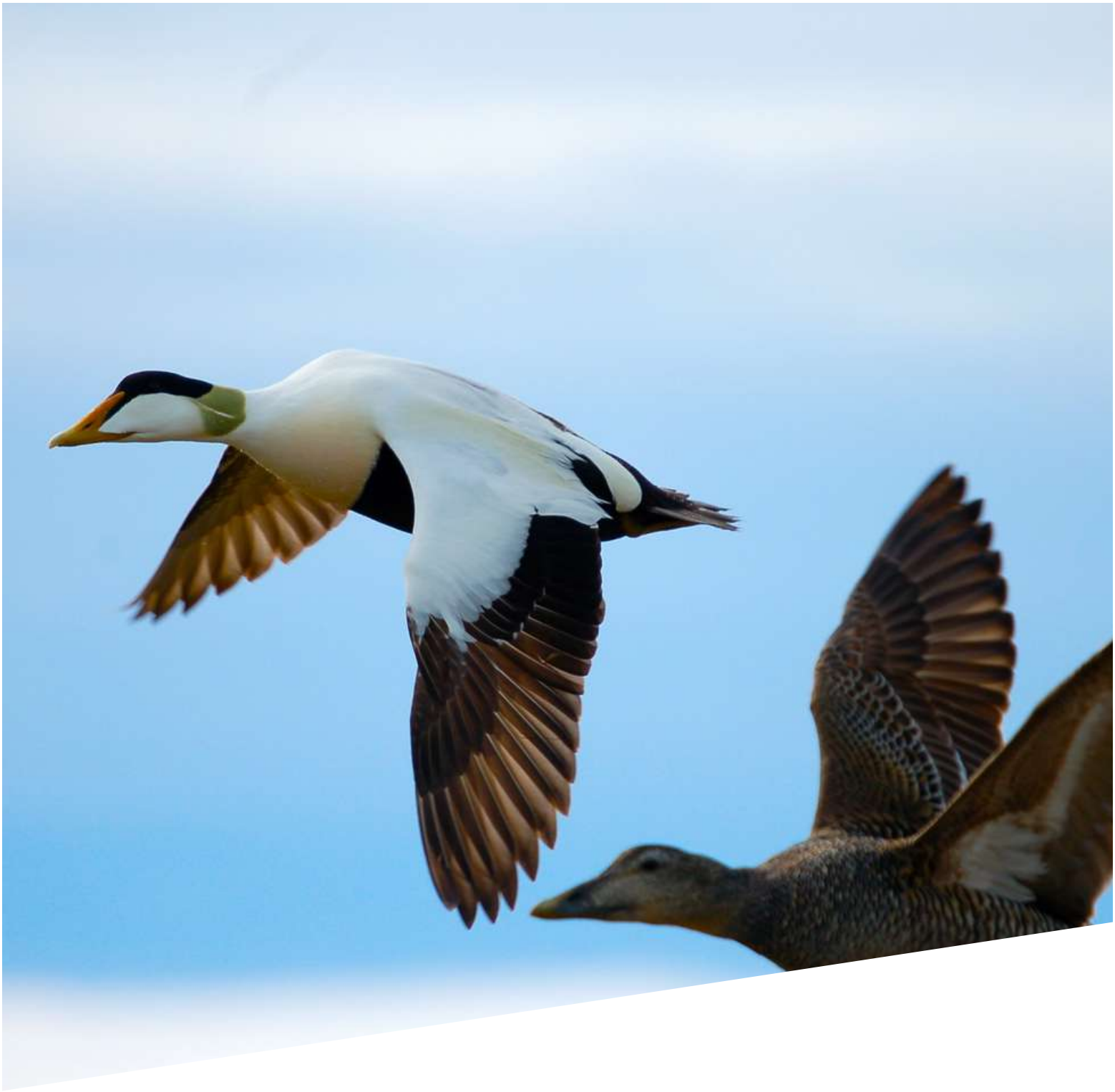


EAST BAY ISLAND

2019 FIELD SEASON REPORT

ENVIRONMENT AND CLIMATE CHANGE CANADA

PROJECT OVERVIEW

Our studies at East Bay 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 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. Increasingly, our findings related to bird movements and their habitat use are contributing to the planning of marine protected areas in Northern Hudson Bay.

