Environment Canada's Arctic Shorebird Research

Progress Report on 2015 Field Research authorized under permits 8WLC-PCE1516 AND 8WLC-PCO1516

Project Overview

Many populations of shorebirds around the globe are declining. This is particularly true for the long-distance migrants who breed in the North America Arctic and migrate to wintering grounds in the Southern Hemisphere. At the same time, conditions in the Arctic are changing rapidly. Ice, weather and habitat are profoundly influenced by long-term shifts in climate. Contaminants transported over long-distances could be affecting tundra-breeding birds or their food webs in unknown ways. Changes in farming practices in the United States have supported dramatic increases in populations of arctic geese, and these now abundant geese are degrading coastal wetlands in some areas where they breed and stop over to refuel during migration. The extent of this degradation and how it might influence other wildlife is unknown.

Environment Canada seeks to understand the ways in which coastal tundra wetlands are changing, and how these changes influence bird populations. We are examining the factors that affect shorebird population variation and breeding success, and are trying to determine the degree to which changes in the North could be responsible for population declines of these species. Recently, our research has been particularly focussed on whether/how snow goose breeding colonies are affecting shorebird populations and nest success. By comparing shorebird breeding success in areas experiencing different degrees of pressure from snow goose colonies, we hope to quantify the effects of goose related changes in habitat structure and predation pressure on shorebird populations, and determine whether these factors play a role in the observed declines in shorebird numbers. In the coming years, we will expand this research to include other wetland birds such as Sabine's Gulls and Arctic Terns.

Research Partnerships

Our research programs at East Bay and Coats Island are a combined effort of many people and organisations. Principle investigators in 2015 included Dr. Paul Smith, Jennie Rausch and Dr. Grant Gilchrist (Environment Canada), Dr. Erica Nol (Trent University), Dr. Mark Mallory (Acadia University), Dr. Oliver Love (University of Windsor), Dr. Stephen Brown (Manomet Center for Conservation Sciences), and Dr. Larry Niles (Conserve Wildlife Foundation of New Jersey). The project coordinators were Christine Eberl, Mike Janssen and Jake Russell-Mercier (Environment Canada). The project is integrated into various international initiatives such as The Arctic Shorebird Demographics Network (ASDN), the Program for Regional and International Shorebird Monitoring (PRISM), and the Arctic Goose Joint Venture (AGJV).

2015 Research Highlights

Fieldwork at Coats Island and East Bay involved finding and monitoring nests of shorebirds, capturing and banding adult shorebirds, collection of invertebrate specimens, and sampling of nest habitat/vegetation. Nests were located and monitored throughout the breeding season to track changes in the timing of breeding, monitor hatching success and determine the impacts of nest predators. Birds were banded with metal bands and some individuals were tagged VHF radio transmitters (nanotags) or geolocators to determine migration routes, wintering locations and migratory behaviour, such as timing of departure from the breeding sites. Sample sizes for nests and banded birds are outlined in Table 1.

Whereas nest densities and nest success were low at both sites in 2014 in comparison to previous years, nesting density in 2015 at Coat was not outside of the normal range for Coats, while nest density remained low at East Bay. Weather was extremely poor for much of the season at both sites this year, but this cannot entirely explain the low densities at East Bay. We are currently investigating whether deteriorating habitat due to increased goose grazing pressure is driving this decrease in shorebird nesting densities. At East Bay, birds were late to arrive, and some of the latest arriving individuals appear to have not bred. Lemmings were extremely rare this year at East Bay: a trapping grid deployed this summer resulted in zero lemming catches. Reduced lemming numbers and reduced numbers of breeding snow geese, attributed to the late snow melt, resulted in increased predation pressure from arctic fox on those shorebirds that did breed in East Bay this past summer.

Table 1. The number of nests found at our East Bay and Coats Island sites, the number of birds banded and the number of tracking devices deployed.

