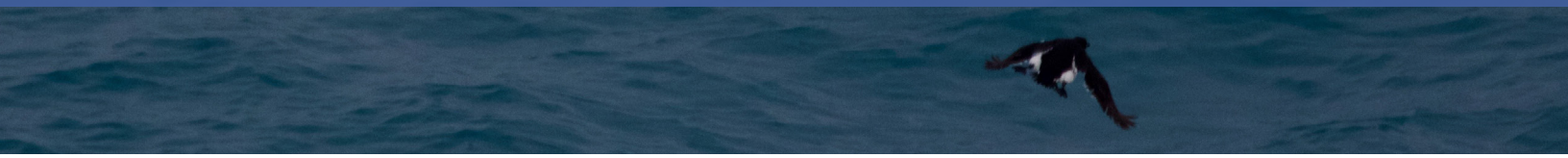
MIGRATORY AND BREEDING ECOLOGY OF BIRDS FACING GLOBAL ENVIRONMENTAL CHANGE:

Report of the 2017 and 2018 field seasons



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Abstract

The Arctic is experiencing the fastest rate of changes on the planet. As part of Canada's contribution to arctic research, the Canadian High Arctic Research Station (CHARS) campus was recently established in Cambridge Bay, Nunavut. This major research infrastructure supports long-term monitoring and research, including terrestrial ecology and migratory bird research.

Migratory birds are sentinels of global change and many species are currently suffering global population declines. On the breeding ground, timing and success of reproduction can be linked to previous events which occurred thousands of kilometres away in areas that may be heavily impacted by human development. Enhanced knowledge of the spaces migratory wildlife use year-round, as well as of variation in species interactions through time and space, would help to define stresses experienced by different species.

The objective of this research program is to monitor the reproduction and migration of arctic-nesting migratory birds (predator and prey species) including nesting habitats, breeding densities, population trends, and migration requirements. Since 2017 the research program has monitored various aspects of migratory bird ecology surrounding Cambridge Bay, particularly the extent of nearby snow goose (*Chen caerulescens*) colony, and the timing, density, and nest success for species of shorebirds. Predation pressure was also monitored through artificial nest experiments, daily vertebrate species counts, and notable vagrant species observations. This report presents the methodology for these research activities, the preliminary results, as well as potential areas of development for the research program for the next few years.

Introduction

Long-term research requires high-quality infrastructure to allow accurate monitoring of climate change while supporting adaptation of local communities and capacity building. Although the Arctic is expected to be affected the most by climate change (Bush and Lemmen, 2019) there is

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a shortage of research taking place in the region (Metcalfe et al., 2018) and the few research stations hosting researchers are only active during the warmer months of the year. The Canadian High Arctic Research Station (CHARS) campus was recently established in Cambridge Bay, Nunavut. This major research infrastructure is operated by Polar Knowledge Canada, a federal agency created in 2015. Located in the High Arctic, the CHARS campus supports long-term monitoring and research year-round.

The objective of this research program is to monitor breeding and migratory ecology of arctic-nesting migratory birds. This research will be used to develop a long-term database to serve for wildlife management, monitoring the state of the environment, and for species conservation efforts. The data will be made available to scientists and the general public for educational and research purposes. The research is focused on predator and prey species, nesting habitats, breeding densities, population trends, and migration requirements. During the breeding season, shorebirds and songbirds prey on terrestrial arthropods. The emergence of arthropods is highly related to temperature and shifts are expected in a context of climate change (Tulp and Schekkerman, 2008). Lemmings also have a key role in the ecosystem. Year-round residents of the arctic tundra, the variation of the lemming population through time has an impact on predator reproductive success and productivity (Ims and Fuglei, 2005).

Migratory animals are currently suffering global declines, and their conservation requires an understanding of the space they use year-round (Wilcove and Wikelski, 2008; Meltofte et al., 2013). What happens elsewhere on the planet will impact the different migratory species observed in the North as they spend most of their annual cycle out of the Arctic. Because they travel between many ecosystems, some travelling as far as the Antarctic (e.g., Arctic Tern, *Sterna paradisaea* (Hatch, 2002)), migratory birds act as sentinel species. Observations of the abundance and health of migratory bird populations in the Arctic reflect the overall quality of habitats they use throughout the year (Piersma and Lindström, 2004).

