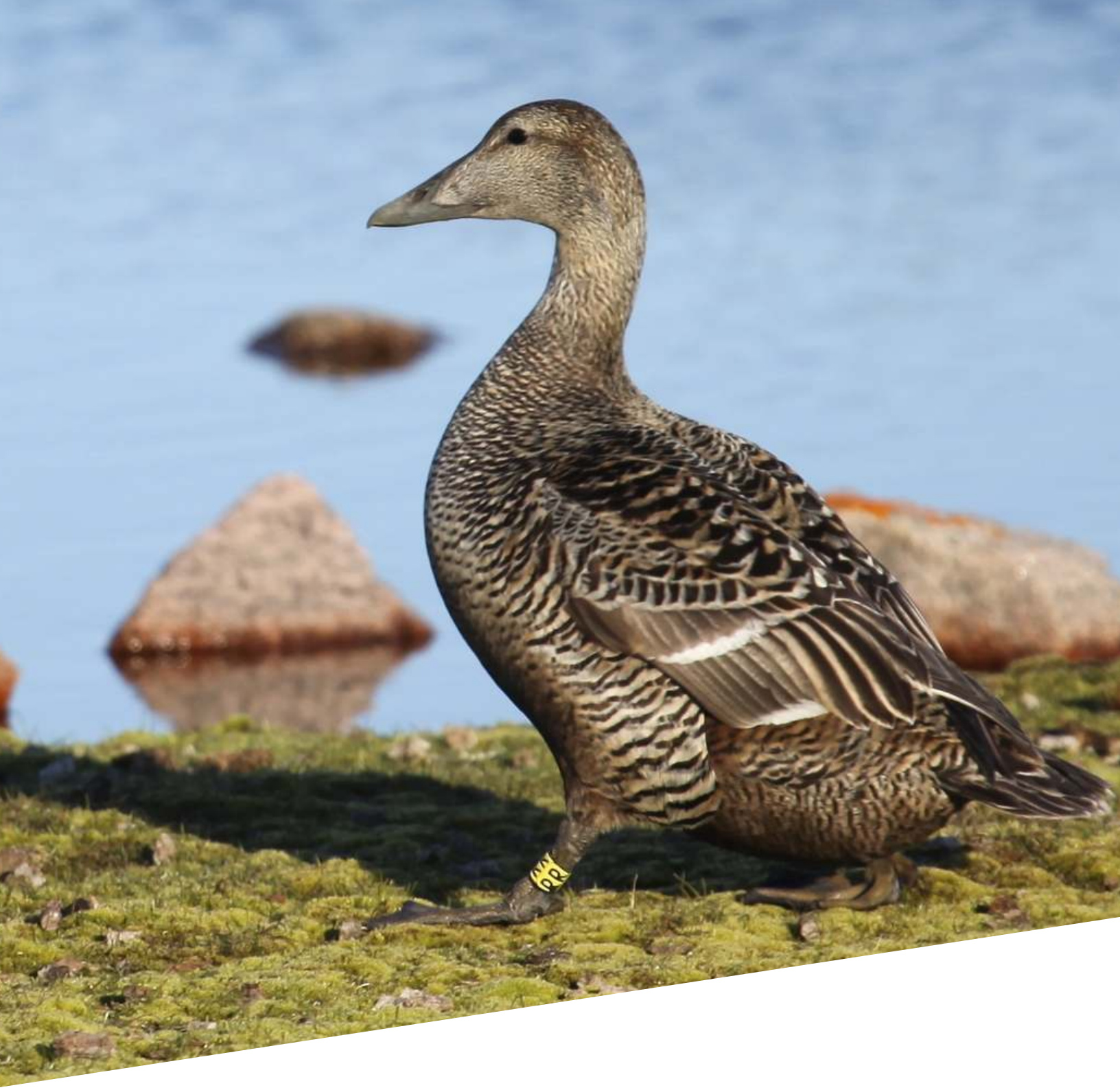


ENVIRONMENT AND CLIMATE CHANGE CANADA

EAST BAY ISLAND

2023 FIELD SEASON AND RESEARCH REPORT

PROJECT OVERVIEW

Our studies at East Bay/Mitivik Island were initiated in 1996 in response to concerns that northern common eider ducks were being overharvested on their wintering grounds in west Greenland. Since then, many new issues have emerged and our long-term dataset has allowed us to expand our research to respond to concerns raised by Northern communities and contribute to environmental assessment initiatives. Many of the emerging issues that we are currently researching include the influence of climate change and resource development on Arctic marine birds. Our findings related to bird movements and their habitat use contribute to the ongoing planning of marine protected areas in Northern Hudson Bay.

