Arctic Coastal Birds and Ecosystems

Environment and Climate Change Canada
2018 Field Season and Research Report

2018 Field Season Overview

Our research program is focused on the ecology and conservation of Arctic birds and their habitats. Two key themes are 1) evaluating the influence of changing conditions in the Arctic on the breeding ecology of tundra birds and 2) developing innovative approaches to improve knowledge of population status.

One important focus of our work is to understand the effects of overabundant Arctic geese on species such as shorebirds and gulls that nest in the same areas. Few studies have evaluated the impact of overabundant geese on other birds but the possibility exists for strong effects, operating through habitat change or altered predator/prey dynamics. Another key current project involves the use of tracking technology (primarily the MOTUS network) to enhance the monitoring of bird populations. We're combining modern technology with modern statistical methods to integrate behavioral data into monitoring programs, in order to improve our understanding of birds' population status. At the core, our research seeks innovative solutions to conservation challenges.

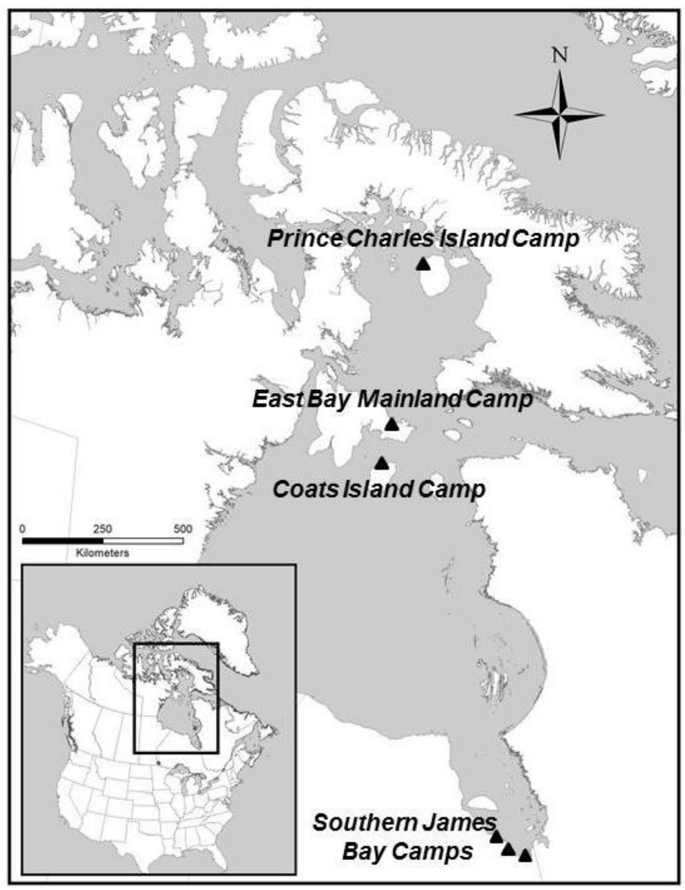


Figure 1. Map of ECCC shorebird research sites in the eastern Canadian Arctic and SubArctic James Bay.

The field camp at East Bay Mainland in early June, 2018

In 2018, we operated out of our primary low-Arctic field site (Figure 1): East Bay Mainland (Qaqsauqtuuq) on Southampton Island, NU. This year marks twenty years of continual monitoring of Arctic-breeding birds, vegetation and climate by Environment and Climate Change Canada (ECCC) from the East Bay Mainland Camp. This site has become one of the most valuable long-term northern monitoring and research stations in Arctic North America. We also carried out field studies in southern James Bay, in collaboration with the Canadian Wildlife Service (CWS). These James Bay sites are used by thousands of shorebirds during their southward migrations in July - September. We did not work at the Coats Island or Prince Charles Island shorebird sites in 2018, although we plan to revisit Prince Charles Island in 2019, and continue to use the data collected there in previous years in our research.

East Bay Mainland

2018 was a year of difficult weather and snow conditions across the Eastern Arctic, and this presented several challenges for the shorebirds breeding at East Bay. The late spring likely contributed to the small number of shorebird nests found: 57 nests were found in 2018, compared to 131 nests in 2017, making 2018 one of the lowest nest counts in the 20 year history of the study. The season was marked by cool temperatures and late snow melt, and similarly bad breeding conditions for shorebirds were observed as far away as Greenland. There were only 5 Red Phalarope nests found this year; much lower than the 61 nests found in 2017.

White-rumped Sandpiper nest with hatchlings at East Bay Mainland

Red Phalarope numbers have varied widely over the 20 years of study, but with the exception of 2017, are much less abundant than they were in the early 2000s. Other species too, especially the Ruddy Turnstone, have declined noticeably in abundance since the late 1990's when monitoring began.

Clockwise from top left: White-rumped Sandpiper (foreground) and Dunlin (background), pair of Red Knots, Semipalmated Plover, and Red-necked Phalarope. Red Knots are an endangered species that has declined by >80% since the 1970s; Southampton Island is one of the most important breeding locations for this species. Red-necked Phalaropes have also declined. They were absent from East Bay in the early 2000s, but are starting to return.

The hatching success of shorebird nests was lower in 2018 than in 2017, but still better than 2016 (also a poor year for shorebirds). In 2018, 12% of nests hatched chicks, compared to 21% in 2017, only 4% in 2016 and 0% in 2015. These rates of nest success are lower than for sites elsewhere in the Arctic. Most of these nest failures are due to predation, and Parasitic Jaegers were the primary predator of nests that were monitored by remote cameras. This year there appeared to be lower numbers of nesting geese at East Bay, potentially due to the late spring, and no Snow Goose nests were found near the camp. In turn, predators like Arctic foxes and Jaegers may have turned to shorebird nests as a food source. Unusually high numbers of Ross' Goose were observed compared to previous years, although we did not find Ross' Goose nests near the East Bay camp (most Snow and Ross' Geese nest farther west).

Another notable occurrence this year was a high proportion of abandoned nests (7%, compared to <3% in typical years). This may have been a result of the late snowmelt and cold weather. Alternatively, there were frequent sightings of snowy owls and peregrine falcons that may have nested nearby, and nest abandonment may have been a result of adult mortality due to avian predators. We found that shorebird egg shells were unusually thin in 2018, perhaps due to a lack of food available in the early season while eggs were being developed.

This year, in addition to our normal science program, we recaptured 3 geolocators that had been deployed on Arctic Terns in 2017 as part of a multi-site collaboration with other researchers throughout North America. We had deployed 20 geolocators in 2017 and re-sighted many with geolocators in the early season of 2018. We hoped for a better recapture rate, however recapture was impossible for several individuals due to a storm that flooded all but one of the Arctic Tern nests. One Sabine's Gull with a geolocator was sighted, but no nest was found and this individual was not recaptured. We will attempt to recapture these birds again in 2019.

Caribou sightings were common at East Bay this year

Project Highlights

Much of the work at our field sites is done in partnership with universities and other organizations. Students play an important role in our research, and we describe some of the 2018 highlights of these student-led projects below. These students and postdoctoral fellows are supervised by Paul Smith, in collaboration with colleagues at Trent, Carleton and York Universities.

