Appendix 48

Whale Tail 2018 migratory bird protection plan report

MEADOWBANK GOLD PROJECT

2018 Migratory Bird Protection Report

In Accordance with NIRB Project Certificate No.008

Prepared by:
Agnico Eagle Mines Limited – Meadowbank Division

March, 2019

EXECUTIVE SUMMARY

Mitigation measures to reduce impacts of flooding on migratory bird nesting at the Whale Tail site will be implemented in 2019 prior to flooding according to the Migratory Bird Protection Plan (July, 2018). As described in the Plan, mitigation measures will consist of deploying visual and audio bird deterrents, and regular sweeps by Agnico Eagle staff to discourage nesting.

Research studies were simultaneously initiated to determine the effectiveness of these mitigation measures (audio and visual deterrents) at nearby reference sites. This was the first of three study years, so complete results are not yet available.

Baseline nest surveys of the Whale Tail and Northeast diversion flood zones were also conducted during peak egg incubation period (June 24 – July 2, 2018) to determine the number of nests in the area to be flooded. A total of 50 nests were identified. This included 15 waterbird nests and 35 upland bird nests. These results indicate that although the proportion of waterbird nests was higher than predicted in the FEIS (10 nests), total impacts of flooding to nesting birds may be lower than predicted, as 98 total nests (waterbird + upland bird) were assumed impacted.

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SECTION 1 • INTRODUCTION

In 2018, Agnico Eagle Mines Ltd. (Agnico) was issued NIRB Project Certificate No. 008 for development of the Whale Tail site, a satellite deposit at the Meadowbank Mine. Agnico has planned two water diversions as part of water management activities for this project.

The Whale Tail Lake (South Basin) diversion (Figure 1) 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-P53. Active flooding from elevation 152.5 to 156.00 masl of the area will occur from 2019 until 2020 causing approximately 157 ha of flooding; this requires migratory bird mitigation. The flooded area will remain at elevation 156.00 masl from July 2020 until 2023, during operations.

The Northeast diversion (Figure 2) consists of construction of the Northeast dike, from February to March 2019, to divert Lake A46 and tributary lakes through Lake C44 in the Lake C38 (Nemo Lake) watershed. Flooded tributary lakes (light blue shading in Figure 2) include Lake A47, Lake A48, Lake A113, Pond A-P38, and Pond A-P68. Flooding of this area will occur between February 2019 to July 2020, and during operations (July 2020 to 2023).

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, the Migratory Birds Protection Plan (the Plan) describes how these impacts will be mitigated through use of visual and audio bird deterrents, and regular sweeps by Agnico Eagle staff to discourage nesting. Mitigation was planned to be focused between 2018 and 2020, or until water levels reach their maximum flood plain.

Since flooding had not yet occurred in 2018, mitigation measures will begin in 2019 in consultation with academic research partners. This report describes the mitigation measures that will be implemented, and results of field studies conducted simultaneously in collaboration with Environment and Climate Change Canada (ECCC) and Trent University to understand the effectiveness of the various types of mitigation (deterrents).

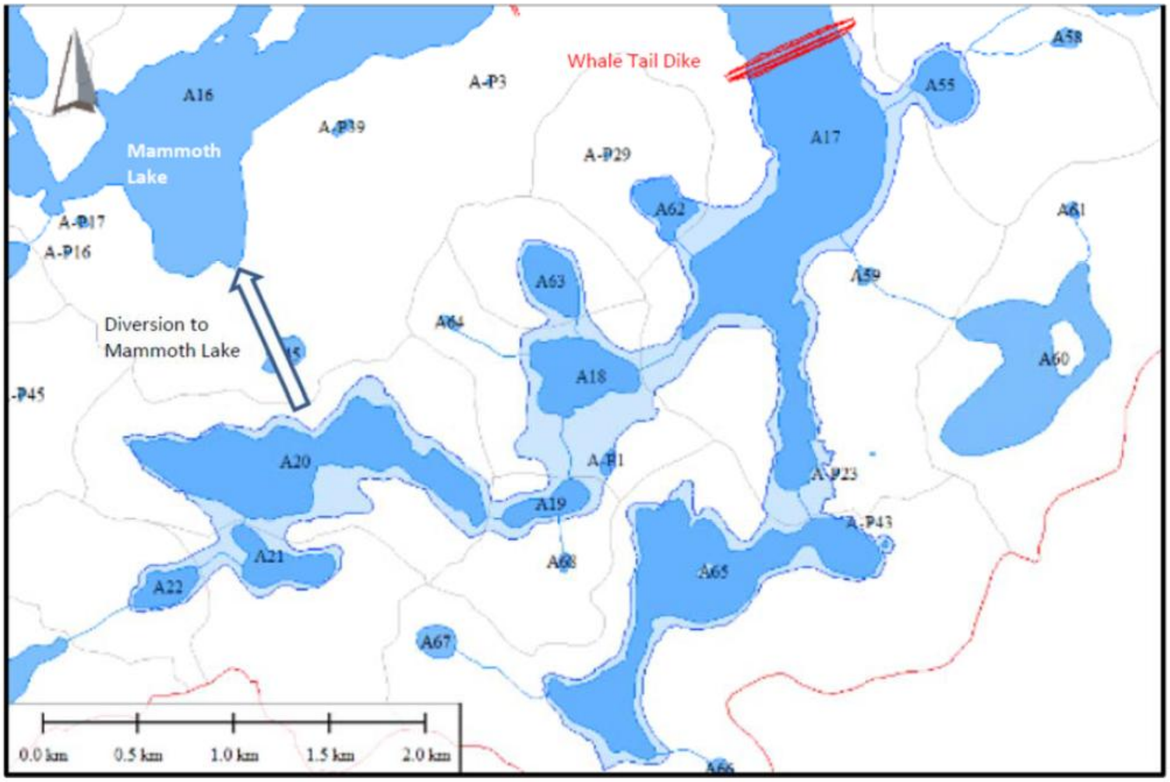

Figure 1. Whale Tail Lake (South Basin) Diversion Flooding occurring between February 2019 and July 2020, and during operation (July 2020 to 2023).