Our research objectives include:

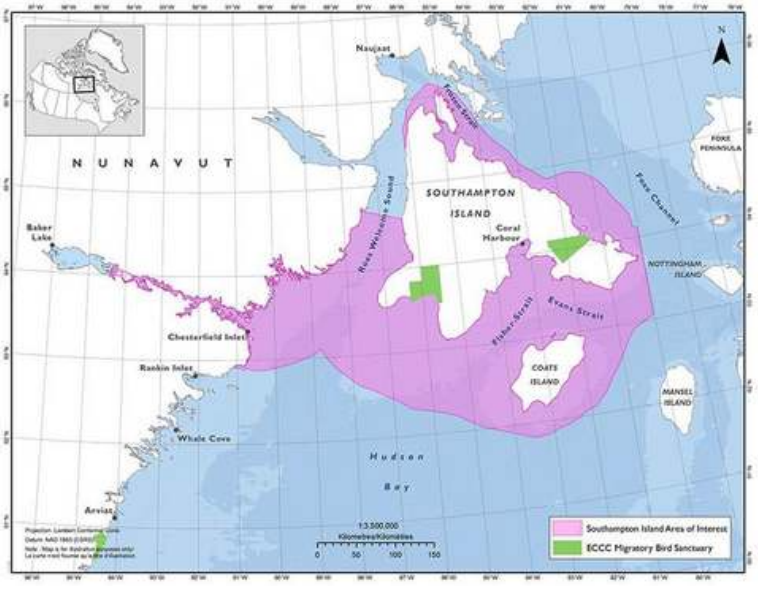
1. Investigating direct effects of variable annual weather conditions and changing sea-ice conditions on eider reproduction and population dynamics.
2. Investigating and forecasting relationships between polar bears and eiders as diminishing sea ice influences bear predation of eider nests.
3. Identifying key seabird marine habitats in an effort to identify potential issues related to northern industrial development, particularly year-round shipping.
4. Understanding the physiological mechanisms linking climate variability, reproduction, and survival of arctic breeding migratory birds.
5. Tracking birds using GPS technologies to quantify their use of coastal and off-shore marine habitats. These findings are contributing to the design of marine protected areas currently proposed in Northern Hudson Bay.

CONTRIBUTING TO MARINE PROTECTED AREAS

The formal protection of the Marine Environment is a national priority. In the Arctic, Government Departments and local communities are working together to identify areas worthy of protection. The spatial use of the ocean by wildlife is one element that considered when designing marine protected areas.

Our team is contributing seabird spatial tracking information which will be useful in the design of 'The Southampton Island Area of Interest'. This area encompasses the nearshore waters around Southampton and Coats Island in the Kivalliq Region of Nunavut. This site comprises 93000 km2 within the Hudson Bay Complex Marine Bioregion, and is approximately 1.6% of Canada's ocean territory.

Southampton Island is the largest island in Hudson Bay, near the confluence of Hudson Bay and Foxe Basin waters; making it an area of high marine productivity. The area is important for key marine species including narwhal, beluga whales, and bowhead whales. It also contains walrus haul-out sites, polar bear dens, and foraging habitats of seabirds. This new protected area will encompass two Environment and Climate Change Canada (ECCC) Migratory Bird Sanctuaries: The Harry Gibbons (Ikkattuaq) Migratory Bird Sanctuary, and the East Bay (Qaqsauqtuuq) Migratory Bird Sanctuary.



Proposed marine protected area.

SEA DUCK JOINT VENTURE

Sea ducks are a large group of waterfowl that, relative to other waterfowl species, little is known about. Some sea duck populations are declining in North America or have lower numbers than they did historically, and they depend on sensitive coastal, arctic, and boreal habitats throughout the continent.

