NWRT Final Project Report

NWRT Project Number: 23-003-01

Project Title

Regional and range-wide causes of decline for shorebirds of the Kivalliq

Project Leader

Paul Smith
Environment and Climate Change Canada
1125 Colonel By Drive
Ottawa, ON K1S 5B6
Telephone: 613-998-7362
E-mail: paulallen.smith@ec.gc.ca

Photo: A Semipalmated Plover returns to its nest near Qaqsauqtuuq.

Summary:

Nunavummiut throughout the Kivalliq have long expressed concerns about shorebird declines. Through a Nunavut Wildlife Studies Fund collaboration between residents of Salliq (Coral Harbour) and scientists at Environment and Climate Change Canada, we summarized IQ about these declines in 2016-2017. These discussions have renewed concerns about shorebirds, and local wildlife managers have provided

suggestions for research topics that they feel are a priority. In 2018, we refined this list of research topics in consultation with the Aiviit HTO and the Irniurviit Area Comanagement Committee (ACMC), and in 2019 we initiated a research program to study these issues of shared priority. With the arrival of the COVID-19 pandemic, we did not continue this project in 2020 and 2021, but renewed discussions with the HTO and ACMC for work in 2022 and 2023. In 2022, the research focus addressed ACMC management plan priorities for Ikkattuaq and Qaqsauqtuuq Migratory Bird Sanctuaries (MBS), including the first rigorous shorebird population surveys for the Ikkattuaq MBS, continued studies of shorebird migration and "connectivity" at Qaqsauqtuuq, and enhanced training of local youth to support future community-based monitoring programs and Inuit self-determination in research.

We continue to work with the community of Salliq to deliver the Inuit Field Training Program, including the successful reboot of the program in 2022 at Qaqsauqtuuq following a hiatus imposed by pandemic restrictions in 2020 and 2021. This program, co-led by Dr.'s Smith and Gilchrist at ECCC, and a local committee composed of HTO and ACMC members, brings keen and capable youth to our field camp to participate in the research, learn about employment opportunities in science fields, and receive mentorship from Inuit and scientific leaders. The IFTP recently received financial support from other government departments, and in 2023 we expanded this program to offer training and employment opportunities to youth from additional communities within the Kivalliq and Qikiqtaaluk.

The scientific outputs of our project are also described in detail in an accompanying field report.

Project Objectives:

Shorebirds are declining to such an extent that many could become Species at Risk. People in Salliq recently reiterated concerns about these large declines and requested that further scientific studies be undertaken, to complement our recent IQ research. We refined these priority research questions with NWRT funding in 2018 (Project 5-18-01), and initiated a research project in 2019 (Project 5-19-02) to address the following objectives. Following a COVID-related hiatus in field work for 2020 and 2021, we resumed this project in 2022 (Project 23-003-01) with an increased focus on objectives 3 and 4, which are current high priorities for wildlife managers in Salliq:

1. Track shorebirds with modern tracking devices to understand their movements throughout the year and how these movements expose them to threats
2. Explore "carry-over" effects, for example, how feeding conditions at stopover sites influence the physiological status of birds upon arrival to Nunavut, and how this influences subsequent survival and reproduction
3. Carry out comprehensive shorebird surveys in Ikkattuaq Migratory Bird Sanctuary, as per ACMC Management Plan objectives, and determine the feasibility of more frequent monitoring and research there.
4. Engage and train local youth to increase their involvement in our research and to develop their employment prospects for the future.

In addition to these wildlife-related objectives, based on community interests and the opportunity presented by leveraging our existing field logistics arrangements to address as many community

priorities as possible, an additional objective for 2022 was the facilitation of archaeological surveys of cultural sites within the Ikkattuaq MBS. These sites have been known to the community for some time, and discussions about having them catalogued in the territorial database began following community visits to the MBS in 2017, when community members expressed interest in learning more about their history. Working with an archaeologist from the Inuit Heritage Trust and the Government of Nunavut, we offered logistical support to define and then address the research interests of community members from Salliq. Adding this component to our wildlife surveys was a cost-effective means of facilitating the community to address their research questions about these sites. This partnership also provided an opportunity to train local youth in the archaeological survey techniques, building further capacity for community based monitoring.

Materials and Methods:

In March 2022, we had planned for in person consultations in Coral Harbour with the Aiviit HTO and the Irniurviit ACMC to refine work plans for the summer field season. However, due to ongoing concerns around COVID-19, we pivoted to a teleconference that took place in early April, 2022. Through consultation with the community and organizations in Coral Harbour, we co-developed a list of research objectives that centers around studies of breeding and migration ecology of shorebirds, especially Red Phalaropes (*Saurraq*) and Ruddy Turnstones (*Tuvvititiiq*), as well as Arctic Terns (*Imiqqutailak*). Specifically, people and organizations in Coral Harbour are interested in better understanding the routes taken by these birds during migration, how these distributions outside of Nunavut expose species to threats, and how changing environmental conditions within and outside Nunavut are contributing to shorebird declines. In 2022, our study objectives focused on work at two sites – Qaqsauqtuuq and Ikkattuaq Migratory Bird Sanctuaries.

At Qaqsauqtuuq, we monitored 72 nests from 7 different shorebird species in the 2022 season. Using advanced analytic techniques for analysis of nest and adult survival, and through deployment of the latest satellite-based tracking technologies, our research team is at the cutting-edge of avian breeding ecology research. Using data collected at Qaqsauqtuuq, we are also carrying out innovative studies of the survival shorebirds throughout the year, to understand how breeding conditions in Nunavut contribute to the population trends of shorebirds. Conversely, we are also studying how conditions outside of Nunavut influence breeding success through “carry-over effects” (Objective 2). These studies rely on feather samples obtained from Qaqsauqtuuq, measured for levels of stress hormones. Our scientific methods for studying breeding shorebirds in the Arctic are well established, and are being applied at several sites throughout the Canadian Arctic and Alaska.

In the Ikkattuaq Migratory Bird Sanctuary, we conducted baseline surveys of shorebirds’ use of the protected area (Objective 3), using the well-established Program for Regional and International Shorebird Monitoring (PRISM) survey methods, developed by Dr. Smith and others. These surveys were carried out by a team of 4 Inuit research assistants, successful participants in previous Inuit Field Training Program sessions, under the mentorship of 2 ECCC scientists. Through this approach, we were able to address the research objectives while also offering a higher-level training and employment opportunity for local youth (Objective 4). We repeated this approach in 2023, to complete the final

surveys needed in the protected area for statistical analysis of the distribution and density of breeding birds.

During the 2022 field season, we also delivered a third edition of the Inuit Field Training Program, in late July, at the East Bay Mainland camp. This exciting training effort brought 7 young Inuit to our camp, mentored by a balanced team of Inuit and southern scientist leaders, to learn about techniques and employment opportunities in environmental science. Logistics and administration of the training program are led by a steering committee based in Coral Harbour, and also by a full-time Nunavut beneficiary working in our office in Ottawa and traveling to the field site to help deliver the program. Additional details of this program are included in an attached field report. In 2023 we were successful in expanding the Inuit Field Training Program to include participants from 3 communities (Coral Harbour, Naujaat, and Sanirajak) at 2 field stations (Qaqsauqtuuq and Prince Charles Island); a detailed report of this program will follow in subsequent reports.

This project continued in 2023 with renewed funding from the NWRT. For the purposes of reporting on the activities undertaken with funds from Project 23-003-01, this report focuses on the 2022 period. Activities and results from 2023 which will be covered in depth future reports in the reporting cycle for Project 23-003-09.

Results:

The purpose of this study is to investigate research questions relating to the declines of shorebirds that interest the community of Coral Harbour, as identified in a preliminary study that was funded by the NWRT (Project 5-18-01). We began addressing these objectives with fieldwork conducted in 2019, with the intention of carrying out a 3-year research program. We paused field activities and did not accept funding from NWRT between 2020-2021 because we felt that it was not appropriate to accept NWRT funding when we would not have the opportunity to spend the funds in Nunavut due to the pandemic; however during this period we continued to make progress on our objectives through analyses of data collected in 2019, and other datasets received from collaborators. When it became possible to return to the field for the 2022 season and continue advancement of the community engagement aspects of the project, we re-applied for NWRT funding in 2022 (Project 23-003-01; activities covered in this report). Activities and results from the project's final funding year will be covered in upcoming reports for Project 23-003-09.

With respect to the specific objectives outlined in this project, we have made considerable progress and have shared results with our partners in our annual field reports. During the current reporting period, we highlight the following achievements:

Shorebird tracking (Objective 1):

We recently summarized a large dataset of geolocator tracks deployed on Red Knots, with the goal of furthering our understanding of red knot migration habits, wintering subpopulations, and possible range overlaps between subspecies. Red Knots migrate up to 15,000 km between wintering areas in South America and breeding grounds in the Arctic and were once commonly sighted by Inuit on Southampton Island, but have declined dramatically in recent decades and are now listed as an endangered species.

We compiled definitive geolocator tracks and data for over 200 Red Knot geolocators deployed between 2009 and 2021 and were able to show clear distinctions within wintering ranges for Red Knots in northern South America, Southeast United States and Caribbean, Western Gulf of Mexico, and Tierra del Fuego with large range overlaps during breeding and on route to and from breeding grounds (Figure 1). These analyses represent and important advance in our understanding of Red Knot migration habits at the subspecies and subpopulation level, which can guide geographically specific conservation measures and assist in determining priorities.

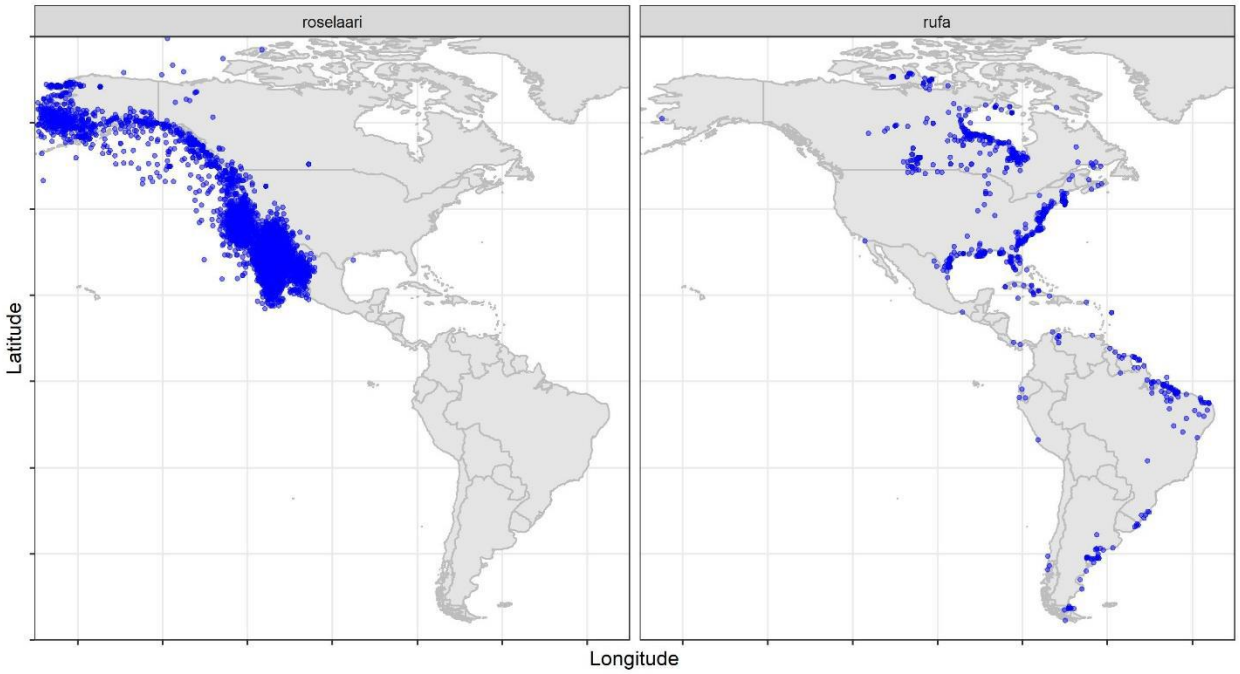


Figure 1: Geolocator locations for Red Knot subspecies rufa and roselaari showing minimal overlap, however some habitats were used by both subspecies. This includes areas of the western gulf (around Padre Island, Texas) and potentially northern Baja peninsula, Mexico.

In addition to compiling definitive migration tracks from previously deployed geolocators, we collaborated in 2022 and 2023 to deploy satellite tracking tags on Red Knots during their northward migration, to determine the current breeding range of Red Knots in the Canadian Arctic. Breeding range was listed as a key knowledge gap for Red Knot recovery, and new satellite tracking technology has allowed investigation of this question by tagging northbound Red Knots in the spring and tracking them in real time to the breeding grounds. Previous technology such as geolocators required birds to be recaptured to access data, which decreased the sample size available for determining breeding range. Several of the tagged birds appear to have nested on Southampton Island, indicating that this area continues to be important for declining Red Knots (Figure 2).

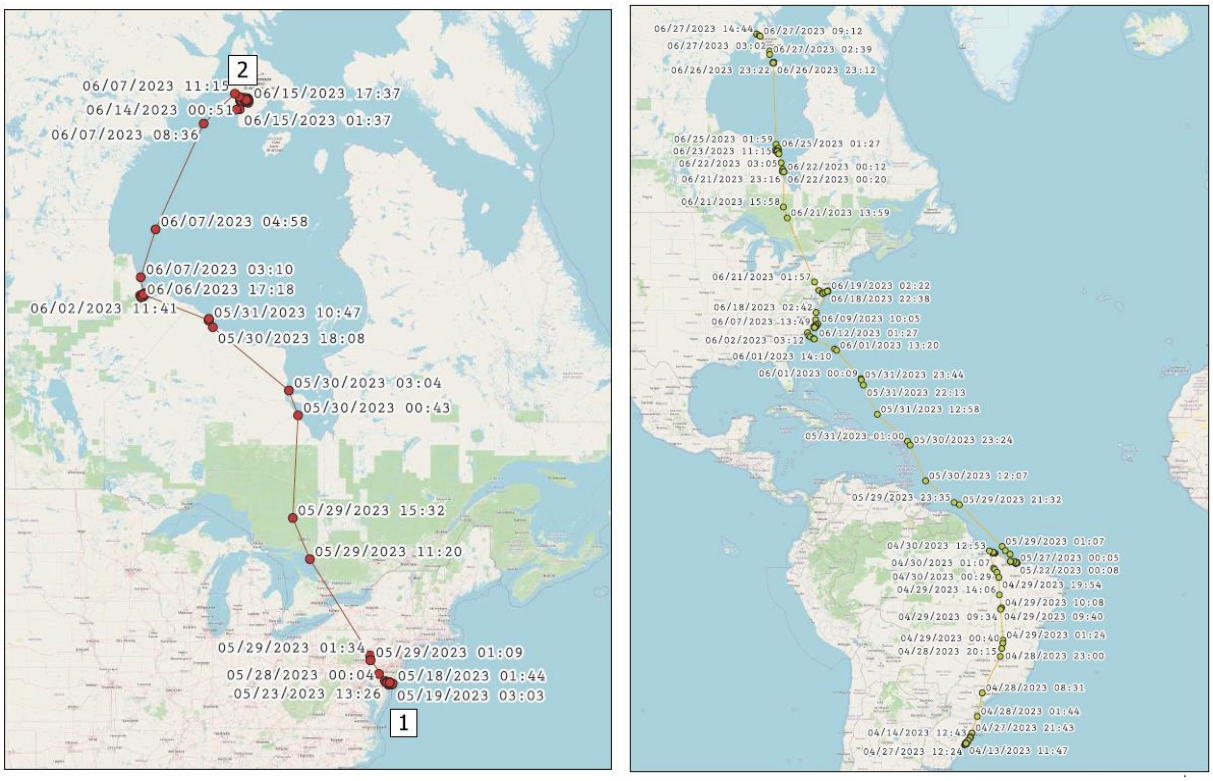


Figure 2: Two sets of satellite tracks from Red Knots that migrated to breed on Southampton Island in 2023. Maps courtesy of Stephanie Feign, unpublished data.

Tracking technology continues to evolve to permit investigation of new aspects of migration ecology for shorebirds, adding greater precision to our understanding of migration habits, and for a greater number of smaller shorebird species. In addition to the recent studies highlighted here, we have contributed to a multitude of collaborative tracking studies and will continue to pursue future studies to address knowledge gaps in migration ecology. To ensure that Inuit can connect with the knowledge generated by these studies, we are working on communications products to bring stories of shorebird migrations to Inuit, which will complement the reports we share annually with interactive visualizations showing the pathways birds take to and from Arctic breeding grounds.

Carry over effects (Objective 2):

PhD student Willow English investigated carry over effects in ten species of shorebirds, using data collected at East Bay and by collaborators at other Arctic breeding sites. Willow completed her thesis in January 2023, and publications from this work are in the peer-review process. One of Willow's PhD thesis chapters tested whether corticosterone levels in feathers ($CORT_f$; a measure of stress incurred on the winter grounds during moult and feather growth) were related to breeding metrics such as nest initiation date, nest success, or egg size. Willow additionally tested whether $CORT_f$ varies among species, sexes, or with morphometric measurements. $CORT_f$ levels varied substantially among species, and were

below detection limits in White-rumped Sandpipers, suggesting that $CORT_f$ may not be a useful measure of stress for all species. For species with detectable $CORT_f$ levels, birds with higher $CORT_f$ had higher nesting success in the natural ecosystem (Figure 3), but lower success in the area with artificially low predation pressure (Figure 4), suggesting that the effects of winter stress levels on breeding may be context-dependent. Overall, these results emphasize how conditions faced by shorebirds during the winter season outside of Nunavut continue to affect birds during the breeding season upon their return to the Arctic. This work highlights the importance of accounting for carry-over effects when explaining variation in reproductive success, and the importance of considering the whole annual cycle when planning conservation measures for migratory species.