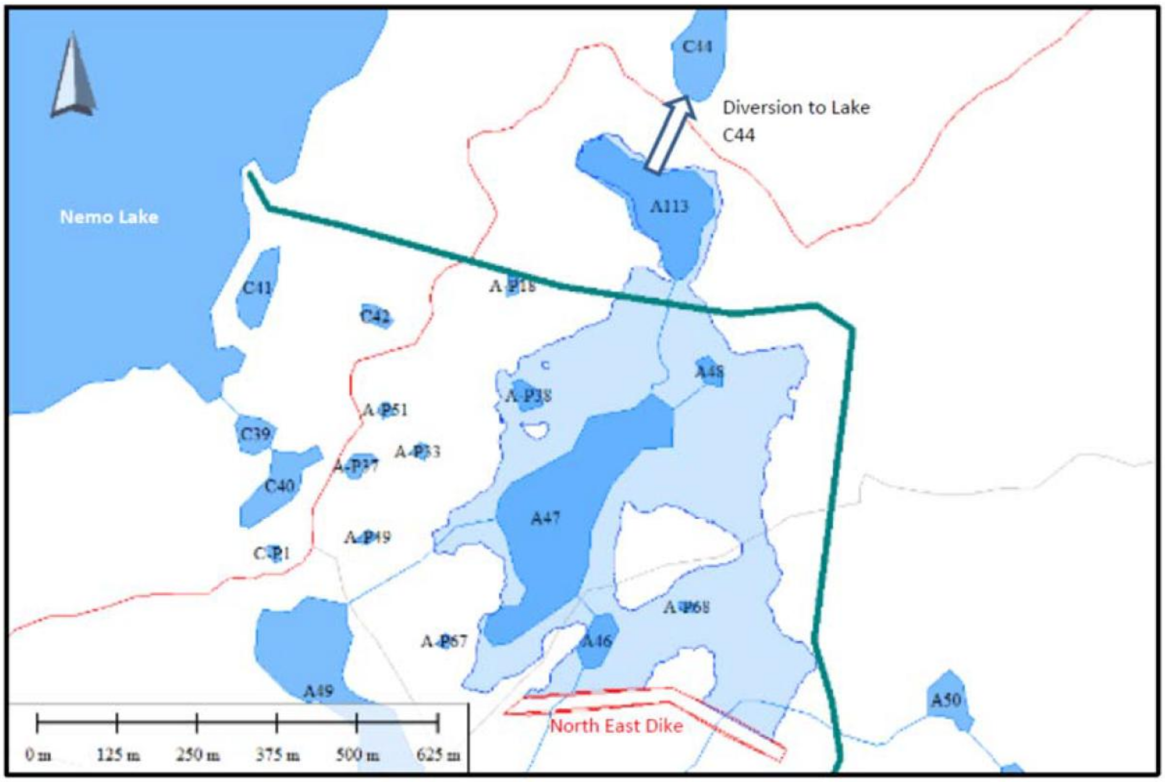

Figure 2. Northeast Diversion Flooding occurring between June 2019 and July 2020, and during operation (July 2020 to 2023).

SECTION 2 • MITIGATION MEASURES

According to the Migratory Bird Protection Plan (July, 2018), the following mitigation measures will be implemented to deter nesting of waterbirds in the Whale Tail Lake and Northeast water diversion areas during flooding:

- Deploying visual and audio bird deterrents,
- Regular sweeps by Agnico Eagle staff to discourage nesting through human activity, and to move the visual and audio deterrents.
- While Agnico may in the future consider the feasibility of using habitat modification or exclusion techniques within the flood zone in consultation with ECCC and academic institutions, these methods are not part of the primary mitigation plan.

In the 2018 nesting season, no flooding had yet occurred. Mitigation measures will be implemented in consultation with academic partners at Trent University prior to and during the 2019 nesting season.

SECTION 3 • EFFECTIVENESS OF THE MITIGATION

In order to determine the effectiveness of mitigation methods aimed at reducing impacts of Whale Tail site flooding on waterbirds, Agnico is conducting a study in partnership with Environment and Climate Change Canada (ECCC) and Trent University. Through this project, Agnico is also contributing to advancing the scientific understanding of conservation methods for at-risk species.

The complete objectives of the research are to assess the degree of risk posed to migratory birds by mining-induced flooding during the nesting period, to determine the most effective bird deterrents, and to determine the manner in which these deterrents should be applied.

Specifically, the study investigates the:

i) breeding densities and timing of bird nest initiation at the Whale Tail study site,

ii) relationship between nesting phenology and the timing of snowmelt,

iii) degree to which deterrents can reduce nesting densities in specific areas,

iv) individual behavioural responses to deterrent applications and changes in response over time,

v) and the dispersal distance of deterred/impacted birds, to understand whether birds displaced from flooded areas nest nearby.

3.1 2018 FIELD STUDIES

A complete summary of 2018 field studies prepared by the research team from Trent University is provided in Appendix A. Data evaluation is preliminary at this stage, so full results will be provided in subsequent reports.

Briefly, the objectives of the 2018 field study were to collect preliminary data to assess the effectiveness of visual deterrents in changing bird behaviour during nesting. Researchers also collected baseline data on nest abundance in the water diversion flood zones (see Section 4).

The field team assessed 21 plots along the Whale Tail Haul Road between the Amaruq Camp and Kilometer 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.

Deterrents were planned to be set up prior to bird arrival, to assess differences in nesting between sites, but delays in shipment meant they were not erected until late June. As a result, changes in behaviour of individual birds after set-up of deterrents was assessed. Due to delays in shipment of audio deterrents, their effectiveness could not be assessed in 2018.

3.2 PLANNED 2019 FIELD STUDIES

At the beginning of the 2019 study season, audio and visual deterrents will be erected in the last week of May, preferably before snow melt, in order to deter birds from nesting within the treatment plots as they arrive to initiate nesting territories. Each of 18 plots will be assigned randomly, to one of two deterrent treatments or a control. Treatment 1 will consist of audio deterrents playing a mix of predatory and distress calls paired with a m 10 x 10 m grid of Mylar® flash tape. Treatment 2 is considered less labor-intensive, and will consist of audio deterrents with the use of Jackite© (a hawk kite effigy). Control plots will have no deterrents present. Comparisons of densities between year one and two of the study and between treatment and control plots will determine if the deterrent applications used were successful in deterring birds from nesting within the plots, and by extension, within habitats similar to those flooded.