The Sea Duck Joint Venture (SDJV) is an American and Canadian conservation partnership of wildlife organizations committed to maintaining sustainable populations of North American sea ducks throughout their ranges. The Joint Venture contributes research funding directly to support sea duck research, monitoring projects, and outreach programs intended to generate greater understanding required for effective population and habitat conservation throughout North America, including the Arctic. Projects are cooperatively funded by Congressional appropriations and partner contributions.

The SDJV, in collaboration with Ducks Unlimited, Inc., has recently developed a graduate student fellowship program to support research on North American sea ducks. The goal of the program is to increase the number of skilled early career professionals interested in sea duck research, management, and conservation and related fields. **Reyd Smith** (Carleton University), **Shayla Kroeze** (Queens University), and **Emily MacDonald** (University of Windsor) have all received Student Fellowship Awards to support their graduate research.

To learn more, please visit the SDJV website: **seaduckjv.org**

How Genetics might have influenced the response of Common Eiders to Avian Cholera

Shayla (Shay) Kroeze - Ph.D. Student, Queen's University Drs. Vicki Friesen and Grant Gilchrist

Arctic species are beginning to face novel diseases, in part due warmer climates increasing the exposure of wildlife to disease vectors (e.g., mosquitoes). However, the genetics of disease resistance in wild populations is surprisingly lacking, particularly in Arctic species. From 2005-2012, the common eider colony on East Bay Island experienced several outbreaks of avian cholera, resulting in high mortality rates and decreased reproductive success. Since 2011, the mortality rate of female eiders has been less than 1%, likely due to herd immunity. However, it is unknown why in years of high cholera mortality, why cholera led to mortality in some eiders, while others remained healthy.

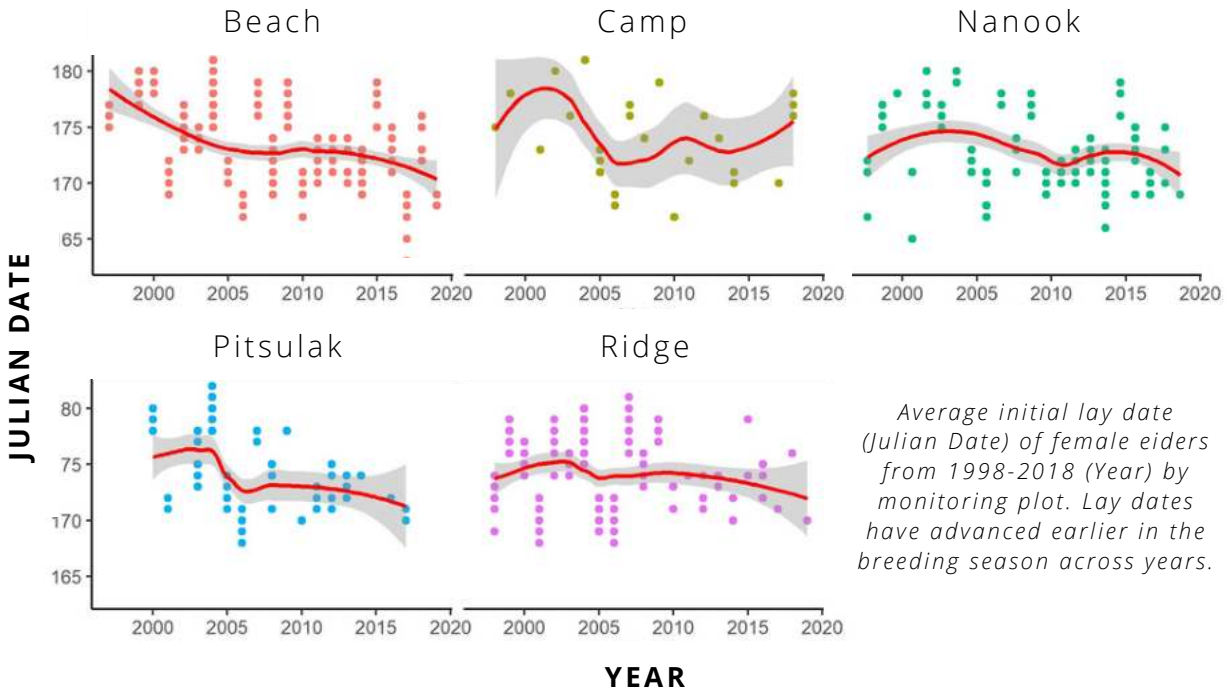
Shay will examine the role of genetics in contributing resistance to cholera in eiders. She will obtain whole genome sequences from eiders that both survived the cholera epidemic and did not, as well as from eiders that were found to have a strong immune response to cholera based on antibody levels. This will be accompanied by a long-term dataset on immune-related variables in these eiders such as age, body size, etc. She will test for correlations between variation in genes and cholera resistance controlling for immune related variables, specifically focused on genes previously found to be involved in immunity in other bird species. Additionally, Shay will explore how these genes changed in frequency before, during, and after the outbreaks, as well as in colonies that have never been exposed to cholera. Results from our research will provide valuable information on the population genetics of disease resistance in wild populations, and the vulnerability of Arctic bird species to emerging infectious diseases.

