ENVIRONMENT AND CLIMATE CHANGE CANADA

ARCTIC SEABIRDS & ECOSYSTEMS

2023 FIELD SEASON AND RESEARCH REPORT

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.

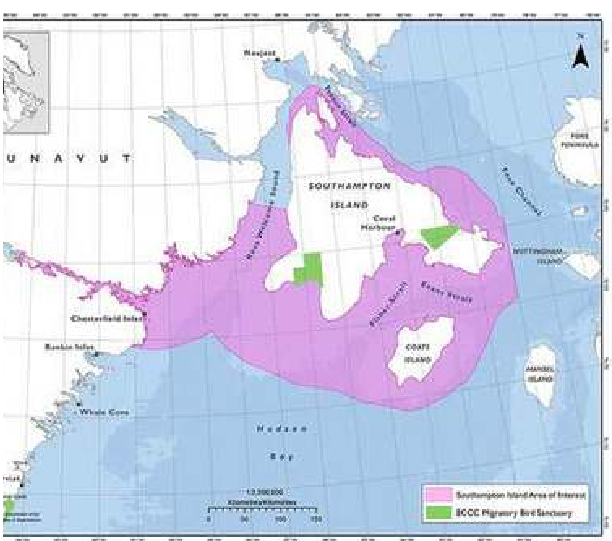
Research efforts in 2023 continued at Coats Island where Environment and Climate Change Canada has been researching thick-billed murres since 1981, and at Cape Graham Moore. These long term data sets, paired with new tracking technologies and physiological approaches, enables us to establish an ecological baseline in both the low and high Arcitc to assess potential impacts of planned shipping activity and projected changes in climate on seabird populations.

CONTRIBUTING TO MARINE PROTECTED AREAS

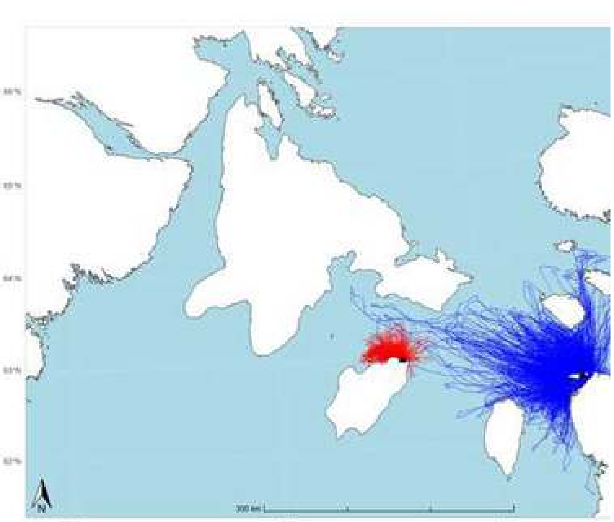
The formal protection of the marine environment is a national priority. In the Arctic, Government Departments and local communities are working together to identify areas worthy of protection. The spatial use of the ocean by wildlife is one element that is considered when designing marine protected areas.

As one example, our team is contributing seabird spatial tracking information which is being used in the design and assessment 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 93,000 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 beluga whales, and bowhead whales. It also contains walrus haul-out sites, polar bear dens, and marine habitats of seabirds. This proposed 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.



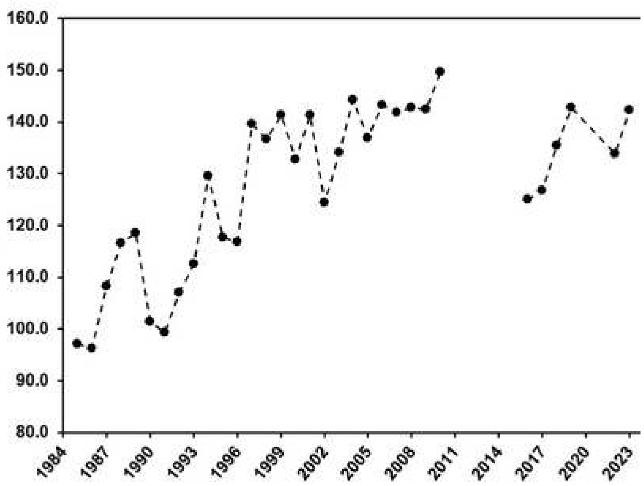
Proposed marine protected area.