This report presents the ongoing work on bird ecology at the CHARS campus. It describes the sampling approach and provides a few results from the 2017 and 2018 field seasons. Notably, the research program about migratory and breeding ecology of birds at the CHARS campus is in the early stages of development. Given the high cost of conducting research in the Arctic and the effort required for a holistic comprehension of the environment, members of the research team strive to collaborate and partner with local, national, and international organizations and researchers.

Monitoring and tracking methods

Shorebird and songbird prey

In 2018, the regional variation in arthropod diversity and abundance was assessed by deploying Malaise traps for extended periods. This work was carried out in collaboration with the University of Guelph.

Small mammals

With the support of experts from the Canadian Museum of Nature (Dr. Dominique Fauteux), a monitoring program on small mammals (notably lemmings) is being developed. In 2018, lemmings were collected through snap-trapping for the Canadian Museum of Nature's collections and for tissue sampling.

Birds

In both 2017 and 2018, data were collected opportunistically and systematically with the use of transects and study areas. Biodiversity data points collected includes location, abundance sex, age (adult or juvenile), and status (breeding or not breeding locally).

In 2018, biodiversity transects of 200 metres (m) were completed close to Cambridge Bay in a monitoring plot northwest of Greiner Lake.

Shorebird nests were opportunistically found and eggs were floated to assess timing of initiation and measured (weight, width, and length) to determine the stage of incubation of the clutch (Liebezeit et al., 2007). Nests were then revisited to define fate (e.g., success, failure).

Snow geese (*Chen caerulescens*) are considered hyperabundant and thus have strong impact on the tundra ecosystem (Batt, 1998; Jefferies et al., 2004, 2011; Flemming et al., 2016, 2019a, b; Lamarre et al., 2017). Two goose colonies were surveyed close to Cambridge Bay (Anderson Bay (centroid at about 50 kilometres (km) and Icebreaker (centroid at about 120 km) goose colonies). Helicopter flight height was maintained at 300 m or above when conducting surveys to delineate the goose colonies and determine whether they had been expanding in comparison to previous surveys (Kerbes et al., 2014).

Additionally, in 2018, in the centre of our main monitoring plot (northwest Greiner Lake) small devices were installed (less than 10 x 10 x 10 centimetres). These devices were used to record sound and test an alternative method to monitor the biodiversity in collaboration with researchers from Moncton University.

Other species

Fox dens found were mapped and monitored to count cubs. Fox feces were collected to examine diet and parasites. Additionally, feces transects (each made of 10 continuous plots of 1 m^2) were used to obtain an estimate of herbivore abundance. Five species groups were considered:

1. geese (*Anser spp.* and *Branta spp.*);
2. hares (*Lepus arcticus*);
3. ptarmigans (*Lagopus lagopus, Lagopus muta*);
4. caribou (*Rangifer tarandus*); and
5. muskoxen *(Ovibos moschatus).*

Migratory species migration paths

The tracking program aims to identify key areas used by migratory species in order to define important areas of use across their range. As part of the programs research activities, technologies such as GPS are used for tracking the migration path of species. For the 2018 field season, American Golden-Plovers (*pluvialis dominica*) were targeted. This was done in collaboration with the Arctic Shorebird Tracking project led by Manomet Inc. and the United States Fish and Wildlife Service – Alaska, and in partnership with McGill University (Dr. Kyle Elliot). When American Golden-Plover nests were found, adults were trapped on the nest with a bownet. Birds were banded nearby, away from the nest, and equipped with GPS devices (Lotek Pinpoint GPS Argos 75, 4.1 grams). The weight of the GPS devices represent less than 5% of the plover mass, as recommended in the "Guidelines to the Use of Wild Birds in Research" (Fair et al., 2010). Basic measurements and samples were taken (blood and feathers).

Results and discussion

Shorebird and songbird prey

Samples were collected from the Malaise traps weekly during the 2018 field season. Identification of species is underway by collaborators at Guelph University.

