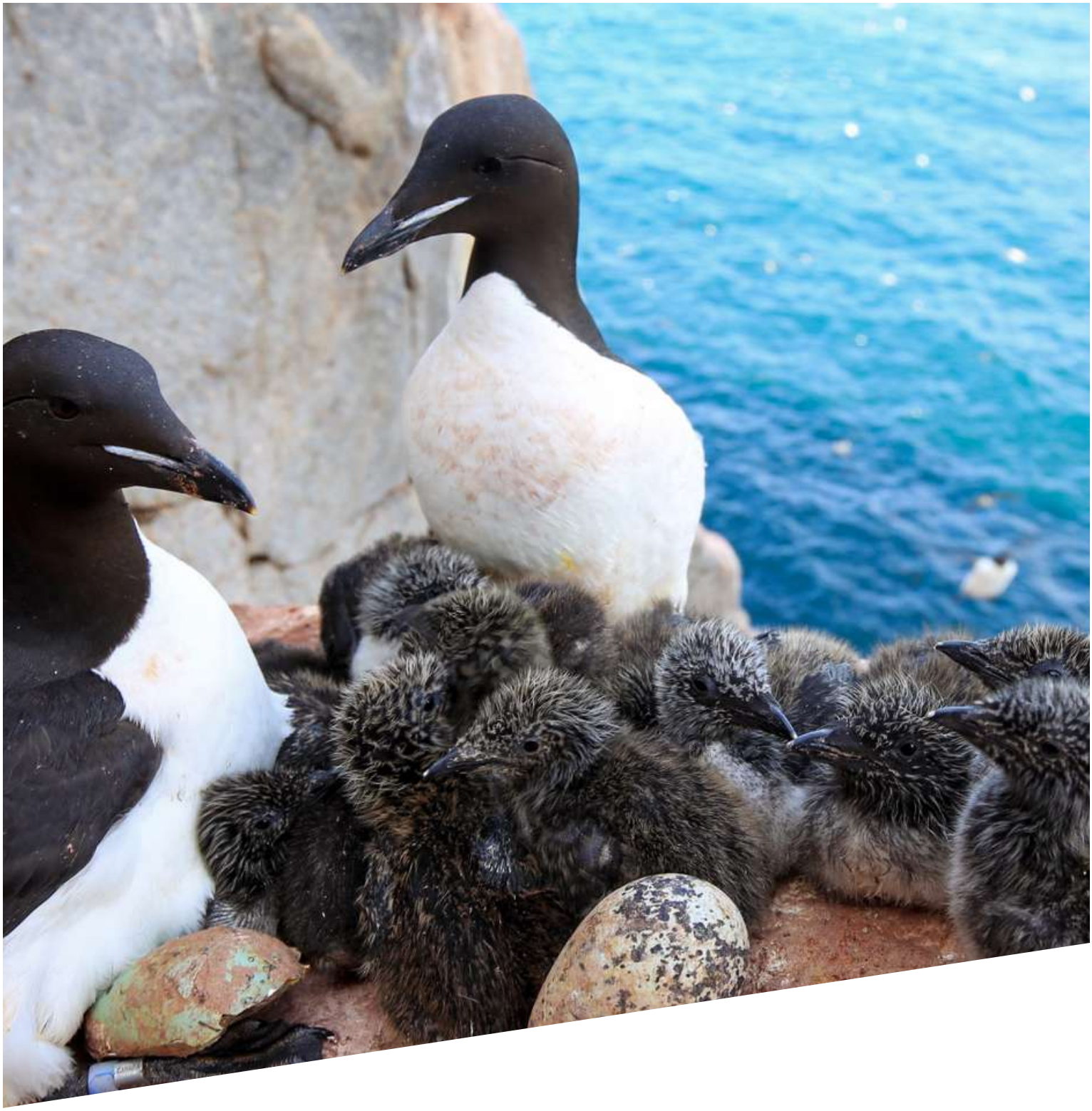


COATS ISLAND

2019 FIELD SEASON REPORT

ENVIRONMENT AND CLIMATE CHANGE CANADA

PROJECT OVERVIEW

Recent increases in resource development activities are projected to also increase shipping traffic in Canada's eastern Arctic marine regions. However there is often not enough information to properly assess the potential ecological impacts of year-round shipping lanes on marine wildlife. Our program's goal is to work in collaboration with industry partners to determine the distribution and abundance patterns of seabirds, in an effort to identify their key marine habitats and contribute to the development of protected areas.