Research Site	Bird Species Studied	Nests Monitored	Birds Banded	Nanotags Deployed	Geolocators Deployed
East Bay Mainland	Black-bellied Plover, American Golden-plover, Ruddy Turnstone, White-rumped Sandpiper, Red Phalarope, Semipalmated Plover, Dunlin, Purple Sandpiper	63	12	20 nanotags	
Coats Island	Black-bellied Plover, American Golden-plover, Ruddy Turnstone, White-rumped Sandpiper, Red Phalarope, Semipalmated Plover, Dunlin, Semipalmated Sandpiper	118	58	28 nanotags	30 (all on SESAs)

Preliminary Results

Shorebird Capture, Banding and Sampling

Work at each site occurs within an area of approximately 12km^2. Intensive surveys of birds were completed in six - 400m x 300m survey plots at Coats Island and East Bay, and these intensively surveyed plots will form the basis of a new index of breeding abundance at the sites, to be tracked for the long-term. As in 2014, nest density was comparatively low at East Bay in 2015 in comparison to other years, but much higher (2.5x the 2014 density) at Coats Island (Figure 1), where the density was closer to average. The poor weather cannot entirely explain the low densities at East Bay. We are currently investigating whether deteriorating habitat due to increased goose grazing pressure is driving this decrease in shorebird nesting densities at East Bay. In terms of nests found, the most abundant species at Coats Island was Semipalmated Sandpiper (81 nests), followed by Dunlin (37), and Ruddy Turnstone, Red Phalarope, and American Golden-plover (16, 15, 15). At East Bay, the most abundant species were White-rumped Sandpipers (56) and Black-bellied Plovers (15). Samples including blood and feathers were collected for a variety of projects (Table 2). For example, blood samples will be analysed to determine parasite loads, physiological conditions and “stress” levels of birds in areas degraded by geese versus intact areas.

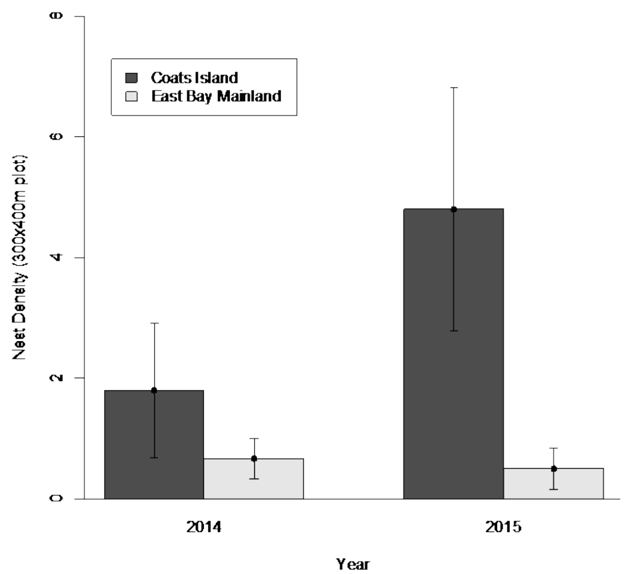

Figure 1. Shorebird nest densities in 300x400m^2 plots at Coats Island and East Bay Mainland in 2014 and 2015.

Table 2. The shorebird tissue samples and tracking tag deployments collected at the Coats Island and East Bay field camps.

Sample (Coats Island / East Bay)	American Golden-plover	Black-bellied Plover	Dunlin	Ruddy Turnstone	Semi-palmated Sandpiper	Semi-palmated Plover	White Rumped Sandpiper	Purple Sand-piper	Total
Total Banded	0/1	4/2	1/0	3/2	18/0	0/2	2/5	0/0	28/12
Blood samples	0/1	4/2	1/0	3/2	18/0	0/2	2/14	0/2	28/23
Feather	0/1	4/2	1/0	3/2	18/0	0/2	2/5	0/0	28/12
Faeces	0/0	4/1	0/0	3/2	0/0	0/2	0/14	0/0	7/19
Nanotags	0/0	4/3	1/0	3/3	18/0	0/2	2/12	0/1	28/21
Geolocators	0/0	0/0	0/0	0/0	30/0	0/0	0/0	0/0	30/0

Nest Vegetation

As part of the ongoing PhD projects assessing the effects of overabundant geese on tundra-nesting shorebirds, vegetation surveys were conducted at all nest sites at both Coats Island and East Bay. At each shorebird nest site, we measure a number of habitat characteristics which have previously been determined as being important to shorebird nest site selection. This year, we also carried out these habitat assessments at a sample of 224 random sites on Coats Island, and 255 on Southampton Island. Comparisons of habitat between nests and random sites allow us to establish habitat preferences, and tracking habitat characteristics and nest preferences over time allows us to explore whether geese are altering habitat in a way that adversely affects nesting shorebirds. Some shorebird species, such as Dunlin and Red Phalarope, select nest sites with tall surrounding vegetation (Figure 2). These species are more likely to be affected by reductions in sward height as a result of goose grazing.