Thick-billed murre foraging tracks

LONG-TERM POPULATION MONITORING

Thick-billed murres (*Uria lomvia*), known as akpa in Inuktitut, are the most abundant seabird in the Canadian Arctic, and one of the most abundant by mass in the global Arctic. Their meat is an important source of protein in winter in Newfoundland, Labrador and Nunatsiavut, and their eggs are an important source of late-spring protein for some communities. Moreover, murres are an ice-associated, Arctic species that act as important indicators for the entire Arctic ecosystem. This is particularly useful given that we are able to easily monitor population and reproductive trends in murres at nesting colonies. This research is difficult to achieve for many other Arctic animals, such as marine mammals and fish.

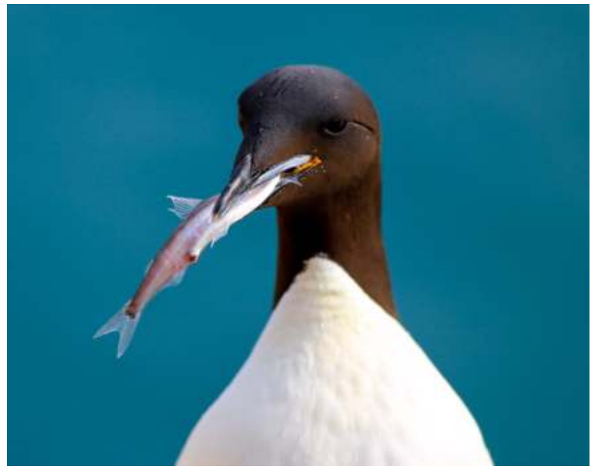


At the Coats Island murre colony, we have been recording long-term changes in the timing of breeding, nestling diet and growth, and population size since the 1980's. This long term data set allows us to piece together what may cause changes in population sizes. This is the only such ongoing study for any seabird in the Canadian Arctic, and the only one of its duration for thick-billed murres in the entire Arctic. Therefore, if we begin to see population declines in Canada, we are in a strong position to identify the causes, and to inform hunting quotas, shipping lanes, and other management protocols.

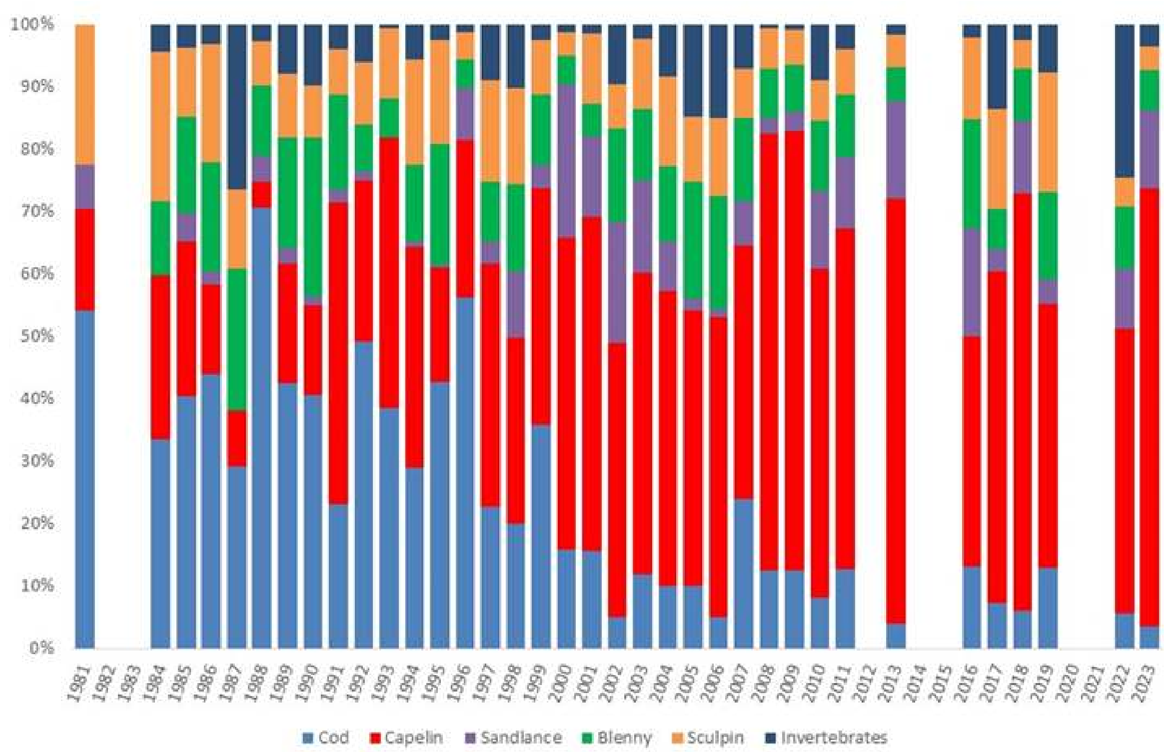
Counts of murres at Coats Island in 2016 and 2017 were lower than the long-term average, however counts in 2018, 2019, and 2022 are at comparable levels from 1997 to 2010. Counts since 2016 could indicate a slight downward population trend, or natural variation around a stable population mean since the late 1990s.