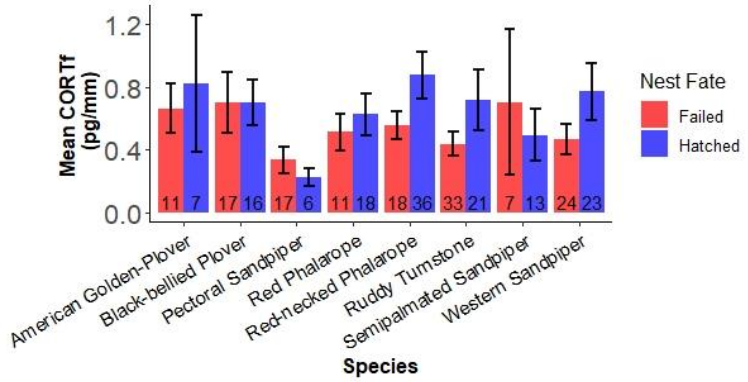


Figure 3. Mean $CORT_f$ levels and standard errors of birds with successfully hatched nests (blue) and depredated nests (pink), by species, from site-years with normal predator regimes (no fox control). Numbers at base of bars are sample sizes.

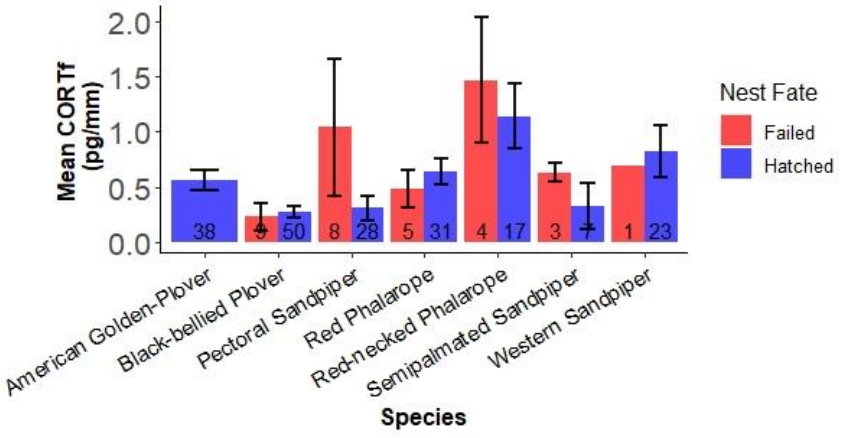


Figure 4. Mean $CORT_f$ levels and standard errors of birds with successfully hatched nests (blue) and depredated nests (pink), by species, from years with Arctic fox control in Utqiagvik, Alaska. Numbers at base of bars are sample sizes.

Shorebird Surveys in Ikkattuaq Migratory Bird Sanctuary (Objective 3):

In 2022 and 2023 we surveyed 28 plots in the Ikkattuaq Migratory Bird Sanctuary, to provide the first rigorous estimate of shorebird populations for this area. Data are currently being analysed, and we expect to provide results to the community in the winter of 2024. This survey effort is an important piece of monitoring data for the sanctuary, following the objectives outlined in the Management Plan developed by the ACMC for the sanctuary, and providing employment and training for 4 local research assistants in 2022 and 3 local research assistants in 2023. One individual, Joseph Pingwartuk, was further employed to conduct shorebird research at Qaqsauqtuuq in 2023, and assist with Southampton Island goose banding led by the Canadian Wildlife Service. We hope to be able to continue employing Joseph to participate in future projects.

During the 2022 season we provided logistical support for an archaeologist from Inuit Heritage Trust, Dr. Lesley Howse, to visit Ikkattuaq and conduct preliminary site investigations of archaeological sites in the area. The community was very supportive of these investigations, and we were happy to be able to facilitate the field visits during the time we had access to a helicopter for the shorebird surveys. We do not report on the results of the archaeological visits here, however a brief overview is provided in the attached field report.

Increase involvement of local youth in environmental monitoring (Objective 4):

The Inuit Field Training Program remains an important annual program for us, as a means of building capacity and interest for environmental monitoring in the communities we work with. This program, first delivered in 2018, brings Inuit mentors and scientists together to encourage youth to consider careers in environmental fields. In 2022, the IFTP took place over 10 days in late July at Qaqsauqtuuq Migratory Bird Sanctuary, based out of the East Bay Mainland research station operated by Environment and Climate Change Canada, and providing a training opportunity to 8 youth from Coral Harbour. In 2023, we expanded the program to invite participants from Coral Harbour and Naujaat to Qaqsauqtuuq, and we ran a second program at our field site on Prince Charles Island that drew participants from Sanirajak, for a total of 11 participants in 2023. The model for the IFTP is for participants to learn a mix of technical skills and land skills, under the leadership of mentors from the community and ECCC. We look forward to continuing this program in future years, and community members remain interested in this opportunity as way to offer training to youth and involve them in the research taking place around their communities.

Past participants in the IFTP have gone on to secure jobs with us and other departments for longer periods, and the program has been a valuable way to provide training in environmental monitoring to youth that might not otherwise have the opportunity to gain these skills.

Additional details of the 2022 fieldwork Inuit Field Training Program are described in the attached reports.

Discussion/Management Implications:

Communities in Nunavut are concerned about the state of shorebird populations, and scientific evidence also shows strong shorebird population declines. Our shorebird research activities are designed with direct input from community organizations (Aiviit HTO and Irniurviit ACMC), and include participation by local people, so that we can ensure that we are addressing local concerns and priorities about shorebirds. These NWRT-funded projects are an excellent complement to the broader suite of monitoring projects that we carry out, funded by Environment and Climate Change Canada. The preexisting infrastructure and our ongoing research and monitoring projects means that, with the additional funding from NWRT, we can efficiently leverage the resources already in place to focus on additional topics of particular interest to Nunavummiut. We are also able connect these local research projects to a broader network of researchers working at other sites across the Arctic. Therefore, research topics that are a community priority can be addressed at a larger spatial scale, allowing insights from across the Canadian Arctic.

2022 was the second full year of this 3-year research project, and consequently, we continue to address the objectives. Nevertheless, we are well on track to addressing them in greater depth in the coming years. Our shorebird tracking studies are yielding insights into migration routes and wintering areas that were previously not described for these species. Our work on Red Knots has allowed us to better understand their incredible migration and identify likely breeding areas throughout the Canadian Arctic. Our studies of feather corticosterone in shorebirds are applying this innovative new technique to measure stress in the previous winter with a feather collected during the summer.

At a national scale, some of the results of these studies could contribute to status reports for shorebirds being considered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). We are currently leading a project to summarize the status of 14 species of Arctic-breeding shorebirds, for review by COSEWIC. Information from the shorebird breeding grounds in Inuit Nunangat is essential for the development of these status reports, and results from Qaqsauqtuuq are the most rigorous source of shorebird breeding data available in Canada. Additionally, the tracking dataset that we have amassed is the largest ever assembled and will provide new insights into the movements of these wide-ranging shorebird species.

The research topics identified in this project relate directly to the NWMB mandate of ensuring the conservation and management of wildlife in Nunavut for the long-term benefit of Nunavut residents. By working directly with community members and HTOs, we strive to provide relevant research results that can inform the management and conservation of terrestrial ecosystems such that they can be enjoyed by current and future generations.

Report by Inuit Participants:

Following the field season in 2022, we conducted mock interviews with Inuit who participated as research assistants conducting shorebird surveys and archaeological surveys in Ikkattuaq Migratory Bird Sanctuary. The following are some excerpts from those interview transcripts describing the thoughts of some of the community members after being a part of the project.

"I'm a local from Coral Harbour, born and raised here. My name is Solomon Nakoolak. […] I learned some things [this summer] that I wasn't even aware of that we were going use, like high-tech equipment. Very interesting for me to use high tech equipment. […] I believe this is good information that we have picked up for future generations to understand, and have an occupation, for our local community, on our island. […] I've seen more than usual polar bears with cubs [during surveys], and it was unusual for me to see them inland, not along the shoreline. That was unusual to see polar bears inland, where there's no snow, in the heat, in the summer. So that was interesting to see that many bears, inland. […] I know for a fact that we can move forward even further, once we get the idea or the understanding of the land. I'm sure this is the type of job that we could create for the future. This is for future generations that we are doing the project here, at the site and at the bird sanctuary. I try and visualize for our younger generations to have occupations, knowing in our community Coral Harbour is lacking occupations. So this is the type of job creation that can be given here, to give occupations for the future, for the long term. […] I'm happy to be included in [the] team, and I liked learning lots." *-Solomon Nakoolak, Coral Harbour, June 2022*

"I liked it, I liked the experience, and I saw some stuff that I had never known, and I learned a bit. [Ikkattuaq was] different from when I first went to East Bay. It was so neat and interesting. I've never ever seen that before and it was pretty neat. I'd be interested [in doing this job again] and I'd also like others to experience it. [It was] way too short, I didn't want to go back home!" - *Jennie Kolit, Coral Harbour, June 2022*

"I heard about this through HTO. I got this job through the HTO and also I went to the Inuit Training Program at East Bay. This week we did bird surveys and historical surveys. [My highlight was] going on the helicopter, seeing lots of land, and visiting all those fox traps [archaeological sites]. I liked learning how to mark the nests and doing the surveys. […] There should be more Inuit people to learn this stuff." *-Joseph Pingwartuk, Coral Harbour, 2022*

Reporting to communities/resource users:

Originally, we had planned for a 3 year project beginning in 2019. Due to the COVID-19 pandemic and our inability to conduct fieldwork during the summers of 2020 and 2021, we were forced to adjust the project timeline accordingly. We have now resumed field activities and the project has proceeded, with the second year of field work and data collection taking place in 2022 (covered by this report, Project 23-003-01), and the final year of field work taking place in 2023 (Project 23-003-09; reporting to follow in upcoming reporting cycle). Since the resumption of activities as pandemic restrictions lifted, we have been able to meet several times with community members in Coral Harbour to share reports, discuss results, and confirm that research objectives remain aligned with community priorities. Most recently, we visited Coral Harbour in February 2023 to meet with the ACMC and HTO in person and share results from the project thus far. We continue to work closely with the community to ensure that this project serves to further community priorities to the greatest extent possible.

Table 1: Summary of project milestones and community consultations.

Output or step	**Start date**	**End date**	**Status**
Initial meetings with HTO/ACMC	15/04/2018	01/09/2018	Completed through in-person meetings in April 2018, and subsequent communications by phone/email.
Project design and consultation	01/09/2018	31/03/2019	Complete
Year 1 of field work	01/05/2019	31/08/2019	Complete
Results sharing/consultation	01/09/2019	31/03/2020	Modified due to COVID – Reports of 2019 research progress were written, translated and distributed to HTO and ACMC by email. We made arrangements for an in-person meeting in March 2020 to discuss the results, but this was cancelled at the last minute due to COVID-related travel restrictions.
Year 2 of field work	01/05/2020	31/08/2020	Modified due to COVID - All 2020 fieldwork was cancelled.
Results sharing/consultation	01/09/2020	31/03/2021	Modified due to COVID - We had planned to visit Coral Harbour to discuss the project during winter 2021, however pandemic lockdowns prevented us from doing so.
Year *2 of field work	01/05/2021	31/08/2021	Modified due to COVID – All 2021 fieldwork was cancelled.
Results sharing/consultation	01/09/2021	31/03/2022	Modified due to COVID – we had planned an in-person visit to Coral Harbour in winter 2022 to prepare for a return to field activities; however a COVID-19 outbreak in Coral Harbour and subsequent community lockdowns forced the cancellation of this trip. Instead, a teleconference was held in April 2022 when the caseload had improved.

Output or step	Start date	End date	Status
Year *2 of field work	01/05/2022	31/08/2022	Complete
Results sharing/consultation	01/09/2022	31/03/2023	Complete – We visited Coral Harbour in February 2023 and met with the ACMC and HTO to discuss project progress. We used this opportunity to distribute research reports and discuss opportunities for further collaboration to meet community research priorities, and also to make a presentation to local high school students about career opportunities in environmental monitoring.
Year *3 of field work	01/05/2023	31/08/2023	Complete
Results sharing/consultation	01/09/2023	31/03/2024	Underway – we are preparing field reports for Year 3 activities and discussing with the ACMC and HTO to schedule timing for a community visit.
Results sharing/Final Reporting	05/01/2024	30/09/2024	Underway – we will prepare a final report for NWRT, the ACMC, and Coral Harbour HTO synthesizing the results of this project. This report will be submitted to the NWRT by September 30, 2024.

NWRT Final Project Report

NWRT Project Number: 23-003-01

Project Title

Regional and range-wide causes of decline for shorebirds of the Kivalliq

Project Leader

Paul Smith
Environment and Climate Change Canada
1125 Colonel By Drive
Ottawa, ON K1S 5B6
Telephone: 613-998-7362
E-mail: paulallen.smith@ec.gc.ca

Photo: A Semipalmated Plover returns to its nest near Qaqsauqtuuq.

Summary:

Nunavummiut throughout the Kivalliq have long expressed concerns about shorebird declines. Through a Nunavut Wildlife Studies Fund collaboration between residents of Salliq (Coral Harbour) and scientists at Environment and Climate Change Canada, we summarized IQ about these declines in 2016-2017. These discussions have renewed concerns about shorebirds, and local wildlife managers have provided

suggestions for research topics that they feel are a priority. In 2018, we refined this list of research topics in consultation with the Aiviit HTO and the Irniurviit Area Comanagement Committee (ACMC), and in 2019 we initiated a research program to study these issues of shared priority. With the arrival of the COVID-19 pandemic, we did not continue this project in 2020 and 2021, but renewed discussions with the HTO and ACMC for work in 2022 and 2023. In 2022, the research focus addressed ACMC management plan priorities for Ikkattuaq and Qaqsauqtuuq Migratory Bird Sanctuaries (MBS), including the first rigorous shorebird population surveys for the Ikkattuaq MBS, continued studies of shorebird migration and "connectivity" at Qaqsauqtuuq, and enhanced training of local youth to support future community-based monitoring programs and Inuit self-determination in research.

We continue to work with the community of Salliq to deliver the Inuit Field Training Program, including the successful reboot of the program in 2022 at Qaqsauqtuuq following a hiatus imposed by pandemic restrictions in 2020 and 2021. This program, co-led by Dr.'s Smith and Gilchrist at ECCC, and a local committee composed of HTO and ACMC members, brings keen and capable youth to our field camp to participate in the research, learn about employment opportunities in science fields, and receive mentorship from Inuit and scientific leaders. The IFTP recently received financial support from other government departments, and in 2023 we expanded this program to offer training and employment opportunities to youth from additional communities within the Kivalliq and Qikiqtaaluk.

The scientific outputs of our project are also described in detail in an accompanying field report.

Project Objectives:

Shorebirds are declining to such an extent that many could become Species at Risk. People in Salliq recently reiterated concerns about these large declines and requested that further scientific studies be undertaken, to complement our recent IQ research. We refined these priority research questions with NWRT funding in 2018 (Project 5-18-01), and initiated a research project in 2019 (Project 5-19-02) to address the following objectives. Following a COVID-related hiatus in field work for 2020 and 2021, we resumed this project in 2022 (Project 23-003-01) with an increased focus on objectives 3 and 4, which are current high priorities for wildlife managers in Salliq:

1. Track shorebirds with modern tracking devices to understand their movements throughout the year and how these movements expose them to threats
2. Explore "carry-over" effects, for example, how feeding conditions at stopover sites influence the physiological status of birds upon arrival to Nunavut, and how this influences subsequent survival and reproduction
3. Carry out comprehensive shorebird surveys in Ikkattuaq Migratory Bird Sanctuary, as per ACMC Management Plan objectives, and determine the feasibility of more frequent monitoring and research there.
4. Engage and train local youth to increase their involvement in our research and to develop their employment prospects for the future.

In addition to these wildlife-related objectives, based on community interests and the opportunity presented by leveraging our existing field logistics arrangements to address as many community

priorities as possible, an additional objective for 2022 was the facilitation of archaeological surveys of cultural sites within the Ikkattuaq MBS. These sites have been known to the community for some time, and discussions about having them catalogued in the territorial database began following community visits to the MBS in 2017, when community members expressed interest in learning more about their history. Working with an archaeologist from the Inuit Heritage Trust and the Government of Nunavut, we offered logistical support to define and then address the research interests of community members from Salliq. Adding this component to our wildlife surveys was a cost-effective means of facilitating the community to address their research questions about these sites. This partnership also provided an opportunity to train local youth in the archaeological survey techniques, building further capacity for community based monitoring.

Materials and Methods:

In March 2022, we had planned for in person consultations in Coral Harbour with the Aiviit HTO and the Irniurviit ACMC to refine work plans for the summer field season. However, due to ongoing concerns around COVID-19, we pivoted to a teleconference that took place in early April, 2022. Through consultation with the community and organizations in Coral Harbour, we co-developed a list of research objectives that centers around studies of breeding and migration ecology of shorebirds, especially Red Phalaropes (*Saurraq*) and Ruddy Turnstones (*Tuvvititiiq*), as well as Arctic Terns (*Imiqqutailak*). Specifically, people and organizations in Coral Harbour are interested in better understanding the routes taken by these birds during migration, how these distributions outside of Nunavut expose species to threats, and how changing environmental conditions within and outside Nunavut are contributing to shorebird declines. In 2022, our study objectives focused on work at two sites – Qaqsauqtuuq and Ikkattuaq Migratory Bird Sanctuaries.