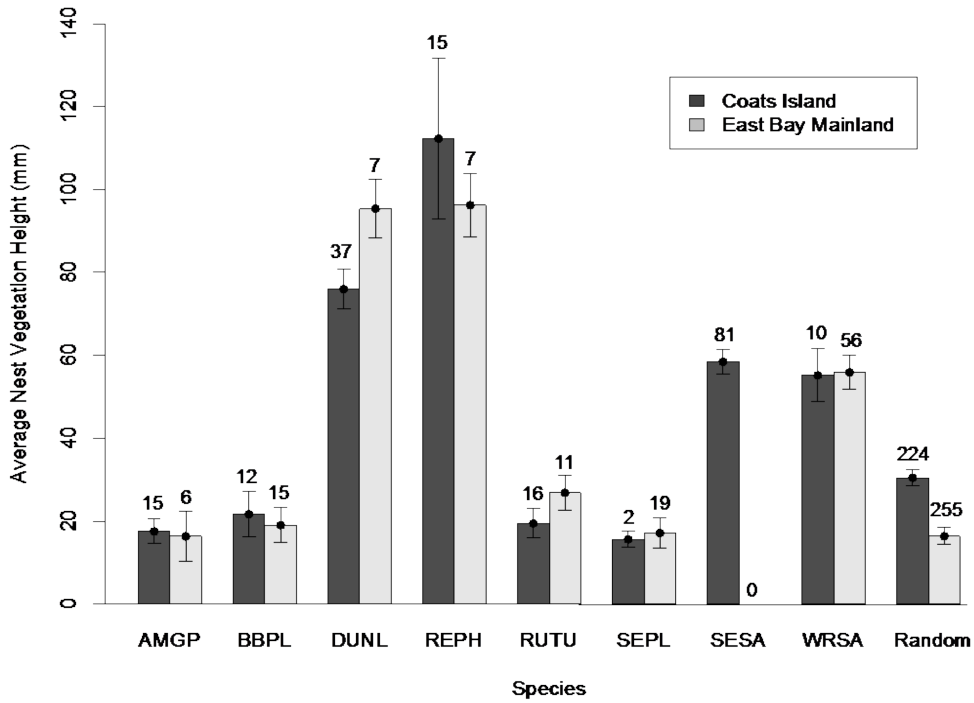

Figure 2. Variations in nest vegetation height between species and random sites at Coats Island and East Bay Mainland. Sample sizes are indicated by numbers above bars. American Golden-plover (AMGP), Black-bellied Plover (BBPL), Dunlin (DUNL), Red Phalarope (REPH), Ruddy Turnstone (RUTU), Semipalmated Plover (SEPL), Semipalmated Sandpiper (SESA), White-rumped Sandpiper (WRSA), random site (Random).

Nest concealment at Arctic Fox eye level is also assessed for each nest cup for all species. Additive effects of reduced above-ground biomass of graminoids such as *Carex subspathacea*, which is targeted by snow geese during grazing, has nest concealment implications for shorebirds such as White-rumped Sandpipers and Red Phalaropes that rely on proactive concealed nesting strategies. Over the past 15 years, nest concealment for species using a concealed nesting strategy hasn't changed much at East Bay (Figure 3). However, nest site selection of concealed nesting species indicates that shorebirds on Coats Island are selecting sites with 30% or more nest concealment compared to shorebirds breeding at East Bay. Nest concealment in conjunction with goose and Arctic Fox activity may help to predict nest success. To understand these interactions better, we are also generating predator and goose activity indices, which will be paired with our nest concealment measurements to compare our two sites.