One possible explanation for population declines 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.



Chick diet in recent years showed high proportions of capelin, with 2023 having the highest proportion of Capelin ever recorded. Additionally, chick diet in 2022 showed the highest proportion of invertebrates.



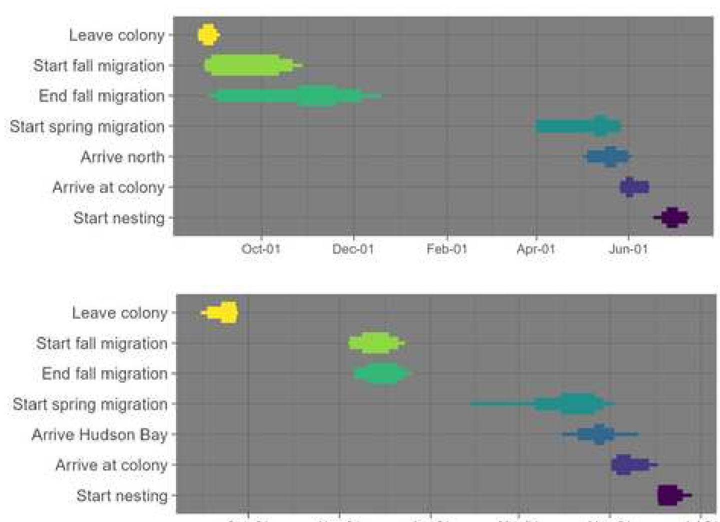
Thick-billed murre prey species delivered to chicks over time at Coats Island