Right: MSc student Brandan Norman measures a shorebird chick at East Bay

Effects of growing populations of snow geese on Arctic-breeding shorebirds

Lisa Kennedy – PhD Candidate, Trent University

Snow geese are increasing in abundance across the Arctic and breed sympatrically with shorebirds. However, interactions between increasing snow goose populations and declining shorebirds are poorly understood. Lisa's project hypothesizes that high densities of snow geese negatively impact shorebird breeding success through direct physical goose presence and/or the indirect effects of habitat degradation from extensive foraging or from attraction of predators. In addition to direct or indirect effects on nest survival, shorebirds may suffer other consequences from the presence of geese such as disruption of incubation behaviour, or increased levels of stress leading to poorer physical condition. Similarly, the behaviour or physiology of shorebirds could be influenced indirectly by changes in habitat quality stemming from goose foraging or increased predator abundance near goose colonies. Lisa's thesis aims to bring empirical evidence to the relative importance of each of these potential mechanisms of interaction between geese and sympatric shorebirds using East Bay and Coats Island as study sites. Lisa has completed the data collection phase of her project and is in the final year of study, with thesis chapters investigating:

(i) goose impacts on shorebird nest concealment and nest success over the past 15 years for East Bay and Coats Island,

(ii) whether shorebird incubation behaviour is influenced directly by disturbance from snow geese, or indirectly through habitat degradation by monitoring time on and off the nests using time-lapse cameras, and

(iii) how shorebirds might be physiologically compromised by the presence of snow geese as a result of disturbance and stress by evaluating differences in body condition, stress hormones, parasites and egg volume across sites with varying levels of goose disturbance.

Preliminary results suggest that shorebirds have reduced physiological condition in response to degraded habitat around snow goose colonies. This reduced condition is reflected in lower size-corrected body mass for shorebirds at East Bay versus Coats Island, where no snow goose colony occurs. We also found evidence of higher baseline corticosterone and total white blood cell (WBC) counts in areas near snow goose colonies, but did not find a response in several other physiological parameters that we measured such as heterophil to lymphocyte ratios, difference in baseline to heightened stress response, and the number of polychromatic cells in the blood. This demonstrates that the physiological response of individuals to habitat degradation varies, and that comprehensive assessments of condition provide a better indication of condition than any single physiological parameter.

Lisa has been active in the public sphere promoting her research on shorebird ecology at East Bay, including as an invited speaker at the Kachemak Bay Shorebird Festival in Homer, Alaska, May 2018, where she presented some of her work on the interactions between shorebirds, weather conditions, and predators, and the impacts on shorebird nesting success.

Lisa presenting at the 2018 Kachemak Bay Shorebird Festival in Homer, Alaska.

Effects of geese on predator abundance and risk of predation for sympatric-nesting shorebirds

Scott Flemming – PhD candidate, Trent University

Much of our recent research focuses on the impacts of overabundant geese on Arctic ecosystems

An important focus of our research is to understand how geese are influencing Arctic habitats and predator-prey relationships, and what this means for other birds. Overgrazing by growing Lesser Snow Goose populations has had adverse impacts on the suitability of shorebirds' nesting habitat. Shorebird nesting success near snow goose colonies may also be negatively affected because of increases in the local populations of generalist egg predators. We hypothesized that these negative effects would be most evident when lemmings, the primary prey of generalist egg predators such as Arctic foxes and Jaegers, are scarce.

To address this research question, we first established the relationships between the abundance of lemmings, Arctic foxes and Jaegers at East Bay Mainland using 16 years of field observations to create yearly predator indices. These data revealed three lemmings peaks (Figure 2). Arctic fox were not influenced by lemming abundance, but Jaeger indices were generally higher the year after lemming peaks.

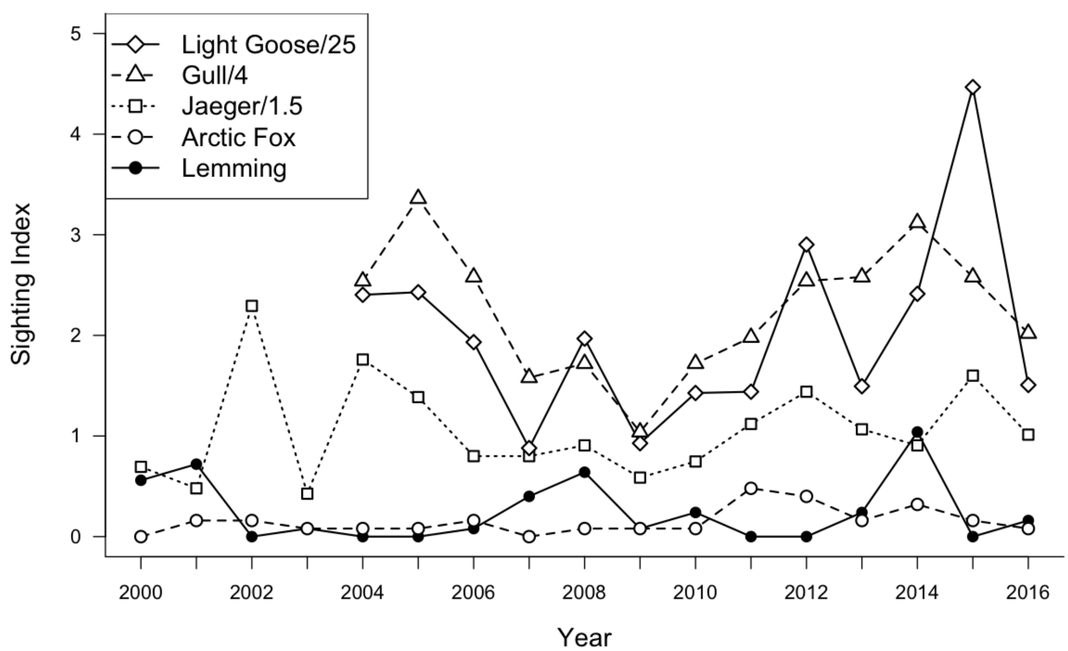


Figure 2. Trends in Snow Goose, Gull, Jaeger, Arctic fox, and lemming sightings per 8-hour person day at East Bay Mainland.

In 2015 and 2016 we placed trail cameras at increasing distances (0km, 3-5km, 8-10km, Coats Island) from the goose colony to collect unbiased predator count data. In these same locations we also placed artificial shorebird nests (four quail eggs) within each habitat type to identify the probability of them surviving a nine day experiment. During the year with low lemming abundance (2015), predator sightings were higher and declined with distance from the goose colony. In 2016, when lemmings were relatively abundant, we found no relationship (Figure 3). This suggests that predators may be concentrating their foraging effort on goose eggs when their primary prey is scarce. Across years, Jaeger indices were lower and both Jaegers and Arctic foxes were sighted less frequently far from the colony than near the colony. Our artificial nest experiment revealed that survival probability was higher when lemmings were abundant, and that when lemmings were scarce survival probability increased with distance from the goose colony. Overall, our results suggest that generalist predators may be mediating interactions between lemmings, snow geese, and shorebirds. Increases in breeding snow goose populations and dampened lemming peaks (a hypothesized consequence of climate change) could therefore be a contributing factor to low reproductive success of shorebirds breeding in the Eastern Canadian Arctic.