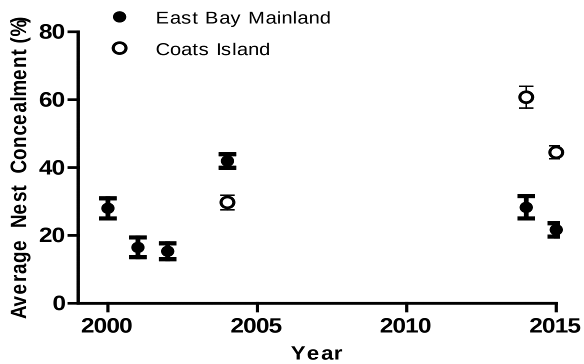

Figure 3. Long term monitoring of average nest concealment (%) at East Bay (Solid) and Coats Island (Open) Nunavut, Canada.

Goose Damage Assessments

In 2015, we continued measuring the extent of goose grazing using the protocol developed by Dr. Ken Abraham and collaborators in Canadian Wildlife Service. Building on the successes of testing this protocol in 2014, a revised version of the following protocol was used at sites across the North American Arctic in 2015. These goose damage assessments were conducted in each primary habitat type at our Coats Island and East Bay sites, to determine the extent of goose-induced habitat degradation (Figure4). Briefly, these assessments consisted of walking 2 -100m strip transects along which the dominant cover type was recorded at each metre mark, and the height, stage of florescence and presence of goose-grazing was recorded every ten metres. We conducted more than 70 such assessments at the two sites, and also at sites spread across Southampton Island, accessed by helicopter in late June.

Figure 4a. Lisa Kennedy and Emma Davis measure the height of vegetation within the snow goose breeding colony at East Bay. We carried out assessments of habitat damage at sites distributed across Southampton Island in 2015. **4b.** Scott Flemming conducting habitat surveys during adverse weather on Coats Island.

Nest Monitoring and Predator Interactions

We monitored shorebird nests throughout the season to determine their fate. In 2015, we were able to confirm the fate of 118 nests on Coats Island. Of these, only 24 successfully hatched young; significantly lower than in previous years and potentially influenced by the poor weather conditions and scarcity of other eggs (especially geese) for predators. Similarly, apparent nest success at East Bay was very low with only 2/63 nests hatching. Historically, nest survival at East Bay is extremely low and significantly lower than at Coats Island. The consistently low nest survival at East Bay is among the factors that sparked our interest in studying the effects of geese on other birds. The pattern of lower nest survival at East Bay may be attributable to higher predator abundances resulting from the close proximity to the goose colony.

Arctic foxes and jaegers are the dominant predators of shorebird nests. To examine whether their abundance was greater near goose colonies, we installed PlotWatcher Pro time-lapse cameras in the vicinity of shorebird nests (Table 3, Figure 5) and at random sites, to generate a standardized index of predator abundance for comparison among sites. We predict that predators will be more abundant closer to the goose colony at East Bay; our anecdotal observations support this conclusion but analyses of time-lapse videos are ongoing. So far, most predation events recorded were from Arctic Fox and 2 depredation events from Parasitic Jaegers.

These cameras were also used to monitor incubation behavior of shorebirds to test the prediction that individuals breeding in degraded habitat are forced to take more frequent or longer incubation recesses. For species with highly concealed nests, we augmented the video with data from temperature probes installed among the eggs. These probes monitor fine-scale changes in temperature that occur when birds leave the nest, allowing us to track incubation patterns with fine temporal resolution.

This year we also initiated an artificial nest experiment to determine if background rates of predation risk are elevated near the goose colony. We monitored the fate of nests of four quail eggs, which closely resemble those of shorebirds, in different habitat types and at varying distances from the goose colony. We deployed 60 artificial nests within the colony at East Bay, 60 nests 5km away from the colony, 60 nests 10km away, and an additional 60 at Coats Island. Analyses of these data are ongoing.

Table 3. Shorebird nest predation events captured by time-lapse cameras at Coats Island and East Bay in 2015.

		AMGP	BBPL	DUNL	REPH	RUTU	WRSA	SEPL	SESA	Total
Coats Island	**Cameras Deployed**	3	1	6	3	0	3	0	12	28
	Predation Events	3	1	3	1	0	2	0	10	20
East Bay	**Cameras Deployed**	3	4	1	2	4	24	7	0	45
	Predation Events	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Figure 5. The Arctic Fox is the most important predator of shorebird nests at the East Bay and Coats Island sites. Our research will determine whether the foxes attracted to goose colonies have a negative effect on shorebirds' breeding success.