YEAR-ROUND MOVEMENTS OF THICK-BILLED MURRES

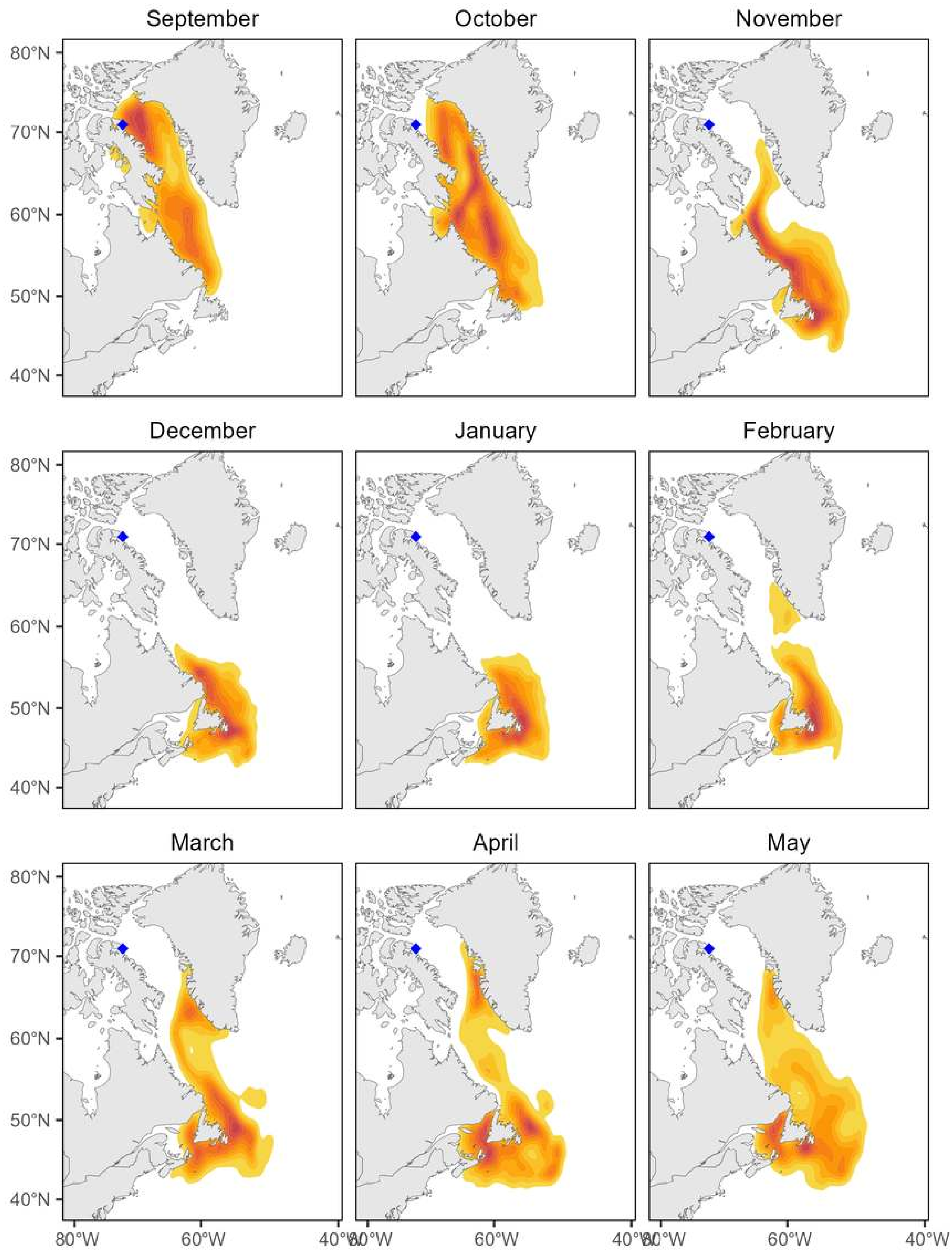
In collaboration with SeaTrack, the Arctic Council, and CWS-Quebec, we have deployed GLS loggers at both Cape Graham Moore and Coats Island. Using these loggers we are able to track murres at sea to identify key habitats used throughout the annual cycle, determine possible overlap with shipping activities in the region, and identify ecological differences between nesting colonies.

At Cape Graham Moore, birds left the colony in late August, either migrating away from the breeding range immediately, while others remained in the area of Lancaster Sound through September and October. Most birds had reached their wintering areas by the start of November; murres from this colony spent the winter south and west of Newfoundland on the southern Labrador Shelf (including the Grand Banks), on the Scotian Shelf, and in the Gulf of St Lawrence.

