone Impact Assessment

In 2020, the study will continue to determine whether re-colonisation occurs in the flooded areas around Whale Tail Lake, as the flood waters recede. This will require the monitoring of the 16 plots within the flood zone surrounding Whale Tail Lake. We hope to understand how nesting birds react to the elimination of previously suitable habitat. How do bird densities change between years as the water line moves, and what role does elevation in the selection of nest sites? These objectives will be accomplished by visiting at least 8 out of 16 the plots within the proposed flood zone. We will select the plots located on the eastern shore of Whale Tail Lake and its tributaries (WT1 and WT2), as time and accessibility will limit the ability to visit the western shore of Whale Tail Lake.

Objective 3. Bird Behavioural Responses

During the 2019 field season, 20 temperature probes were deployed on 20 nests within the experimental treatment (n = 10) and control (n = 10) plots. While these data have not yet been analysed, results may provide whether there were subtle negative reactions by nesting birds to the presence of the deterrents.

References

A.T. Kearney, Inc. 2015. The Council Perspective: The Future of the Arctic. Global Business Policy Council 2(1).

Arctic Monitoring and Assessment Programme (AMAP). 2017. Adaptation actions for a changing arctic (AACA) – Baffin Bay/Davis Strait region overview report. Arctic Council.

Belayneh, A., T. Rodon and S. Scott. 2018. Mining economies: Inuit business development and employment in the eastern subarctic. The Northern Review 47: 59-78.

Bernath-Plaisted, J. and N. Koper. 2016. Physical footprint of oil and gas infrastructure, not anthropogenic noise, reduces nesting success of some grassland songbirds. Biological Conservation 204: 434-441.

Cameron, E. and T. Levitan. 2014. Impact and benefit agreements and the neoliberalization of resource governance and indigenous-state relations in northern Canada. Studies in Political Economy 93(1): 25-52.

Gajera, N.B., A.K.R. Mahato and V.V. Kumar. 2013. Status, distribution, and diversity of birds in mining environment of Kachchh, Gujarat. International Journal of Biodiversity.

Hassan, Y.A. 2016. The impacts of mining on arctic environment and society from corporate social responsibility and sustainable development perspectives; the case of Jokkmokk (Kallak) iron mines in northern Sweden. Department of Physical Geography, Stockholm University. 109 p. Accessed from: Diva Portal; Last updated 2016 Apr 29.

Hof, A.R., G. Rodríguez-Castañeda, A.M. Allen, R. Jansson and C. Nilsson. 2017. Vulnerability of subarctic and arctic breeding birds. Ecological Applications 27(1): 219-234.

Johnson, C.J., M.S. Boyce, R.L. Case, H.D. Cluff, R.J. Gau, A. Gunn and R. Mulders. 2005. Cumulative effects of human developments on Arctic wildlife. Wildlife Monographs 160: 1-36.

Marcus, J.F., Dinan, J.J., Johnson, R.J., Blankenship, E.E., and Lackey, J.L. 2007. Directing nest site selection of Least terns and Piping plover. Waterbirds, 30(2): 251-258.

Parliament of Canada, House of Commons. Migratory Birds Convention Act, 1994. S.C. 1994, c. 22. [Online]. Justice Law Website (CA); 2018 Nov 19. Available from https://laws-lois.justice.gc.ca/eng/acts/m-7.01/

Reijnen, R., R. Foppen and G. Veenbaas. 1997. Disturbance by traffic of breeding birds: evaluation of the effect and considerations in planning and managing road corridors. Biodiversity and Conservation 6(4): 567-581.

Smith, P.A., Gilchrist H.G., Forbes, M.R., Martine, J.L. and Allard, K. 2010. Inter-annual variation in the breeding chronology of arctic shorebirds: effects of weather, snowmelt and predators. J. Avian Bio. 41(3): 292-304.

Wauchope, H.S., J.D. Shaw, Ø. Varpe, E.G. Lappo, D. Boertmann, R.B. Lanctot and R.A. Fuller. Rapid climate-drive loss of breeding habitat for Arctic migratory birds. Global Change Biology 23(3).

Williamson FSL. 1968. Alaska longspur. In: Austin OL Jr (ed) Life histories of North American cardinals, grosbeaks, buntings, towhees, finches, sparrows, and allies. US National Museum Bulletin 237, part 3. pp 1608-1627

Wilson, R.R., J.R. Liebezeit and W.M. Loya. 2013. Accounting for uncertainty in oil and gas development impacts to wildlife in Alaska. Conservation Letters 6(5): 350-358.