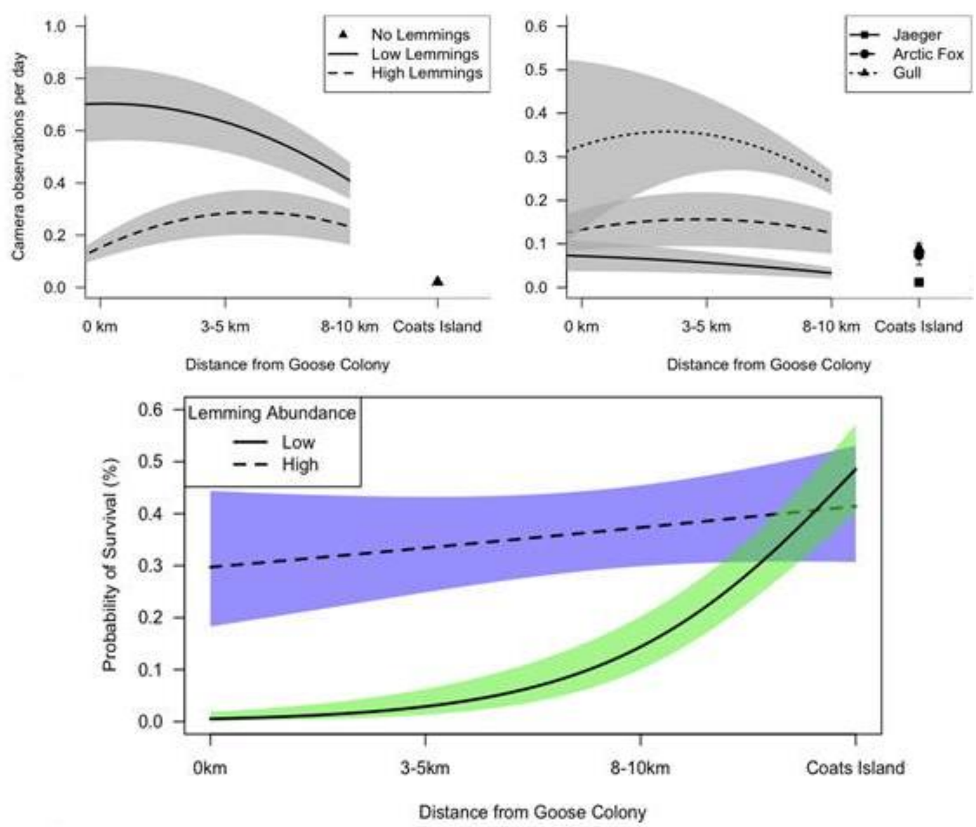


Figure 3. Relationships between distance from goose colony and predator abundance during a low and a high lemming year (top left), and species-specific predator sightings combined over both years (top right). Survival probability of artificial nests placed at increasing distances from a goose colony during low and high lemming abundances (bottom).

Effects of Overabundant Arctic Geese on Freshwater Ecosystems

Dr. Heather Mariash, NSERC Visiting Fellow – Environment and Climate Change Canada

Over the past 4 years, we conducted a freshwater habitat assessment program in the Eastern Canadian Arctic, with the goal of understanding the effects of geese on freshwater ecosystems. Geese have traditionally been viewed as a terrestrial herbivore, so their effects on freshwater systems have not yet been explored across most of the Arctic. However, our work over the past years has showed that they can have a substantial influence on the chemistry and biodiversity in the ponds within areas that they frequent.

This year was the final year for this project, and Dr. Heather Mariash's activities were focused on analyzing and synthesizing data collected in previous years for publication in peer-reviewed journals. Two manuscripts were published and another manuscript is currently undergoing peer review. Key findings from this year included evidence from our study sites on Southampton Island and Prince Charles Island that water chemistry has been changing over the past decade in conjunction with goose population growth.

Heather Mariash filtering water and setting up the nutrient experiment in the wet lab at the East Bay Mainland field camp

We also published experimental evidence that goose droppings in water increase dissolved nitrogen and phosphorus levels, which results in a decrease in the nitrogen:phosphorus ratio and an increase in cyanobacteria in the goose dropping treatment.

We set up a "mesocosm experiment" at East Bay to understand how sedge and goose faeces differ in terms of nutrient transfer. We found that goose faeces transfer nitrogen and phosphorous much more rapidly, leading to changes in the productivity and community in the ponds.

Climate change and the energetics of Red Knot migration

Dr. Sjoerd Duijns, Postdoctoral Fellow – Environment and Climate Change Canada

The *rufa* Red Knot travels the full length of the western hemisphere during its migrations, doubling and halving its body mass en route. Our recent research on this endangered species used banding data and MOTUS wildlife telemetry to link energetic status to subsequent breeding success and survival. This work showed the profound influence of wind conditions on the migration performance of Red Knots; in years when significant adverse wind conditions are encountered, Red Knots can suffer significantly reduced breeding success and/or survival.

A Red Knot resighted at East Bay in 2018 that was previously banded in Delaware Bay, New Jersey, during migration

Climate change is thought to have altered wind conditions in ways that could impact migratory birds, but the consequences are still largely unknown. Dr. Sjoerd Duijns is currently reviewing the changes in wind conditions that migrating Red Knots have encountered over the last 50 years, to assess the energetic implications of these changes on the body condition and potential breeding success of Red Knots. Figure 4 shows the large variation in estimated cost of migration for two parts of Red Knot migration over a 50 year timespan, based on wind conditions, body mass, and departure timing. The results of this project, in conjunction with previous work, will provide important insights into the role of energetic challenges during migration in explaining demographic changes in this endangered species.

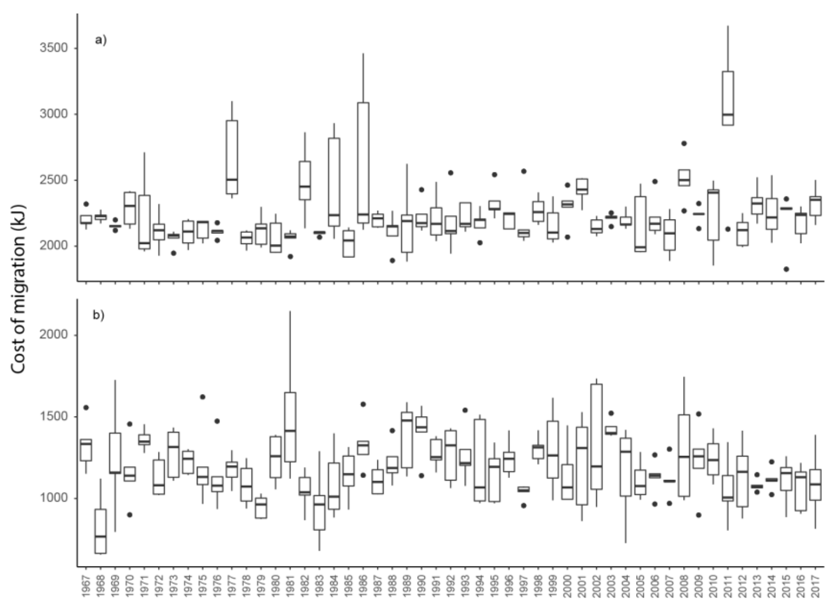


Figure 4. Overview of the cost of migration for Red Knots, for two migration legs: a) departing from Maranhão, Brasil, and migrating to Delaware Bay, USA, and b) from Delaware Bay to Nelson River, MB.

Improving Migration Monitoring and Tracking

Dr. James McLaren, NSERC Visiting Fellow – Environment and Climate Change Canada

Dr. McLaren is studying the migratory behaviour of Arctic-breeding shorebirds using modeling techniques and data from the Motus Wildlife Tracking Network for radio-tagged birds. These data provide unprecedented resolution, with hundreds of towers sampling every 6 seconds. This sheer volume of data presents unique challenges, and unique opportunities, for analysis. Dr. McLaren is using diverse modelling approaches to deduce flight trajectories, stopover durations at staging areas, and birds' behaviour in response to wind conditions.

Dr. McLaren's research focus in 2018 has been to assess the exposure of Arctic-breeding shorebirds to offshore wind energy development areas along the Atlantic coast of the United States (Figure 5), and to study how heterogeneity in life-history strategies and capture phenology of radio-tagged shorebirds influences their apparent stopover duration. Red Knots that were captured at a particular site were found to stay longer at that site than those captured off-site, by an average of 4 days during spring migration and 16 days during fall migration (Figure 6). This suggests that birds that are captured differ in their behaviour, perhaps because of handling effects or because of bias in the sample of individuals that are captured and tagged.