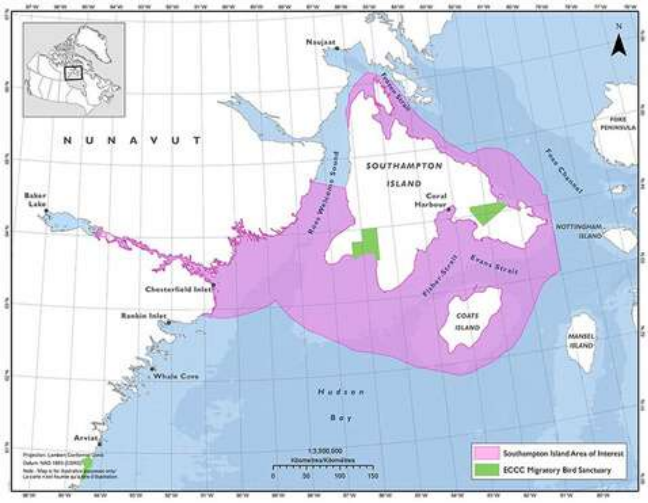
Research efforts in 2019 were concentrated at Coats Island where Environment and Climate Change Canada has been researching thick-billed murres since 1981. This long term data set, paired with new tracking technologies and physiological approaches, enables us to establish an ecological baseline to assess potential impacts of planned shipping activity and projected changes in climate on populations and individual seabirds in the region.

CONTRIBUTING TO MARINE PROTECTED AREAS

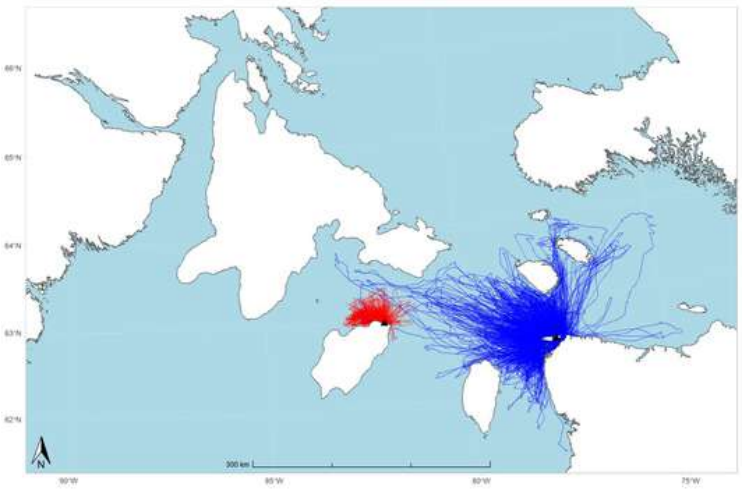
The formal protection of the Marine Environment is a national priority. In the Arctic, Government Departments and local communities are working together to identify areas worthy of protection. The spatial use of the ocean by wildlife is one element that considered when designing marine protected areas.

Our team is contributing seabird spatial tracking information that is 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.