At Qaqsauqtuuq, we monitored 72 nests from 7 different shorebird species in the 2022 season. Using advanced analytic techniques for analysis of nest and adult survival, and through deployment of the latest satellite-based tracking technologies, our research team is at the cutting-edge of avian breeding ecology research. Using data collected at Qaqsauqtuuq, we are also carrying out innovative studies of the survival shorebirds throughout the year, to understand how breeding conditions in Nunavut contribute to the population trends of shorebirds. Conversely, we are also studying how conditions outside of Nunavut influence breeding success through “carry-over effects” (Objective 2). These studies rely on feather samples obtained from Qaqsauqtuuq, measured for levels of stress hormones. Our scientific methods for studying breeding shorebirds in the Arctic are well established, and are being applied at several sites throughout the Canadian Arctic and Alaska.

In the Ikkattuaq Migratory Bird Sanctuary, we conducted baseline surveys of shorebirds’ use of the protected area (Objective 3), using the well-established Program for Regional and International Shorebird Monitoring (PRISM) survey methods, developed by Dr. Smith and others. These surveys were carried out by a team of 4 Inuit research assistants, successful participants in previous Inuit Field Training Program sessions, under the mentorship of 2 ECCC scientists. Through this approach, we were able to address the research objectives while also offering a higher-level training and employment opportunity for local youth (Objective 4). We repeated this approach in 2023, to complete the final

surveys needed in the protected area for statistical analysis of the distribution and density of breeding birds.

During the 2022 field season, we also delivered a third edition of the Inuit Field Training Program, in late July, at the East Bay Mainland camp. This exciting training effort brought 7 young Inuit to our camp, mentored by a balanced team of Inuit and southern scientist leaders, to learn about techniques and employment opportunities in environmental science. Logistics and administration of the training program are led by a steering committee based in Coral Harbour, and also by a full-time Nunavut beneficiary working in our office in Ottawa and traveling to the field site to help deliver the program. Additional details of this program are included in an attached field report. In 2023 we were successful in expanding the Inuit Field Training Program to include participants from 3 communities (Coral Harbour, Naujaat, and Sanirajak) at 2 field stations (Qaqsauqtuuq and Prince Charles Island); a detailed report of this program will follow in subsequent reports.

This project continued in 2023 with renewed funding from the NWRT. For the purposes of reporting on the activities undertaken with funds from Project 23-003-01, this report focuses on the 2022 period. Activities and results from 2023 which will be covered in depth future reports in the reporting cycle for Project 23-003-09.

Results:

The purpose of this study is to investigate research questions relating to the declines of shorebirds that interest the community of Coral Harbour, as identified in a preliminary study that was funded by the NWRT (Project 5-18-01). We began addressing these objectives with fieldwork conducted in 2019, with the intention of carrying out a 3-year research program. We paused field activities and did not accept funding from NWRT between 2020-2021 because we felt that it was not appropriate to accept NWRT funding when we would not have the opportunity to spend the funds in Nunavut due to the pandemic; however during this period we continued to make progress on our objectives through analyses of data collected in 2019, and other datasets received from collaborators. When it became possible to return to the field for the 2022 season and continue advancement of the community engagement aspects of the project, we re-applied for NWRT funding in 2022 (Project 23-003-01; activities covered in this report). Activities and results from the project's final funding year will be covered in upcoming reports for Project 23-003-09.

With respect to the specific objectives outlined in this project, we have made considerable progress and have shared results with our partners in our annual field reports. During the current reporting period, we highlight the following achievements:

Shorebird tracking (Objective 1):

We recently summarized a large dataset of geolocator tracks deployed on Red Knots, with the goal of furthering our understanding of red knot migration habits, wintering subpopulations, and possible range overlaps between subspecies. Red Knots migrate up to 15,000 km between wintering areas in South America and breeding grounds in the Arctic and were once commonly sighted by Inuit on Southampton Island, but have declined dramatically in recent decades and are now listed as an endangered species.

We compiled definitive geolocator tracks and data for over 200 Red Knot geolocators deployed between 2009 and 2021 and were able to show clear distinctions within wintering ranges for Red Knots in northern South America, Southeast United States and Caribbean, Western Gulf of Mexico, and Tierra del Fuego with large range overlaps during breeding and on route to and from breeding grounds (Figure 1). These analyses represent and important advance in our understanding of Red Knot migration habits at the subspecies and subpopulation level, which can guide geographically specific conservation measures and assist in determining priorities.

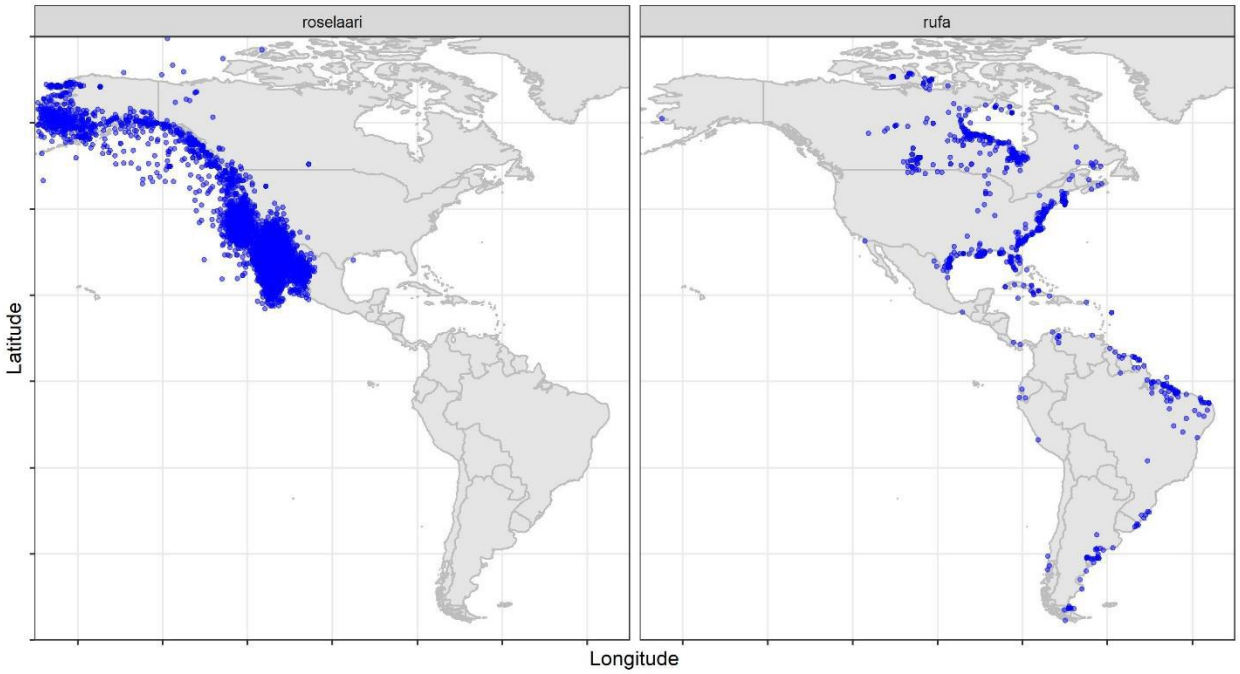


Figure 1: Geolocator locations for Red Knot subspecies rufa and roselaari showing minimal overlap, however some habitats were used by both subspecies. This includes areas of the western gulf (around Padre Island, Texas) and potentially northern Baja peninsula, Mexico.

In addition to compiling definitive migration tracks from previously deployed geolocators, we collaborated in 2022 and 2023 to deploy satellite tracking tags on Red Knots during their northward migration, to determine the current breeding range of Red Knots in the Canadian Arctic. Breeding range was listed as a key knowledge gap for Red Knot recovery, and new satellite tracking technology has allowed investigation of this question by tagging northbound Red Knots in the spring and tracking them in real time to the breeding grounds. Previous technology such as geolocators required birds to be recaptured to access data, which decreased the sample size available for determining breeding range. Several of the tagged birds appear to have nested on Southampton Island, indicating that this area continues to be important for declining Red Knots (Figure 2).

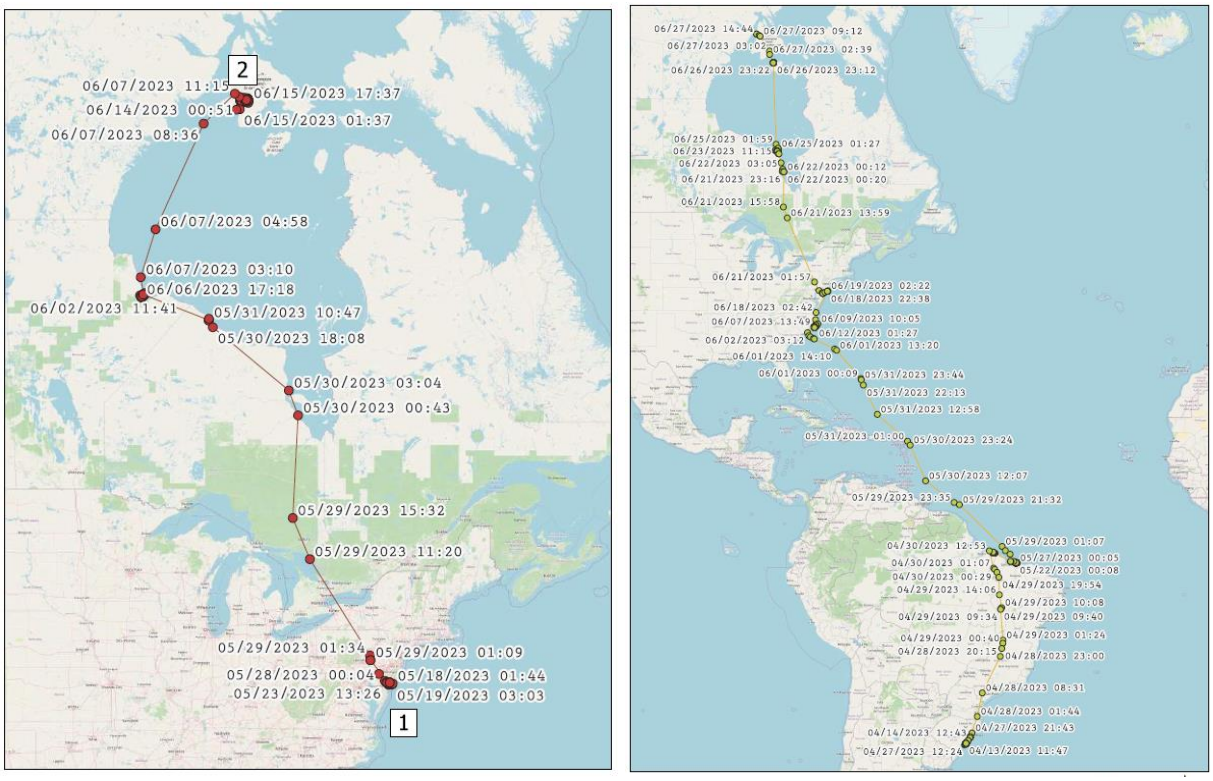


Figure 2: Two sets of satellite tracks from Red Knots that migrated to breed on Southampton Island in 2023. Maps courtesy of Stephanie Feign, unpublished data.

Tracking technology continues to evolve to permit investigation of new aspects of migration ecology for shorebirds, adding greater precision to our understanding of migration habits, and for a greater number of smaller shorebird species. In addition to the recent studies highlighted here, we have contributed to a multitude of collaborative tracking studies and will continue to pursue future studies to address knowledge gaps in migration ecology. To ensure that Inuit can connect with the knowledge generated by these studies, we are working on communications products to bring stories of shorebird migrations to Inuit, which will complement the reports we share annually with interactive visualizations showing the pathways birds take to and from Arctic breeding grounds.

Carry over effects (Objective 2):

PhD student Willow English investigated carry over effects in ten species of shorebirds, using data collected at East Bay and by collaborators at other Arctic breeding sites. Willow completed her thesis in January 2023, and publications from this work are in the peer-review process. One of Willow's PhD thesis chapters tested whether corticosterone levels in feathers ($CORT_f$; a measure of stress incurred on the winter grounds during moult and feather growth) were related to breeding metrics such as nest initiation date, nest success, or egg size. Willow additionally tested whether $CORT_f$ varies among species, sexes, or with morphometric measurements. $CORT_f$ levels varied substantially among species, and were

below detection limits in White-rumped Sandpipers, suggesting that $CORT_f$ may not be a useful measure of stress for all species. For species with detectable $CORT_f$ levels, birds with higher $CORT_f$ had higher nesting success in the natural ecosystem (Figure 3), but lower success in the area with artificially low predation pressure (Figure 4), suggesting that the effects of winter stress levels on breeding may be context-dependent. Overall, these results emphasize how conditions faced by shorebirds during the winter season outside of Nunavut continue to affect birds during the breeding season upon their return to the Arctic. This work highlights the importance of accounting for carry-over effects when explaining variation in reproductive success, and the importance of considering the whole annual cycle when planning conservation measures for migratory species.

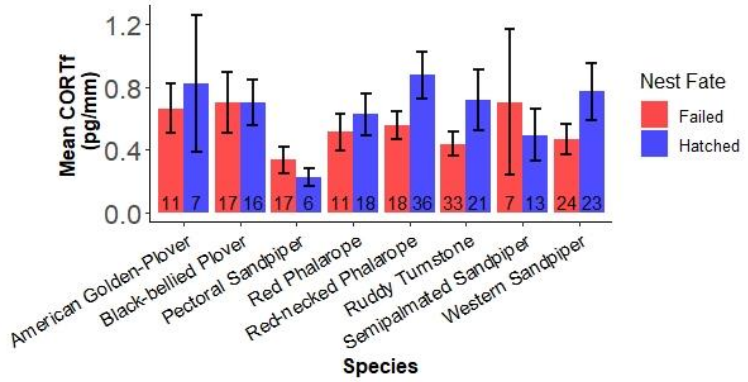


Figure 3. Mean $CORT_f$ levels and standard errors of birds with successfully hatched nests (blue) and depredated nests (pink), by species, from site-years with normal predator regimes (no fox control). Numbers at base of bars are sample sizes.

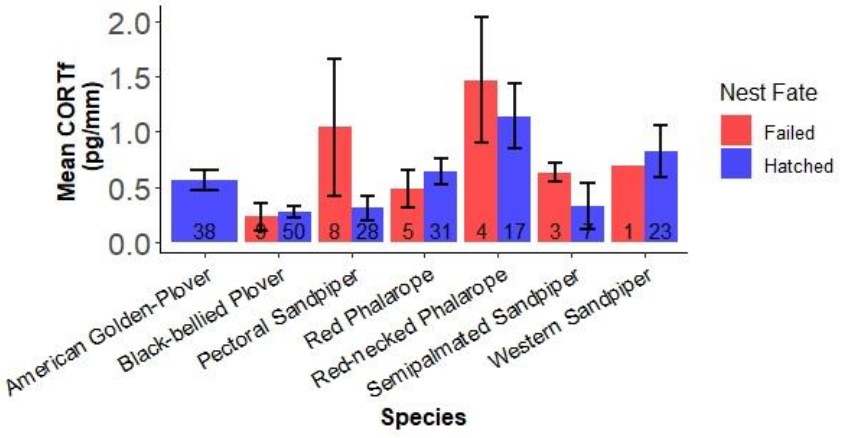


Figure 4. Mean $CORT_f$ levels and standard errors of birds with successfully hatched nests (blue) and depredated nests (pink), by species, from years with Arctic fox control in Utqiagvik, Alaska. Numbers at base of bars are sample sizes.

Shorebird Surveys in Ikkattuaq Migratory Bird Sanctuary (Objective 3):

In 2022 and 2023 we surveyed 28 plots in the Ikkattuaq Migratory Bird Sanctuary, to provide the first rigorous estimate of shorebird populations for this area. Data are currently being analysed, and we expect to provide results to the community in the winter of 2024. This survey effort is an important piece of monitoring data for the sanctuary, following the objectives outlined in the Management Plan developed by the ACMC for the sanctuary, and providing employment and training for 4 local research assistants in 2022 and 3 local research assistants in 2023. One individual, Joseph Pingwartuk, was further employed to conduct shorebird research at Qaqsauqtuuq in 2023, and assist with Southampton Island goose banding led by the Canadian Wildlife Service. We hope to be able to continue employing Joseph to participate in future projects.

During the 2022 season we provided logistical support for an archaeologist from Inuit Heritage Trust, Dr. Lesley Howse, to visit Ikkattuaq and conduct preliminary site investigations of archaeological sites in the area. The community was very supportive of these investigations, and we were happy to be able to facilitate the field visits during the time we had access to a helicopter for the shorebird surveys. We do not report on the results of the archaeological visits here, however a brief overview is provided in the attached field report.

Increase involvement of local youth in environmental monitoring (Objective 4):

The Inuit Field Training Program remains an important annual program for us, as a means of building capacity and interest for environmental monitoring in the communities we work with. This program, first delivered in 2018, brings Inuit mentors and scientists together to encourage youth to consider careers in environmental fields. In 2022, the IFTP took place over 10 days in late July at Qaqsauqtuuq Migratory Bird Sanctuary, based out of the East Bay Mainland research station operated by Environment and Climate Change Canada, and providing a training opportunity to 8 youth from Coral Harbour. In 2023, we expanded the program to invite participants from Coral Harbour and Naujaat to Qaqsauqtuuq, and we ran a second program at our field site on Prince Charles Island that drew participants from Sanirajak, for a total of 11 participants in 2023. The model for the IFTP is for participants to learn a mix of technical skills and land skills, under the leadership of mentors from the community and ECCC. We look forward to continuing this program in future years, and community members remain interested in this opportunity as way to offer training to youth and involve them in the research taking place around their communities.

Past participants in the IFTP have gone on to secure jobs with us and other departments for longer periods, and the program has been a valuable way to provide training in environmental monitoring to youth that might not otherwise have the opportunity to gain these skills.

Additional details of the 2022 fieldwork Inuit Field Training Program are described in the attached reports.