Small mammals

Unfortunately, due to late snow thaw, trapping activities were limited and the program's research activities were mainly constrained to a snow-free area in Augustus Hills, west of Cambridge Bay. Five collared lemmings and three brown lemmings were captured. Organs were collected for epidemiological studies through colleagues at the University of Saskatchewan and the University of Calgary. The year 2018 was likely one of high lemming abundance as signs of activities were easy to find (lemming tunnels, fresh defecation, and winter nests dug out by foxes) and predators were often spotted. However, more detailed surveys over several years

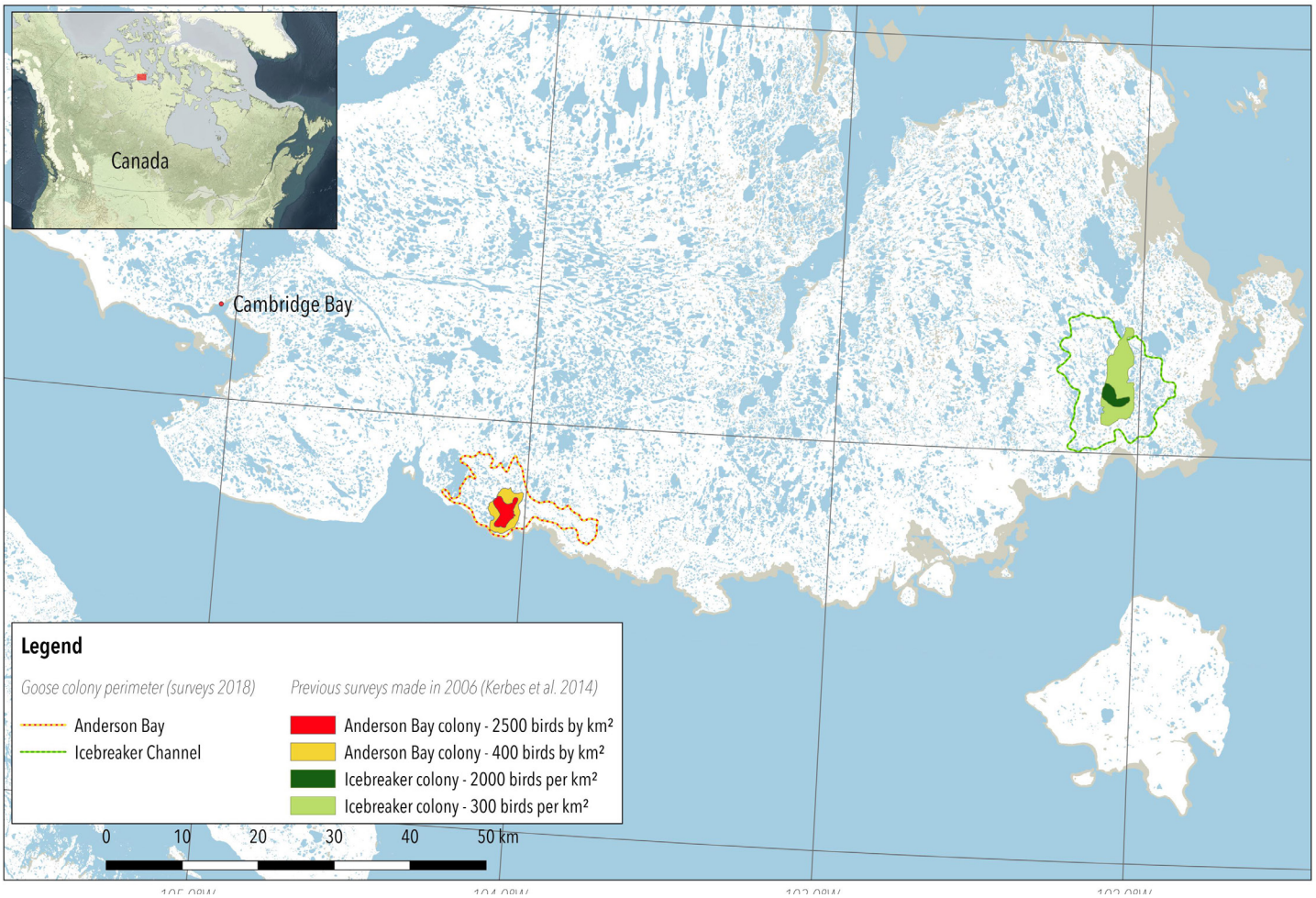

Figure 1: Southeastern Victoria Island snow goose colonies: Anderson Bay and Icebreaker. The extent found in 2006 is presented by density for both colonies as published in Kerbes et al., (2014). Orange and green lines represent the extent found in the 2018 surveys.

are required to define lemming density and how they vary through time.