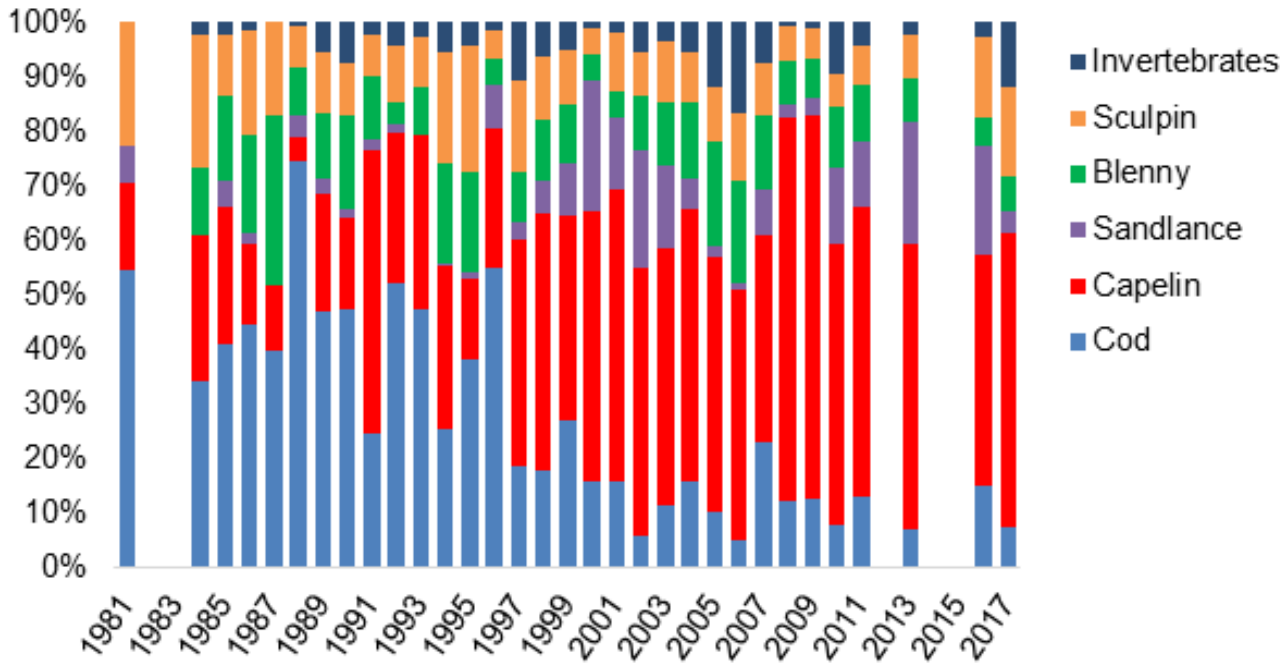
Thick-billed murre foraging tracks

LONG-TERM POPULATION MONITORING

We have been collecting data on the timing of breeding, nestling diet and growth, and population size of thick-billed murres at Coats Island since 1981. Beginning in 2010 the counts of birds have been lower than the long term average suggesting a decline. A similar decline has been observed at the Digges Island colony, 200 km to the east suggesting similar factors may be negatively influencing both of these thick-billed murre colonies in Hudson Strait.

One possible explanation is a change in diet. We have seen a shift in the main prey species brought to chicks at Coats Island, with capelin replacing Arctic cod as the primary prey species. We suspect this is due to reduced summer ice cover that began in the mid 90's. However, this has not affected nestling growth, suggesting that adult murres are able to compensate for the shifts in prey species.

With the change in prey, these novel conditions could potentially lead to more interspecific competition. For example, razorbills typically out-compete murres and they have now been observed at the Coats Island colony in years when sandlance were more abundant.



Thick-billed murres prey species over time at Coats Island.

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!).

Examining the physiologcial responses of Arctic marine predators to environmental change

Dr. Emily Choy (Post Doc, McGill University with Dr. Kyle Elliott)

The Arctic is undergoing multiple, concurrent changes which is having cascading effects on the species living within it. For instance, with warming temperatures and earlier timing of ice break-up, the distribution fish species is changing. This may impact the species that rely on them as prey. Indeed, with the Atlantification of Hudson Bay, the prey of thick-billed murres has shifted from predominately ice-associated Arctic cod to capelin, sandlance and other species. This may in turn alter the energy expenditure of the murres. We are using an experimental approach to determine the direct and indirect effects that a warming climate and shift in prey has on thick-billed murres.