Discussion/Management Implications:

Communities in Nunavut are concerned about the state of shorebird populations, and scientific evidence also shows strong shorebird population declines. Our shorebird research activities are designed with direct input from community organizations (Aiviit HTO and Irniurviit ACMC), and include participation by local people, so that we can ensure that we are addressing local concerns and priorities about shorebirds. These NWRT-funded projects are an excellent complement to the broader suite of monitoring projects that we carry out, funded by Environment and Climate Change Canada. The preexisting infrastructure and our ongoing research and monitoring projects means that, with the additional funding from NWRT, we can efficiently leverage the resources already in place to focus on additional topics of particular interest to Nunavummiut. We are also able connect these local research projects to a broader network of researchers working at other sites across the Arctic. Therefore, research topics that are a community priority can be addressed at a larger spatial scale, allowing insights from across the Canadian Arctic.

2022 was the second full year of this 3-year research project, and consequently, we continue to address the objectives. Nevertheless, we are well on track to addressing them in greater depth in the coming years. Our shorebird tracking studies are yielding insights into migration routes and wintering areas that were previously not described for these species. Our work on Red Knots has allowed us to better understand their incredible migration and identify likely breeding areas throughout the Canadian Arctic. Our studies of feather corticosterone in shorebirds are applying this innovative new technique to measure stress in the previous winter with a feather collected during the summer.

At a national scale, some of the results of these studies could contribute to status reports for shorebirds being considered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). We are currently leading a project to summarize the status of 14 species of Arctic-breeding shorebirds, for review by COSEWIC. Information from the shorebird breeding grounds in Inuit Nunangat is essential for the development of these status reports, and results from Qaqsauqtuuq are the most rigorous source of shorebird breeding data available in Canada. Additionally, the tracking dataset that we have amassed is the largest ever assembled and will provide new insights into the movements of these wide-ranging shorebird species.

The research topics identified in this project relate directly to the NWMB mandate of ensuring the conservation and management of wildlife in Nunavut for the long-term benefit of Nunavut residents. By working directly with community members and HTOs, we strive to provide relevant research results that can inform the management and conservation of terrestrial ecosystems such that they can be enjoyed by current and future generations.

Report by Inuit Participants:

Following the field season in 2022, we conducted mock interviews with Inuit who participated as research assistants conducting shorebird surveys and archaeological surveys in Ikkattuaq Migratory Bird Sanctuary. The following are some excerpts from those interview transcripts describing the thoughts of some of the community members after being a part of the project.

"I'm a local from Coral Harbour, born and raised here. My name is Solomon Nakoolak. […] I learned some things [this summer] that I wasn't even aware of that we were going use, like high-tech equipment. Very interesting for me to use high tech equipment. […] I believe this is good information that we have picked up for future generations to understand, and have an occupation, for our local community, on our island. […] I've seen more than usual polar bears with cubs [during surveys], and it was unusual for me to see them inland, not along the shoreline. That was unusual to see polar bears inland, where there's no snow, in the heat, in the summer. So that was interesting to see that many bears, inland. […] I know for a fact that we can move forward even further, once we get the idea or the understanding of the land. I'm sure this is the type of job that we could create for the future. This is for future generations that we are doing the project here, at the site and at the bird sanctuary. I try and visualize for our younger generations to have occupations, knowing in our community Coral Harbour is lacking occupations. So this is the type of job creation that can be given here, to give occupations for the future, for the long term. […] I'm happy to be included in [the] team, and I liked learning lots." *-Solomon Nakoolak, Coral Harbour, June 2022*

"I liked it, I liked the experience, and I saw some stuff that I had never known, and I learned a bit. [Ikkattuaq was] different from when I first went to East Bay. It was so neat and interesting. I've never ever seen that before and it was pretty neat. I'd be interested [in doing this job again] and I'd also like others to experience it. [It was] way too short, I didn't want to go back home!" - *Jennie Kolit, Coral Harbour, June 2022*

"I heard about this through HTO. I got this job through the HTO and also I went to the Inuit Training Program at East Bay. This week we did bird surveys and historical surveys. [My highlight was] going on the helicopter, seeing lots of land, and visiting all those fox traps [archaeological sites]. I liked learning how to mark the nests and doing the surveys. […] There should be more Inuit people to learn this stuff." *-Joseph Pingwartuk, Coral Harbour, 2022*

Reporting to communities/resource users:

Originally, we had planned for a 3 year project beginning in 2019. Due to the COVID-19 pandemic and our inability to conduct fieldwork during the summers of 2020 and 2021, we were forced to adjust the project timeline accordingly. We have now resumed field activities and the project has proceeded, with the second year of field work and data collection taking place in 2022 (covered by this report, Project 23-003-01), and the final year of field work taking place in 2023 (Project 23-003-09; reporting to follow in upcoming reporting cycle). Since the resumption of activities as pandemic restrictions lifted, we have been able to meet several times with community members in Coral Harbour to share reports, discuss results, and confirm that research objectives remain aligned with community priorities. Most recently, we visited Coral Harbour in February 2023 to meet with the ACMC and HTO in person and share results from the project thus far. We continue to work closely with the community to ensure that this project serves to further community priorities to the greatest extent possible.

Table 1: Summary of project milestones and community consultations.

Output or step	**Start date**	**End date**	**Status**
Initial meetings with HTO/ACMC	15/04/2018	01/09/2018	Completed through in-person meetings in April 2018, and subsequent communications by phone/email.
Project design and consultation	01/09/2018	31/03/2019	Complete
Year 1 of field work	01/05/2019	31/08/2019	Complete
Results sharing/consultation	01/09/2019	31/03/2020	Modified due to COVID – Reports of 2019 research progress were written, translated and distributed to HTO and ACMC by email. We made arrangements for an in-person meeting in March 2020 to discuss the results, but this was cancelled at the last minute due to COVID-related travel restrictions.
Year 2 of field work	01/05/2020	31/08/2020	Modified due to COVID - All 2020 fieldwork was cancelled.
Results sharing/consultation	01/09/2020	31/03/2021	Modified due to COVID - We had planned to visit Coral Harbour to discuss the project during winter 2021, however pandemic lockdowns prevented us from doing so.
Year *2 of field work	01/05/2021	31/08/2021	Modified due to COVID – All 2021 fieldwork was cancelled.
Results sharing/consultation	01/09/2021	31/03/2022	Modified due to COVID – we had planned an in-person visit to Coral Harbour in winter 2022 to prepare for a return to field activities; however a COVID-19 outbreak in Coral Harbour and subsequent community lockdowns forced the cancellation of this trip. Instead, a teleconference was held in April 2022 when the caseload had improved.

Output or step	Start date	End date	Status
Year *2 of field work	01/05/2022	31/08/2022	Complete
Results sharing/consultation	01/09/2022	31/03/2023	Complete – We visited Coral Harbour in February 2023 and met with the ACMC and HTO to discuss project progress. We used this opportunity to distribute research reports and discuss opportunities for further collaboration to meet community research priorities, and also to make a presentation to local high school students about career opportunities in environmental monitoring.
Year *3 of field work	01/05/2023	31/08/2023	Complete
Results sharing/consultation	01/09/2023	31/03/2024	Underway – we are preparing field reports for Year 3 activities and discussing with the ACMC and HTO to schedule timing for a community visit.
Results sharing/Final Reporting	05/01/2024	30/09/2024	Underway – we will prepare a final report for NWRT, the ACMC, and Coral Harbour HTO synthesizing the results of this project. This report will be submitted to the NWRT by September 30, 2024.

ENVIRONMENT AND CLIMATE CHANGE CANADA

ARCTIC COASTAL BIRDS & ECOSYSTEMS

2022 FIELD SEASON AND RESEARCH REPORT

A Sandhill Crane glides by a survey plot in Ikkattuaq Migratory Bird Sanctuary

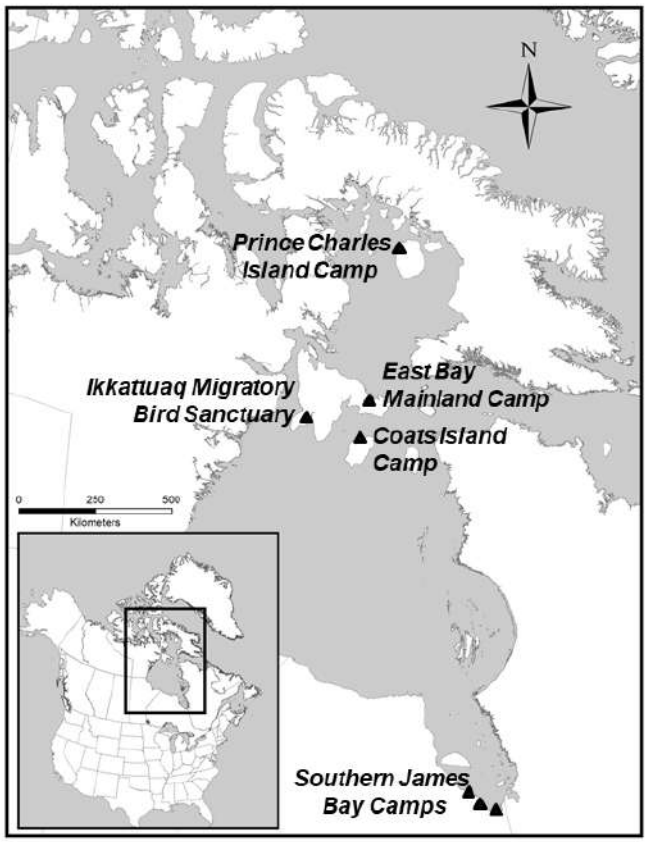
FIELD SEASON OVERVIEW

Coastal Arctic ecosystems are important habitats that support millions of nesting migratory birds each year. Our research is focused on better understanding these ecosystems, to inform their management and conservation. Shorebirds are the most abundant and diverse group of birds in coastal tundra, and are a group of conservation concern due to widespread population declines over the past several decades. We focus on shorebirds as an integral component of coastal Arctic ecosystems, and carry out research to:
1) understand long-term changes in the breeding ecology of shorebirds and other tundra birds in relation to changing conditions in the Arctic, 2) use innovative tracking technology to follow shorebirds throughout the annual cycle to identify threats to populations elsewhere in their ranges, and 3) develop novel techniques to refine knowledge of population status.

During the first two years of the global COVID-19 pandemic, our research was forced to shift temporarily away from field-based projects. However, despite this change of focus, we were able to advance many collaborations to further shorebird conservation in the Western Hemisphere. We focused on conservation projects that used pre-existing data, to avoid Northern travel during periods of community concern and public health restrictions. For example, one exciting project that we were able to advance considerably with support from the United States Fish and Wildlife Service and the Canadian Wildlife Service is a study of existing tracking data, band resightings, and feather samples from *rufa* Red Knots to better understand how migration patterns and wintering regions influence survival for this endangered Arctic-nesting species. In another project, we have reviewed the status of 18 Arctic-nesting shorebird species, and will present this report to the Committee on the Status of Endangered Wildlife in Canada, for evaluation of these species as potential Species at Risk.

As restrictions from the pandemic began to lift and resuming research at Arctic field sites became more possible, we assembled science equipment kits to support community-based monitoring efforts and facilitated a community driven project in 2022. There is growing interest in community involvement in environmental monitoring in the North. We aim to support these efforts wherever possible, by building capacity through programs like the Inuit Field Training Program, and by providing scientific advice to help communities collect data on their topics of interest.

In 2022, we returned to fieldwork at two established sites in the low Arctic: The East Bay Mainland camp at Qaqsauqtuuq on Southampton Island, NU, and our field site Prince Charles Island in the Foxe Basin, NU (Figure 1). East Bay Mainland is widely recognized as one of the most valuable long-term monitoring sites and research stations in Arctic North America, and Environment and Climate Change Canada has been collecting information on Arctic-breeding birds, vegetation, and climate at this site annually since the late 1990s – with the exception of the 2020 and 2021 field seasons during the COVID-19 pandemic when visiting the sites was not possible. At Prince Charles Island, 2022 was our third field season operating the camp, which is proving to be a promising mid-Arctic site for studies of shorebirds and geese. In particular, Prince Charles Island is a key area for nesting Brant: a goose species that has declined in recent decades in contrast to the boom in populations of Snow and Ross' Geese. This year we laid the foundation for future studies of Brant at Prince Charles Island, and we plan to continue monitoring at this site in years to come.



This year, we also visited the Ikkattuaq Migratory Bird Sanctuary on Southampton Island, NU, for a special project in collaboration with the Irniurviit Area Co-Management Committee (ACMC) to conduct breeding bird and archaeological surveys in support of the management objectives for this protected area. This project was designed to address ACMC priorities, employ local participants from Coral Harbour to assist in the surveys, and also provide an opportunity for an archaeologist from Inuit Heritage Trust to join our team to investigate cultural sites in the bird sanctuary through site visits and interviews with local elders.

We did not work at the Coats Island shorebird site in 2022, nor at the shorebird migration monitoring sites in southern James Bay (Figure 1). However, the existing data collected from these sites continues to be used in our research, and we are optimistic that studies will continue to make use of these sites in years to come.

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

EAST BAY MAINLAND

After two summers (2020 and 2021) away from East Bay, we were excited to resume monitoring of the breeding bird community. It was an average year for shorebird nesting at East Bay. We found 72 shorebird nests, of which 11 hatched for a 15% success rate (Figure 2). While not atypical for this site (33% success rate in 2019 and 12% in 2018), nest survival at East Bay is low in comparison to sites in the Central and Western Arctic. Similarly to recent years, White-rumped Sandpiper and Red Phalarope were the dominant shorebird species observed, and there continues to be relatively few Ruddy Turnstones compared to early years of monitoring. Monitoring data from migration sites suggest that Ruddy Turnstones have declined by 75% over the last 40 years; a decline similar in magnitude to the endangered Red Knot.

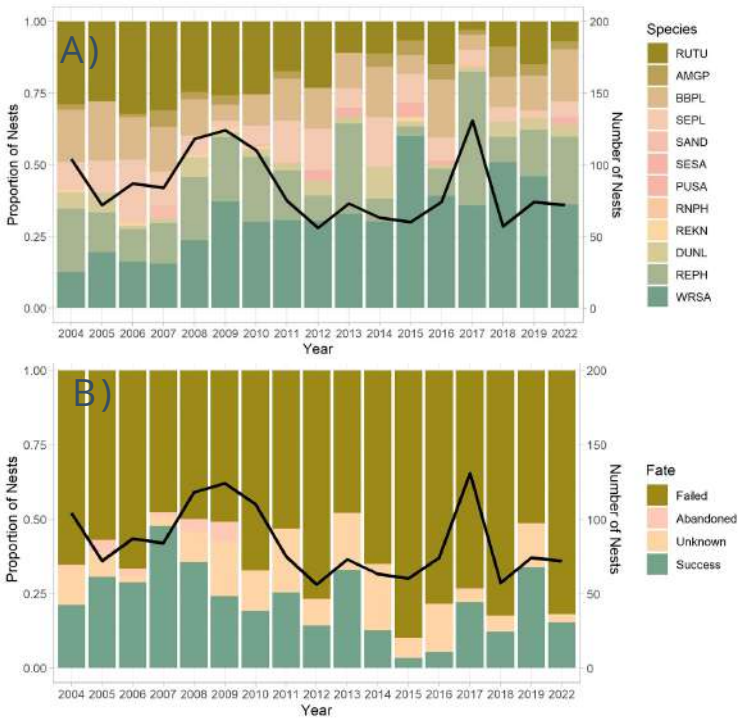


Figure 2. The number of shorebird nests monitored at East Bay (black line, both panels) in a 3 km by 4 km survey area between 2004 and 2022. Underlaid bars show species composition in panel A, and nest fate in panel B. 2020 and 2021 are omitted as no data were collected during these years.

The news is not all bad, however. This year there were good numbers of Black-bellied Plover, and we also found two nests of the Semipalmated Sandpiper, a species that was last observed nesting at East Bay in 2016, despite being common at nearby sites such as Coats Island.

A Semipalmated Plover performs a broken wing display to protect its nest

We intentionally set modest goals for science projects at East Bay this year, in case the camp infrastructure needed repairs following an absence of almost three years. However, we were pleased to find that the cabins had weathered the pandemic just fine without us, and we were able to conduct a full season of nest monitoring. Some of the projects undertaken are described in later sections of this report.

We were also able to contribute to collaborative projects, such as collecting feather down samples from Cackling Goose nests for genetic analysis. In recent years, harvesters in Nunatsiavut have noticed the arrival of small-bodied "white-cheeked" (Canada/Cackling) geese,

and this project is trying to determine the genetic relationships of white-cheeked geese across the North. We also conducted some reconnaissance surveys for nesting Brant along the coast of East Bay, to determine if Brant numbers there would support a research project. Our hope is to study breeding "propensity" (i.e., the proportion of individuals that attempt to breed), to help understand why this species continues to decline while other goose species have flourished.

Overall, 2022 was a successful return to field activities at East Bay. We look forward to continuing the long-term monitoring work at this important site in future years, and working with partners in Coral Harbour to address community research priorities. Our work at this site contributes to a better understanding of Arctic-nesting shorebird ecology, and supports international collaborations aimed at conserving shorebird populations throughout their ranges.

PRINCE CHARLES ISLAND

Our field season at Prince Charles Island was highly productive. We built a new cabin for cooking and lab work, which supplements an existing sleeping cabin and permanent electric bear fence. The camp can now safely and comfortably accommodate a research team of up to 8 people. In addition to this important infrastructure upgrade, we were able to advance several projects at the site, including studies of the impacts of overabundant geese on other species of nesting birds, an aerial survey of the coastal habitats of Prince Charles Island and Air Force Island, and reconnaissance surveys to support future studies of nesting Brant at this site.