Birds

In 2018, an area on the northwest shore of Greiner Lake was surveyed primarily but other sites close to Cambridge Bay (surroundings of Water Lake) were also visited. Sixteen shorebird nests were found with the most abundant species being the American Golden-Plover (10 nests, mean onset of incubation was June 19). The second most abundant species found nesting was the semipalmated sandpiper (*Calidris pusila*, five nests, mean onset of incubation was June 23). One stilt sandpiper nest was also found (*Calidris himantopus*, one nest, onset of incubation June 21). Incubation dates were mostly obtained by egg floatation (12 nests) but also by clutch completion (two nests) and hatching date (two nests). Nest success was about 56% (nine nests hatched). Others failed due to predation (three nests, about 19%) or had an unknown fate (four nests, 25%). The biodiversity sound logger was retrieved, and the full year of data is currently being analyzed by researchers based at Moncton University.

On June 25, 2018 an aerial survey of the two snow goose colonies was conducted on the southeastern part of Victoria Island following previous documentation by Kerbes et al., (2014). Both nesting colonies expanded in area. In 2006, the Anderson Bay goose colony had approximately 21 500 nesting geese in an area of about 20 km^2 (Figure 1). The nesting area found in 2018 was about 100 km^2. As for the Icebreaker goose colony,

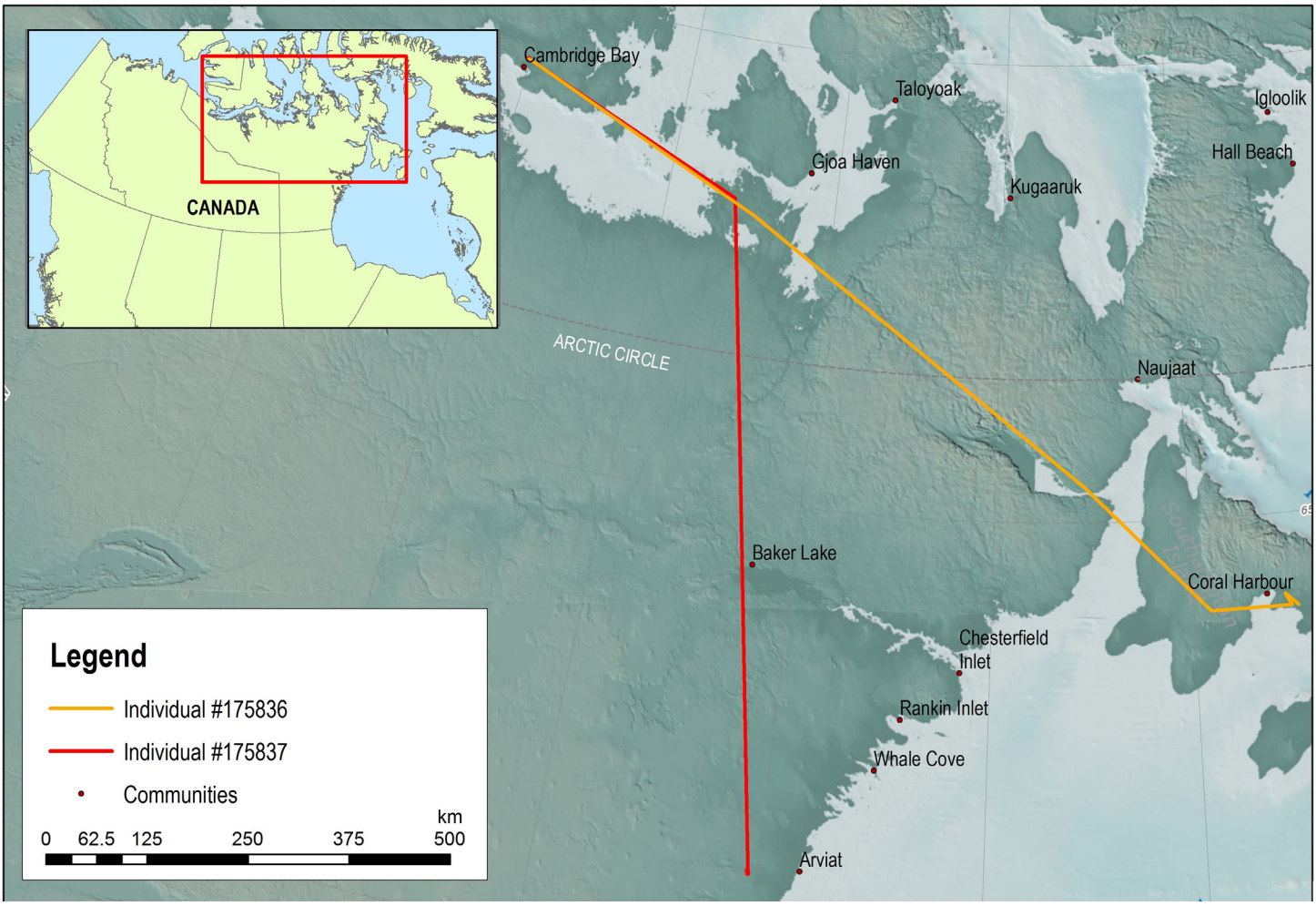

Figure 2: Migratory path of two American-Golden plovers (*Pluvialis dominica*) tagged during the 2018 breeding season close to Cambridge Bay, Nunavut.

in 2006, approximately 16 642 geese were nesting in an area of about 38 km² (Figure 1). The nesting area observed in 2018 was 180 km². For both goose colonies, this represents a about five-fold increase in area in the last 12 years. This expansion is consistent with other types of surveys conducted in 2011 in southeastern Victoria Island where about 130 000 geese were estimated to be nesting (Groves and Mallek, 2012). Although aerial pictures were taken from the helicopter, the resolution was not sufficient to count nesting birds. Research protocols will be adjusted to better estimate the abundance of geese in 2019 and document how the area is impacted by changes in local goose abundance.

Other species

In 2018, e.g., one active fox den with nine cubs was found on July 1, providing further evidence for a high abundance year for lemmings, the main prey of foxes. To obtain an estimate of herbivore abundance through feces counts 35 transects were performed. This contributes to the Interaction Working Group (Gilg et al., 2018) database studying the impacts of indirect interactions in the tundra ecosystem across a network of circumpolar sites.