To investigate the direct effects of increasing temperatures on murres, we are using open-flow respirometry and a heating chamber. We found that murres had a maximum upper limit of heat tolerance of 38°C. Given that there have been several reports in recent years of murres dying in the wild from dehydration on their nests during days with high temperatures, this research may help to predict how rising temperatures will affect heat-related deaths in the colony.

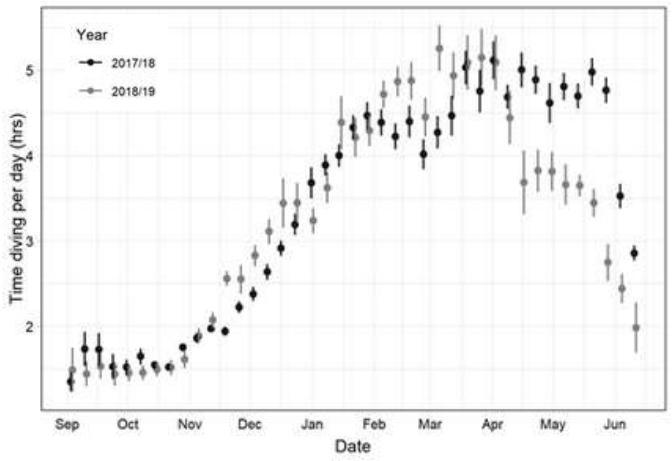
Emily Choy releases a thick-billed murre after sampling

Using heart rate as a proxy for metabolic rate, we are determining the indirect effects of diet shifts on thick-billed murre energy expenditure. Using heart-rate monitors from 7 birds, we found the average heart rate of murres was 272 beats per minute (bpm), but ranged from 44 to 689 bpm, suggesting high variability in the energy required for different behaviours. To measure the energy expenditure of specific behaviours in murres, we also attached accelerometers which track the speed of their movements to calculate energy use. These measurements are being paired with feeding observations of the murres themselves, to attribute differences in energy expenditures with foraging behaviour and prey selection.

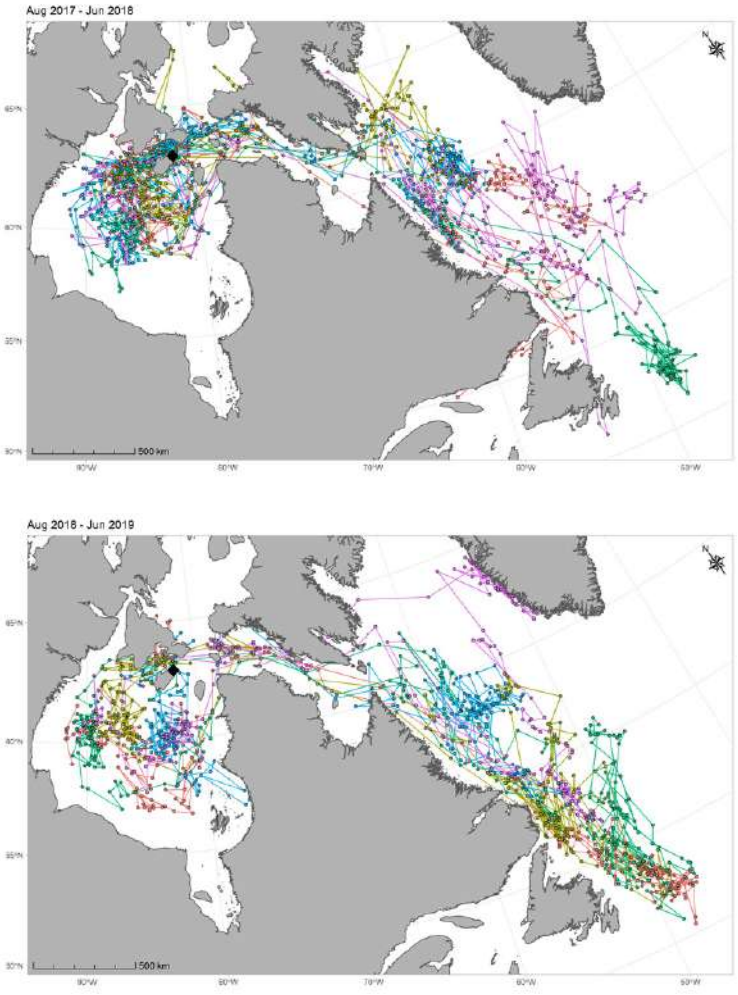
Distribution, habitat use and foraging behavoir of thick-billed murres