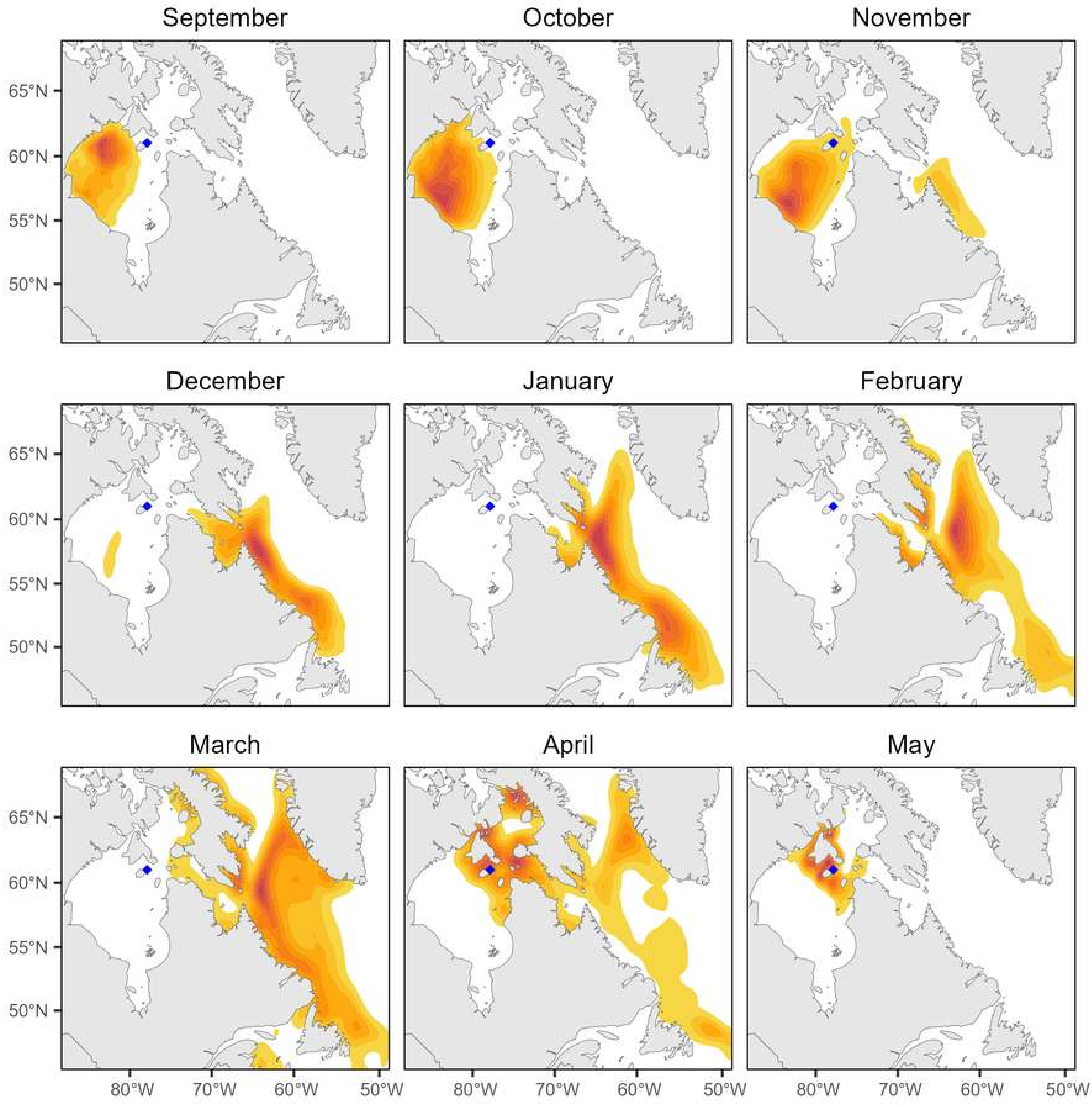
By contrast, birds at Coats Island left the colony in late August and remained in Hudson Bay through the feather moult in September to November. Fall migration began in November and December when birds migrated through Hudson Strait to reach the Northern Labrador Shelf. During winter, birds from Coats Island spread out within the Labrador Sea, the Eastern Scotian Shelf and the East Greenland Shelf.