SECTION 4 • FLOOD ZONE NEST SURVEYS

4.1 WHALE TAIL AREA BASELINE SURVEY

Research teams surveyed the Whale Tail area flood zones over 8 days during peak incubation (June 24 – July 2, 2018). Within the North East Diversion flood zone, a total of 15 nests were found over two days of surveying and within the Whale Tail Diversion flood zone a total of 35 nests were found over 6 days of surveying (see figures in Appendix A for locations).

Out of the 50 nests, 30 individual birds of 4 species were banded with individual markers so that they may be identified in the 2019 field season, to determine if they breed nearby once they are prevented from returning to their breeding territories by flooding.

4.2 COMPARISON TO IMPACT PREDICTIONS

As described in the Migratory Bird Protection Plan (July, 2018), a total of 10 waterbird nests and 88 upland bird nests were predicted to be impacted by flooding. This prediction was made by extrapolating data from limited shoreline surveys conducted in 2015/2016.

Baseline surveys conducted by the University of Trent researchers in 2018 identified a total of 50 nests in the flood zones, consisting of 15 waterbird nests and 35 upland bird nests. These results indicate that although the proportion of waterbird nests was higher than predicted, total impacts to nesting birds may be lower than predicted.

APPENDIX A

2018 Study Summary Report

Water Bird Mitigation Project

Year One: Field Season and Research Report
March 2019

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Trent University, Environment and Climate Change
Canada and Agnico Eagle Mines Ltd.

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Water Bird Mitigation Project

Year One: Field Season and Research Report – March 2019

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 manipulation 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 these landscapes leading to loss in nesting habitat there is an even greater chance for 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).

Project Overview

Adult Least Sandpiper

Agnico Eagle Mines Ltd. has proposed the Whale Tail Project, approximately 130km North of Baker Lake, NU. The project includes the construction of two dykes within Whale Tail Lake that will divert water from the proposed mining pit into the surrounding lakes and tributaries, resulting in flooding that will elevate the water levels by 4 m above current levels over two years, causing approximately 157 ha of tundra to be flooded

Semipalmated Sandpiper nest with four chicks

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.

This research project is a collaboration between Trent University, Environment and Climate Change Canada and Agnico Eagle Mines Ltd. Its intent is to explore mitigation options for the proposed flooding during the construction of the Whale Tail Pit. Mitigation options seek to deter birds from nesting in high-risk areas, so that the impacts from mining-induced flooding or other localized disturbances can be minimized. Through the experimentation with the use of deterrents, we can add to the understanding of mitigation options for protecting birds.

The objective of the research is to assess the degree of risk posed to migratory birds by mining-induced flooding during the nesting period, and to determine what the most effective bird deterrents are and the manner in which these deterrents should be applied. The two board study objectives, and their respective sub-objectives are as follows:

Objective 1: Determine the impact of mining-induced flooding on nest loss, success and dispersal of arctic-nesting birds, by quantifying the timing and distribution of nesting behaviour relative to the timing and distribution of the flooding. This objective will be met through the completion of three activities:

- **A:** Census the pre-determined flood zone for active nests of arctic-nesting birds to determine the numbers of nests and the density of breeding birds within the flood zone.
- **B:** Document dispersal distance after flooding-induced nest losses as well as the likelihood of re-nesting, and the changes in nest densities in areas adjacent to the flood zone by tracking movements of banded birds.
- **C:** Determine the timing of post-flooding re-colonization by breeding birds, by documenting nest densities as a function of time post-flooding.

Objective 2: Evaluate mitigation options for deterring arctic-nesting birds from nesting in potential flood zones. This objective will be met through the completion of three activities:

- **A:** Compare effectiveness of two deterrent treatments (Treatment 1: flash tape, predator effigy and predator calls. Treatment 2: predator effigy and predator calls) with a control (no deterrents), in reducing nesting bird densities.
- **B:** Determine individual behavioural responses of female Lapland Longspur (the most abundant species) to deterrent treatments, by observing the difference in time on and off the nest between treatment and control plots with the use of temperature loggers.
- **C:** Evaluate the human and financial resources required to erect and maintain the deterrent treatments used in the experiment, to determine their efficiency and practicality.

Year One – 2018: Overview

2018 was the first of three field seasons for the study. The 'Waterbird' field crew, including Gillian Holmes, MSc Candidate, and technicians Sarah Bonnett, Jessica Ballie, and Nathalie Paquette, along with ECCC biologist, Dr. Paul Smith arrived to Meadowbank Mine on June 4th. On the first day at Meadowbank, the crew received safety training and a tour of Meadowbank from staff of the Environmental Department. On June 5th the Waterbird crew of five drove up to Amaruq Mine where they stayed for the duration of the field season. The crew arrived to a landscape of 100% snow cover, with few migrating birds. Within a few weeks, the snow cover had receded, and the landscape was lush with vegetation and busy with nesting birds. Additional crew members that arrived during the 2018 field season were Dr. Erica Nol (Trent University) and Jean-Françios Dufour (ECCC/CWS).

Objectives

A key objective for year one was to obtain baseline data within the pre-determined flood zone prior to the flooding event. This involved a census of the two diversion sites outlined in the Migratory Birds Protection Plan (2007) by Golder Associate; the Whale Tail (South Basin) Diversion and the Northeast Diversion.

Methods

The first season of data collection involved setting up 21 plots along Amaruq Road between Amaruq Camp and Kilometer 48. As the landscape was 100% snow covered when we arrived, plots were chosen with the use of Ecological Land Classification maps and ground truthing during freshet. Plots are 200 x 300 meters (6 ha), covering a mix of low-lying wet sedge habitat types representative of the habitats proposed to be flooded around Whale Tail Lake. The purpose of the plots was to allow spatially-independent samples in which to test deterrents.