Allison Patterson (Ph.D. Candidate, McGill University with Dr. Kyle Elliott)

We have been using small biologgers to track the year-round movements and behaviour of thick-billled murres from Coats Island. In 2019, we retrieved 31 of these loggers from murres and since 2017 we have tracked 63 murres during the non-breeding season. With these data we can see where murres from Coats island go during fall, winter, and spring, and also what the birds are doing in these different regions and seasons. This information will be used to help identify and protect important marine habitat for this species.



Time diving per day (in hrs) between Feb. and Apr. Birds spend nearly all daylight hours in Feb. diving.



Winter movements of ten murres tracked from Coast Island, NU, between August 2017 and June 2019.

Effects of climate on the timing of breeding in thick-billed murres

Shannon Whelan (Ph.D. Candidate, McGill University with Dr. Kyle Elliott)

Across the globe, climate change is advancing the timing of spring events. Many plants and animals are adjusting to warming spring conditions by breeding earlier. However, not all species, populations, or individuals are advancing at the same rate. For example, species that respond directly to temperature (e.g. invertebrates) might adjust reproduction quickly to match environmental change, but predators such as seabirds may be slower to react because of the time associated with arriving to the breeding colony, establishing a nest site, and building reserves to lay an egg. This can result in a mismatch within food webs and therefore a mismatch between energy needs of breeding seabirds and the emergence of their prey. In sub-Arctic waters, sea-surface temperatures are known to be rising, and sea-ice break ups are advancing. This may in turn change food availability and shift the timing of breeding of seabirds.

A thick-billed murre returning from a foraging trip with a capelin fish.

For sea-ice dependent thick-billed murres, these advances in spring climate could shift the timing of reproduction and reproductive success. To test this prediction, we used long-term (since 1981), individual-based datasets of thick-billed murres breeding at Coats Island, NU. We tested whether climate factors that vary annually (e.g., ambient temperature, snow-depth, sea-ice concentration, sea-surface temperature) predicted annual variation in laying dates.

Preliminary results suggest that murres lay their eggs about 0.13 days earlier for every day that sea-ice break-up advances, indicating that they may be able to keep up with environmental change. We will begin analyses to determine whether the rate an individual advances its laying date influences breeding success.

Determining foraging success of thick-billed murres using GPS tracking and energetic physiology

Alyssa Eby (M.Sc. Student, University of Windsor with Dr. Oliver Love)

We are determining whether murres exhibit flexible foraging strategies in response to environmental variability and which foraging strategies are the most successful. We deployed GPS accelerometers throughout the breeding season at Coats Island, NU in 2018 (64 units during incubation) and 2019 (70 units during incubation and 72 units during chick-rearing).

Foraging tracks from an incubating female murre in early July 2018 (blue) and 2019 (red).

A GPS transmitter affixed to a thick-billed murre.

From GPS accelerometers, we can extract foraging metrics, including maximum distance birds have flown from the colony, total distance travelled, trip duration, and location of foraging bouts to determine the level of foraging flexibility and effort exhibited by murres. To determine the foraging success of trips, we also collected blood samples from murres before and after GPS deployments. These samples allowed us to assess an individual's energetic state using hormones (baseline corticosterone) and energetic metabolites (non-esterified fatty acids, beta-hydroxybutyrate, and triglycerides).