In 2022, we were once again joined by researchers from Centre National de la Recherche Scientifique (CNRS, France), who had visited Prince Charles Island in 1996-1997 and were with us in 2019 during our last visit to the site. This year, we completed the data collection for a comparative study of breeding bird density and habitat use by re-surveying plots that were visited more than 20 years prior. Our field crews collected data on nest abundance for several species of shorebirds, including White-rumped Sandpiper, Red Phalarope, Dunlin, Black-bellied Plover, and Ruddy Turnstone, and non-shorebirds such as the passerine Lapland Longspur and several species of geese and gulls. We re-visited nest sites that had been photographed in 1996-1997, to document changes to the habitat that had occurred over 25 years. Preliminary results from this project

Left: A caribou at East Bay. We continue to track observations of caribou and other mammals as part of our monitoring protocols.

Right: The new cabin built at the Prince Charles Island camp in 2022.

indicate that abundance of some bird species, particularly Red Phalarope and Lapland Longspur, has decreased from 1990s levels, in conjunction with changes to preferred nesting habitat consistent with increased goose abundance. Nest abundance for species selecting dry tundra for nesting (Ruddy Turnstone, Black-bellied Plover) appear to have remained stable. Further results will be reported in upcoming project reports.

During our field visits in 2019, the effects of increased goose abundance on the habitat were dramatic: many areas that had previously been sedge communities are now dominated by mosses. To further investigate these changes, in 2022 we constructed a series of small exclusion plots to quantify the effect of goose herbivory on vegetation. We also collected measurements on gas flux in relation to goose grazing, to explore how these habitat changes from geese might influence greenhouse gas exchange. This type of study has not yet been conducted in the Canadian Arctic, and provides another important dimension for studies of the effects of geese on Arctic ecosystems. Data are currently being analyzed for this project.

This summer, we were also excited to lay the groundwork for future studies of Brant at the Prince Charles Island field camp. The Atlantic population of Brant has been identified as a conservation priority by the Arctic Goose Joint Venture, due to knowledge gaps surrounding the factors driving large fluctuations in population over recent decades. Inuit communities have also expressed concerns about Brant populations. The survival of adult Brant has remained stable over time, so the leading hypothesis for population decline in Brant is that low breeding success at Arctic sites is driving population declines. Studies at Arctic field sites will help to clarify whether low breeding success is a consequence of widespread loss of nests, or because adults are deferring breeding in some years.

Changes to the habitat available to breeding birds at Prince Charles Island are readily apparent in this pair of photos taken at the same location in 1996/1997 (below, left) and 2019/2022 (below, right).

Using GPS tracking tags deployed during migration and winter, collaborators from the University of Saskatchewan have found that many Atlantic Brant breed on Prince Charles Island. This site offers a unique opportunity to study breeding effort and breeding success in this important population. While at the Prince Charles Island field site in 2022, we conducted reconnaissance surveys, both on foot from the camp and to sites farther afield by helicopter, to assess the suitability of the Prince Charles Island camp to undertake a suite of studies focused on Brant. During these reconnaissance efforts, we found 41 active Brant nests within walking distance of the camp, and observed 280 Brant during the aerial survey.

We also used this opportunity to re-survey the coastlines of Prince Charles and Air Force Islands for all wildlife species to compare species abundance and composition with previous survey data from 2002-2003. During these surveys, we recorded 17 species, with Snow Geese and Cackling Geese as the most abundant species. We also recorded a small number of caribou with calves, and wide variety of other birds including gulls, ducks, loons and shorebirds (Figure 3). Overabundant Snow and Ross' Geese in the Arctic are decreasing the quality of tundra habitats for themselves and for other species. Supporting this, in 2022, we observed large numbers of non-breeding snow geese, including groups of moulting snow geese, particularly as we surveyed inland portions of Prince Charles Island. We also recorded colonies of breeding Ross' Geese on western Air Force Island in 2019; this species is moving eastwards across Nunavut, and this is new evidence of breeding for this species in this area. Densities of Snow and Ross' Geese appear to fluctuate dramatically at these sites. For example, breeding densities of Snow Geese around the Prince Charles Island camp in 2022 were approximately 1/4 of the density recorded in 2019 (68 nests per km² in 2022 versus 256 nests per km² in 2019).

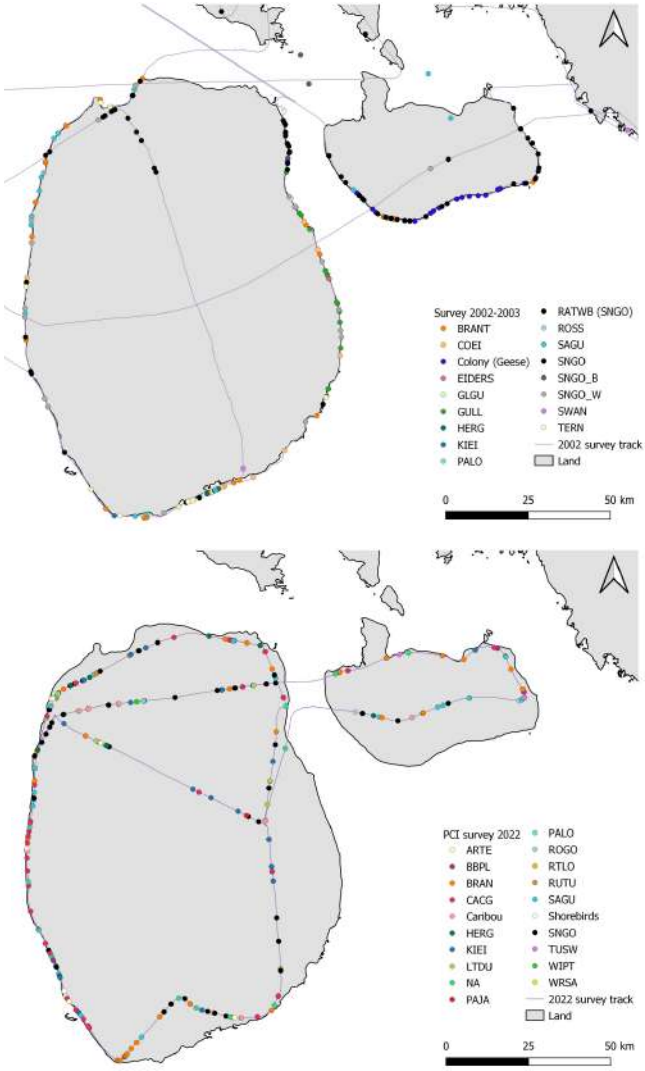


Figure 3. Helicopter survey routes and species recorded on aerial surveys of Prince Charles and Air Force Islands in 2002-2003 (A) and 2022 (B).

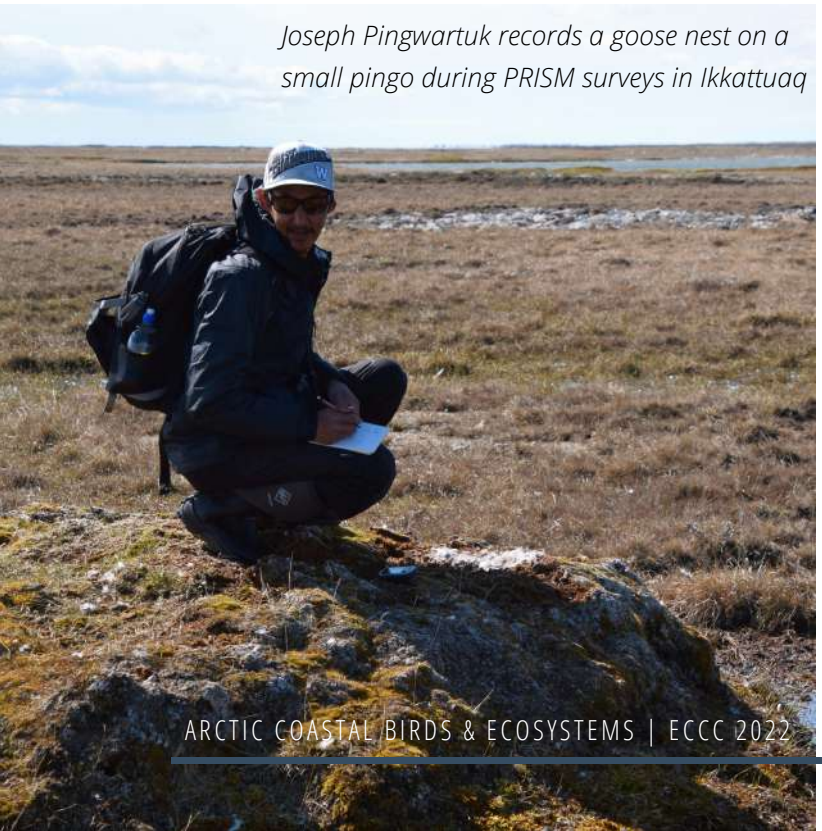
IKKATTUAQ MONITORING SURVEYS

This year, in collaboration with the Irniurviit ACMC, we visited Ikkattuaq Migratory Bird Sanctuary to address several management priorities for the protected area. Few wildlife surveys have been conducted in this area in recent years, and baseline data for breeding densities of birds are lacking. Community representatives on the ACMC requested our assistance, so with the help of local research assistants from Coral Harbour we conducted surveys in late June 2022 to document the abundance and distribution of birds, using the PRISM protocol (Program for Regional and International Shorebird Monitoring).

Right: A 3D model of a meat drying rack, one of many archaeological features investigated in Ikkattuaq in 2022. Courtesy L. Howse.

An additional ACMC and community priority was to investigate two cultural sites that are located in the bird sanctuary, but that were not yet registered in the territorial archaeological catalogue. We were able to make steps toward doing so with the help of Inuit Heritage Trust archaeologist Lesley Howse, who spent two weeks in Coral Harbour interviewing elders and community members, visiting the cultural sites to begin cataloguing artifacts and features, and providing training on archaeological survey methods to local research assistants. One site, near Itijuarjuk along Manico Point, consisted of a dense array of tent rings, activity areas, caches, animal bones, and chert flakes, which in combination with the location on an upper beach ridge suggest it was a Tuniit (Dorset) occupation. The second site, north of Nunattaunngi, contained a great number of features constructed from large limestone slabs, including caches, fox traps, hunting blinds, meat drying racks, and tent rings as well as parts of whale bone sled runners. This site was likely occupied by Sallirmiut prior to the complete decimation of the local population in the 20th century. Many additional features and sites were visible from the helicopter, indicating the importance of this region over time and a need for a more thorough survey effort to define the full extent of the cultural sites in this area and their relationship to each other. During

Joseph Pingwartuk records a goose nest on a small pingo during PRISM surveys in Ikkattuaq



interviews, several local elders and knowledge holders shared their observations and stories about these sites, which led to many rich discussions over the course of the workshops. We hope these efforts to document and understand these cultural sites will continue, so they can serve as cultural and educational resources for the community.

While based in Coral Harbour to conduct surveys in Ikkattuaq, we took the opportunity to conduct a preliminary survey of a predator-free eider colony near the community, where there had been sightings of banded eiders from East Bay. This site is an excellent candidate for a community-based monitoring project, to understand whether eiders are leaving East Bay in favour of other nesting sites because polar bears are increasingly destroying the nests at East Bay. This project gave us an opportunity to work closely with people interested in environmental monitoring in Coral Harbour, and provided training opportunities to help facilitate future community-based monitoring efforts. We plan to continue this project in 2023, conducting additional shorebird surveys in Ikkattuaq and providing further support for community interest in environmental monitoring and management of protected areas on Southampton Island.

INUIT FIELD TRAINING PROGRAM

We were excited to resume the Inuit Field Training Program (IFTP) in 2022, after a two-year hiatus during the peak of the global COVID-19 pandemic. The IFTP remains an important priority for us, as a means of building capacity and interest for environmental monitoring in the communities we work with. This annual program, first delivered in 2018, brings Inuit mentors and scientists together to encourage youth to consider careers in environmental fields.

As in previous years, the IFTP took place over 10 days in late July at Qaqsauqtuuq Migratory Bird Sanctuary, based out of the East Bay Mainland research station operated by Environment and Climate Change Canada. Participants from Coral Harbour learned a mix of technical skills and land skills, under the leadership of mentors from the community and ECCC. We look forward to continuing this program in future years, and have plans to expand to accommodate a similar program at the Prince Charles Island field site in 2023.

Participants and leaders in the 2022 Inuit Field Training Program pose for a group photo at East Bay

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 2022 highlights of these projects below. These students and post-doctoral fellows are supervised by Paul Smith, in collaboration with colleagues at Trent University, Carleton University, and the University of Windsor.

Right: MSc student Sara Bellefontaine holds a Red Phalarope chick at Qaqsauqtuuq

How much does climate affect the distribution of shorebirds breeding in the Arctic?

Christine Anderson – PhD Candidate, Carleton University

Like many Arctic species, shorebirds will likely be affected by the rapid climate change predicted to occur in the Arctic over the next century. Canada is one of the few places on earth where there is land mass available for low Arctic species and habitats to shift northwards. High Arctic habitats are likely to shrink, as there is no land further north to expand into.

Many governments and wildlife management agencies use predictive models to help make decisions about managing wildlife in the context of climate change. Currently, many of the models predicting how species will respond to climate change use only climate information like temperature and precipitation to predict how species will respond. However, species may have stronger associations with other factors such as food, nesting habitats, competing species, or predators that may only be weakly related to climate. If this is the case, the predictions made by climate-only models will not be very accurate. By including these other factors, our ability to predict how species will respond to climate change will improve.

Part of Christine's PhD project is trying to understand the relationship between climate, arctic habitats, and breeding shorebirds. Her research uses data collected as part of the Program for Regional and International Shorebird Monitoring (PRISM) between 1994-2018. To test if climate is the best predictors of where shorebirds breed, we created models of the distribution of 17 shorebird species. Our results show that on average only 42% of the

predictive ability of the models related to climate – 16% from the direct effect of climate on shorebirds, and 26% from the indirect effect of climate on additional factors like land cover, elevation, and timing of snow melt. These additional factors accounted on average for 58% of the predictive ability of our models of shorebird distribution (Figure 4).

These results indicate that if predictions of how shorebirds will shift their distribution in response to climate change are made solely based on climate, the predictions will have a high degree of uncertainty. Including additional factors such as land cover and elevation to predictions of future distributions should improve their accuracy.

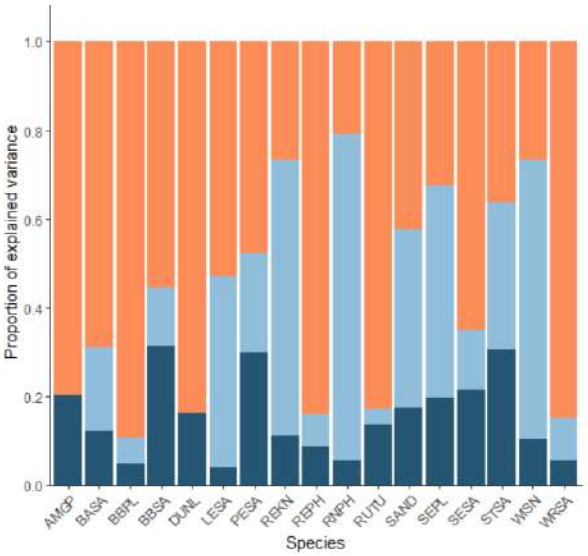


Figure 4: The proportional predictive ability of direct climate effects (dark blue; temperature and precipitation), indirect climate effects through their effect on additional predictors (light blue; land cover, elevation, timing of snow melt), or the unique effect non-climate predictors (orange) on shorebird breeding presence at sites throughout the Arctic.

Physiological and behavioural responses of Arctic-breeding shorebirds to weather and habitat conditions

Sara Bellefontaine – MSc Candidate, University of Windsor

Suitable nest habitat can provide thermal protection and decrease the energetic demands faced by incubating shorebirds. However, nest-site decisions generate a trade-off between thermal protection and visibility of approaching predators. Shorebirds appear to prefer nests with concealment on one side while leaving the other side more open, but these preferences do not influence nest success. Instead, selecting appropriate nest sites may benefit incubating shorebirds by lowering energetic costs, rather than directly improving hatching success.

Sara has been combining historical data from East Bay Mainland with empirical data collected in the 2022 field season to examine physiological and behavioural responses of shorebirds to conditions on the breeding grounds. The prevailing winds that blow in from over the open water to the Northeast are significantly colder than other winds at the study site (Figure 1). Historical data show that

White-rumped Sandpiper

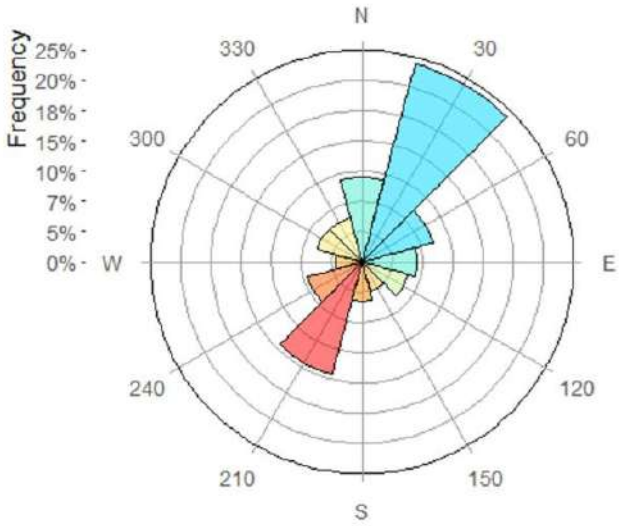


Figure 5. Frequency of wind directions across 13 years of shorebird breeding seasons at East Bay Mainland. Bar colour represents relative differences in ambient temperature associated with each wind direction.