Camera footage has also revealed that Black-bellied Plovers will readily defend their nests from approaching snow geese, by calling and flying around the nest site (Figure 6). This behavioural response increases activity around nest sites which in turn may attract predators and reduce the daily survival probability of nests. Because brood-rearing, flightless Snow geese avoid humans, they tend to use the study site and come in contact with nesting shorebirds only late in the day when crews are less likely to be in the field. Placing cameras on the nests has captured this interesting behavioural response by the Plovers which we would otherwise have missed due to the snow goose sensitivity, heighted by their moult and subsequent flightlessness, to human presence.

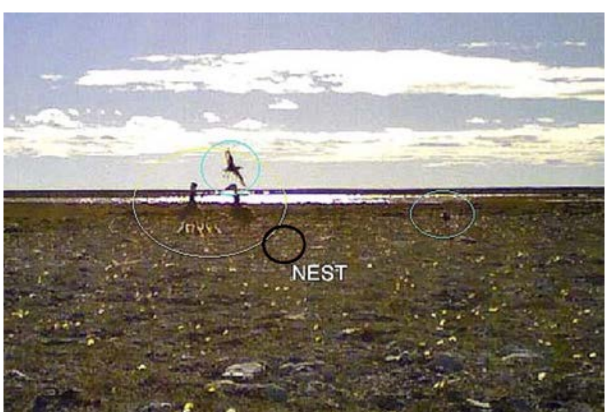

Figure 6. Black-bellied Plovers actively defending their nest from approaching pair of adult geese with their young.

Effects of Habitat Change on Aquatic Ecosystems

Ponds and wetlands are a ubiquitous feature of coastal arctic tundra. The habitat changes caused by geese grazing in terrestrial habitats have the potential to influence aquatic ecosystems as well. Working with Weston Postdoctoral Fellow Dr. Heather Mariash, we continued a study initiated in 2014 to examine whether geese are altering the flow of nutrients through these systems, and whether communities of aquatic invertebrates (prey for other bird species) are affected (Figure 7). Analyses are still underway, and on the basis of preliminary results, we may undertake additional sampling in 2016.

Figure 7. Dr. Heather Mariash filtering water for detailed analyses of nutrient flow from terrestrial to aquatic ecosystems, and through the various trophic levels of aquatic invertebrates.

Invertebrate Sample Collection

Invertebrates are the primary prey of shorebirds and a number of other small tundra-nesting birds. Invertebrate samples were collected every 7 days using pitfall traps placed in dry and moist habitats types, as has been done in prior years at these sites. The abundance and diversity of invertebrate species will be calculated to determine the effects of goose grazing on shorebird prey items.

Tracking Shorebird Migration Using Geolocators

We continued our project using solar geolocators to track migration routes of Semipalmated Sandpipers in 2015. This summer, we continued our collaboration with the Manomet Center for Conservation Sciences, and deployed 30 solar Geolocators on Semipalmated Sandpipers shorebirds at the Coats Island camp. Retrieval of these, next summer, will help us track the migration routes of this species and contribute to a collaborative effort to understand migratory connectivity across their range.

MOTUS Wildlife Telemetry Array

Recent advances in technology have greatly reduced the cost of VHF tracking receivers, making it possible to deploy many receivers across a broad geographic area. This is currently happening in Eastern North America, with hundreds of towers now up at a variety of key stopover locations for shorebirds and other birds (Figure 8). We have been an important collaborator in this effort and carried out a variety of projects with this technology starting in 2014. Using small towers we deployed in 2014 at the Coats Island and East Bay camps to track local movements of birds (within 20km), and by attaching very small tags (<1g) to birds' backs with glue, we have been developing our understanding of behaviour during the breeding season. These towers are solar powered and operate year-round allowing us to resolve exactly when birds arrive or depart the breeding grounds, even if we're not present at the site. Ph.D. student Lisa Kennedy from Trent University will use these data to determine how habitat damage from geese influences foraging range and timing of breeding and departure. This new information will help to improve our monitoring of shorebird populations at stopover sites, and information from the breeding grounds will help to identify the possible effects of overabundant geese on birds' condition, departure, and subsequent migration behaviour.