Influence of Environmental Variability on Nest Site Selection by Common Eiders

Duncan Wright - M.Sc. Student, University of Windsor with Dr. Christina Semeniuk

Choosing the right habitat is critical to an organism's survival and reproduction as it can affect access to quality food resources, secure mates, avoid predation, and optimisation of physiological processes. When selecting habitats, individuals to distribute themselves non-randomly to balance these tradeoffs. Nesting selection patterns follow the same trends, but with an emphasis on individual survival and reproductive success. In avian species, we assume the earliest nesting birds choose the highest quality sites, and achieve the highest reproductive success.

Although responses to climatic and environmental stressors have been demonstrated during nesting in Common Eiders (*Somateria mollissima*), little is known about nest site preferences on a broad spatial scale. Further, despite the predicted effect of temperature on lay dates in Common Eiders, it is currently unknown if nesting behaviour has been adjusted by rapidly changing climatic conditions. Using long-term monitoring data from East Bay/Mitivik Island (1999-2018) Duncan aims to assess the role of climatic cues (temperature, precipitation, wind speed, wind direction), and nest site characteristics (distance to water, base substrate, wind cover, and viewshed) on nest site selection metrics (nest site location, nesting date) on a spatial-temporal scale. This 20 year dataset will provide insight into high quality sites and nest site selection in a Habitat Selection Theory framework.



Average initial lay date (Julian Date) of female eiders from 1998-2018 (Year) by monitoring plot. Lay dates have advanced earlier in the breeding season across years.

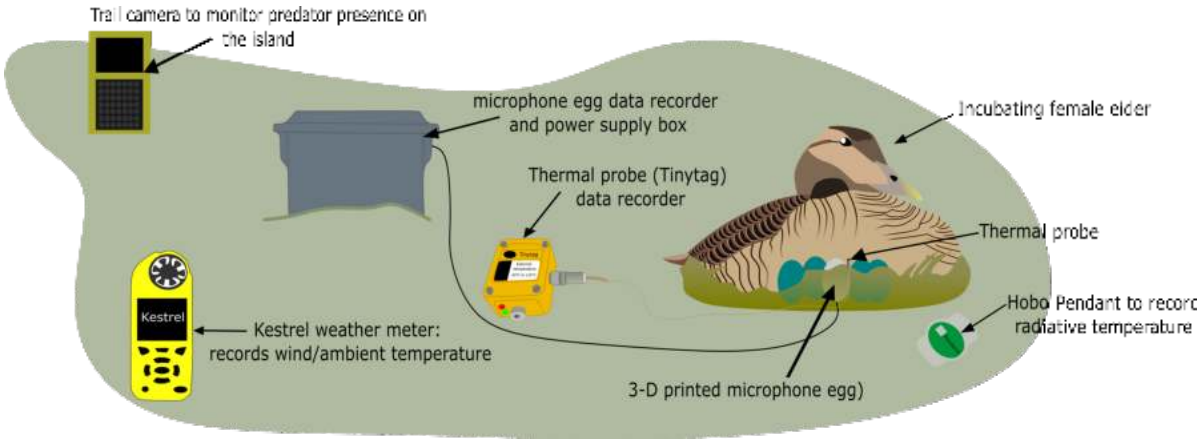
Impacts of Thermal Stress on the Nesting Behaviour and Physiology of Eiders