The long-term goal of Dr. McLaren's research is to develop a framework to assess migratory strategies at the individual and population levels in terms of trade-offs and risk aversion, given endogenous and exogenous factors, and the extent to which phenotypic plasticity and within-population diversity allow populations to cope with environmental variability and climate change.

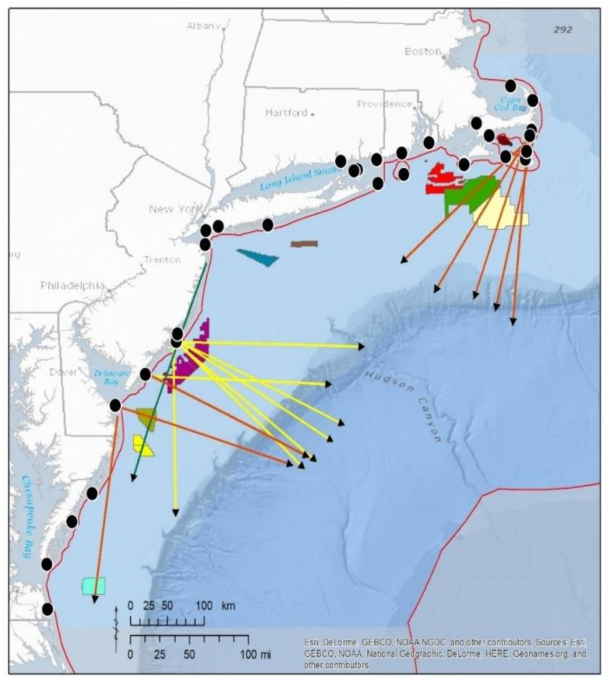


Figure 5. Predicted open ocean migratory trajectories of Red Knots modeled from MOTUS detection data (coloured arrows), showing potential exposure to wind energy development areas (coloured polygons) along the Atlantic coast of the United States.

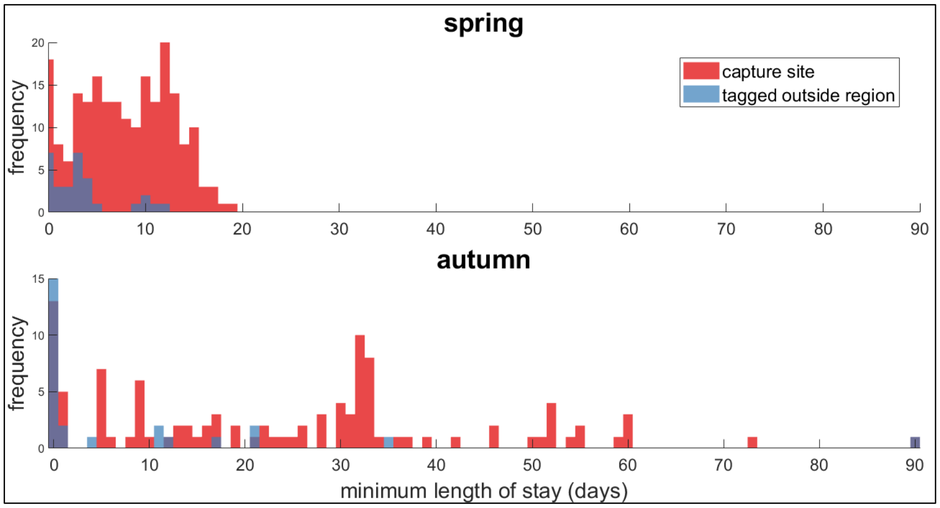
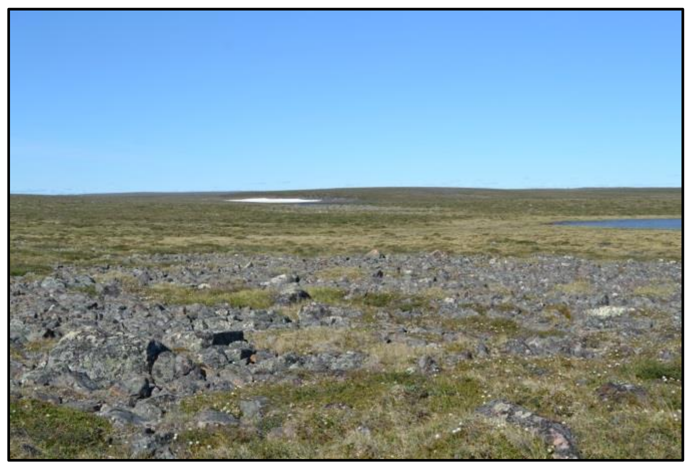


Figure 6. Estimated stopover duration for rufa Red Knots during spring (top) and autumn (bottom) migrations at Quebec's Mingan Archipelago, a major migratory staging area. Red Knots tagged on-site are indicated in red and those tagged off-site are in blue.

Mitigation of mining impacts on Arctic migratory birds using deterrents

Gill Holmes, MSc Candidate – Trent University

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. Gill's study is a collaboration between Trent University, Environment and Climate Change Canada and Agnico Eagle Mines Ltd. and explores options to deter birds from nesting in high risk areas, so that the impacts from mining-induced flooding or other localized disturbances can be mitigated. Agnico Eagle Mines Ltd. has proposed the Whale Tail Project, approximately 90km North of Baker Lake, NU. This project involves the development of a mining pit within the northern portion of Whale Tail Lake. The project includes the construction of two dykes that will divert water from the proposed mining pit into surrounding lakes and tributaries, resulting in flooding that will elevate the water levels by 4 m above sea level over two years, causing approximately 157 ha of tundra to be flooded 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.



Plot 1, overlooking part of Whale-tail Lake and the proposed flooding zone.

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. This study investigates:

i) the timing of bird nest initiation at the study site,
ii) the relationship between nesting phenology and the timing of snowmelt,
iii) the potential impacts of flooding on species-specific nest loss with and without the use of deterrents, and
iv) the individual behavioural responses to deterrent applications any changes in response over time.

2018 was the first of three field seasons for this study. A total of 112 nests of 12 species were found, and nest success was estimated at 52%. The early season was marked by 100% snow cover and very few migrating birds. Within a few weeks, the snow cover had receded, and the landscape was lush with vegetation and busy with nesting birds.

We surveyed 18 plots of 200m x 300m repeatedly throughout the season to locate and monitor nests. The first nest was found on June 12th (Horned Lark), where a female was still applying nest lining. The earliest estimated date of nest initiation was June 11th (Rock Ptarmigan). Lapland Longspur was our most abundant species, with 48 nests and an estimated success rate of 46%. Semipalmated Sandpiper was the most abundant shorebird in the plots, with 14 nests and an estimated success rate of 71%.

Estimated nest densities obtained in plots in 2018 will be compared to the densities in 2020 after the application of deterrent treatments in the established plots, in order to provide advice on how to mitigate the impacts of disturbance on breeding birds in vulnerable Arctic environments.

In 2018, deterrents were tested on several pairs of nesting birds during the nestling phase. In this preliminary trial, we did not find a significant change in behaviour before or after the use of deterrents. In 2019, we will use locally-relevant predator calls as a deterrent and expect a stronger response from birds.

Within the proposed flooding zones, we found 56 active nests from 9 species over 6 days of surveying during peak incubation. Birds from these nests were banded with individual markers so that they can be re-sighted in 2019, during active flooding, to observe if they return to the area and how far they nest from their previous nesting site.