We surveyed 18 out of the 21 plots repeatedly throughout the six-week field season to locate and monitor nests. Three of the most distant plots could not be monitored consistently because of time constraints. At the end of the field season, all 21 plots were surveyed for habitat types and unique land formations; photos were taken at all four corners of the plot for future reference.

Rock Ptarmigan nest with eggs

The crew conducted a census of nests present within the flood zones between June 24 – 25 and June 29 - July 2, with a complete census of the Whale Tail Diversion site carried out on June 25. After an initial survey within the entire area of the Whale Tail Diversion site for bird presence and habitat types the Whale Tail diversion site was sectioned into three main areas (WT1, WT2 and WT3). These areas were selected based on the habitat quality (predominately sedge meadow), low elevation, and presence of nesting birds. The crew was helicoptered out to the three sections over three days (June 29 – July 1). The crew spent a full day at each section, surveying for nests and nesting birds. A census of The Northeast Diversion in its entirety was conducted on June 24 and July 2 in its entirety.

The flood zone census involved walking a transect with four surveyors spread out 10 meters from the edge of the lake to the proposed flood line as determined by topographic maps on Garmin Basecamp. Surveyors were spread out between 15-30 m apart to cover an even amount of area. Surveyors walked in unison with their eyes on the ground to spot flushing birds or other breeding activity. When a bird was spotted, 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 is used to mark each nest found, and observations and notes were written in a field notebook.

First Season Results

Nests and Initiation Dates

Within the 18 regularly-monitored plots, we found a total of 59 nests. In and outside the plots we found 110 nests of 12 species that we monitored for the full breeding season. Nests fledging at least one young were considered successful, and nest success is reported as successful/total nests (i.e., “apparent” nest success). The overall estimated nest success rate of all species was 52%. Lapland Longspur was the most abundant species with 48 total nests and an estimated success rate of 46%. Semipalmated Sandpiper was the most abundant shorebird species, with 14 nests and an estimated success rate of 71%.

Nest initiation date was back-calculated through egg flotation (Liebezeit et al. 2007), or by assuming that 1 egg was laid per day. The first nest found was on June 12th (Horned Lark); the female was applying nest lining and had not laid any eggs. The earliest estimated date of nest initiation was June 11th (Rock Ptarmigan). The first observed nestlings were Horned Lark on June 27th, which were estimated to have hatched on June 25th. Known causes of failure were predation, abandonment and intraspecific competition (dispersal of eggs at nest and observed male competition for a female).


Adult female Horned Lark with nesting material

Within the proposed flooded zones, we found 50 active nests of 8 species over 6 days of surveying during peak to late incubation (June 24 – 25 and June 29 - July 2). Within the Northeast Diversion, we found 15 nests over two days of surveying and within the Whale Tail Diversion site, we found 35 nests over 4 days of surveying.

We found 1 Lapland Longspur nest with a one-day old nestling on July 1st and found 1 Lapland Longspur nest with 1 egg on July 1st, which is suspected to be a second nest attempt since it was laid so late in the season. Out of the 50 nests, 30 individual birds of 4 species were banded with individual markers so that they may be identified in the 2019 field season, to determine if they breed nearby once they are prevented from returning to their breeding territories by flooding. Tables outlining nests found within flood zones can be found in Appendix III.

Territory and Nest Densities

Nests of tundra birds are difficult to find, and territory density reflects the density of breeding birds for which we did or did not find a nest. Territory density in the flood zone was 3.4 territories per ha, and in the plots, was 1.2 territories per ha. These differences suggest that areas around Whale Tail Lake are more heavily used by birds than our (non-random) sample of low-lying wet sedge habitats selected for plots. These differences will be explored in more detail through GIS analyses to determine the proportional cover of specific habitat types in plots vs. the flood zone, and the relationships between habitat types and bird densities.

Experimental Mitigation

Deterrents were originally proposed to be used at the beginning of the 2018 field season before nesting birds arrived on site. This was so that the deterrents would be erected within the established plots to immediately deter birds from those plots prior to nesting. In addition, we had proposed to test two levels of deterrents to determine which was more effective in dissuading nesting by birds. Due to the late arrival of both visual and audio deterrents to the site, the plots were established without the erection of deterrents.

Once the visual deterrents arrived in late June, we were able to test the effectiveness of flash tape and Jackite© (a hawk kite effigy) deterrents on individual nesting birds. In this preliminary trial, observations were recorded before and after the use of visual deterrents to assess whether the behaviour of nesting birds changed when deterrents were placed within their territory. We found no significant change in the behaviour of incubating birds before or after the use of these deterrents. Audio deterrents did not arrive in Val d'Or until early to mid-July and were not shipped to Amaruq in time for testing. These preliminary results are not conclusive. Further evaluations of the effectiveness of deterrents will be carried out during the second year of the study.

Erected deterrents; 10m string of flash tape and Jackite© hawk kite effigy

Year 2 – 2019: Upcoming Season

Objectives

Lapland Longspur pair, left: male, right; female

The objectives for Year 2 of the study are to determine the impacts of incremental flooding on arctic-nesting birds, to test the efficiency of deterrents as outlined above, and to evaluate the costs and labour required to use these deterrents.

Experimental Design - Plots

At the beginning of the 2019 study season, deterrents will be erected within the first week of our arrival (last week of May), preferably before snow melt, so that we may deter birds from nesting within the treatment plots as they arrive to initiate nesting territories. Each of the 15 plots will be assigned randomly, to one of two deterrent treatments or a control. Treatment one is considered the most labour-intensive, consisting of audio deterrents playing a mix of predatory and distress calls paired with Jackite© predator effigy, and a 10 x 10 m grid of flash tape. Treatment two is less labour-intensive, consisting of audio deterrents and an effigy only. Control plots will have no deterrents. Comparisons of densities of all nest and territories, between year one and two of the study and between treatment and control plots, will determine if the deterrent applications were successful in deterring birds from nesting within the plots. This experimental approach will allow for strong inferences about the effectiveness of deterrents in the areas proposed for flooding.