White-rumped Sandpipers (WRSA) and Red Phalaropes (REPH) prefer nests with more vegetation protecting them from these cold, prevailing winds. Sara equipped nests of 20 WRSA and 13 REPH with temperature loggers and egg-based microphones to record adult shorebirds' heart rate and off-nest-bouts throughout incubation in the 2022 field season. Heart rate can be used as a proxy for metabolic rate, with higher heart rates representing higher energy burn. These recordings, coupled with data on concealment around each nest and daily weather conditions, will be used to assess how weather and habitat conditions affect energy burn of incubating shorebirds, and whether this in turn influences incubation behaviour.

Atlantic Brant breeding ecology on Prince Charles Island

Lindsay Carlson – PhD Candidate, University of Saskatchewan

The Atlantic brant (*Branta bernicla hrota*) population has fluctuated dramatically in recent years, from 111,000 individuals in 2015 to 170,000 individuals in 2018. Because adult survival has been relatively constant since 1980, fluctuations in population size are most likely due to "booms" and "busts" in annual productivity. Annual fall age-ratios suggest as many as 40% juveniles in some years, and as few as 2% in other years. However, it is unknown whether low ratios of juveniles are due to widespread breeding failure or deferral of breeding attempts.

Beginning in 2018, Dr. Mitch Weegman (University of Saskatchewan) and a group of international collaborators (NY State Department of Environmental Conservation, NJ Division of Fish and Wildlife, Canadian Wildlife Service, Niskamoon Corporation, Eeyou Marine Region Wildlife Board, University of Quebec at Rimouski, and Ducks Unlimited Canada) have been building a program to study Atlantic brant movement and population ecology across their annual cycle. This group has since deployed GPS-acceleration (ACC) transmitters on more than 200 Atlantic brant during winter in coastal NJ and NY, with the goal of linking the effects of winter and spring movements and behaviour with subsequent breeding propensity and full-term incubation (as determined by GPS and ACC data). By examining these processes in a full annual cycle modeling framework, the research aims to evaluate trade-offs between breeding and deferring reproduction in a given year and test environmental drivers on productivity.

There are important information gaps remaining in our understanding of Atlantic brant breeding ecology, and addressing these gaps is highlighted as an objective in the Arctic Goose Joint Venture 2022 Strategic Plan. The GPS-ACC devices provide a reasonably robust

understanding of individual reproductive success, but we cannot understand the factors that determine reproductive outcomes, particularly at the local scale. Atlantic brant are thought to breed in a dispersed manner across the Foxe Basin, which is supported by locations from tagged individuals that span from Southampton Island to Baffin Island. Considering that a majority of tagged individuals (more than 2/3) used Prince Charles Island at some point during summer and migration, this site with ECCC logistical support and infrastructure became a compelling location for a study of breeding ecology to complement and enhance the satellite tracking data.

In 2022, Lindsay joined the ECCC-led research team at Prince Charles Island, and completed reconnaissance surveys by helicopter and on foot to evaluate the feasibility of a long-term study of brant breeding on Prince Charles Island. The helicopter survey took place in early July (mid-incubation) and flew a route to visit areas of high-usage by GPS-tagged brant in previous years (Figure 6). The team found evidence for at least two nesting "hot spots" on the northern end of the island and observed 280 total brant, including 25 presumed nesting pairs, and 16 confirmed brant nests. Lindsay and the field crew spent 7 days nest searching areas within walking distance of the existing cabin and located 41 Atlantic brant nests, mostly on large pond systems within 2 km of the coast.

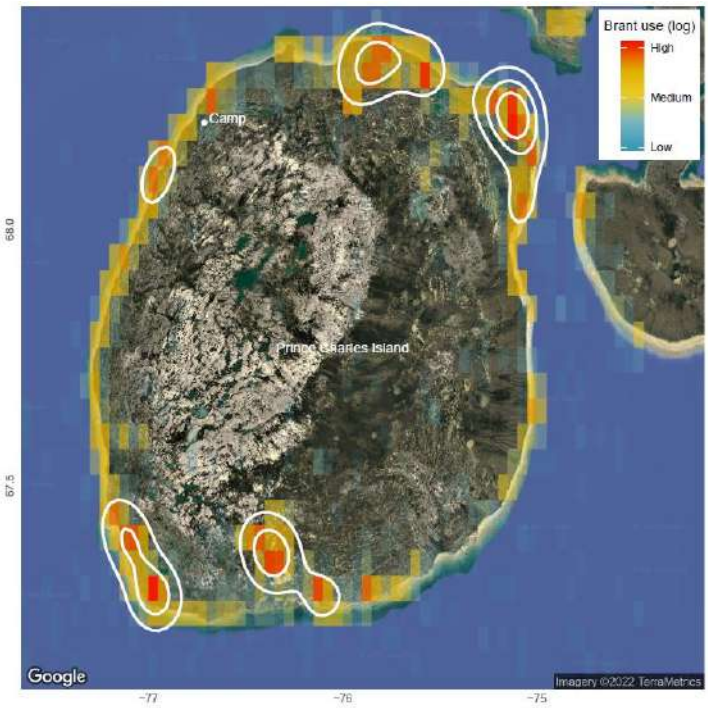


Figure 6. Kernel density estimates and 'hotspots' of brant use of Prince Charles Island from GPS satellite transmitter data.

The proximity of breeding brant to the field camp, and the density at which likely-breeders were observed elsewhere on the island, were encouraging signs for the feasibility of a suite of studies of Atlantic brant breeding ecology using this site. Lindsay will return to Prince Charles Island to initiate more extensive nest monitoring for 2023, with hopes to establish a longer-term research project to address several important knowledge gaps in our understanding of breeding ecology for this species of conservation concern.

A pair of breeding brant on Prince Charles Island. Photo: Lindsay Carlson

Insight into ecosystem changes following two decades of monitoring at Qaqsauqtuuq

Emma Davis - Postdoctoral Fellow, ECCC

In early days of monitoring, the camp at Qaqsauqtuuq consisted of several longhouse tents used for sleeping and cooking.

The Qaqsauqtuuq Migratory Bird Sanctuary (MBS) at East Bay, Southampton Island, Nunavut is an important nesting, brood-rearing and moulting area for migratory shorebirds and waterfowl. Arctic-breeding shorebirds have undergone significant population declines in recent decades and are the subject of on-going research at Qaqsauqtuuq. The site is also designated as an Important Bird Area, and the monitoring that takes place there contributes to the Program for Regional and International Shorebird Monitoring (PRISM) as a long-term, intensive survey site for shorebirds (Arctic PRISM, Tier II). In 2022, to mark two decades of monitoring at Qaqsauqtuuq, Emma summarized the shorebird and environmental data collected at the site into a report describing the trends and changes that have occurred during that time. The report, which will be made public following a final round of edits, highlights the importance of Qaqsauqtuuq as a long term monitoring site to assess inter-annual variation in not only the breeding bird community, with a total of 1,594 shorebird nests monitored between 2000-2019, but also trends in environmental variables such as snow cover, temperature, and precipitation, which can contribute to reproductive success for nesting birds and serve as a baseline for future monitoring as climate change continues to impact Arctic environments.

Over two decades of monitoring, White-rumped Sandpiper nests make up the greatest proportion of those located and their relative proportion appears to have increased over time from 2000 to 2019 (total of 443 nests

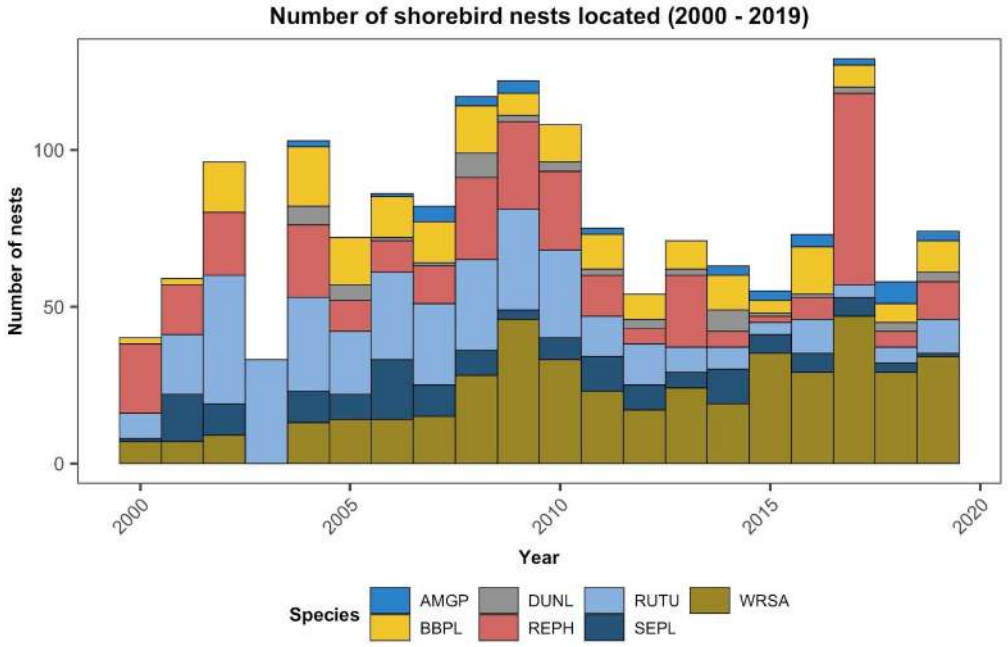


Figure 7. Total number of shorebird nests located each year from 2000 to 2019 for each focal species. Note that observer effort and search area vary across years, and that fieldwork activities in 2003 were dedicated to locating Ruddy Turnstone nests only.

monitored). In contrast, Ruddy Turnstone nests were abundant in early years of monitoring, but the proportion of Ruddy Turnstone nests has declined (total of 370 nests monitored; Figure 7). The daily survival probability of nests across all shorebird species was > 0.90 in all years, with the exception of the 2015 breeding season when nest survival was very low, and the overall nest survival probability was 0.18, indicating that on average, 18% of located nests survived to the end of the nesting period. There was no trend over time in survival, however there was a high degree of inter-annual fluctuation likely related to breeding conditions in a given year.

The report also highlights the trends in seasonal progression of snowmelt and ambient temperatures. From 2000 to 2019, average minimum temperatures increased from approximately -2°C at the beginning of June to +3°C near the end of July (blue line, Figure 8), whereas average maximum temperatures increased from 2°C to 12°C over the same period (red line, Figure 8). The study area at Qaqsauqtuuq is generally completely snow covered in late-May/early-June when field crews arrive (grey solid line, Figure 9). The percentage

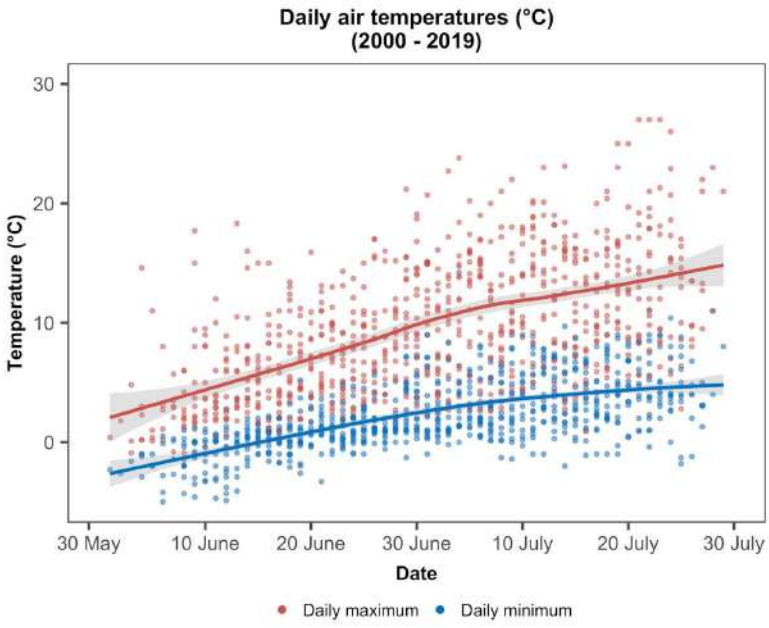


Figure 8. Daily maximum (red) and minimum (blue) air temperatures (°C) during the 2000 to 2019 field seasons at Qaqsauqtuuq MBS. Points represent daily observations, solid lines show a loess smoothing function.

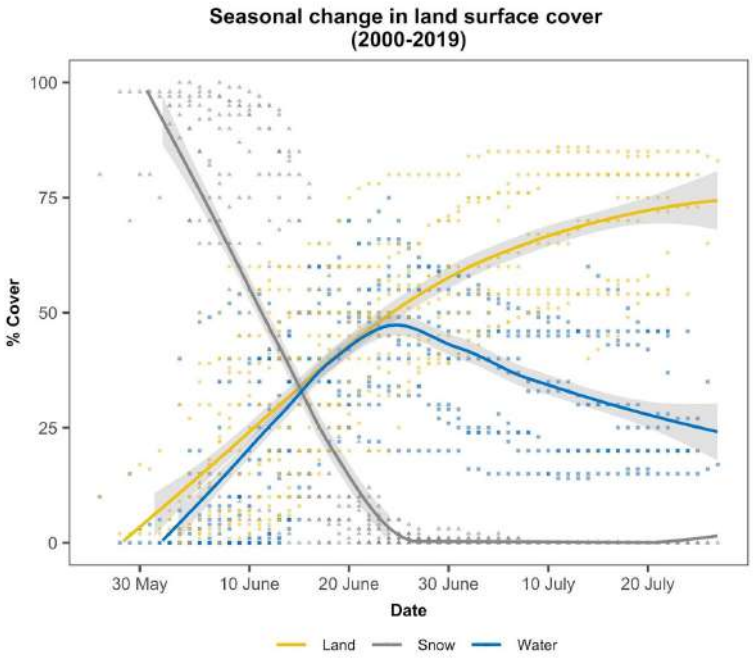


Figure 9. Seasonal changes in land surface cover from 2000 to 2019. Points show daily observations of % land (yellow circle), snow (grey triangle), and water (blue square) estimates. Solid lines show a loess smoother (conditional mean) between day of year and % cover with grey shading indicating the associated 95% confidence intervals.

of land and water increases over the course of the field season as snow cover declines. On average, surface water peaks (approximately 48%), and snow disappears (reached apx. 0%) around June 25. This period in late June coincides with the peak of nest initiation for most shorebird species.

Overall, the first two decades of monitoring data from Qaqsauqtuuq provide a wealth of information about the ecology at this important site, and set a backdrop for future monitoring to take place as environmental changes continue to take place at Qaqsauqtuuq and across the Arctic. Many thanks to all those field crews, researchers, and technicians who contributed to the collection and curation of these datasets over the past 20 years!

Carry-over effects in Arctic-breeding shorebirds

Willow English - PhD, Carleton University

Breeding success is a key metric used to track population health, but it has become increasingly apparent that it can be not only affected by local conditions, but through carry-over effects from other seasons. Feather corticosterone (CORTf) is a measure of how much stress hormones are incorporated into feather tissues, and reflects stress levels experienced by a bird while the feather was being grown. Willow collected feathers from ten species of shorebirds at the East Bay Migratory Bird Sanctuary, and collaborated with researchers in Alaska to obtain feather samples for birds at additional reference sites, one of which had abnormally low predation levels due to fox control. One of Willow's PhD thesis chapters tested whether CORTf levels were related to breeding metrics such as nest initiation date, nest success, or egg size. Willow additionally tested whether CORTf varies among species, sexes, or with morphometric measurements. CORTf levels varied substantially among species, and were below detection limits in White-rumped Sandpipers, suggesting that CORTf may not be a useful measure of stress for all species. For species with detectable CORTf levels, birds with higher CORTf had higher nesting success in the natural ecosystem (Figure 10B), but lower success in the area with artificially low predation pressure (Figure 10A), suggesting that the effects of winter stress levels on breeding may be context-dependent. Overall, these results show that winter condition continue to affect birds during the breeding season, highlighting the importance of including carry-over effects when explaining variation in reproductive success, and the importance of considering the whole annual cycle when planning conservation measures for migratory species.

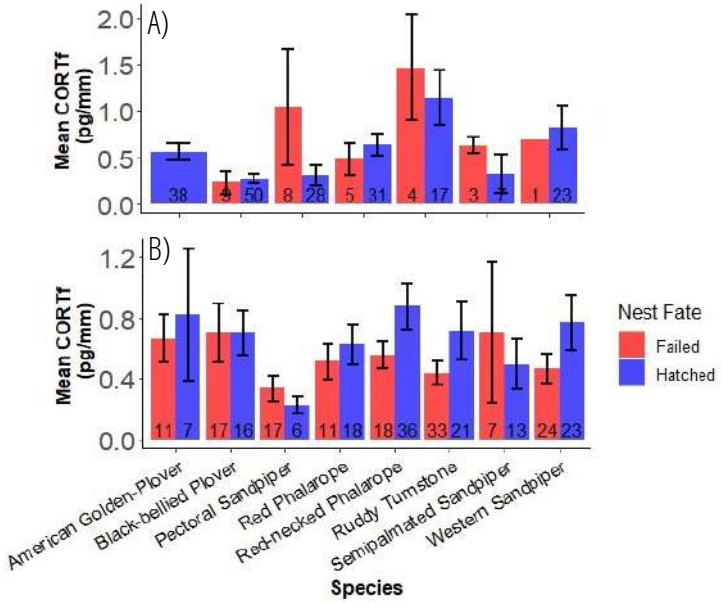


Figure 10. Mean CORTf levels and standard errors of birds with successfully hatched nests (blue) and depredated nests (pink), by species, from years with Arctic fox control in Utqiagvik, Alaska (panel A), and site-years with normal predator regimes in panel B (no fox control). Numbers at base of bars are sample sizes.

In 2022, Willow finished her PhD thesis and successfully defended it in January 2023. Over the summer, Willow worked with the Canadian Wildlife Service on the PRISM rapid survey crew in the Ahiak (Queen Maud Gulf) Migratory Bird Sanctuary in Nunavut. These surveys count shorebirds and other vertebrates at randomly selected sites of differing habitat quality, and provide valuable data used to estimate numbers of breeding birds in Arctic Canada, and determine how numbers are changing over time.