Our research objectives include:

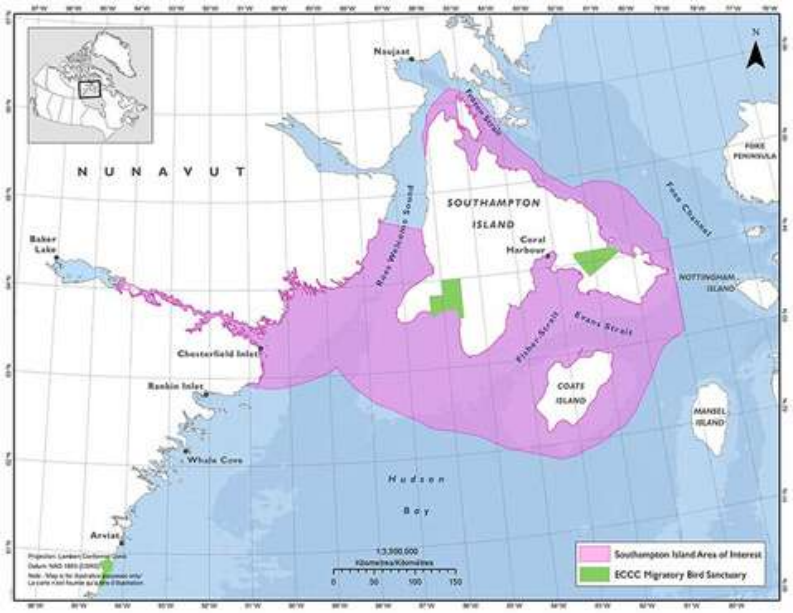
1. Investigating direct effects of variable annual weather conditions and changing sea-ice conditions on eider reproduction and population dynamics.
2. Investigating and forecasting relationships between polar bears and eiders as diminishing sea ice influences bear predation of eider nests.
3. Identifying 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.

BUILDING IN SAFETY

Our team of Government researchers, northerners, academic professors and students have benefited from the use of established field stations to conduct long-term ecological studies. Cabins provide a comfortable living and working space, electrified bear fences provide safe living conditions within their perimeter, and solar power has diversified the types of research that can be achieved as we apply new technologies to monitor the changing Arctic environment.

In 2019, Environment and Climate Change Canada provided our team with additional funds to construct a kitchen cabin on the East Bay Island. The cabin was constructed in early June by carpenters Keenan Peddie, Josiah Nakoolak, Jupie Angootealuk, and Mark Eetuk. The cabin will provide a safe structure for crew members to cook and eat and will help expand our research of polar bears at East Bay.

Cabin construction crew (from left to right; above) Mark Eetuk, Jupie Angootealuk, Keenan Peddie and Josiah Nakoolak.

NEW TO THE CREW

We are very excited to announce that Dr. Holly Hennin has recently taken the position as the Wildlife Research Technician of the marine bird program with Environment and Climate Change Canada. She joins the team at the National Wildlife Research Centre on the campus of Carleton University in Ottawa.

Holly is very well known and respected from her contributions to the marine bird program as a graduate student, Post Doctoral research associate, and most recently as the Wildlife Technician over the course of nearly a decade. If we were to add up all of the months she has spent in the field over the years, she has lived on East Bay Island for over 13 months.