APPENDIX I

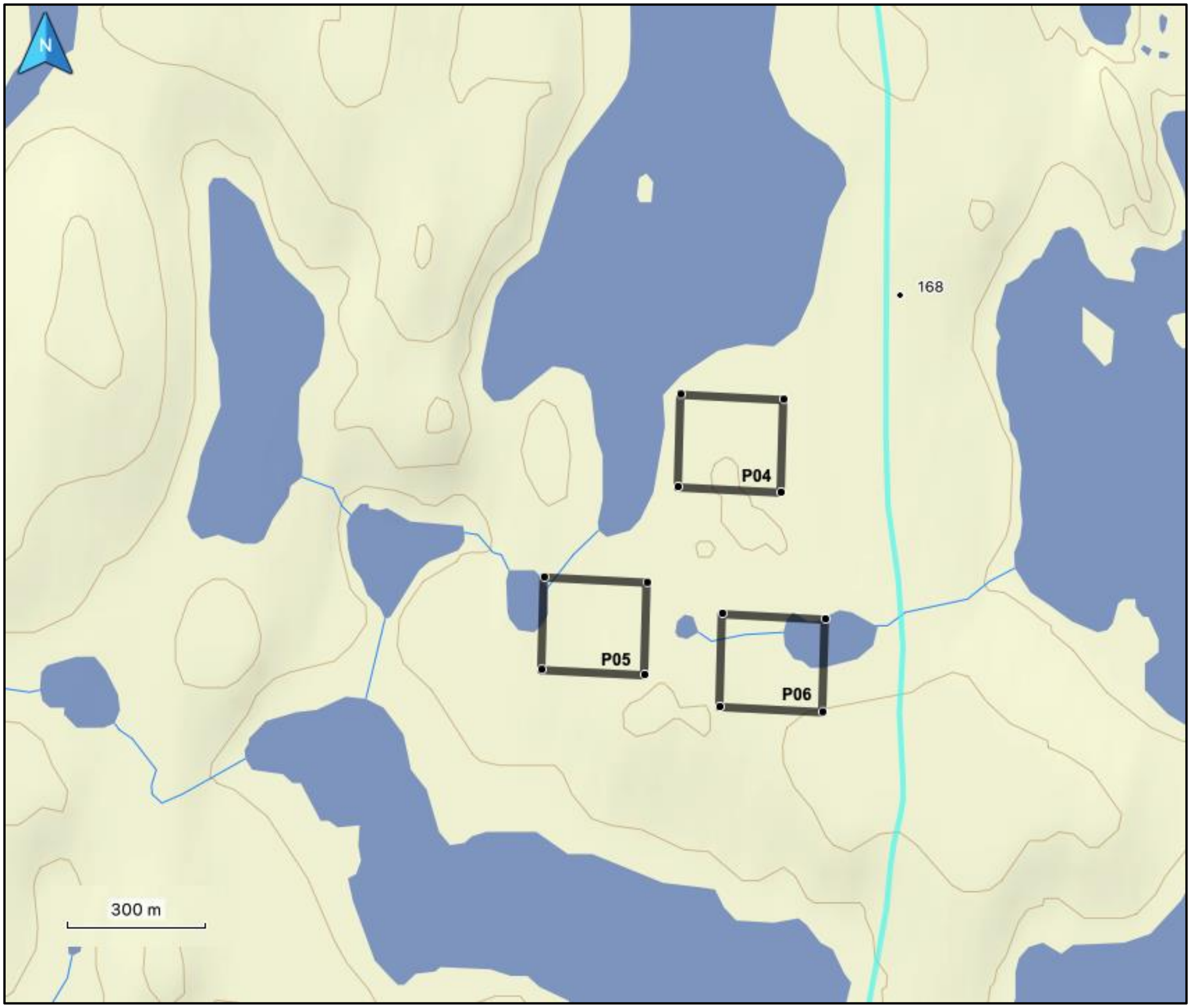

Figure 9: a map of Plot 4 (Treatment 2), 5 (Control) and 6 (Treatment 1), located on the west side of Kilometer 174 on Amaruq Road (light blue line)