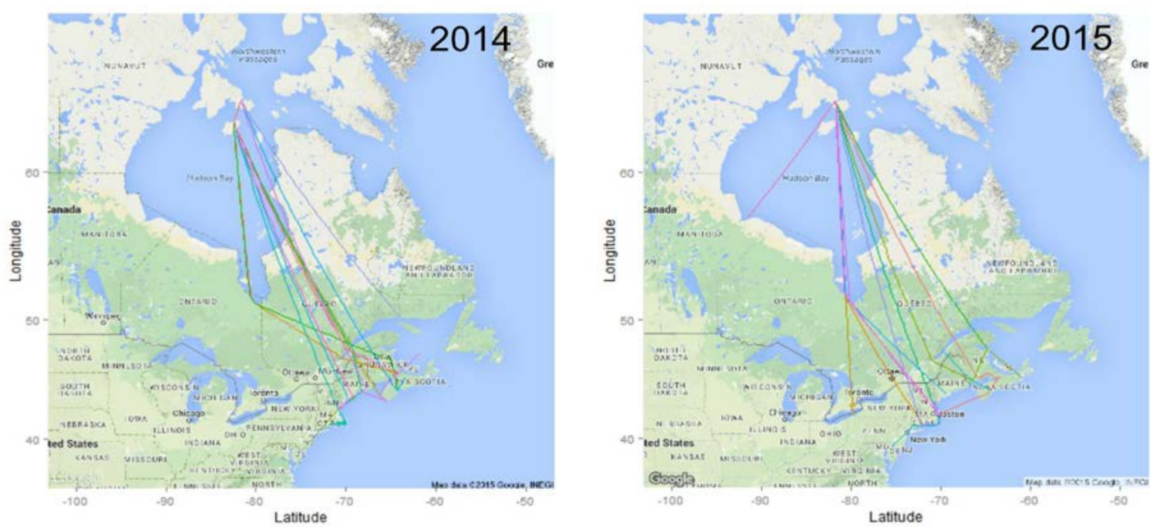

Figure 8. Bird tracks from shorebirds breeding on Southampton Island and Coats Island Nunavut through the MOTUS VHF telemetry array (www.motus-wts.org, sensorgnome.org). Detections from birds at each tower can be used to determine migratory departure timing from the breeding sites and migratory progress to the Bay of Fundy and Delaware Bay, important bird sanctuaries for migratory refuelling.

Honours Student Research Projects

Two students from Trent University, Kevin Young and Shawna-lee Masson collected data for their Honours research projects this year. Kevin will be looking at the potential impacts of our trail camera nest monitoring on predation rates of shorebirds throughout the breeding season across intertidal and sedge meadow habitat types. Shawna-lee will also be using data collected from our trail cameras to determine how environmental variables such as weather influence fox predation rates.

Meso-scale Habitat Mapping

In 2015, we initiated a pilot project to develop fine-scale habitat maps of our sites using an unmanned aerial vehicle (UAV). Using Agisoft software, we are digitally merging images to create high-resolution 3D models of nesting areas (Figure 9). This will allow us to carry out analyses of shorebirds' habitat use in three dimensions, and at a scale larger than is possible for observers on the ground (but smaller than with satellite imagery, which is too coarse for assessments of nest habitat use). This approach will allow us to gain a different perspective on how shorebirds are selecting nest habitat.