A Lapland Longspur nest with nestlings

Stopover and migration ecology of shorebirds using the southwestern coast of James Bay, Ontario, Canada

Allie Anderson, PhD Candidate – Trent University

Allie's PhD research seeks to understand patterns and drivers of stopover and migration strategies for shorebirds using the southwestern coast of James Bay during southbound migration. This stopover area supports thousands of migratory shorebirds which rest and refuel prior to migrating to wintering areas in South America. Because of the remote location of this area where the boreal forest meets the Arctic Ocean, little is known about shorebird needs and how stopover in this region affects subsequent migration legs and the annual cycle for individual birds. Allie conducted field work for this project from 2014-2017 with the James Bay Shorebird Project coordinated by the Canadian Wildlife Service, Trent University, and Moose Cree First Nation. Allie spent 2018 transitioning into data analysis and thesis writing, which will be completed in 2019.

Research highlights from 2018 include an intensive analysis of shorebird stopover and migration strategies using automated radio telemetry through the Motus Wildlife Tracking System. This study seeks to understand how migration distance and body condition influence shorebird stopover and migration strategies. Allie presented her work on this project at the International Ornithological Conference in Vancouver, British Columbia, in August 2018, including her findings that extreme-long-distance migrants (traveling to southern South America) accumulate larger fat loads, fly with faster ground and airspeeds, and are more likely to make a non-stop flight over the Atlantic Ocean than long-distance migrants (traveling to northern South America; Figure 7). These extreme-long-distance migrants are thought to be declining more so than other shorebird species, perhaps because of the extreme energetic demands of their migrations. Subsequent analyses will assess how refueling rates in James Bay influence migration decisions, and will determine whether changing prey resources are influencing the ability of shorebirds to accumulate the fat required for successful migration to their wintering grounds in southern South America.

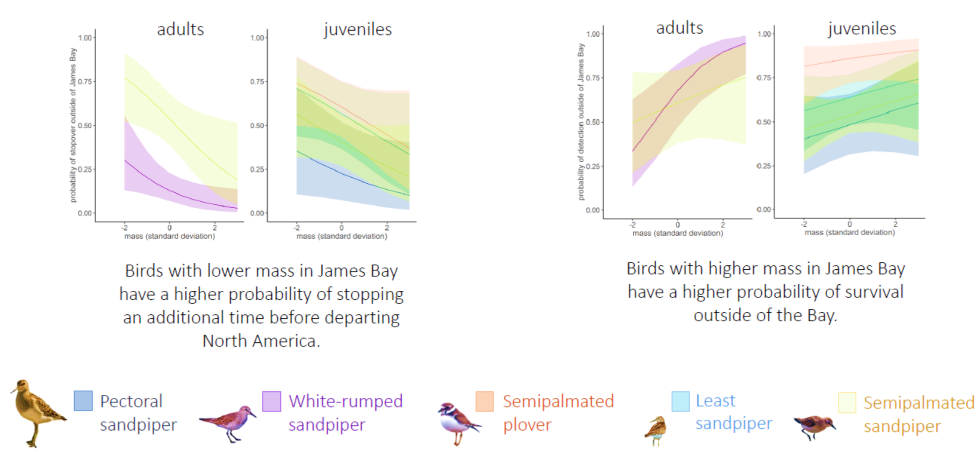


Figure 7. Relationship between mass as measured in James Bay before fall migration and the probability of making additional stopovers during migration (left) and the probability of survival upon leaving James Bay (right).

Importance of James Bay as stopover habitat for endangered Red Knots

Amie MacDonald, MSc Candidate – Trent University

Every year, thousands of endangered Red Knots pass through James Bay during southbound migration between Arctic breeding grounds and non-breeding areas as distant as Patagonia. Despite recording daily maximum counts as high as 6000 birds, we lack a quantitative estimate of how many *rufa* Red Knots use James Bay as a stopover site over the course of a season. To understand population declines and move towards recovery of the species, we need to study the Red Knot's full annual cycle, including assessing the importance of James Bay as stopover habitat for the species. Fortunately, nearly 9% of Red Knots in James Bay have been marked with uniquely coded leg flags that can be read without recapture. By analyzing resighting patterns of individual knots, we can estimate how many birds stage in James Bay during southbound migration. During the 2017 season, preliminary analysis suggests that as much as a quarter of the total *rufa* Red Knot population stopped in southwestern James Bay, demonstrating that this is a crucial stopover area.

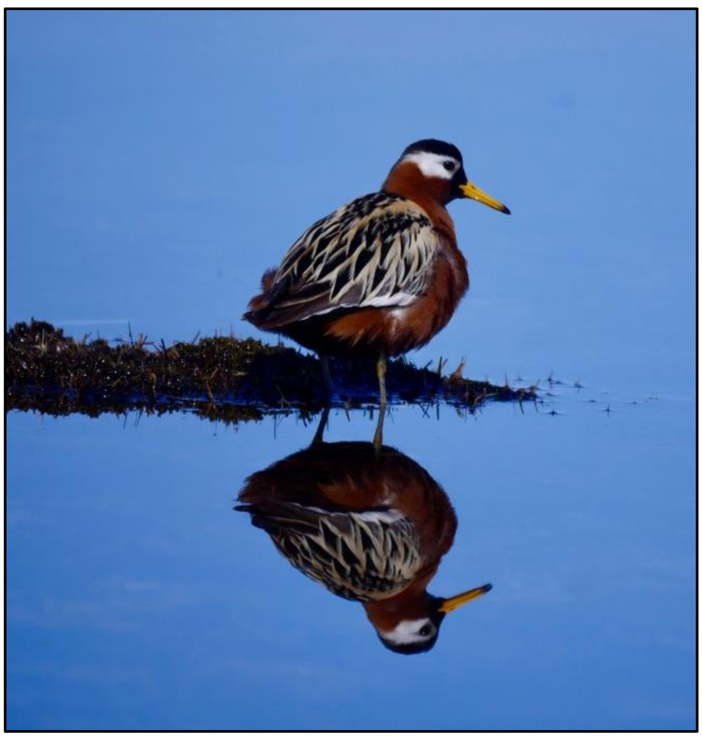
In 2018, we operated three remote field camps on the southwestern coast of James Bay from mid-July to mid-September. Over the season we collected over 1500 flag resights and recorded a high count of 3593 Red Knots at Little Piskwamish Point on August 10th, 2018. An aerial survey of the coast from the Quebec border to Akimiski Island documented 13760 knots on August 10th, 2018. In addition to resighting Red Knots, we also conducted daily shorebird surveys across a 15-km survey zone at each camp. Highlights included a Sabine's Gull at Longridge Point, over 40,000 White-rumped Sandpipers in a single day at Little Piskwamish Point, and a Ruff at Northbluff Point (the first record for the project). Overall, we noted that juvenile shorebirds arrived 7-10 days later than in other years, likely due to high snow cover and poor breeding success in the Arctic this year. However, breeding appears to have been successful in some locations as we recorded over 1000 juvenile Red Knots on multiple days in September. A small banding crew at Longridge Point focused their efforts on catching and deploying GPS tracking devices on Lesser Yellowlegs as part of a collaborative project to study declines in the species.

Left: Red Knots in flight at Little Piskwamish Point; Right: Resighting Red Knots on the James Bay coast

Carry-over effects in Arctic-Breeding Shorebirds

Willow English, PhD Candidate – Carleton University

Technological limitations have necessitated that many studies of migratory birds focus on only one part of their geographic range. Innovations in tracking technology have recently allowed individuals to be followed throughout the entire annual cycle, which in turn has allowed an appreciation for the importance of carry-over effects on demography and phenology. In species where tracking remains unfeasible, other methods of assessing the impacts of carry-over effects are necessary.



A Red Phalarope at East Bay

One such technique is using feather corticosterone (fCORT), as feathers are thought to incorporate blood corticosterone during their growth, and retain representative levels after feathers are no longer vascularized. Thus, fCORT in feathers collected during the summer can be linked to stress levels occurring during the period of feather growth, and can be compared to breeding characteristics to determine whether carry-over effects are present.