A Red Phalarope at Qaqsauqtuuq

Annual survival of Red Knots (*Calidris canutus rufa*) staging in James Bay, Ontario, Canada on southbound migration

Amie MacDonald – Trent University & Birds Canada

Amie completed her Masters thesis in 2019, and is currently a biologist with Birds Canada where she continues to conduct research on Red Knots. Recently, she led the completion of a scientific manuscript quantifying the survival of Red Knots that were resighted at an important post-breeding staging site in southwestern James Bay, Ontario. Almost a quarter of the *rufa* Red Knot population have been observed using this site on their southbound migration, presenting an excellent opportunity to observe demographic rates using mark-resight-recovery methods for leg-flag resighting data. Adult survival rates are an important driver of shorebird population dynamics, and site-specific estimates can help to identify segments of the population that are at greatest risk of decline. These estimates are lacking for Red Knots, particularly at post-breeding sites. Amie estimated adult annual survival probabilities from 2009 - 2019 using a Bayesian mark-resight-recovery model for Red Knots staging in southwestern James Bay during southbound migration.

Survival was stable at approximately 81% over the 10-year period and was not influenced by snow cover on the Arctic breeding grounds during nest initiation, sea surface temperature along the United States east coast during pre-breeding migration, or broad climate indices. The stable survival rate suggests that adult Red Knots may be able to withstand some level of environmental variation. This survival estimate is similar to or slightly lower than other estimates derived from data collected at other sites during other periods of the annual cycle in overlapping years, suggesting different vital rates (e.g., fecundity) may have a stronger effect on population trajectories, or that mortality is not occurring disproportionately at sites where survival rates have been estimated, though more mortality may be occurring at sites where survival has not been estimated. Ultimately, this project contributes to a better understanding of rufa Red Knot demographics, to help direct conservation efforts and reverse declines for this endangered species.

Reporting sightings of banded birds, such as this Red Knot observed at East Bay, contributes to a better understanding of migration habits and survival rates. Photo: Willow English

The role of camouflage in nest survival of Arctic shorebirds

Meghan Oliver - BSc, Carleton University

In the Arctic, incubation behaviour is influenced by trade-offs, as incubating birds must balance their on-nest thermoregulatory duties with off-nest foraging to meet their energetic demands. The duration and frequency with which a nest is left uncovered increases the susceptibility of the clutch to predation. These trade-offs may be more pronounced in uniparental incubating species, where one individual is responsible for all parental care. Meghan's project studies the role of camouflage as an anti-predator strategy affects the survival of Arctic shorebird nests, with a focus on Black-bellied Plover, a biparental species, and uniparental White-rumped Sandpiper. Standardized photographs of nests and eggs from 57 nests were analyzed using image processing software and a dichromatic vision model of an Arctic fox, the dominant nest predator in this system. Background colour match, background pattern match, and edge disruption were quantified, and Cox proportional hazard models were used to assess the influence of these factors on nest survival.

Meghan's analyses found that both species selected concealed nest sites, with camouflage metrics indicating high levels of pattern matching, colour matching, and edge disruption. White-rumped Sandpiper nests we significantly better concealed than nests of the Black-bellied Plover. However, model selection did not indicate support for camouflage as a predictor

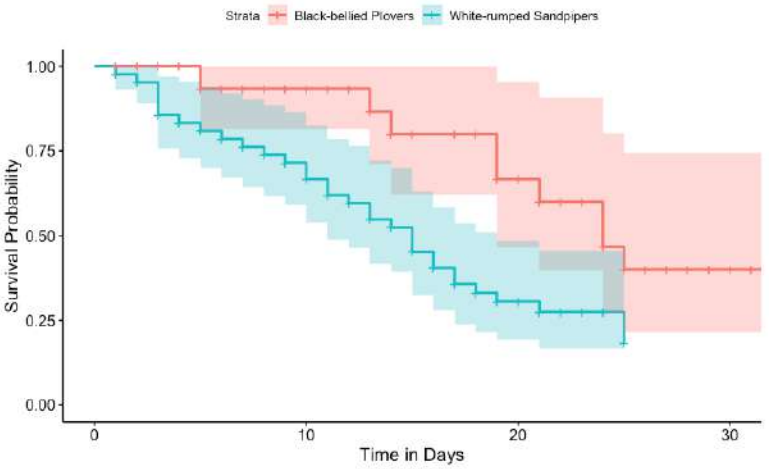


Figure 11. Survival probability and confidence interval of Black-bellied Plover and White-rumped Sandpiper nests estimated using the Cox proportional hazard regression. 2016-2019; over the study period, 38% WRSA, 40% BBPL nests survived to hatch.

of nest success, perhaps because suitably camouflaged nest sites are not limiting, or alternatively there may be additional factors that supersede egg and nest camouflage in determining nest survival (e.g., incubation behaviour and parental nest defense strategies, camouflage of parental plumage, or landscape-scale factors that influence predator encounter rates such as coarse scale nest site habitat selection or abundance of primary prey species such as geese and lemmings that regulate predator densities). This study is the first to apply image processing software to nest photographs to assess the link between camouflage and survival, and the results suggest that despite high levels of camouflage for both species studied here, nest survival is not adequately explained by camouflage alone.

Meghan used standardized photos of shorebird nests, like these of a Black-bellied Plover nest (left) and a White-rumped Sandpiper nest (right), to quantify and compare nest camouflage among species, and evaluate the link between camouflage and nest survival.

Using geolocator tracking data to advance understanding of Red Knot migration habits

Genevieve Perkins - Ninox Consulting

The Red Knot has undergone dramatic declines in recent decades and researchers have sought to improve knowledge about the species' ecology in an effort to understand these declines. Red Knots migrate up to 15,000 km between wintering areas in South America and breeding grounds in the Arctic, and over the past decades researchers have been studying the migration ecology of this species using tracking technology deployed on individuals, to better understand how threats experienced at various stages of their annual migration have contributed to observed declines. Since 2009, light sensitive and GPS geolocator devices have been deployed on Red Knots, *rufa* subspecies (*Calidris canutus rufa*) and *roselaari* subspecies (*Calidris canutus roselaari*), to better understand migratory patterns and potential range overlap. While some of the data have been summarized in publications and reports, a comprehensive review of these movement data has not conducted. With the goal of furthering our understanding of red knot migration habits, wintering subpopulations, and possible range overlaps between subspecies, this project compiled definitive geolocator tracks and data for over 200 *rufa* and *roselaari* Red Knot geolocators deployed between 2009 and 2021. With collaboration from scientists Joanna Burger, David Newstead, and Jim Johnson who originally deployed and curated geolocator data, consultant Genevieve Perkins (Ninox Consulting) cleaned and compiled the data to arrive at a single most

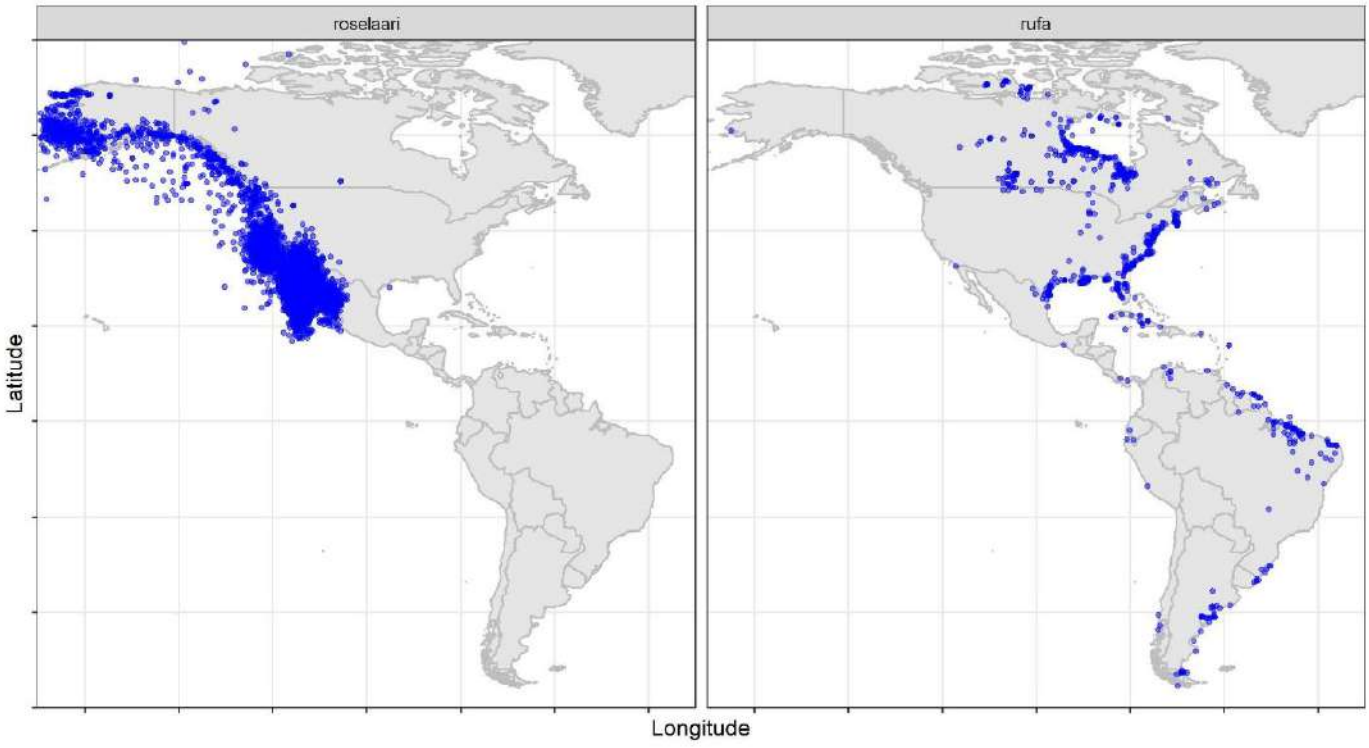


Figure 12. : The overlap between Red Knot subspecies rufa *and* roselaari *was minimal, however some habitats were used by both subspecies. This includes areas of the western gulf (around Padre Island, Texas) and potentially northern Baja peninsula, Mexico.*

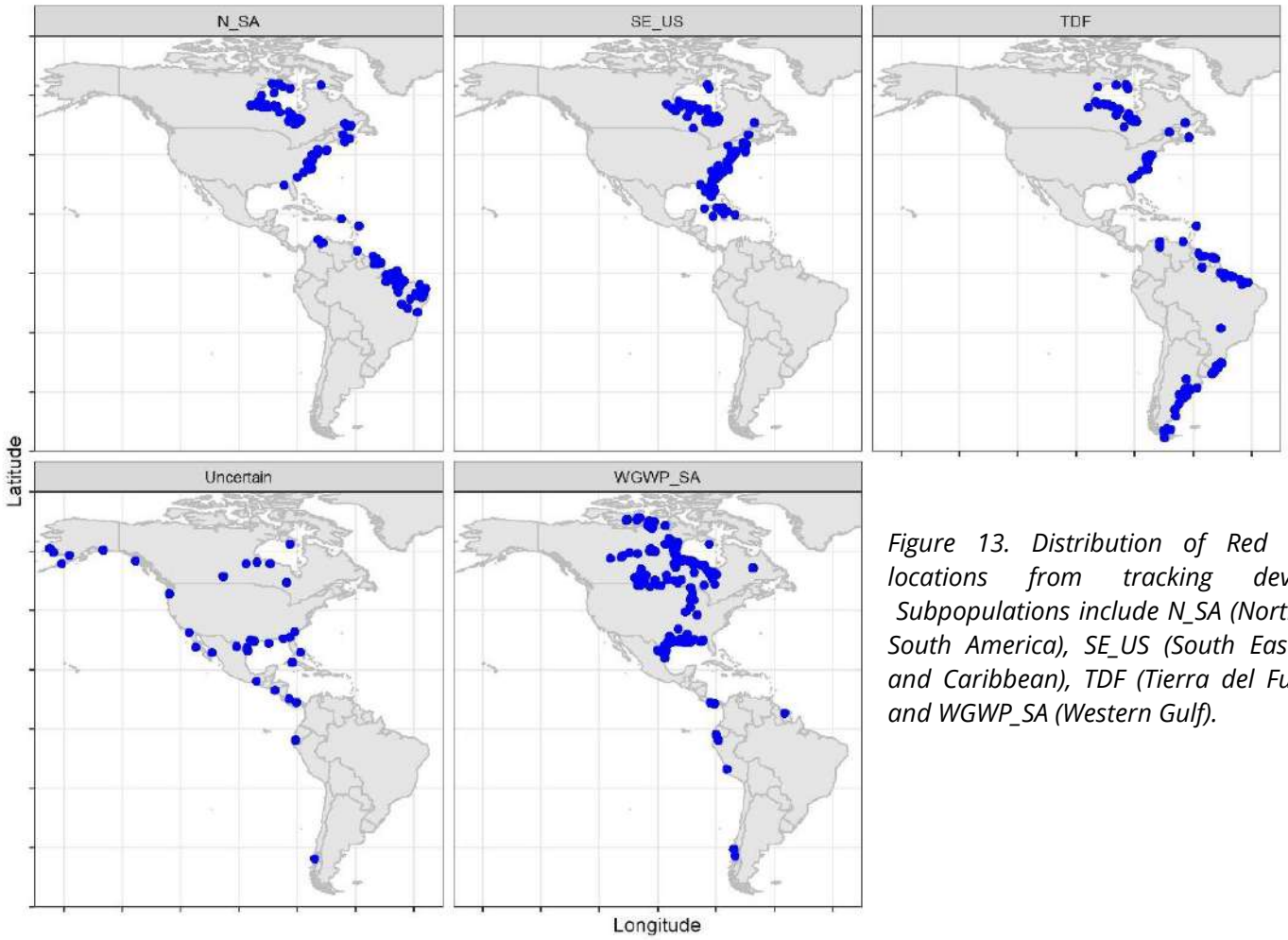


Figure 13. Distribution of Red Knot locations from tracking devices. Subpopulations include N_SA (Northern South America), SE_US (South East US and Caribbean), TDF (Tierra del Fuego) and WGWP_SA (Western Gulf).

accurate set of locations for each geolocator, to the effect that tracks are comparable and ready for use in further analyzes. These data were summarized to assign wintering locations to individuals and evaluate overlap between subpopulations and subspecies, and will be archived in an open-access database housed at Movebank.org.

Rufa subpopulations showed clear distinctions within their wintering ranges in northern South America, Southeast United States and Caribbean, Western Gulf of Mexico, and Tierra del Fuego with large range overlaps during breeding and on route to and from breeding grounds. The greatest overlaps occurred in eastern USA, where three subpopulations were migrating around the same time. Alternatively the western gulf population was more distinct with movement limited to central Canada and USA. Several individuals moved between subpopulations and some overlap occurred. *Rufa* and *roselaari* subspecies were largely spatially separated, although some individuals use common areas in the western gulf of Mexico and on the pacific coast.

These analyses represent and important advance in our understanding of Red Knot migration habits at the subspecies and subpopulation level, which can guide geographically specific conservation measures and assist in determining priorities. Furthermore, compiling geolocator (light and GPS) data into a standardized and accessible database will facilitate ongoing updates as new data is acquired. This will increase the ability to monitor conservation actions and redirect priorities as new data is collected.

INUIT PARTICIPATION

Josiah Nakoolak has been a part of Environment Canada research teams at East Bay and Coats Island every year since 1997. His wisdom and knowledge is essential to the safe operation of the field camps. Josiah also acts as a mentor for younger field assistants.

Jupie Angootealuk has worked at East Bay since 2013. He is a highly effective team leader and has occupied critical roles over his tenure with this project, including as a mentor for participants in the Inuit Field Training Program that took place at East Bay.

Mark Eetuk was a keen participant in the Inuit Field Training Program in 2018, and was recruited to East Bay in 2019 to work as a research assistant. Mark returned to join the team again in 2022 as part of the Inuit Field Research Assistant program.

J**oseph Pingwartuk, Laa Saviakjuk,** and **Jenny Kolit** all participated in the Inuit Field Training Program in 2019, and in 2022 formed the field team along with Solomon Nakoolak, archaeologist Lesley Howse (Inuit Heritage Trust), and ECCC staff to visit Ikkattuaq to conduct shorebird and archaeological surveys in the bird sanctuary.

Solomon Nakoolak has been a senior mentor for participants in the Inuit Field Training Program since the first session in 2018. Solomon brings a rich experience to the role, and his knowledge, curiosity, and desire to help others make him a natural fit in the field camp. In 2022, in addition to the Inuit Field Training Program, Solomon assisted in Ikkattuaq shorebird and archaeological surveys.

Adamie Samayualie works at Prince Charles Island as a guide and research assistant. Adamie started working at Prince Charles Island in 2016 and 2017 when the camp was established, and his enthusiasm and work ethic are an important part of the field team.

Paolassie Ottokie works at Prince Charles Island as a guide and research assistant. Paolassie was unable to join the field crew in 2022 due to other commitments, but we look forward to having him join the field crew in upcoming seasons.

Maliki Attaqutaluk joined the team at Prince Charles Island for the first time in 2022. Maliki made great contributions to the construction of a new kitchen cabin, and participated in conducting surveys by helicopter and on foot.

Jenny Kolit counting eiders at a nesting colony near Coral Harbour

CURRENT AND RECENTLY COMPLETED STUDENTS

Christine Anderson (PhD candidate, Carleton University) is studying the effects of climate change on the distributions of shorebirds breeding in the eastern Canadian Arctic. Christine has played an active mentorship role in the delivery of the Inuit Field Training Program.

Sara Bellefontaine (MSc candidate, University of Windsor) is studying the physiological and behavioural responses of Arctic-breeding shorebirds to weather and habitat conditions, to investigate the trade-offs in nest-site selection that may influence nesting success.