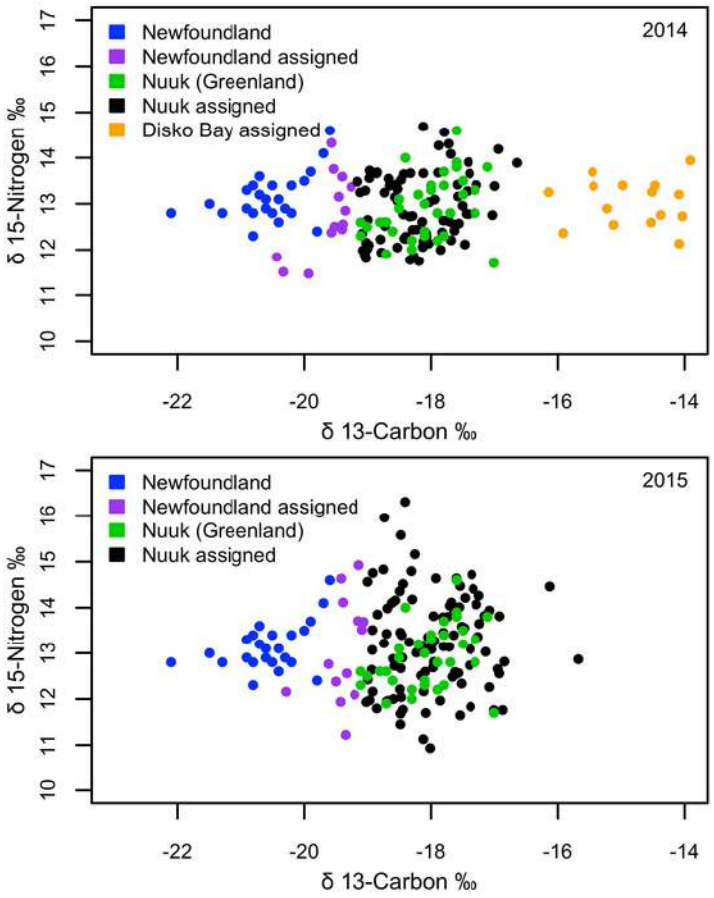
Holly has published many articles in top scientific journals, represented the program nationally and internationally at conferences, and has won awards for her scientific findings and presentations. Her years of experience leading field teams in the Arctic as well as her contributions to delivering the complex and varied administrative tasks throughout the year, are a tremendous asset. More importantly, Holly brings a wonderful, energetic enthusiasm to everything she does which is greatly appreciated when you're sitting in the freezing rain waiting for eider ducks to arrive from the floe edge. Holly has recently moved to Ottawa with her family; Eric and son, Rowan (aged 1!).

Common eiders can compensate for poor winter conditions during the spring pre-breeding period

Rolanda Steenweg (Ph.D. Candidate, Dalhousie University with Dr. Oliver Love and Dr. Glenn Crossin)

For wild animals, energy fuels life stages, affects the decisions individuals make, and can have long-term impacts on subsequent life stages (carry-over effects). However, few studies can examine carry-over effects due to the challenges of tracking individuals through multiple stages of their lives without impacting their behaviour while simultaneously collecting the information needed. Common eiders breeding at East Bay Island, NU make an interesting system to test this question because the birds that breed here overwinter in three distinct areas: Nuuk, Greenland, Disko Bay, Greenland, and coastal Newfoundland, Canada. Although these birds all experience the same spring climate and breed together at East Bay, they often have experienced different winter conditions.

Using stable isotopes collected from eiders as they arrive to the nesting colony in June, we have been able to determine where birds have spent their winter. Stable isotopes differ between locations and are incorporated into tissues as they are grown. As we captured females, we collected claw samples which were grown on the wintering grounds. These claw samples carry a wintering isotope signature.



We validated the use of carbon and nitrogen stable isotopes in claws to assign common eiders to their overwintering areas.

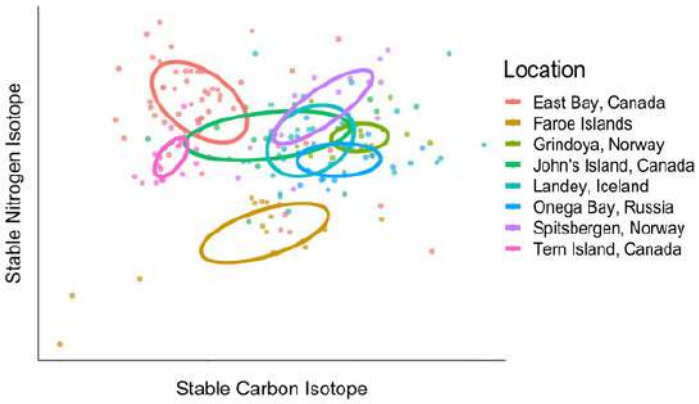
We found that warmer spring temperatures at the breeding grounds meant that females arrived at the breeding colony earlier and in higher body condition. Females with better body condition were more likely to breed. Interestingly, winter temperatures did not predict the decision to breed, suggesting that eiders can mitigate the carry-over effects of winter conditions during the spring pre-breeding period.