Emily MacDonald - M.Sc. Student, University of Windsor with Drs. Christina Semeniuk and Oliver Love

Arctic temperatures are rising at an alarming rate, yet its direct impact on Arctic species remains understudied. To address this, Emily is examining the physiological and behavioural response of incubating female eiders to thermal stress at the East Bay/Qaqsauqtuuq Migratory Bird Sanctuary, Nunavut. Female eiders here may be especially at risk of over-heating during incubation because their nests are frequently thermally exposed, and they fast for the duration of their incubation (i.e., 24-26 days without energy input to combat increased costs of thermoregulation).

This summer, Emily monitored the heart rate (proxy for metabolic rate and physiological indicator of heat stress) and incubation consistency/nest movements (behavioural response to heat stress) of nesting female eiders to ambient temperatures. To do this, she installed a heart rate recording microphone and a thermal probe in 36 female eider nests while simultaneously recording ambient and radiative temperature, and wind speeds around the nests and breeding colony. Emily's dataset is builds on similar data from 2018 (20 females), 2019 (12 females), and 2022 (14 females).

Assessing heat stress effects on the energetic and behavioural costs of breeding in female Common Eiders will provide insight on their vulnerability to a rapidly warming Arctic. Further, predicting temperatures at which eiders experience thermal stress can inform projected climate impacts and management strategies of this culturally important seabird.



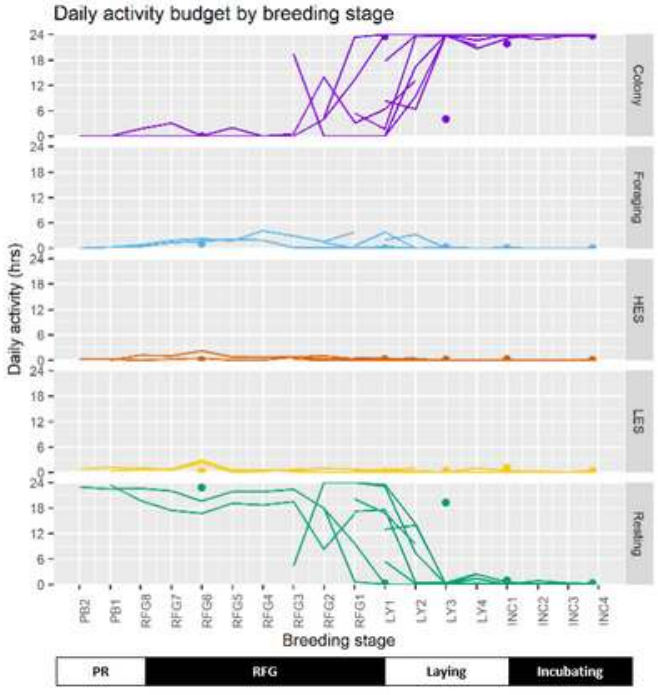
Example set up of heart rate and temperature recorders in a Common Eider nest with surrounding environmental temperature recording devices

Behavioral Energetics and Spatial Trends of Arctic Common Eiders

Erika Nissen - M.Sc. Student, University of Windsor with Drs. Oliver Love and Holly Hennin

Arctic breeding seabirds face significant intra- and inter-annual variation in ice cover which affects access to marine prey and the ability of a female to gain the resources necessary to reproduce. In Common Eiders (*Somateria mollissima*), females must gain energetic (fat) stores quickly upon arrival on the breeding grounds to reproduce. Individuals therefore need to adapt their behaviour to changing energetic demands as they prepare to reproduce, and must adapt foraging strategies and spatial use depending on environmental parameters and body condition.

To examine how and why females make pre-breeding foraging decisions, Erika integrated GPS data loggers, bathymetric maps, and satellite ice imagery to determine where birds travelled and foraged to examine how environmental parameters influenced energetic management and spatial use of the breeding habitat. She aimed to identify key foraging areas for female eiders, examine variation in time budgets across the pre-breeding period, and explore whether females show behavioural flexibility necessary for reproductive success with increasingly variable environmental conditions.