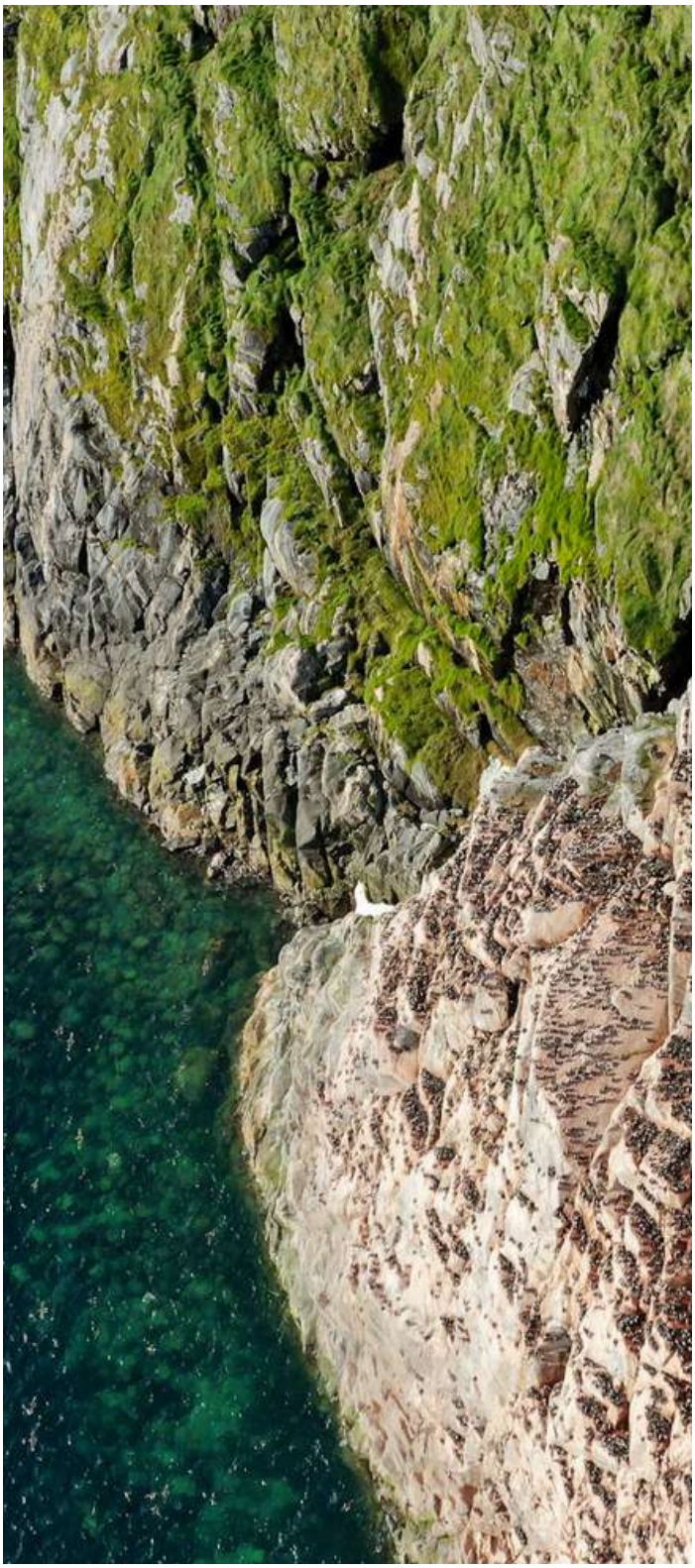
Finally, to quantify inter-annual environmental variability, we measured sea ice extent weekly throughout the breeding period (June to August) using Canadian Sea Ice Service maps from 2018 and 2019. By combining environmental variables with foraging ecology and energetic physiology, we are gaining insights into the conditions an individual is experiencing while foraging and what may be driving changes in fin their foraging behaviour over time. We can then use this information to predict variation in seabird breeding success and survival.

Using thick-billed murres as an indicator species of Arctic marine ecosystems

Émile Brisson-Curadeau (M.Sc., McGill University with Dr. Kyle Elliott)

Climate change is having many effects on the Arctic marine ecosystem, including the disturbance of the aquatic species and fish population dynamics. At the Coats Island thick-billed murre colony, we are researching the foraging behaviour of thick-billed murres to determine if they can act as indicators of ecosystem change. Specifically, we are trying to use thick-billed murre presence to predict where fish are located in the ocean, and then use murre foraging locations to learn about how distribution of fish is affected by climate change.