Predicting the resiliency of Arctic common eiders to climate change using stable isotopes

Kyle Parkinson (M.Sc. Student, University of Windsor with Dr. Oliver Love)

Rapid and unpredictable environmental change is occurring in the Arctic. However, it is uncertain whether individuals and populations will be resilient to these changes. For some species, like the common eider duck, the ability to gain fat stores quickly is critical for their successful reproduction. Acquiring this energy may become more challenging in this rapidly-changing environment. Our goal is to determine the prevalence of foraging specialists (those birds that eat a few prey species) and generalists (those that eat wide array of prey species) within and among populations. Generalists are expected to be more resilient to environmental change because they are less selective in their diet. Within a population, we will relate diet specialization to breeding. We will then scale this to the population level to determine how environmental conditions may shape these relationships between diet and resilience across the circumpolar range of common eider.

We have begun to assess the diet of eiders using nitrogen (what an individual ate) and carbon stable isotopes (where an individual ate) from common eider blood samples collected at their arrival at East Bay Island, NU. Analyses from nearly 1000 female common eiders over a 9 year period (2010-2018) show substantial annual variation which we have discovered is largely driven by broad climate metrics.



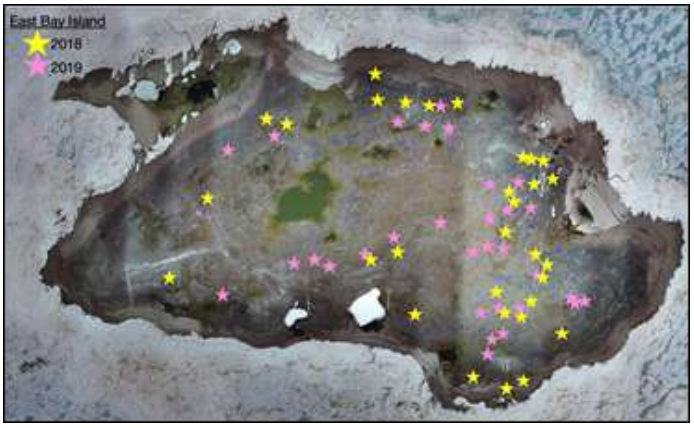
Nitrogen and carbon isotope values of common eider females at multiple populations across the circumpolar Arctic.

We have also developed an international network of collaborators to collect blood samples from common eider females for further isotope analysis across their circumpolar range. Again, there is substantial variation across populations, suggesting that populations forage on different items and vary in the degree of specialization of their diets. This is the first inter-population study of foraging variation across the circumpolar-range of common eiders, all with the intent to explore and predict the resiliency of Arctic-breeding species to climate change.

How mercury and temperature interact to affect hormones and reproduction in common eiders

Reyd Smith (M.Sc. Student, University of Windsor with Dr. Oliver Love)

The Arctic is experiencing multiple changes including increased temperatures, diminishing sea ice extent, and increased exposure of wildlife to some contaminants. We are exploring the interactions between temperature and mercury (a prevalent contaminant which transfers to wildlife and humans), and how they may influence two key reproductive hormones of eider ducks: luteinizing hormone (involved in the decision to breed) and prolactin (important for the female to bond to her nest and subsequent offspring).



Location of common eider nests in 2018 (yellow) and 2019 (pink) studied across East Bay Island, NU.

We study common eiders nesting at East Bay Island, NU because females rely on stored fat and protein during reproduction and its use by female eiders can release contaminants into their blood stream. Prior research of eiders and other nesting waterfowl has demonstrated that warmer air temperatures increase the time females spend off their nest. Increasing temperatures, when paired with exposure to mercury may impact hormone secretion of eiders in the wild. This in turn could affect their reproductive behaviours, weaken nest attentiveness, and lower reproductive success.

We continued our work in 2019 and collected blood samples from 32 female eiders. We also monitored 51 eider nests using cameras and temperature sensors. Our preliminary results suggest that females vary widely in their nest attentiveness and we are now linking this to their contaminant levels.