Additionally, Tinytag© temperature probes will be deployed in Lapland Longspur nests found within the experimental plots; ten placed within treatment plots and ten placed within the control plots. The Tinytag© records temperature of the nest during incubation, demonstrating a change in temperature when the nesting bird leaves the nest for an incubation recess. We can use this information to determine if the presence of deterrents alters bird's nesting behaviour.

Flood Diversion Monitoring

The Whale Tail Diversion site has been proposed as the primary site during flood monitoring for the second year of the study. As mentioned above, three main sections (WT1, WT2, and WT3) of the Whale Tail Diversion demonstrate a dense abundance of nesting birds and high-quality habitat. These sections will be monitored for breeding birds and nests, capturing and marking of nesting birds, measuring water levels as flooding occurs in increments, and monitoring the dispersal of marked birds post-flooding.

Helicopter flights are the most practical way to access two out of the three of the Whale Tail Diversion sites. The experimental plots can be accessed easily by truck or by foot, but assistance from a helicopter during erection of deterrents, (specifically to assist with deployment of heavy 12V batteries), would ensure a smooth set up. Monitoring of all plots will rotate over five days in order to check nests in a timely manner and ensure the maintenance of deterrents.


Lapland Longspur nest with eggs

Review of Literature

One way of limiting impacts of human infrastructure and development on wildlife is by discouraging them from interacting with at risk areas. This can be achieved with the use of deterrents. Deterrents come in a variety of forms, from visual deterrents (e.g. flash tape, flares, helium balloons), to acoustic deterrents (e.g. cannons, predator and prey distress calls, bangers and crackers) and perceived predation (e.g. canines, falconry). Deterrents have been used as a way to discourage pest birds from congregating in human made landscapes for many decades. Some of these landscapes include airports, where domestic canines are used to deter birds from congregating on airstrips and subsequently colliding with aircrafts (Patterson 2000). Agricultural lands and fisheries use deterrents to limit yield loss, as demonstrated as early as the 1980s when Conover (1985) used an effigy of an animated crow-killing owl model to deter crows from feeding on crops in Connecticut. Andelt et al. (1997) used a combination of pyrotechnics, flashing lights and human effigies to deter herons from occupying fisheries. Additionally, urbanized areas such as parks and subdivisions are areas of congregation for blackbirds and other flocking passerines. Mott (1985) used helium-filled balloons as a method for dispersing blackbirds and starlings from urbanized areas in the southeastern United States to prevent flocks from becoming a greater nuisance. Deterrents are a practical tool to prevent wildlife from destroying property and to reduce harm to wildlife in at risk areas (Cleary and Dolbeer 2005; Schlichting et al. 2017).

There are many studies related to the use of deterrents for discouraging birds from mining sites. More often, studies are conducted to deter migratory birds from landing on tailing ponds or inhabiting environmentally disturbed areas. One of the earliest documentations observing the efficiency of deterrent use at tailing ponds was conducted by Boag and Lewin (1980) in the boreal forest of Alberta. In their study, they tested three types of deterrents; a simulated flying falcon effigy, aluminum reflectors suspended from a frame and a human effigy. The researchers reported their efficiency in preventing waterfowl from entering natural and artificial pond by comparing daily counts of waterfowl on the testing ponds before and after the use of deterrents. Results of the experiment varied by species with habituation occurring most commonly with birds that settled on the ponds, but ultimately these researchers found that 100% efficiency was not obtainable with any of their combinations of deterrents.

Habituation is the one of the greatest challenges in successfully deterring birds. Birds habituate within a few days to visual deterrents such as effigies, even when performing simulated actions (Conover 1985). To combat this, Ronconi and St. Clair (2006) used a radar-activated on-demand hazing system for deterring waterfowl from oil sands tailing ponds. Bird densities were compared between ponds when two sets of deterrent systems were applied and with periods where no deterrents were used. The first treatment type consisted of human effigies and propane cannons that were programmed to set off continuously at random time intervals. The second treatment consisted of a robotic peregrine falcon effigy with speakers broadcasting peregrine calls, a high-intensity strobe light and a propane cane. Additionally, the second treatment included an on-demand radar-activated system containing a marine radar linked to a computer station where incoming birds were detected by the radar, which then activated deterrents. Results of the study showed that bird landings were significantly less likely to occur with the second treatment (on-demand system) than the control, while the use of the first treatment (human effigies and cannons) did not result in any change in the number of incoming birds in comparison to that of the control. Another important finding from this study was that shorebirds were more likely to land on ponds than ducks, which may demonstrate that shorebirds may be more difficult to deter (Ronconi et al. 2004). Overall, the study demonstrates a solution to habituation by birds and contributes knowledge of behaviour of birds during migration.

The use of deterrents has been successful in mitigating impacts of pollution on migratory birds, but there is little research on how to deter birds from nesting (Marcus et al. 2007) or mitigating impacts on offspring in at risk areas (Kruk et al. 1997; Gentes et al. 2007). Consequently, there is a gap in literature related to the use of deterrents for preventing nesting of migratory birds. With a limited budget and a need for effective but inexpensive deterrent methods, I found through this research that the most applicable deterrent methods were audio and visual deterrents. Furthermore, a combination of both increases efficiency (Andelt et al. 1997;). With this, I came up with the methods of using flash tape in grid format, along with predator and prey calls with the additional use of a hawk kite effigy. Treatment experiments are outlined in the "Next Steps" portion of this report.