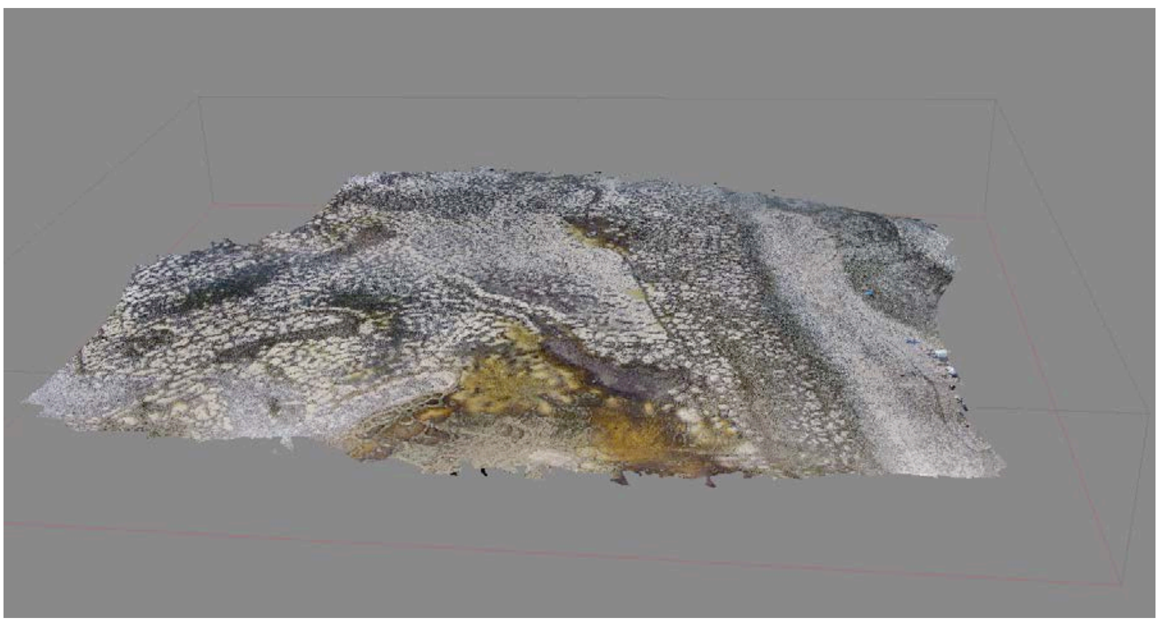

Figure 9. A habitat model created using aerial photographs taken with our drone.

Red Knot Tracking and Habitat Mapping on Southampton Island

The rufa Red Knot was recently listed as Endangered in Canada and Threatened in the United States. Beginning in 2013, we carried out aerial surveys, ground based habitat surveys and VHF telemetry to better understand the distribution and habitat use of this species across Southampton Island, in the core of its range. In 2013, a ground crew led by collaborator Dr. Larry Niles (Conserve Wildlife Foundation of New Jersey) searched for breeding rufa Red Knots across the island, while in 2013 and 2014, Environment Canada carried out helicopter- and ground-based surveys in late June. Measurements of breeding habitat were recorded, and in combination with satellite imagery, these data have helped to develop a model of preferred habitat for knots across Southampton Island (Figure 10) which is currently under review for publication. This model can also be extended to other areas, to predict where this sparsely distributed species is expected to occur, and where surveys should be conducted in the future.