Time budgets across the breeding period for Common Eider females, examining time in hours spent per day at the breeding colony, foraging, in flight (HES), swimming (LES), and resting

Quantifying intra- and inter-individual variation in foraging decisions during this life history stage will provide critical missing information on the proximate mechanisms driving breeding investment within the context of a stochastic environment. Access to resources limited by environmental factors ultimately impact fitness and survival metrics with important downstream consequences for breeding initiation, laying phenology, and overall reproductive success.

Collaboration Between Local Indigenous and Visiting Non-Indigenous Researchers

Samuel Richard - M.Sc. Student, Carleton University with Dr. Grant Gilchrist and Dr. Vivian Nguyen

There is a growing appreciation for the value of collaborative research projects involving local Indigenous and visiting non-Indigenous researchers. Examples of such partnerships are now numerous and diverse, and best practices and respectful approaches have been well presented, including the five priorities of the National Inuit Strategy on Research (NISR) defined by Inuit Tapiriit Kanatami in Canada. However, the application of best practices remains challenging, and examples of 'on-the-ground' implementation remain scarce in the literature.

Sam reviewed a case study in which he examined the practical challenges of delivering a multi-decadal collaboration monitoring Arctic Common Eiders (*Somateria mollissima*), which has been co-delivered by Inuit and scientists from Environment Canada.

There were three key challenges that Sam identified in his review. First, was co-designing a data collection protocol that combined both Indigenous and Western scientific methods. Second, the federal government's administrative approaches present a challenge to employ seasonal Indigenous workers living in remote communities, particularly in Canada. Finally, Sam determined that sociocultural factors have made it challenging to ensure the safety of all field workers consistently. Sam's work aims to invite other research teams to reflect on the gaps that exist within their research to improve collaborative approaches nationally and internationally.

Mismatch as a Consequence of a Warming Arctic in a Cold-Adapted Passerine

Alysha Riquier - M.Sc. Student, University of Windsor with Dr. Oliver Love and Dr. François Vézina

Snow Buntings (*Plectrophenax nivalis*) are a circumpolar Arctic-breeding passerine that are experiencing a significant population decline. They are the earliest-arriving spring avian migrant to the Arctic, and are also income breeders, relying solely on biomass accumulated on the breeding grounds for egg formation. This presents a challenging reproductive constraint given that Snow Buntings feed predominantly on arthropods (e.g., flies, beetles, spiders), which in turn is dependent on the timing of snow melt. Given that climate change has altered the timing of snowmelt and subsequent emergence of arthropods, it is critical that snow buntings have the ability to adjust their chick-rearing period to match with the peak of arthropod emergence.

A female Snow Bunting feeding her chicks

A male Snow Bunting carrying a mouthful of arthropods

Alysha's goal is to understand how increasingly variable climate is affecting Snow Bunting laying decisions by examining the link between phenology and arthropod availability. She collected key breeding metrics (i.e., lay date and clutch size), and reproductive outcomes (i.e., hatching and fledging success) from nesting snow buntings at East Bay/Mitivik Island, Nunavut. To quantify arthropod biomass throughout the Snow Bunting nesting season, she used pitfall traps to collect arthropod samples which she then analysed and sorted in the lab. Her research will also be able to include several years of historical data, making this a unique and relatively long term study to test her questions (2007-2023). Alysha's research aims to find important mechanistic links between climate change and a key resource base for this declining, Arctic passerine.

Linking Thermal and Behavioural Responses to Fitness in an Arctic Songbird

Rebecca Jardine - M.Sc. Student, University of Windsor with Dr. Oliver Love

The Arctic is experiencing rapid rates of climate change, where temperatures are increasing faster than the global average. However, since Arctic species are adapted to cold conditions throughout their annual cycle, they may not be physiologically prepared for warmer conditions. Of specific concern are Snow Buntings (*Plectrophenax nivalis*), an Arctic breeding songbird whose populations are rapidly declining without a clear reason as to why.