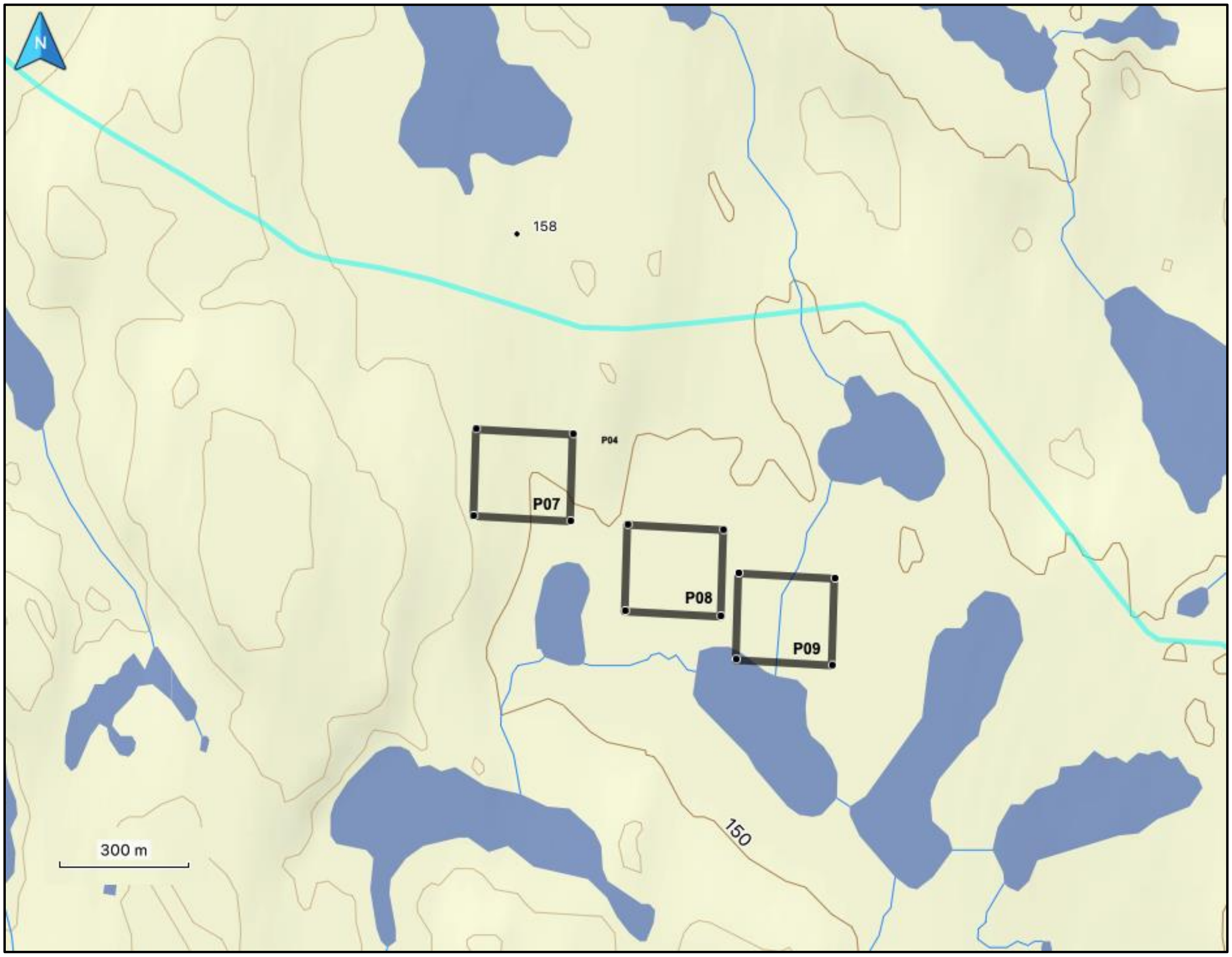

Figure 10: a map of Plot 7 (Control), 8 (Treatment 2), and 9 (Treatment 1), located on the south side of Kilometer 164 on Amaruq Road (light blue line)