This year, Willow and her field team at East Bay collected secondary feathers from 39 individuals of 6 species of shorebird that will be analyzed to determine fCORT levels. Willow's thesis will use these data, in addition to samples collected during previous seasons at East Bay and at other sites, to investigate whether fCORT levels explain variation in breeding parameters such as nest initiation date, egg size, and daily nest survival, and to assess whether these patterns vary between geographic areas and over time. This will help us to determine if stress encountered during the non-breeding period carries over to impair subsequent reproductive success.

Willow presented her PhD project design and hypotheses at the Western Hemisphere Shorebird Group Meeting in Paracas, Peru in fall 2017, and at the International Ornithological Congress in Vancouver, British Columbia in summer, 2018. Willow is entering the second year of her PhD program, and plans to lead an additional year of field data collection at East Bay in 2019.

Habitat selection by shorebirds breeding on the Yukon North Slope

Christine Anderson, PhD Candidate – Carleton University

Christine is studying the effects of climate change on the distributions of shorebirds breeding throughout the Canadian Arctic. Her PhD project uses data collected by partners at CWS and USFWS for the Program for Regional and International Shorebird Monitoring (PRISM; a systematic survey of breeding shorebirds across the North American Arctic), and a primary goal of the project is to address the lack of information about shorebird distribution that is a barrier to identifying and protecting important shorebird habitats. In 2018, Christine conducted an analysis of habitat selection by shorebirds breeding on the Yukon North Slope, which she plans to expand to include the entire scope of the PRISM monitoring surveys. Christine used data collected by the Yukon Breeding Bird Survey and PRISM to identify which habitat and landscape characteristics breeding shorebirds are associated with on the Yukon North Slope, and to map the most suitable habitat for 9 key species.

3100 km^2 of habitat was identified as suitable breeding habitat for at least one of the modeled shorebird species (Figure 8A). A core area of 780 km^2 was identified as suitable habitat for 5 or more of the modeled shorebird species (Figure 8B). Most suitable shorebird breeding habitat was in the lowland plains near the coast. While the western portion of the Mackenzie River Delta composes only a small portion of the Yukon North Slope, almost all of this area was identified as suitable shorebird breeding habitat. 60% (1850 km^2) of all suitable shorebird habitat was located within Ivvavik National Park.

In addition to her PhD research, Christine has been working as an academic mentor for students at Nunavut Sivuniksavut, an Inuit Studies program based in Ottawa.

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B)

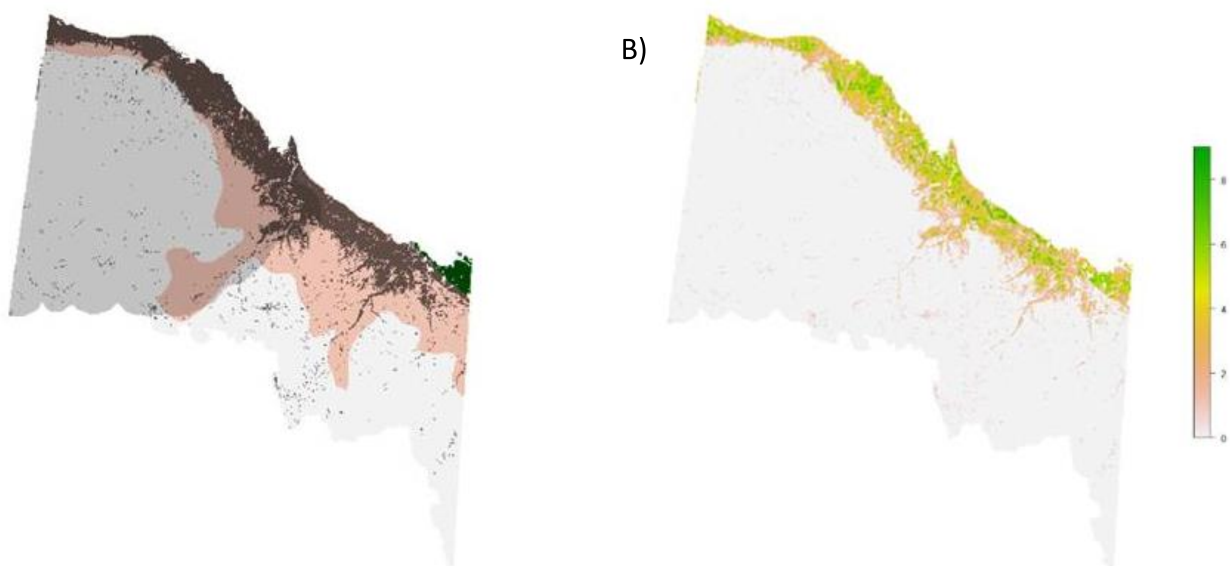

Figure 8. A) Habitat on the Yukon North Slope identified as suitable for at least one shorebird species (black) is concentrated in the Lowland Plains (pink) and Mackenzie River Delta (green). 60% of all suitable shorebird habitat was located within Ivvavik National Park (dark grey). B) Predicted number of shorebird species on the Yukon North Slope.

Effects of Resource Availability on Growth and Survival of Shorebird Chicks

Brandan Norman, MSc Candidate – York University

Long distance migrants such as Arctic-nesting shorebirds rely upon a finely tuned synchrony between nest hatching and peaks in arthropod abundance in order to capitalize on food resources to ensure growth and survival of their broods. Arthropods are one of the key drivers of community structure and composition in Arctic food webs, providing a resource for many species; however, many arthropods are emerging earlier due to warming temperatures, meaning that migratory species relying on arthropods may miss peaks in food abundance. Shorebird chicks are precocial and therefore capable of moving soon after hatch to forage for themselves without aid from their parents. When chicks hatch at times that do not coincide with arthropod resource peaks, this mobility may permit them to take advantage of fine scale spatial and temporal variation in arthropod abundance, to mitigate the effect of "mismatched" timing of hatch. At East Bay, Brandan's project replicated methods used in Churchill, Manitoba, to determine the variation of arthropod biomass and microclimate on a local scale, to see how shorebirds responded to these variations, as seen in Figure 9.

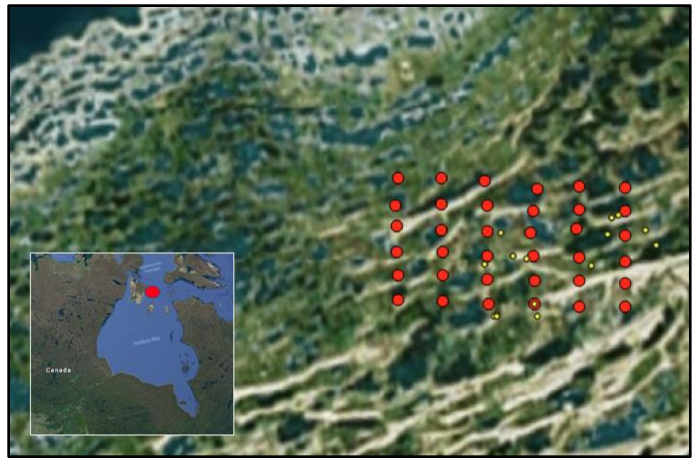

Figure 9. Detection data (yellow) of shorebirds from July 13-25, 2018 in relation to stations at East Bay Mainland (red) where arthropod biomass and temperature were recorded.

Over the fall/winter of 2018/19, Brandan will be consolidating and analyzing data on arthropod biomass and temperature, and creating occupancy models using the detection data. Preliminary results indicate that shorebird abundance and brood recapture rate at East Bay was much lower than in previous implementations of this experimental design in Churchill, likely due to late arrival of birds and poor weather conditions in 2018. Nevertheless, these data collected at East Bay on arthropod biomass and temperature in relation to chick occupancy will prove invaluable for furthering our understanding of how shorebird chicks respond to variable resource availability.