Sarah Bonnett (MSc candidate, Trent University) is studying the breeding success of Lapland Longspurs across an elevation gradient in an area where mining activity will induce hydrological changes.

Lindsay Carlson (PhD candidate, University of Saskatchewan) is studying the movement and behavior of Atlantic brant throughout their full annual cycle, with a focus on linking habitat use in James Bay staging areas to individual reproductive success. Lindsay is supervised by Dr. Mitch Weegman.

Willow English (PhD, Carleton University) completed her PhD thesis in January 2023 and has started working as a biologist for the Canadian Wildlife Service in Ottawa. Her thesis investigated the links between migration and breeding ecology of Arctic-shorebirds in order to understand the role of carry-over effects.

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.

From left to right: Sara Bellefontaine, Doug MacNearney, Kiavash Ghorbanzadeh, Eloise Girard, Sarah Neima, Grant Gilchrist, Josiah Nakoolak, and Oliver Love in the early season at Qaqsauqtuuq

RECENT POPULAR PRESS AND OUTREACH

Buxton, R., A. Reid, J. Bennett, and P.A. Smith. 2021. **Respect for Indigenous knowledge must lead nature conservation efforts in Canada**. The Conversation. Popular press article. Available at: *https://theconversation.com/respect-for-indigenous-knowledge-must-lead-nature-conservation-efforts-in-canada-156273*

Cramer, D. 2021. **A South Carolina Island is a haven for tens of thousands of shorebirds.** The New York Times. Multimedia piece, using results provided by P. Smith. Available at: *https://www.nytimes.com/interactive/2021/06/19/opinion/carolina-coast-whimbrel-deveaux.html*

Bognar, J., A. Brum, C. Buidin, J. Burger, A. Dey, T. Diehl, C. Espoz Larrain, C. Fedrizzi, S. Feigin, J. Finger, S. Gates, F. Labra Rodríguez, R. Lathrop, D. Merchant, L. Niles, D. Paludo, M. Peck, V. Petry, Y. Rochepault, C.D. Santos, H. Sitters, J. Smith, P. Smith, J. Trimble, R. Sacatelli, Aiviit Hunters & Trappers Association, Centro Bahi Lomas, ICMBio, Conserve Wildlife Foundation of New Jersey, National Wildlife Research Centre, NJ Endangered & Nongame Species Program, Royal Ontario Museum, and US Fish & Wildlife Service. 2022. **Tracking the Red Knot: The nine thousand mile journey of a nine-inch shorebird.** ArcGIS Story Map. Available at: *https://storymaps.arcgis.com/stories/c22de70e09ab458186cce9b1bc4912a5*

McKee, J. 2022. **Injury or Illusion? Why a Bird With a Broken Wing May Not Be What It Appears.** National Audubon Society. Dr. Smith was interviewed for his perspectives on injury feigning, following the publication of a review paper in a prominent journal. Available at: *https://www.audubon.org/news/injury-or-illusion-why-bird-broken-wing-may-not-be-what-it-appears*

Leber, J. 2022. **How Migrating Snow Geese Helped Stretch My Perspective.** Audubon Magazine: National Audubon Society. A short piece profiling the overabundance of geese, and the harvest support program in Nunavut to manage geese and increase food security. Available at: *https://www.audubon.org/magazine/spring-2022/how-migrating-snow-geese-helped-stretch-my*

Left: A day-old White-rumped Sandpiper chick. This species has become more prevalent at Qaqsauqtuuq over the past years. Photo: Sarah Neima

RECENT SCIENTIFIC PUBLICATIONS

Anderson, A., C. Friis, C.L. Gratto-Trevor, C.M. Harris, O.P. Love, R.I.G. Morrison, S. Prosser, E. Nol, and P.A. Smith. 2021. **Drought at a coastal wetland affects refuelling and migration strategies of shorebirds.** Oecologia 197: 661-674.

Anderson, C., L. Fahrig, J. Rausch, J.-L. Martin, T. Daufresne, and P.A. Smith. 2023. **Climate-related range shifts in Arctic-breeding shorebirds.** Ecology and Evolution, in press.

Aronsson, M. S. Heiðmarsson, H. Jóhannesdóttir, T. Barry, J. Braa, C.T. Burns, S.J. Coulson, C. Cuyler, K. Falk, H. Helgason, K.F. Lárusson, J.P. Lawler, P. Kulmala, D. MacNearney, E. Oberndorfer, V. Ravolainen, N.M. Schmidt, M. Soloviev, C. Coon and T. Christensen. 2021. **State of the Arctic Terrestrial Biodiversity Report.** Conservation of Arctic Flora and Fauna International Secretariat, Akureyri, Iceland. ISBN 978-9935-431-94-3.

Barrio, I.C., D. Ehrich, E.M. Soininen, V.T. Ravolainen, G.G. Bueno, O. Gilg, A.M. Koltz, J.D.M. Speed, D.S. Hik, M. Mörsdorf, J.M. Alatalo, A. Angerjörn, J. Bêty, L. Bollache, N. Boulanger-Lapointe, G.S. Brown, I. Eischeid, M.A. Giroux, T. Hájek, B.B. Hansen, S.P. Hofhuis, J.-F. Lamarre, J. Lang, C. Latty, N. Lecomte, P. Macek, L. McKinnon, I.H. Meyers-Smith, Å.Ø. Pedersen, J.S. Prevéy, J.D. Roth, S.T. Saalfeld, N.M. Schmidt, P. Smith, A. Sokolov, N. Sokolova, C. Stolz, R. van Bemmelen, Ø. Varpe, P.F. Woodard, and I.S. Jónsdóttir. 2021. **Developing common protocols to measure tundra herbivory across spatial scales.** Arctic Science e-first 12 March 2021: 1-42.

Bart, J., and P.A. Smith. 2022. **Arctic PRISM in Canada: Completion Report for Phase I.** 113pp.

Burns, C.T., M.L. Burns, S. Cannings, M.L. Carlson, S. Coulson, M.A.K. Gillespie, T.T. Hoye, D. MacNearney, E. Oberndorfer, J.J. Rykken, and D.S. Sikes. 2022. **Arctic Pollinators**. Arctic Report Card 2022, M.L. Druckenmiller, R.L. Thoman, and T.A. Moon, eds., doi: 10.25923/3zy4-th20

Buxton, R.T., J.R. Bennett, A.J. Reid, C. Shulman, S.J. Cooke, C.M. Francis, E.A. Nyboer, G. Pritchard, A.D. Binley, S. Avery-Gomm, N.C. Ban, K.F. Beazley, E. Bennett, L.K. Blight, L.E. Bortolotti, A.F. Camfield, Z. Gadallah, A.L. Jacob, I. Naujokaitis-Lewis, C. Raudsepp-Hearne, D.G. Roche, F. Soulard, D. Stralberg, K.D. Sadler, K.A. Solarik, C.D. Ziter, J. Brandt, C.W. McKindsey, D.A. Greenwood, P.C. Boxall, C.F. Ngolah, K.M.A. Chan, D. Lapen, S. Poser, J. Girard, C. DiBacco, S. Hayne, D. Orihel, D. Lewis, D. Littlechild, S.J. Marshall, L. McDermott, R. Whitlow, D. Browne, J. Sunday, and P.A. Smith. 2021. **Key information needs to move from knowledge to action for biodiversity conservation in Canada.** Biological Conservation 256:108983.

Buxton, R.T., S. Hamit, J.J.W. Geauvreau, S. Davis, P.A. Smith, and J. Bennett. 2022. **Balancing research, monitoring, and action to recover Canada's Species at Risk.** Environmental Science and Policy 132: 198-205.

Christin, S., C. Chicoine, T. O'Neill Sanger, M. Guigueno, J. Hansen, R. Lanctot, D. MacNearney, J. Rausch, S. Saalfeld, N.M. Schmidt, P. Smith, P. Woodard, E. Hervet, and N Lecomte. Submitted. **ArcticBirdSounds: an open-access, multi-year, and detailed annotated dataset of bird songs and calls.** Ecology.

Cooke, S.J., S. Michaels, E.A. Nyboer, L. Schiller, D.B.R. Littlechild, D. Hanna, C.D. Robichaud, A. Murdoch, D. Roche, P. Soroye, J.C. Vermaire, V.M. Nguyen, N. Young, J.F. Provencher, P.A. Smith, G.W. Mitchell, S. Avery-Gomm, C.M. Davy, R.T. Buxton, T. Rytwinski, L. Fahrig, J.R. Bennett, and G. Auld. 2022. **Reconceptualizing conservation.** PLoS Sustainability and Transformation 1(5): e0000016.

Davis, E., P.A. Smith and D. MacNearney. 2022. **Long-term studies at the Qaqsauqtuuq Migratory Bird Sanctuary, East Bay, Southampton Island, 1999-2022.** PRISM Tier II report. 50pp.

English, W. 2021. **Lingering consequences: how important are carry-over effects in Arctic-breeding shorebirds?** Arctic 74(4): 418-583.

Flemming, S.A., P.A. Smith, L.V. Kennedy, A.M. Anderson, and E. Nol. 2022. **Habitat alteration and fecal deposition by geese alter tundra invertebrate communities: Implications for diets of sympatric birds.** PLoS ONE 17(7): e0269938.

Grishaber, N. 2022. **Relationships between birds densities and distance to mines in Northern Canada.** M.Sc. Thesis, Trent University. 143pp.

Holmes, G.I., E. Nol, and P.A. Smith. 2023. **Attempts to mitigate mining development: Deterrents fail to change nesting behaviour of Arctic-nesting birds.** Avian Conservation and Ecology.

Kadykalo, A.N., R.T. Buxton, P. Morrison, C.M. Anderson, H. Bickerton, C.M Francis, A.C. Smith, and L. Fahrig. 2021. **Bridging research and practice in conservation.** Conservation Biology 35:1725-1737.

Lamarre, J.F., G. Gauthier, R.B. Lanctot, S.T. Saalfeld, O.P. Love, E.T. Reed, O.W. Johnson, J. Liebezeit, R.L. McGuire, M. Russell, E. Nol, L. Koloski, F. Sanders, L. McKinnon, P.A. Smith, S.A. Flemming, N. Lecomte, M.-A. Giroux, S. Bauer, T. Emmenegger, and J. Bêty. 2021. **Timing of breeding site availability across the North-American Arctic partly determines spring migration schedule in a long-distance neotropical migrant.** Frontiers in Ecology and Evolution 9:710007.

MacDonald, A.J., P.A. Smith, C.A. Friis, J.E. Lyons, Y. Aubry, and E. Nol. 2021. **Stopover ecology of Red Knots in southwestern James Bay during southbound migration.** Journal of Wildlife Management 85: 932-944.

McGuire, R.L., C.J. Latty, S. Brown, S. Schulte, S. Hoepfner, S. Vassallo, and P.A. Smith. 2022. **No evidence that cameras affect shorebird nest survival on the coastal plain of Arctic National Wildlife Refuge, AK.** Ibis 164: 329-335.

Meyer, N., L. Bollache, M. Galipaud, J. Moreau, F.-X. Dechaume-Moncharmont, E. Afonso, A. Angerbjörn, J. Bêty, G. Brown, D. Ehrich, V. Gilg, M.-A. Giroux, J. Hansen, R. Lanctot, J. Lang, C. Latty, N. Lecomte, L. McKinnon, L. Kennedy, J. Reneerkens, S. Saalfeld, B. Sabard, N. M. Schmidt, B. Sittler, P. Smith, A. Sokolov, V. Sokolov, N. Sokolova, R. van Bemmelen, Ø. Varpe, and O. Gilg. 2021. **Behavioural responses of breeding arctic sandpipers to ground-surface temperature and primary productivity.** 2021. Science of the Total Environment 755:142485.

Nyboer, E.A., V.M. Nguyen, N. Young, T. Rytwinski, J.J. Taylor, J.F. Lane, J.R. Bennett, N. Harron, S.M. Aitken, G. Auld, D. Browne, A.L. Jacob, K. Prior, P.A. Smith, K.E. Smokorowski, S. Alexander, and S.J. Cooke. 2021. **Supporting actionable science for environmental policy: advice for funding agencies from decision makers.** Frontiers in Conservation Science 2: 1-22.

While in the field, all wildlife sightings are recorded to document trends in observations over the years. Polar bears can be observed passing by Qaqsauqtuuq throughout the spring and summer.

Rytwinski, T., S. Cooke, J.J. Taylor, D.G. Roche, P.A. Smith, G. Mitchell, K. Smokorowski, K. Prior, J. Bennett. 2021. **Acting in the face of evidentiary ambiguity, bias, and absence arising from systematic reviews in applied environmental science.** Science of the Total Environment 775: 145122.

Shaftel, R., D.J. Rinella, E. Kwon, S.C. Brown, H.R. Gates, S. Kendall, D.B. Lank, J.R. Liebezeit, D.C. Payer, J. Rausch, S.T. Saalfeld, B.K. Sandercock, P.A. Smith, D.H. Ward, and R.B. Lanctot. 2021. **Predictors of invertebrate biomass and rate of advancement of invertebrate phenology across eight sites in the North American Arctic.** Polar Biology 44: 237-257.

Smith, P.A., A.C. Smith, B. Andres, C.M. Francis, B. Harrington, C. Friis, R.I.G. Morrison, J. Paquet, B. Winn, and S. Brown. 2023. **Accelerating declines of North America's shorebirds signal the need for urgent action.** Ornithological Applications, in press.

Thomas-Walters, L., E. Nyboer, J. Taylor, T. Rytwinski, J. Lane, N. Young, J. Bennett, V. Nguyen, N. Harron, S. Aitken, G. Auld, D. Browne, A. Jacob, K. Prior, P. Smith, K. Smokorowski, S. Alexander, and S. Cooke. 2021. **An optimistic outlook on the use of evidence syntheses to inform environmental decision making.** Conservation Science and Practice 3: e426.

Wong, J.B., S. Lisovski, R.T. Alisauskas, W. English, A.-L. Harrison, D.K. Kellett, M. Maftei, A. Nagy-MacArthur, R. Ronconi, P.A. Smith, M.L. Mallory, and M. Auger-Méthé. 2022. **Variation in migration behaviours used by Arctic terns (*Sterna paradisaea*) breeding across a wide latitudinal gradient.** Polar Biology 45: 909-922.

Wong, J.B., S. Lisovski, R.T. Alisauskas, W. English, M.-A. Giroux, A.-L. Harrison, D. Kellett, N. Lecomte, M. Maftei, A. Nagy-MacArthur, R.A. Ronconi, P.A. Smith, M.L. Mallory, and M. Auger-Méthé. 2021. **Arctic tern from circumpolar breeding colonies share common migratory routes.** Marine Ecology Progress Series 671: 191-206.

Young, K.G., L. Kennedy, P.A. Smith, and E. Nol. 2021. **Testing whether camera presence influences habitat specific predation pressure on artificial shorebird nests in the Canadian Arctic.** Arctic 74: 22-29.

Joseph Pingwartuk, Laa Saviakjuk, and Lesley Howse pose for a photo during archaeological surveys near Nunattaunngi

A Twin Otter on the gravel strip 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 (Canadian Wildlife Service, CWS), Dr. Grant Gilchrist (ECCC), Lisa Pirie-Dominix (CWS), Dr. Lenore Fahrig (Carleton University), Dr. Joe Bennett (Carleton University), Christian Friis (CWS), Dr. Jean-Louis Martin (CNRS), Dr. Tanguy Daufresne (INRA-France), Dr. Elodie Courtois (CNRS), Dr. Oliver Love (University of Windsor), Dr. Christina Semeniuk (University of Windsor), Dr. Mitch Weegman (University of Saskatchewan), and Wendy Walsh (USFWS). Technical leadership and coordination is provided by Doug MacNearney, Bonnie Taparti, Holly Hennin, and Kristen Lalla (ECCC). In 2022, Nik Clyde (CWS) provided support and coordination for PRISM and Red Knot projects, Alannah Kataluk-Primeau (CWS) co-led the PRISM surveys in Ikkattuaq, and Lesley Howse (Inuit Heritage Trust) led archaeology surveys in Ikkattuaq.

These projects are logistically complicated and labour intensive, requiring a large, dedicated crew of students and biologists. In 2022, our field crews at East Bay Mainland, Prince Charles Island, and Ikkattuaq included James Alexander, Christine Anderson, Jupie Angootealuk, Steven Maliki Attaqutaluk, Sara Bellefontaine, Lindsay Carlson, Dr. Elodie Courtois, Dr. Tanguy Daufresne, Kiavash Ghorbanzadeh, Eloise Girard, Lesley Howse, Rebecca Jardine, Alannah Kataluk-Primeau, Jenny Kolit, Kristen Lalla, Doug MacNearney, Dr. Jean-Louis Martin, Josiah Nakoolak, Solomon Nakoolak, Sarah Neima, Joseph Pingwartuk, Alysha Riquer, Adamie Samayualie, Laa Saviakjuk 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, Trent University, Carleton University, University of Windsor, Polar Continental Shelf Program, ArcticNet, the Nunavut Wildlife Management Board via the Nunavut Wildlife Research Trust, Agnico Eagle Mines Ltd., Baffinland Iron Mines, Northern Scientific Training Program, United States Fish and Wildlife Service, Polar Knowledge Canada, CanNor, Institut Polaire Français Paul-Émile-Victor (IPEV), Oceans North, the Natural Sciences and Engineering Research Council, and the W. Garfield Weston Foundation.

CONTACT INFORMATION

If you have any questions, comments, or concerns, please contact:

Paul Smith
National Wildlife Research Centre
Environment and Climate Change Canada
Telephone: 613-998-7362
E-mail: paulallen.smith@ec.gc.ca

Doug MacNearney
National Wildlife Research Centre
Environment and Climate Change Canada
Telephone: 613-990-9746
E-mail: douglas.macnearney@ec.gc.ca