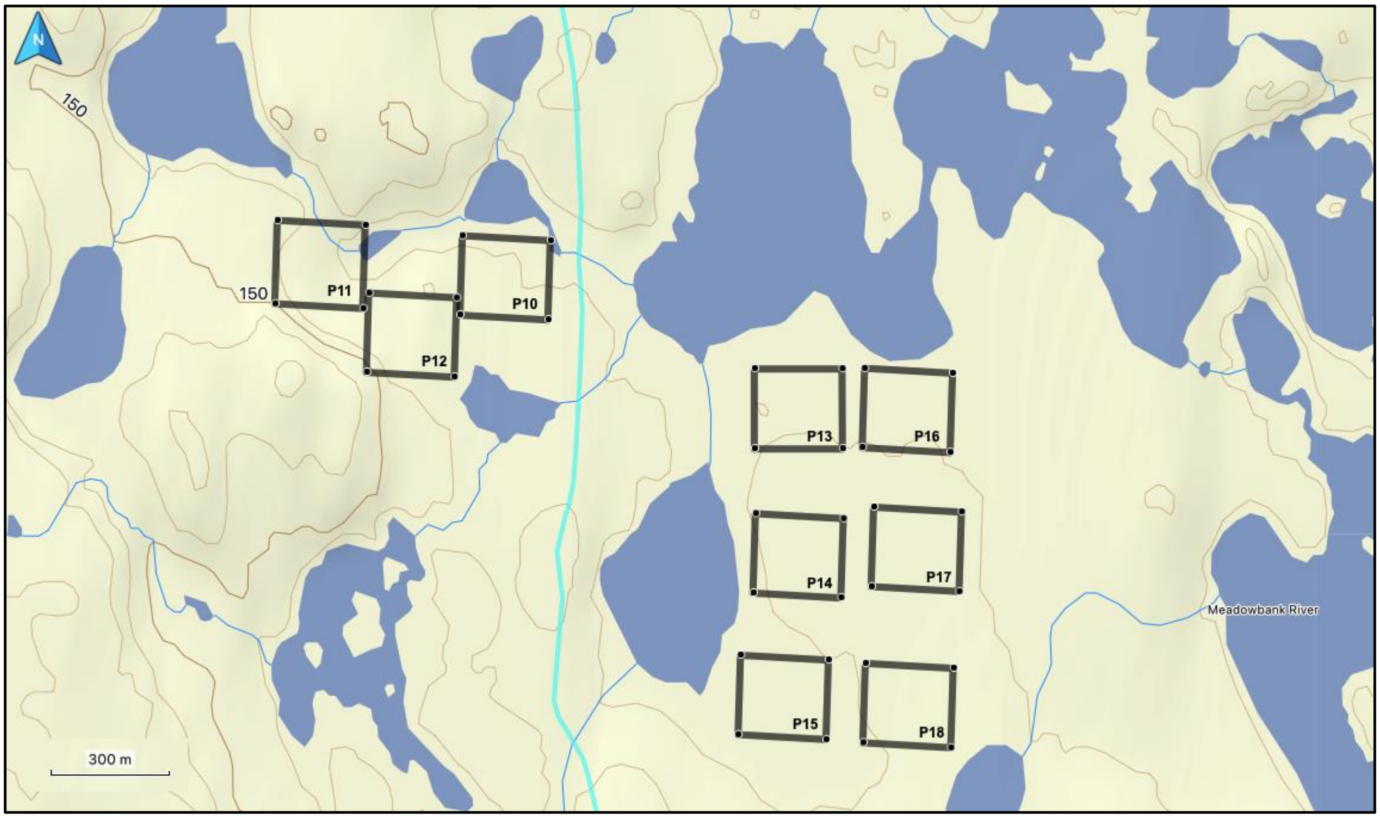

Figure 11: Figure 6: a map of Plot 10-12 located on the west side, and Plot 13-18 on the east side at Kilometer 160 on Amaruq Road (Light Blue Line). Plot 10, 13 and 16 (Treatment 1), Plot 12, 14, and 17 (Treatment 2), and Plot 11, 15, and 18 (Control).

APPENDIX II

Table 1: Nest density estimates (nest/km2) of all nests found within the three treatment plots between 2018 and 2019.

	2018	2019
Control	80.0	70.0
Treatment 1	66.6	116.6
Treatment 2	73.3	56.6

Table 2: Nest density estimates (nest/km2) of terrestrial birds (LALO, HOLA, SAVS) found within the three treatment plots between 2018 and 2019.

	2018	2019
Control	46.6	56.6
Treatment 1	46.6	83.3
Treatment 2	53.3	36.6

Table 3: Nest density estimates (nest/km2) of shorebirds (SESA, LESA, AMGP) found within the three treatment plots between 2018 and 2019.

	2018	2019
Control	10.0	13.3
Treatment 1	13.3	30.0
Treatment 2	13.3	16.6

Table 4: Nest density estimates (nest/km2) of Lapland Longspur nests found within the three treatment plots between 2018 and 2019.

	2018	2019
Control	36.6	50.0
Treatment 1	23.3	70.0
Treatment 2	36.6	33.3

Table 5: Nest density estimates (nest/km2) of Semipalmated Sandpiper found within the three treatment plots between 2018 and 2019.

	2018	2019
Control	10.0	6.6
Treatment 1	13.3	30.0
Treatment 2	6.6	13.3