By combining feeding observations and the distribution of murres while foraging at sea, we created a map showing the distribution of prey caught by murres. Larger and fatter prey (bottom fish and Arctic cod) were found further from the colony than smaller prey (shrimp, sculpin, capelin). Also, some prey were caught consistently offshore (e.g., some species of bottom fish), while others were caught near the coast (e.g., other species of benthic fish including cod and sculpin). These results demonstrate that we can use the thick-billed murre to determine shifting prey distributions in a changing Arctic.

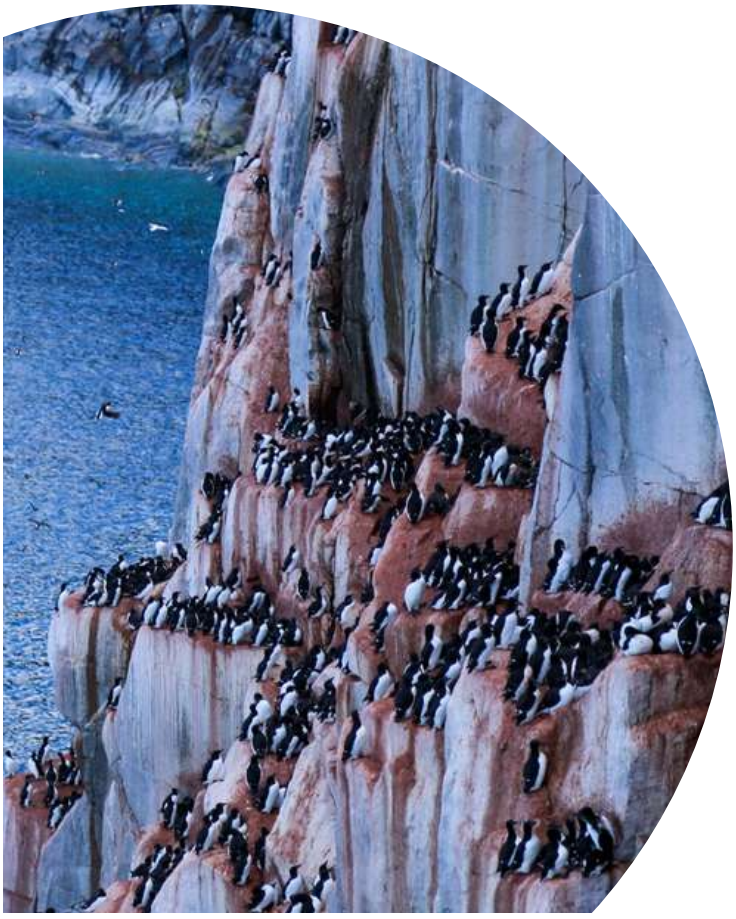


Links between gut bacterial communities and diet in thick-billed murres

Esteban Gongora (M.Sc., McGill University with Dr. Kyle Elliott)

The thick-billed murres nesting at Coats Island eat a variety of prey items. Some individual murres specialize on one particular prey item. This is known as "individual prey specialization" and occurs in many seabirds. Seabirds, including thick-billed murres at Coats Island, are often used to monitor contaminant levels in the ocean because they feed over large areas and return to their colonies where they can be easily sampled. Given that diet influences the accumulation of contaminants in wildlife, individual prey specialization should be taken into consideration when using wildlife as contaminant monitors.

Thick-billed murres returning from a foraging trip with capelin (left) and sculpin (right).



Diet also affects the type and amount of bacteria that live in the guts of animals, which might impact the health and the nutrition of the animal. We examined the interactions between thick-billed murres and gut bacteria to determine how these birds consume nutrients and accumulate mercury. These bacteria make mercury available for animals and affect bioaccumulation.

For the first time, we documented the bacteria that live in the gut of thick-billed murres, showing substantial differences among individuals, which may be unique to help them digest their individually specialized prey items. This research has helped us appreciate how microscopic organisms play an important role in the ecology of seabirds.