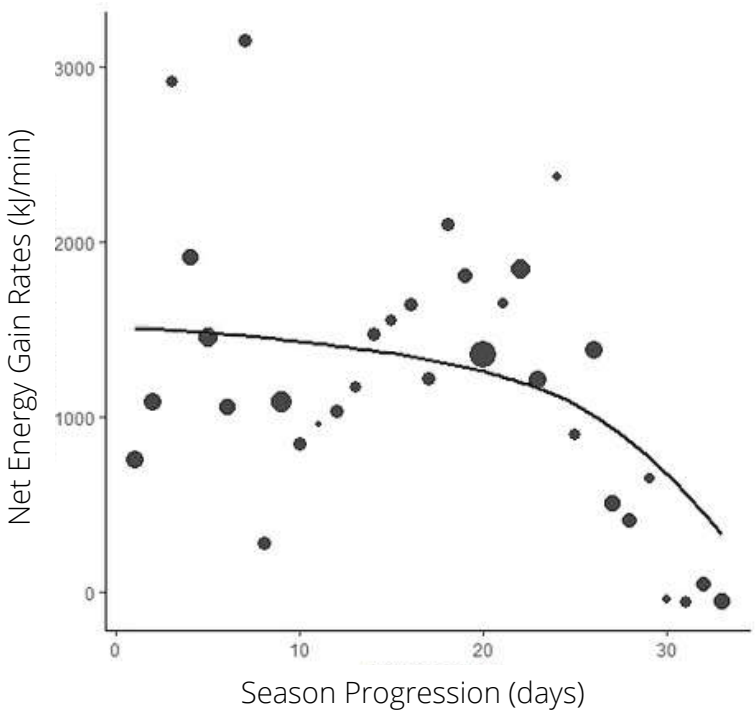
Polar bear terresterial foraging ecology in a common eider colony

Patrick Jagielski (M.Sc. Student, University of Windsor with Dr. Christina Semeniuk)

Declining sea-ice conditions in northern Hudson Bay are apparently causing polar bears to change their movement patterns earlier in the spring. Polar bears are currently arriving onto East Bay Island weeks earlier than they did a decade ago, which now overlaps with the timing of common eider egg laying and incubation. As a result, bears are foraging on the eggs in this large common eider colony in large numbers.

We used aerial drones to collect video footage of polar bears foraging at East Bay Island. We measured the energetic costs (walking, resting, ingesting eggs) and benefits (energy gained by consuming eggs) of their egg predation.

Our results indicate that the energetic cost of foraging is negligible. As the season progressed, polar bears consumed eggs at a declining rate (because fewer nests were available), and therefore they acquired less energy over time. Additionally, we found that bears who used visual cues during foraging (flushing eider hens) were more successful at locating nests than bears who ignored them. Overall, this research has shown that polar bears can benefit by foraging on eider eggs opportunistically in the face of declining sea-ice conditions, but that the benefits of this declines as the summer progresses due to prey depletion.



The rate of energetic gain declines as the season progresses.

Behavioural and physiological responses of common eiders to polar bear predation risk

Erica Geldart (M.Sc. Student, University of Windsor with Dr. Christina Semeniuk and Dr. Oliver Love)

Break-up of sea ice in Northern Hudson Bay occurs earlier in the summer, creating a shortened seal-hunting season for polar bears. This has generated an increase in polar bears foraging on terrestrial food sources such as the eggs of ground nesting birds. Although polar bear presence at seabird colonies is not new, the frequency at which they are present at colonies and their predation of eggs has increased. To examine how common eiders (a colonial seaduck) and polar bears interact during these predation events, we are working at East Bay Island, NU. Here, the eider colony has experienced a dramatic increase in polar bear nest predation in recent years. Our goal is to assess and measure physiological and behavioural responses or eiders during polar bear encounters.

To measure behavioural and physiological responses of common eiders to polar bears, we are combining trail camera videography at eider nests (2018-2019) and heart rate monitors placed in the nest (2019). The cameras allow us to assess how soon birds detect bears, their response (continue incubating or flush from the nest), how far away they move, and how long it takes them to return to resume incubation.

Pairing these behavioural decisions with heart rate responses will allow us to assess differences in individual responses to polar bears, and measure the amount of energy required to respond. By measuring these responses we will determine the degree to which they can assess risks. This work will provide insight into the ability of common eiders to adapt to indirect consequences of anthropogenic climate change.

Heart-rate recording (inset) of an incubating common eider hen (red circle) as a polar bear approaches.

Polar bear terresterial foraging behaviours during the ice-free season

Chelsea Frank (B.Sc. Student, University of Windsor with Dr. Christina Semeniuk)

Recent research has focused on polar bear terrestrial diets, feeding behaviours and their associated bioenergetics; however, general knowledge of the time budgets of polar bear terrestrial behaviour is still poorly understood. Given that most estimates of foraging effort are restricted to when observers are present, producing a 24-hour catalog of polar bear behaviours will allow us to generate better estimates of foraging effort and time allocation. Using passive, 24-hour recording cameras, we have begun to quantify polar bear terrestrial behaviours on East Bay Island, NU as they arrive on the island to forage on common eider eggs. From July 10-23 we placed trail cameras both on raised platforms (29 cameras), and near actively-incubating common eider nests (19 cameras). We collected over 100 minutes of bear foraging activity.