Migratory species migration paths Three Argos Pinpoint-120 GPS tags were deployed on nesting American Golden-Plover in Cambridge Bay. Tags were also deployed in several sites in Alaska (Utqiaġvik (Barrow), Prudhoe Bay, and Canning Bay). Unfortunately, the tags deployed close to

Cambridge Bay did not transmit GPS fixes for the full duration of the fall migration. Locations were recorded until Foxe Basin and Hudson Bay (Figure 2), and one tag never left the surroundings of Cambridge Bay. Potential reasons for this include tag loss, mortality of the individual, or loss of battery life. The tags will be retrieved, if possible, during the 2019 field season and moretags will be deployed in the area surrounding Cambridge Bay.

The 2018 migration data acquired by the Arctic Shorebird Tracking Project from 13 individuals will be utilized for an undergraduate honours thesis at McGill University. This thesis will relate the timing of migration events with weather indices such as temperature and wind speed. This project will allow a better understanding of the relationship between avian migration and weather conditions, and of the factors impacting the migration of American Golden-Plovers.

Plan for 2019

Research activities are planned to continue in 2019 to build the dataset about migratory bird ecology. To help locate nest sites for cryptic species, drone surveys with thermal and optical sensors will be developed once incubation is underway. Temporary field camps will be established close to two goose colonies (Anderson Bay and Icebreaker) to look at geese impact on biodiversity in collaboration with researchers from Moncton University. Basic perimeter surveys will be conducted yearly on those two colonies, and research activities will expand to another nearby colony on Jenny Lind Island.

Additionally, partnering with local hunters,the research program will test the use of a local feather plucking station for harvested overabundant light goose. Hunters will be able to use this machine to accelerate the plucking of the harvested goose. This will allow basic measurement of geese (e.g., weight, fat score, and wing length), provide count and harvest location, and allow for basic tissue sampling. This station will be located at the CHARS campus initially and may be mounted on a trailer or a sled to take it closer to the harvest location.

The research program will continue to develop a migration monitoring program. This includes potentially adding new species to better document how birds are connecting the Arctic with the rest of the world.

The success of this work relies on developing strong partnerships with various local, national, and international researchers and organization. The research program aims at coordinating its effort to have a broad spatial coverage and target as many species as possible in order to develop the knowledge about migratory bird ecology in the central Canadian Arctic .

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