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Brisson-Curadeau, É. 2018. The Thick-billed Murre: A Bird of All Records. Magazine cover and article for Above & Beyond – Canada's Arctic Journal. April 30, 2018. http://arcticjournal.ca/featured/the-thick-billed-murre/

Brisson-Curadeau, É. 2018. Coats Island. Magazine article in "Up Here", edition of winter 2018.

STUDENTS AND POST DOCS

Dr. Emily Choy

(Post-Doctoral Fellow, McGill Univerity) is studying relationships between physiological strategies and foraging movements in thick-billed murres (Weston Foundation and Fonds Nature et Technologies Post Doctoral Fellow).

Thomas Lazarus

(Ph.D. 2015-2020; McGill University) is studying the at-sea distribution of thick-billed murres to map their energy intake hotspots at sea (Natural Sciences and Engineering Research Council of Canada Mitacs and CREATE scholarships).

Allison Patterson

(Ph.D. 2016-2020; McGill University) is studying the year-round distribution and foraging behaviour of thick-billed murres in relation to weather and sea ice conditions (Weston Foundation Scholarship; Natural Sciences and Engineering Research Council of Canada Mitacs and CREATE scholarships).

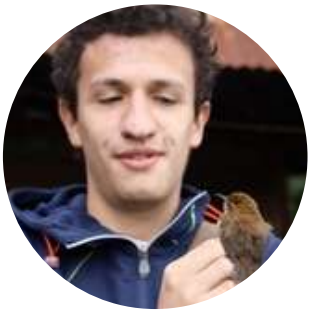
Shannon Whelan

(Ph.D. 2017-2021, McGill University) is studying individual variation in phenology and foraging behaviour in black-legged kittiwakes and thick-billed murres.

Émile Brisson-Curadeau

(M.Sc. 2016-2018, McGill University) is using “bio-logger” devices to examine thick-billed murre diet in relation to detailed foraging activity budgets.

Esteban Gongora



(M.Sc. 2016-2018, McGill University) is measuring fecal bacteria and prey DNA to see if individual specialization in diet is associated with a particular microbiome.

Alyssa Eby

(M.Sc. 2018-2020, University of Windsor) is studying the relationship between blood metabolites and movement behaviour in thick-billed murres (Weston Foundation and Ontario Graduate Scholarships).

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 Coats Island since 2013. He is a highly effective team leader and has occupied critical research roles for the past 4 years.

RESEARCH PARTNERS AND FINANCIAL SUPPORT

Our research at Coats Island is a combined effort of many people and organizations. Dr. Kyle Elliot (McGill University) leads the project together with Dr. Grant Gilchrist (Environment and Climate Change Canada (ECCC)). Dr. Kim Fernie (ECCC) co-leads a project on the effects of contaminants on the resilience to climate change in seabirds. Dr. Oliver Love (University of Windsor) is a key collaborator and co-leads projects involving physiology. We particularly thank Dr. Tony Gaston whose helpful insights continue to benefit the Coats Island program.

Remote research is logistically complicated and labour intensive. Our work would not be possible without our extensive crew of climbers, students, biologists and local guides. This year's Coats Island crew included Allison Patterson, Alyssa Eby, Shannon Wheelan, Sam Richard, Emily Choy, Sarah Poole, Russell Turner and Douglas Noblet. Logistical support and local expertise was provided by Jupie Angootealuk and Josiah Nakoolak from Coral Harbour. Pictures were provided by Douglas Noblet, Alyssa Eby, Russell Turner and Sarah Poole.

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, Canadian Wildlife Service, Baffinland Iron Mines Corporation, Carleton University, the PEW Charitable Trusts, Oceans North, Mitacs, Polar Knowledge Canada, ArcticNet, Polar Continental Shelf Program (PCSP), University of Windsor, McGill University, Natural Sciences and Engineering Research Council of Canada, Bird Studies Canada, Wildlife Habitat Canada Murre Fund, The Weston Foundation and the Northern Contaminants Program.

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