We categorized behavior into one of three groups (walking, eating and resting) and analysed the duration of each behavior accounting for bear body condition and general age. Bears visited the island consistently throughout the day, and while on the island, they spent most of their time walking. As the season progressed and the number of nests declined, the time that bears spent walking increased and the time they spent feeding declined. Neither bear condition nor age affected the proportion of time spent foraging. These findings will contribute to future research focused on the changing costs and benefits of polar bear foraging on eider eggs in a changing system.

Trail camera video stills from landscape-scale camera position (top) and ground eider-nest position (bottom).

PUBLICATIONS

Submitted Manuscripts

Anderson, C., H. G. Gilchrist, R. A. Ronconni, K. Slepr, D. Clark, D. Fifield, G. J. Robertson, and M. L. Mallory. Short and long distance migrants use similar migration strategies in North American Herring Gulls. Submitted to **Movement Ecology**.

Dey, C., C. A. D. Semeniuk, S. A. Iverson, and H. G. Gilchrist. Changes in the distribution of nesting Arctic seaducks are not strongly related to variation in polar bear presence. Submitted to **Arctic Science**.

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Hennin, H., C. Dey, J. Bety, H. G. Gilchrist, P. Legagneux,T. D. Williams, and O. P. Love. 2018. Higher rates of pre-breeding condition gain positively impacts clutch size: A mechanistic test of the condition-dependent individual optimization model. **Functional Ecology** 32: 2019-2028.

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Completed manuscripts – soon to be submitted

Clyde, N., M. R. Forbes, J. Bump, and H. G. Gilchrist. Nesting eider ducks bio-vector substantial marine nutrient subsidies to otherwise nutrient-impoverished Arctic islands.

Jagielski, P. J., C. J. Dey, H. G. Gilchrist, E. S. Richardson, and D. A. D. Semeniuk. Polar bear foraging on common eider eggs: Estimating the energetic consequences of a climate-mediated behavioural shift.

POPULAR PRESS

Dey, C. 2018. A bear in the henhouse. Article in Canadian Geographic. February 15, 2018. https://www.canadiangeographic.ca/article/bear-henhouse

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STUDENTS AND POST DOCS

Dr. Cody Dey

(Post-Doctoral Fellow, University of Windsor) is using computer simulation models to quantify and predict the consequences of climate induced changes to polar bear and common eider predator-prey relationships (Liber Ero Fellow).

Rolanda Steenweg

(Ph.D. 2014-2019; Dalhousie University) is assessing the impact of over-wintering carry-over effects on common eider males and the potential downstream consequences for female reproduction (Natural Sciences and Engineering Research Council of Canada Scholarship).

Patrick Jagelski

(M.Sc. 2017-2019; University of Windsor) is working to quantify polar bear optimal foraging strategies and energetics using behavioural data and computer simulation models (Natural Sciences and Engineering Research Council of Canada Scholarship Mitacs scholarship).

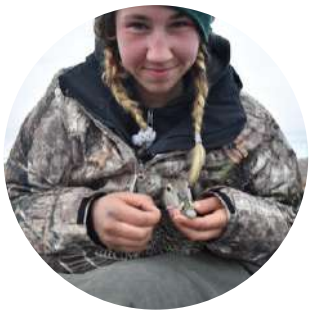
Kyle Parkinson

(M.Sc. 2017-2019, University of Windsor) is examining climate change resiliency among common eiders by analyzing their foraging decisions at multiple scales in the circumpolar Arctic (Ontario Graduate Scholarship).

Russell Turner

(M.Sc. 2017-2019, Queen's University) is researching the genetic structure of common eider populations in North America (Arthur B. McDonald and TD Bank Finacial Group Graduate Fellowship awards).

Reyd Smith



(M.Sc. 2018-2020, University of Windsor) is examining the interactive effects of endocrine-disrupting chemicals and temperature on incubation behaviour of common eiders (Ontario Graduate Scholarships).

Erica Geldart

(M.Sc. 2018-2020, University of Windsor) is investigating the behavioural and physiological responses of an Arctic seabird to growing predation risk from polar bears (Natural Sciences and Engineering Research Council of Canada's Canada Graduate Scholarship).