Climatic warming is predicted to significantly effect Snow Buntings during the summer breeding period, particularly during chick rearing when they must work above their basal metabolic rate foraging to feed their offspring. Due to high metabolic rates and correspondingly high body temperatures, effective heat dissipation during chick rearing is vital to avoid reaching lethal body temperatures. Thus, when environmental temperatures exceed optimal levels, breeding birds may need to adjust their behaviors to maintain normal body temperatures.

In 2022 and 2023, Rebecca recorded temperatures on the breeding grounds and measured the physiological and behavioural response of Snow Buntings throughout the breeding season using thermal Radio-Frequency Identification (RFID) tags. These tags measure body temperature and parental foraging responses in Snow Buntings. Rebecca will combine these data to determine the temperature threshold at which Snow Buntings may need to decrease chick feeding behaviours to avoid heat stress. Ultimately, allowing us to understand how this species may respond to the current and future threats of increased temperature due to global warming.

Female Snow bunting at the entrance of her nest with RFID antenna at the entrance

PUBLICATIONS

Barnas AF, EA Geldart, OP Love, PM Jagielski, CM Harris, HG Gilchrist, HL Hennin, ES Richardson, CJ Dey, CAD Semeniuk. 2022. Predatory cue use in flush responses of a colonial nesting seabird during polar bear foraging. **Animal Behaviour** 193: 75-90.

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Simone C, EA Geldart, CAD Semeniuk, OP Love, HG Gilchrist, AF Barnas. 2023. Conspecific nest attendance behaviour of Common Eider (*Somateria mollissima*) in response to Polar Bear (*Ursus maritimus*) foraging activity: error or intent? **Canadian Field Naturalist** 136(3).

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Smith RA, SS Albonaimi, HL Hennin, HG Gilchrist, J Fort, KJ Parkinson, JF Provencher, OP Love., 2022. Exposure to cumulative stressors affects the laying phenology and incubation behaviour of an Arctic-breeding marine bird. **Science of the Total Environment** 807.

STUDENTS AND POST DOCS

Shayla Kroeze

(Ph.D. 2023–2027, Queen's University) is examining the role of genetics in contributing resistance to avian cholera infection in Common Eiders (Natural Sciences and Engineering Research Council of Canada's Canadian Graduate Scholarship - Doctoral, SeaDuck Joint Venture Fellowship).

Emily MacDonald

(M.Sc. 2022-2024, University of Windsor) is examining the physiological and behavioural responses of Arctic-breeding Common Eiders to heat stress (University of Windsor Entrance Scholarship, Ontario Graduate Scholarship, SeaDuck Joint Venture Fellowship, Weston Family Awards in Northern Research).

Duncan Wright

(M.Sc. 2022-2024, University of Windsor) is exploring Common Eider nesting patterns using GIS spatial modeling (ESRI ArcGIS scholarship).

Alysha Riquier

(M.Sc. 2022-2024, University of Windsor) is examining how variation in weather affects arthropod availability and Snow Bunting breeding phenology to ultimately determine whether buntings have the capacity to keep pace with climate change in a rapidly changing Arctic.

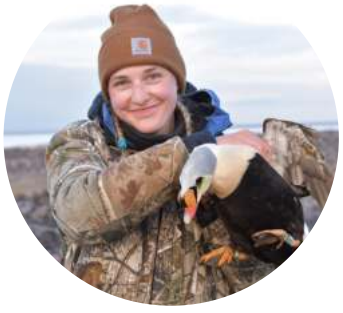
Rebecca Jardine

(M.Sc, 2022-2024, University of Windsor) is investigating the behavioural, physiological and fitness responses of an Arctic songbird to increasing temperatures on their breeding grounds (SCO-SOC Discovery Award).

Samuel Richard

(M.Sc. 2020-2022, Carleton University) examined the long term population trends and nesting distribution of common eiders in the Belcher Islands. He also evaluated ongoing challenges to hire Inuit to contribute to environmental monitoring studies.

Erika Nissen



(M.Sc. 2020-2023, University of Windsor) examined pre-breeding foraging decisions and behavioural time budgets in female Common Eiders (Ontario Graduate Scholarship, Weston Family Awards in Northern Research, Lynda Corkum Essex County Nature Bursary).