Arctic PRISM and Mining Impacts on Shorebird Densities

Natalie Grishaber, MSc Candidate – Trent University

The ore loading dock of Baffinland Iron Mines' Mary River Project, as seen from a helicopter on July 4th, 2018.

As a result of increasing mining activity in the Arctic, there is a growing need to understand how the cumulative effects of mining are influencing Arctic habitats and wildlife, including how this may be affecting shorebird densities. With the increase in alterations to natural habitat and ecosystems, there is a reduction in suitable breeding habitat for shorebird species. In turn, this could result in a further reduction of shorebird populations, many of which are currently or will soon be under consideration for listing as Species at Risk.

To explore the changes in habitat and bird abundance that have arisen due to mining actives in the Arctic, Natalie's MSc thesis will use the PRISM shorebird survey dataset which provides density estimates dating back to 1994. Increased mining is expected to reduce the suitability of nearby habitats, not only through the loss preferred habitat types, but also through the creation of "habitat" and the provision of food resources that may favour generalist predators, such as ravens, gulls, and foxes. These habitat changes could result in locally depressed nesting densities, while subsidized populations of predators could lead to regionally depressed densities. However, the magnitude of impact on range-wide populations of Arctic-breeding shorebirds is assumed to be small, given the limited footprint of mining in Canada's North. Given the ongoing declines in many shorebird populations, and the expanding interest in developing mineral resources in the Arctic, it is important to clarify the scale of these impacts and the mechanisms through which they operate (e.g., habitat vs. predators).

In support of her MSc thesis, Natalie assisted the Canadian Wildlife Service with PRISM surveys on Baffin Island in June and July, 2018, with a focus on the area near the Mary River (Baffinland) mine. Each PRISM plot consists of walking 25 m transects to cover an area of 12 ha to detect shorebird densities, diversity, and habitat use. Natalie will combine these data with the entirety of the PRISM dataset collected at mine sites, and unimpacted sites, since 1994 to determine whether mining activity leads to locally or regionally depressed densities of birds.

Effect of Microtopography on Nest Site Selection for Concealed-Nesting Shorebirds

Noah Korne, BSc Honours Candidate – Trent University

Arctic-breeding shorebirds employ a variety of nest site selection strategies. Some choose open nest sites with a wide field of view, while others use vegetation or landscape formations to help conceal their nests. For his Honour's thesis, Noah is attempting to evaluate the influence of the tundra's "microtopography" on the nest site selection of concealed-nesting shorebirds, using both field measurements and an Unmanned Aerial Vehicle (drone) to build fine-scale models of the microtopography around the nest.

Over the course of the 2018 field season at East Bay, Noah measured the relative hummock height around the nest cup, horizontal concealment from a height mimicking the perspective of Arctic fox (an important nest predator), as well as information on vegetation communities and habitat classification at 33 nests (3 Dunlin, 4 Red Phalarope, and 26 White-rumped Sandpiper). In addition, a randomly selected site was measured near to each nest, providing control data. We predict that shorebirds select sites with moderate hummock height and high horizontal concealment, so that they balance nest concealment with an ability to see approaching predators that threaten their own safety.

Noah also employed a drone to take aerial photographs of each nest site, including the control points. These photo surveys were flown at 10m altitude, after nesting was completed. Each survey recorded at least 81 overlapping images, allowing us to reconstruct a 3D model of each nest area with "structure-from-motion" software. This software identifies features within each image and tracks them from the different perspectives in each photograph; the high level of overlap between photos provides the multiple angles needed to build the model (Figure 11). This is an emerging technique that has the potential to greatly facilitate topographical and habitat-based ecological research. If successful, these models will corroborate the findings of our manual measurements, as well as allow for detailed microtopographical analysis at a wider scale than is feasible through manual methods.

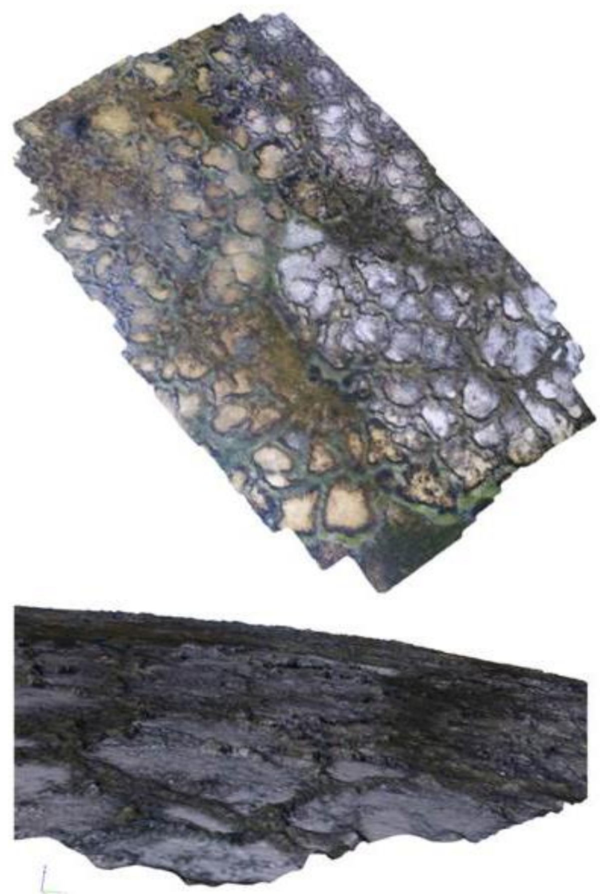

Figure 11. Preliminary 3D models of micro-topography around a Red Phalarope nest, shown from overhead (top) and from a horizontal perspective (bottom). The top image covers an area of approximately 10m x 20m.

2018 Students and Post Docs

Dr. Sjoerd Duijns (Post-Doctoral Fellow, Carleton University) is using the MOTUS automated telemetry network to study the migratory ecology of shorebirds, focusing on the endangered *rufa* Red Knot.

Dr. Heather Mariash Was formerly an NSERC Visiting Fellow at the National Wildlife Research Centre, studying the freshwater ecology of Arctic ponds and lakes in relation to changing climate conditions and increasing goose populations. Dr. Mariash recently accepted a position as a wetlands scientist with Parks Canada in Saskatchewan.

Dr. James McLaren (NSERC Visiting Fellow, National Wildlife Research Centre) is helping refine the tracking abilities of the MOTUS network and improve stopover duration estimates.

Alexandra Anderson (PhD candidate, Trent University) is studying the migration ecology of shorebirds using James Bay as a stopover site.

Christine Anderson (PhD candidate, Carleton University) is studying the effects of climate change on the distributions of shorebirds breeding in the eastern Canadian Arctic.

Willow English (PhD candidate, Carleton University) is studying the links between migration and breeding ecology for Arctic-shorebirds, in order to understand the role of "carry-over effects".

Scott Flemming (PhD candidate, Trent University) is studying the effects of increasing goose populations of the nesting habitat of shorebirds and the abundance and behaviour of predators in the Canadian Arctic.

Lisa Kennedy (PhD candidate, Trent University) is studying the effects of increasing goose populations on the nesting behavior and physiology of shorebirds breeding in the Canadian Arctic.

Natalie Grishaber (MSc candidate, Trent University) joined the lab in 2018, and is studying the impacts of mining activity in the Arctic on breeding shorebird densities using the PRISM database.

Gill Holmes (MSc candidate, Trent University) joined the lab in 2018, and is studying the use of deterrents on breeding migratory birds to mitigate the impacts of mining-induced flooding on migratory bird nesting success.