Flash tape, as a visual deterrent, has shown to be the most effective at deterring birds from nesting (Kruk et al. 1997) when placed densely in nesting habitat, as done by Marcus et al. (2007) where flash tape was placed in a 7 x 7 m grid within experimental plots (0.36 ha) to deter Piping Plovers and Least Terns from nesting in gravel mines. Results demonstrated that out of 120 nests initiated in the study plots, 3% were found in deterrent plots within the first year of the study. Both species selected none treatment plots over deterrent plots, and for those individuals who did nest in deterrent plots, nest success did not appear to be impacted by the flash tape. The study suggested that an unaccompanied flash tape grid treatment was successful in offering a considerable decrease in the number of nesting birds. With that, the authors suggest continued maintenance of the flash tape grids to ensure continued efficacy throughout the breeding season. Additionally, studies have shown that birds are less likely to nest in areas with

Horned Lark nest with chicks

higher predation (Møller et al. 2017). Within my study, the use of audio deterrents to play predator calls in addition to a flash tape grid could have a greater efficacy of deterring breeding birds. By using a mix of predator effigies, predator calls and distress calls from prey birds that mimic predation (Pearson et al. 1967; Conover 1985), there is an increase in the apparent risk of predation, which will contribute to an individual's assessment in the quality of the nesting habitat. These deterrents are cost effective, maintenance is necessary but practical, and the deterrents can be easily distributed through plots within the appropriate time frame to ensure that deterrents are erected when birds arrive on the birding grounds at Whale Tail Lake, NU.

Significance

Mitigation options seek to deter birds from nesting in high-risk areas, so that the impacts from mining-induced flooding or other localized disturbances can be minimized. Through the use of experiments to assess the efficacy of deterrents, we can add to the understanding of mitigation and conservation of at-risk species. The understanding of deterrents and their applications is well studied in relation to migratory birds and tailing ponds at mining sites (Ronconi et al. 2004; Ronconi and St. Clair, 2006), but there are few studies relating to the use of deterrents for nesting birds (Marcus et al. 2007) and the impact of mining disturbances such as flooding. I anticipate that the results of the proposed research will add to the knowledge of deterrent use for nesting birds, specifically those at risk of decline, such as arctic-nesting birds (Wauchope et al. 2016).

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. The applications developed within this study aim to add knowledge related to mitigating impacts of disturbance to at risk species in already vulnerable habitats. Furthermore, outcomes of this study can be applied in the future to ensure that vulnerable populations are able to sustain their numbers in a changing environment.

References

Andelt, W.F., T.P. Woolley and S.N. Hopper. 1997. Effectiveness of barriers, pyrotechnics, flashing lights, and scarey man for deterring heron predation on fish. *Wildlife Society* 25(3): 686-694.

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.

Boag, D.A. and V. Lewin. 1980. Effectiveness of three waterfowl deterrents on natural and polluted ponds. *Journal of Wildlife Management* 44(1): 145-154.

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.

Conover, M.R. 1985. Protecting vegetables from crows using an animated crow-killing owl model. *Journal of Wildlife Management* 49(3): 643-645.

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*.

Gentes, M.L., T.L. Whitworth, C. Waldner, H. Fenton and J.E. Smits. 2007. Tree swallows (*Tachycineta bicolor*) nesting on wetlands impacted by oil sands mining are highly parasitized by the bird blow fly *Protocalliphora spp*. *Journal of Wildlife Diseases* 43(2): 167-178.

Kruk, M., M.A.W. Noordervliet and W.J. ter Keurs. 1997. Survival of Black-tailed Godwit chicks *Limosa limosa* in intensively exploited grassland areas in the Netherlands. *Biological Conservation* 80: 127-133.

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.

Liebezeit, J.R., P.A. Smith, R.B. Lanctot, H. Schekkerman, I. Tulp, S.J. Kendall, D.M. Tracy, R.J. Rodrigues, H. Meltofte, J.A. Robinson, C. Gratto-Trevor, B.J. McCaffery, J. Morse and S.W. Zack. 2007. Assessing the development of shorebird eggs using the flotation method: species-specific and generalized regression models. *Condor* 109: 32-47.

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

Møller, A.P., Z. Kwiecinski and P. Tryjanowski. 2017. Prey reduce risk-taking and abundance in the proximity of predators. *Current Zoology* 63(6): 591-598.

Mott, D.F. 1985. Dispersing blackbird-starling roosts with helium-filled balloons. Second Eastern Wildlife Damage Control Conference. 34.

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/.

Patterson, B. 2000. Wildlife control at Vancouver international airport: introducing border collies. International Bird Strike Committee.

Pearson, E.W., P.R. Skon and G.W. Corner. 1967. Dispersal of urban roosts with records of starling distress calls. *Wildlife Society* 31(3): 502-506.

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.

Ronconi, R.A., C.C. St. Clair, P. O'Hara and A.E. Burger. 2004. Waterbird deterrence at oil spills and other hazardous sites: potential applications of a radar-activated on-demand deterrence system. *Marine Ornithology* 32: 25-33.