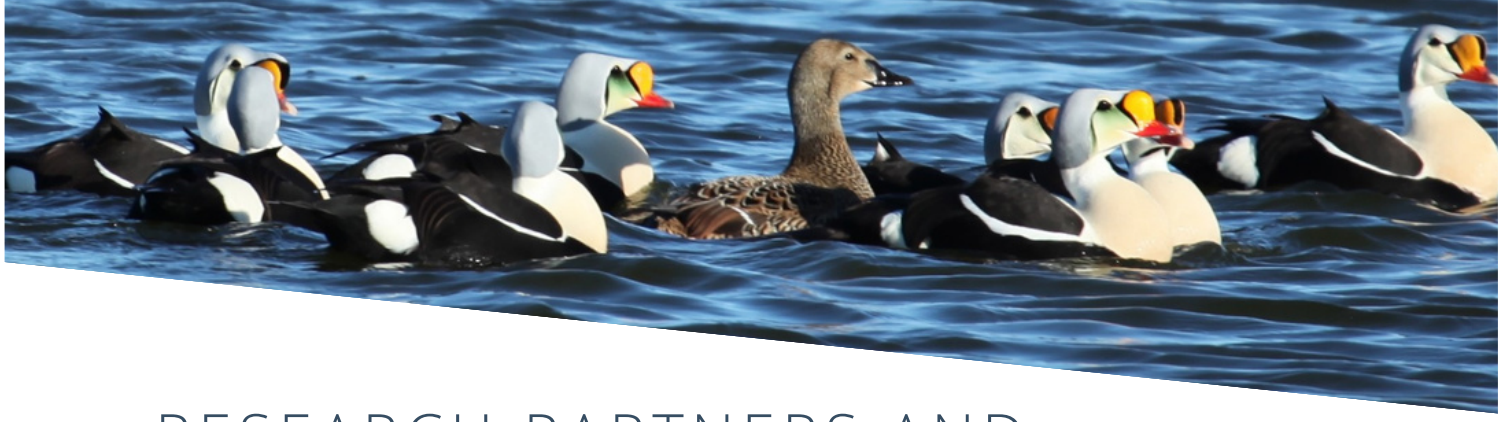
INUIT PARTICIPATION

Josiah Nakoolak

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

Mark Eetuk

participated in the Inuit Field Training Program in 2018, was recruited to East Bay Island in 2019 to work as a research assistant, and has returned to join the team every year since. He will be rejoining us in 2024.



RESEARCH PARTNERS AND FINANCIAL SUPPORT

Our research at East Bay Island is a combined effort of many people and organizations. Dr. Grant Gilchrist (Environment and Climate Change Canada; ECCC) co-leads the project together with Drs. Oliver Love (University of Windsor), Christina Semeniuk (University of Windsor), Mark Forbes (Carleton University), Paul Smith (ECCC), Evan Richardson (ECCC) and Holly Hennin (ECCC). Support in Coral Harbour is provided through the Aiviit Hunters and Trappers Organization, and with special thanks to Noah Nakoolak. We thank Isabel Buttler and Rob Kelly for their ongoing contributions to data management.

The research at East Bay Island is logistically complicated and labour intensive, requiring a dedicated crew of students, biologists and Northerners. Our eider field crew in 2023 included Mark Eetuk, Grant Gilchrist, Oliver Love, Josiah Nakoolak, Alysha Riquier, Rebecca Jardine, Shay Kroeze, James Alexander, and Zachary Peck. Photos in this report provided by Alysha Riquier, Rebecca Jardine, Erika Nissen, and Grant Gilchrist.

Research in Canada's North is expensive and funding for this work is provided by a network of partnerships that includes but is not limited to: Environment and Climate Change Canada (ECCC) Wildlife Research Division, ECCC Ecotoxicology and Wildlife Health Division, ECCC Canadian Wildlife Service, Baffinland Iron Mines Corporation, ArcticNet, Oceans North, Carleton University, University of Windsor, Polar Continental Shelf Program, Northern Scientific Training Program, Natural Sciences and Engineering Research Council of Canada, the Weston Family Foundation, and the Canada Research Chairs program.

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