Chelsea Frank

(B.Sc. 2019-2020, University of Windsor) is investigating the terrestrial foraging behavior of polar bears (University of Windsor Entrance Scholarship).

INUIT PARTICIPATION

Josiah Nakoolak

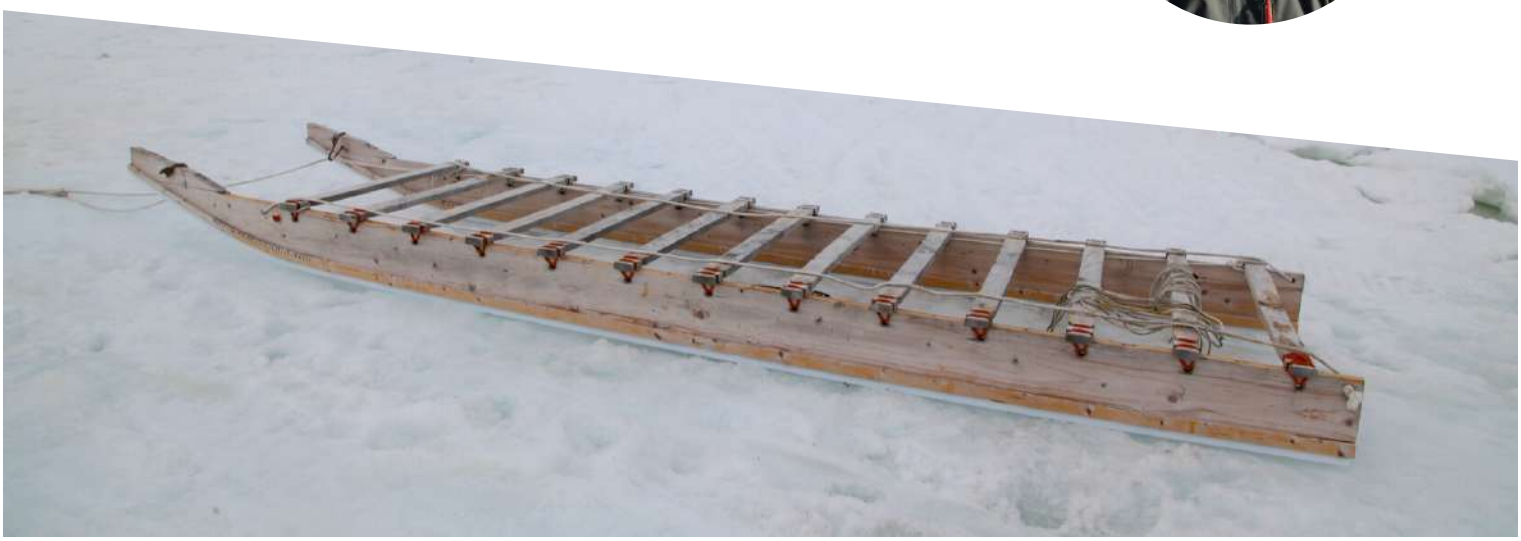
has worked with us as a guide and research assistant every year since 1997 and was recently awarded the Community Contribution to Research Award by the Northern Contaminants Program of the federal government. Josiah also operates as a mentor to our younger field workers.

Jupie Angootealuk

has worked with us at East Bay since 2013. He is a highly effective team leader and has occupied critical research roles for the past 4 years.

Mark Eetuk

participated in the Inuit Field Training Program in 2018 and was recruited to East Bay Island for four weeks in late May/early June of 2019 to work as a research assistant.



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) leads the project together with Dr. Oliver Love (University of Windsor), Dr. Christina Semeniuk (University of Windsor), Dr. Joël Bêty (Université du Québec à Rimouski) and Dr. Evan Richardson (ECCC). The project coordinators in 2019 were Bronwyn Harkness and Holly Hennin (ECCC). Support in Coral Harbour was provided through the Aiviit HTO, and especially by Natasha Ottokie and Jupie Angootealuk.

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 2019 included Jupie Angootealuk, Christophe Boyer, Mark Eetuk, Erica Geldart, Grant Gilchrist, Bronwyn Harkness, Oliver Love, Josiah Nakoolak, Brandan Norman, Keenan Peddie, Lincoln Savi, Reyd Smith, and Russell Turner.

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