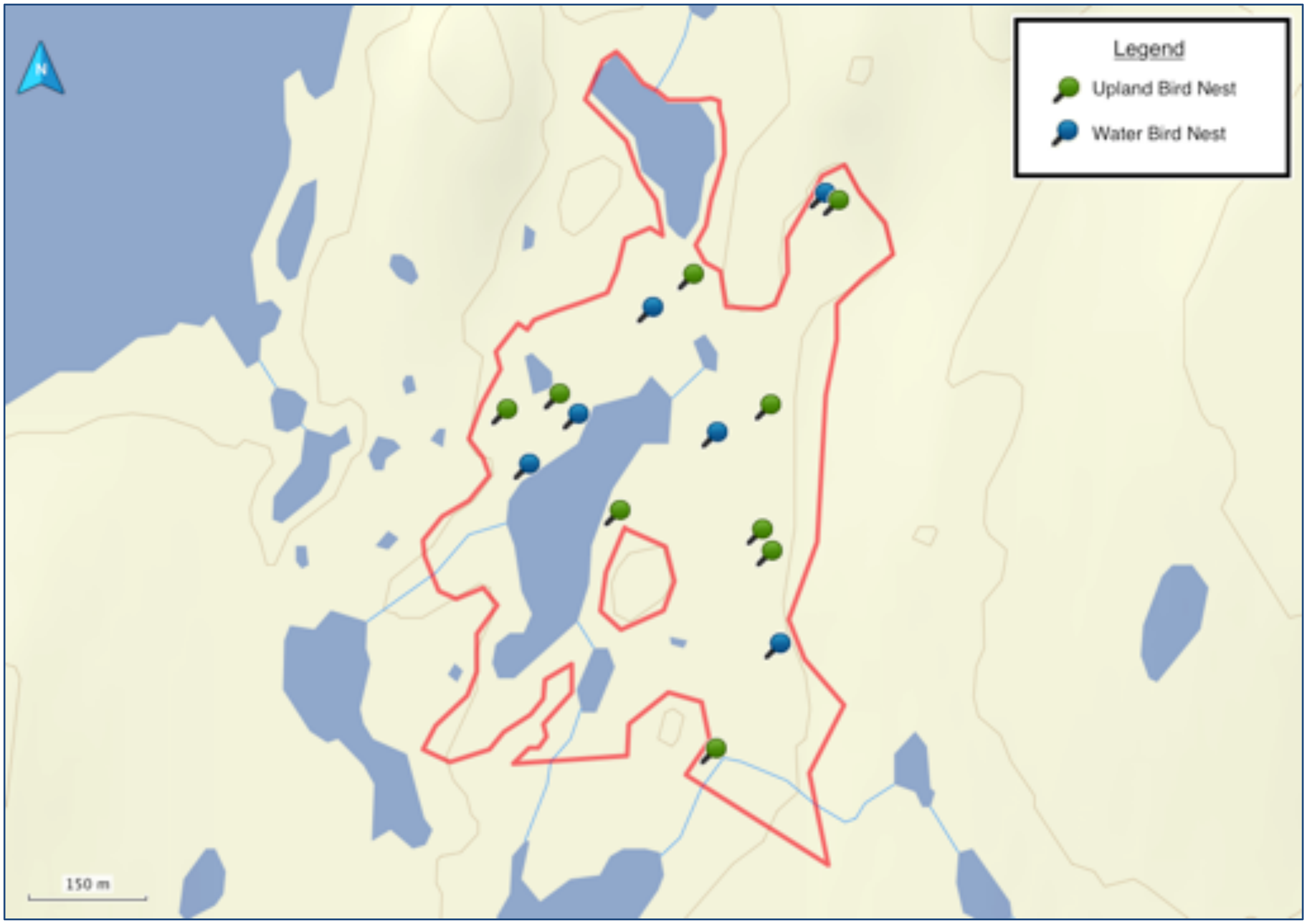
Ronconi, R.A. and C.C. St. Clair. 2006. Efficacy of a radar-activated on-demand system for deterring waterfowl from oils sands tailings ponds. *Journal of Applied Ecology* 43: 111-119.

Schlichting, P.E., A.E. Holland, J.C. Beasley, A.L. Bryan, R.A. Kennamer, T.L. DeVault, B.F. Blackwell and O.E. Rhodes, Jr. 2017. Efficacy of an acoustic hailing device as an avian dispersal tool. *Wildlife Bulletin* 41(3): 453-460.

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).

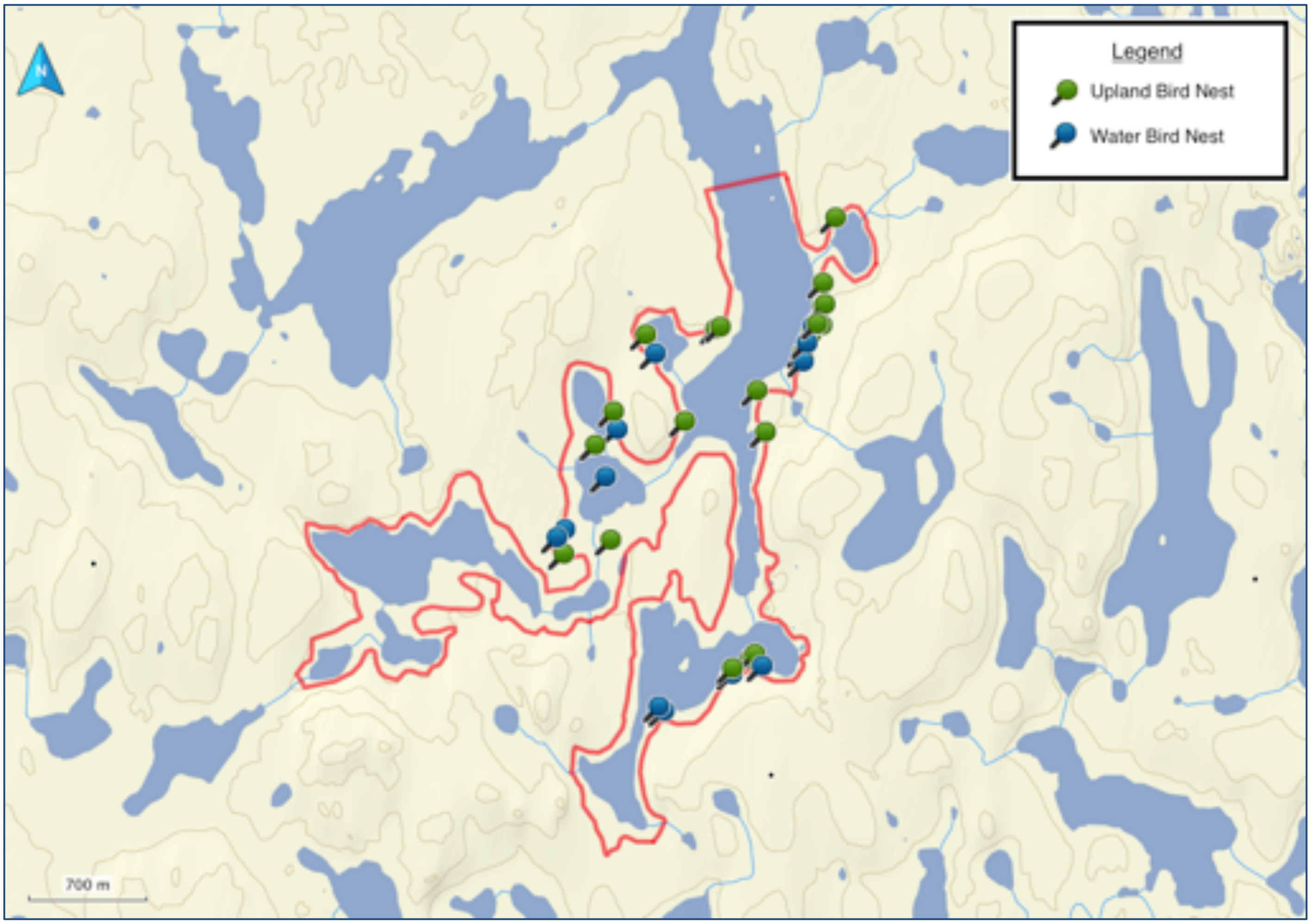
Wilson, R.R., J.R. Liebezeit and W.M. Loya. 2013. Accounting for uncertainty in oil and gas development impacts to wildlife in Alaska. *Conservation Letters* 6(5): 350-358.