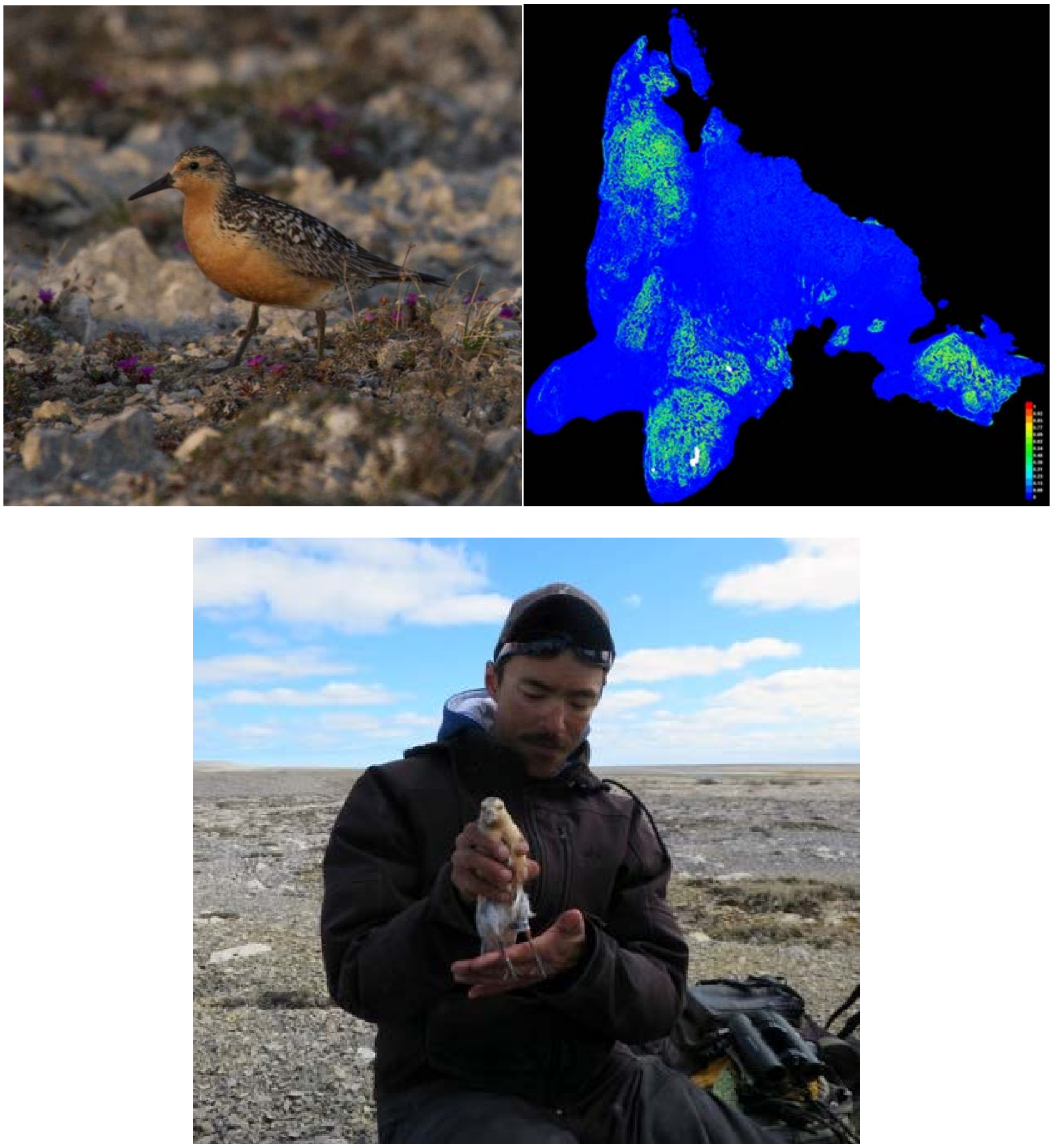

Figure 10. The rufa Red Knot is listed as endangered in Canada and threatened in the United States. Southampton Island is within the core of its breeding range. Working with collaborators Larry Niles (Conserve Wildlife Foundation New Jersey) and Rick Lathrop (Rutger's University), we have produced a model describing preferred habitat across Southampton Island. Warmer colours (greens and yellows) indicate preferred habitat, while blue indicates unsuitable areas.

Field Teams and HQP

The 2015 field crews at Coats Island and East Bay consisted of a mix of experienced arctic researchers, students and Inuit guides. PhD students/team leaders Scott Flemming and Lisa Kennedy began their studies in 2014, and will spend at least the next two seasons at Coats Island and East Bay Island, respectively, studying the effects of overabundant geese on tundra-breeding shorebirds. The 2015 Coats Island Team included: Scott Flemming, Paul Smith, Shawna-Lee Masson, Rianne Mariash, Malkolm Boothroyd and Shiloh Schulte. Shiloh Shulte, a collaborator from the Manomet Centre for Conservation Sciences, joined the Coats Island crew in June to deploy geolocator tracking devices that will be retrieved in 2016. The 2015 Team at East Bay included: Lisa Kennedy, Paul Smith, Victoria Putinski, Heather Mariash, Kevin Young, Brandan Norman, Kate Roper, Gillian Holmes, Josiah Nakoolak and Jupie Angootealuk. Postdoctoral Researcher Dr. Heather Mariash, is studying how geese influence nutrient flow through the food webs of tundra wetlands. From late May through June, we were joined by Josiah Nakoolak and Jupie Angootealuk of Coral Harbour. Josiah has more than 20 years' experience assisting with our research and is mentoring Jupie.

Logistical support was provided by Christine Eberl, Mike Janssen and Jake Russell-Mercier.

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