Amie MacDonald (MSc candidate, Trent University) is using mark-recapture methods to estimate the passage population size and annual survival of Red Knots in James Bay, to determine its importance as a staging area for Knots.

Brandan Norman (MSc candidate, York University) joined the lab in 2018, and is studying the effects of resource availability on shorebird chick growth and survival

Noah Korne (BSc Honours candidate, Trent University) joined the lab in 2018, and is studying the effect of microtopography on nest site selection for shorebird species at East Bay.

Noah Korne measuring hummock height around a nest cup at East Bay.

2018 Inuit Participation

Jupie Angootealuk has worked with us at East Bay since 2013, and has proven himself as a highly effective research assistant. Jupie occupied important roles on our research teams once again this year, including as mentor/leader for the Inuit Field Training Program that took place in August at the East Bay Mainland camp.

Josiah Nakoolak has worked with us a guide and research assistant every year since 1997 and was recently awarded the Community Contribution to Research Award by the Northern Contaminants Program. Josiah also operates as a mentor to our younger guides.

Lenny Emiktaut was trained as a community researcher in winter 2017/2018, as part of our IQ study exploring the effects of Snow Geese on wildlife and habitats. Lenny then joined us at East Bay as a field technician with the IFRA program. In July, Lenny participated in goose banding with the Canadian Wildlife Service, and later rejoined us at East Bay for the Inuit Field Training Program. Lenny has a keen interest in wildlife, and we look forward to continuing to work with him.

Lenny Emiktaut of Salliq (Coral Harbour) worked as a field technician for Environment and Climate Change Canada at East Bay Mainland for the first time in 2018

Recent Popular Press and Outreach

Munro, M. Birds packing high-tech gear help scientists understand the migratory mysteries and dangerous life of the red knot. *Special to the Globe and Mail*, April 22 2018
https://www.theglobeandmail.com/canada/article-birds-packing-high-tech-gear-help-scientists-understand-the-migratory/

Fitzpatrick, JW and NR Senner. Shorebirds, the world's greatest travelers, face extinction. *New York Times,* April 27 2018
https://www.nytimes.com/interactive/2018/04/27/opinion/shorebirds-extinction-climate-change.html

Ackerman, D. Late snowpack signals a lost summer for Greenland's shorebirds. *Scientific American*, July 13 2018
https://www.scientificamerican.com/article/late-snowpack-signals-a-lost-summer-for-greenlands-shorebirds/

Krupp, L. The Arctic is no longer a safe haven for breeding shorebirds. *Audubon Society Magazine*, November 13 2018
https://www.audubon.org/news/the-arctic-no-longer-safe-haven-breeding-shorebirds

Vernimmen, T. Climate change may curtail shorebirds' need to fly north*. Scientific American,* November 13 2018
https://www.scientificamerican.com/article/climate-change-may-curtail-shorebirds-need-to-fly-north/

Paul Smith, Grant Gilchrist, Jennifer Provencher, and Jason Duffe answer questions from the public during about conducting Arctic research during a live televised Ask a Scientist event:
https://www.facebook.com/EnvironmentandClimateChange/videos/263249377691495/

Recent Academic Publications

Anderson, CM, S Iverson, A Black, ML Mallory, A Hedd, F Merkel, JF Provencher (2018) Modelling demographic impacts of a growing Arctic fishery on a seabird population in Canada and Greenland. *Marine Environmental Research* (In Press)

Avery-Gomm S, JF Provencher, M Liboiron, FE Poon, PA Smith (2018) Plastic pollution in the Labrador Sea: An assessment using the seabird northern fulmar *Fulmarus glacialis* as a biological monitoring species. *Marine Pollution Bulletin* 127:817-822

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Lathrop RG, L Niles, PA Smith, M Peck, A Dey, R Sacatelli, J Bognar (2018) Mapping and modeling the breeding habitat of the Western Atlantic Red Knot (*Calidris canutus rufa*) at local and regional scales. *Condor* 120(3):650-665 https://doi.org/10.1650/CONDOR-17-247.1

Mariash HL, PA Smith, M Mallory (2018) Decadal response of Arctic freshwaters to burgeoning goose populations. *Ecosystems* 21:1230-1243

Martin J-L, PA Smith, A Béchet, T Daufresne (2018) Late snowmelt can result in smaller eggs in Arctic shorebirds. *Polar Biology* 41(11):2289-2295

Martin TG, L Kehoe, C Mantyka-Pringle, I Chades, S Wilson, RG Bloom, SK Davis, R Fisher, J Keith, K Mehl, B Prieto Diaz, ME Wayland, TI Wellicome, KP Zimmer, PA Smith (2018) Prioritizing recovery funding to maximize conservation of endangered species. *Conservation Letters* https://doi.org/10.1111/conl.12604

Smith PA, DB Edwards (2018) Deceptive nest defence in ground-nesting birds and the risk of intermediate strategies. *PLoS ONE* 13(10):e0205236 https://doi.org/10.1371/journal.pone.0205236

Smith PA, L McKinnon, H Meltofte, R Lanctot, T Fox, J Leafloor, M Soloviev, A Franke, K Falk, A Smith. Status and trends of tundra birds across the circumpolar Arctic. *AMBIO* (Submitted).

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Weiser E, SC Brown, RB Lanctot, HR Gates, KF Abraham, RL Bentzen, J Bêty, M Boldenow, R Brook, TF Donnelly, W English, S Flemming, S Franks, HG Gilchrist, M-A Giroux, A Johnson, S Kendall, L Kennedy, L Koloski, E Kwon, J-F Lamarre, DB Lank, CJ Latty, N Lecomte, JR Liebezeit, L McKinnon, E Nol, J Perz, J Rausch, M Robards, ST Saalfeld, NR Senner, PA Smith, M Soloviev, D Solovyeva, DH Ward, PF Woodard, B Sandercock (2017) Effects of environmental conditions on reproductive effort and nest success of Arctic-breeding shorebirds. *Ibis* https://doi.org/10.1111/ibi.12571

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Young K, LV Kennedy, PA Smith, E Nol. Does camera presence influence predation pressure on Arctic-breeding shorebird nests at East Bay, Southampton Island. *Polar Biology* (Submitted)

A White-rumped Sandpiper at East Bay Mainland

Research Partners and Financial Support

The research projects described in this report are a combined effort of many people and organizations. Dr. Paul Smith (Environment and Climate Change Canada, ECCC) leads the program together with key collaborators Dr. Erica Nol (Trent University), Jennie Rausch (CWS), Christian Friis (CWS), and Dr. Grant Gilchrist (ECCC). Technical leadership and coordination is provided by Doug MacNearney (ECCC), with assistance and support from Holly Hennin, Bronwyn Harkness, Bonnie Taparti, and Zaya Kuyena (ECCC).

These projects are all logistically complicated and labour intensive, requiring a large, dedicated crew of students and biologists. Our East Bay Mainland field crew in 2018 included Jupie Angootealuk, Lenny Emiktaut, Willow English, Noah Korne, Doug MacNearney, Josiah Nakoolak, Brandan Norman, Keenan Peddie, and Dr. Paul Smith.

Research in Canada's north is expensive and funding for this work is necessarily provided by a network of partnerships that includes but is not limited to: Environment and Climate Change Canada Wildlife Research Division, the Canadian Wildlife Service – Northern Division, The Bureau of Ocean Energy Management, The United States Fish and Wildlife Service, Trent University, Carleton University, Polar Continental Shelf Program, Agnico Eagle Mines Ltd., Baffinland Iron Mines, Northern Scientific Training Program, the Natural Sciences and Engineering Research Council, and the W. Garfield Weston Foundation.

An American Golden Plover at East Bay Mainland

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