Appendix I



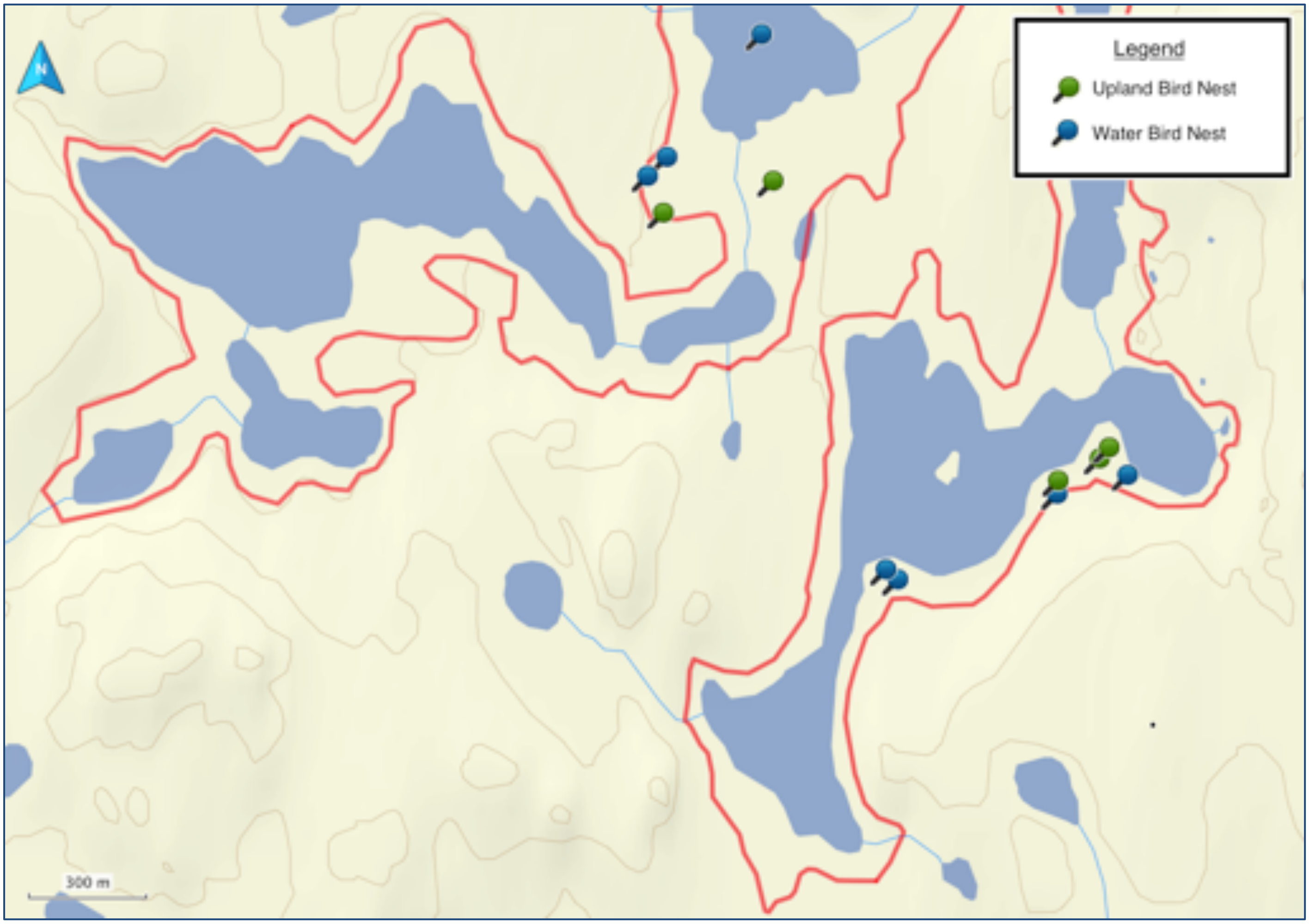
Map of Northeast Diversion proposed flood zone with nest waypoints found in 2018

Appendix II



Map of Whale Tail Diversion proposed flood zone with nest waypoints found in 2018

Map of the northern portion of Whale Tail Diversion proposed flood zone with nest waypoints found in 2018



Map of the southern portion of Whale Tail Diversion proposed flood zone with nest waypoints found in 2018

Appendix III

Table 1: Nests found within the flood zone of all diversion sites (Whale Tail Diversion and Northeast Diversion) split into types and species.

Type	*Species*	*Number of Nests*
Upland bird	Lapland Longspur	25
	Horned Lark	2
	Savannah Sparrow	5
	Common Redpoll	1
Water bird	Semipalmated Plover	1
	Least Sandpiper	5
	Semipalmated Sandpiper	8
	Herring Gull	1
	Long-tailed Duck	1
	Northern Pintail	1

Table 2: Nests found within the flood zone of Whale Tail Diversion split into types and species.

Type	*Species*	*Number of Nests*
Upland bird	Lapland Longspur	18
	Horned Lark	1
	Savannah Sparrow	4
	Common Redpoll	1
Water bird	Semipalmated Sandpiper	8
	Herring Gull	1
	Long-tailed Duck	1
	Northern Pintail	1

Table 3: Nests found within the flood zone of Northeast Diversion split into types and species.

Type	*Species*	*Nests Found*
Upland bird	Lapland Longspur	7
	Horned Lark	1
	Savannah Sparrow	1
Water bird	Semipalmated Plover	1
	Least Sandpiper	5