Timing of key stages of the annual cycle for thick-billed murres from Cape Graham Moore (top) and Coats Island (bottom) tracked between 2023-2023. Thinnest lines show range of dates for all birds, medium thickness lines the dates show 90% of birds, and thickest lines show the dates for 50% of birds.



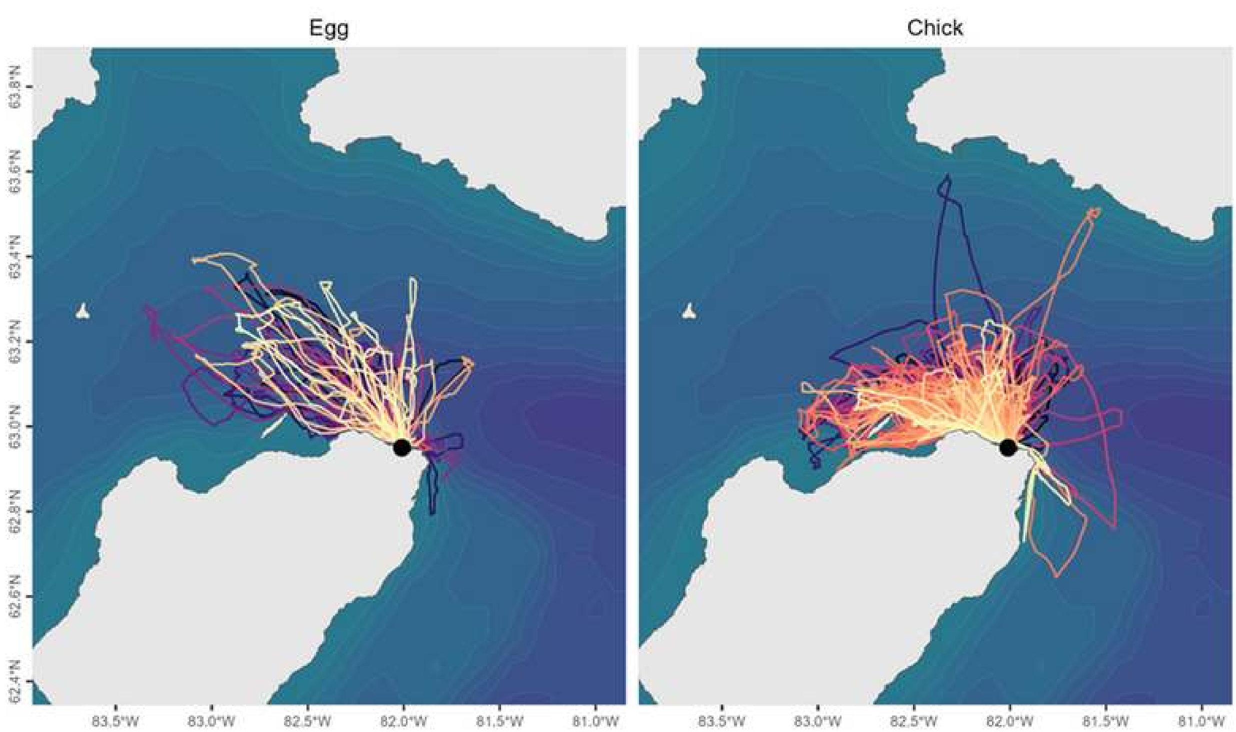
Non-breeding distribution of thick-billed murres (14 individuals) from ***Cape Graham Moore*** *(winter 2022-2023). Lighter colours indicate areas of highest use for each month. Blue diamond indicates the colony.*



*Non-breeding distribution of thick-billed murres (20 individuals) from **Coats Island** (winter of 2022-2023). Lighter colours indicate areas of highest use. Blue diamond indicates colony location.*

MOVEMENTS WHILE BREEDING

GPS tracking devices have been deployed at Coats Island as part of our long term monitoring and as part of several student projects. This tracking is important to characterize differences in habitat use through the breeding season, to inform the development of a marine protected area in the region, and to assess how overlap with shipping in the region may change in relation to breeding stages.



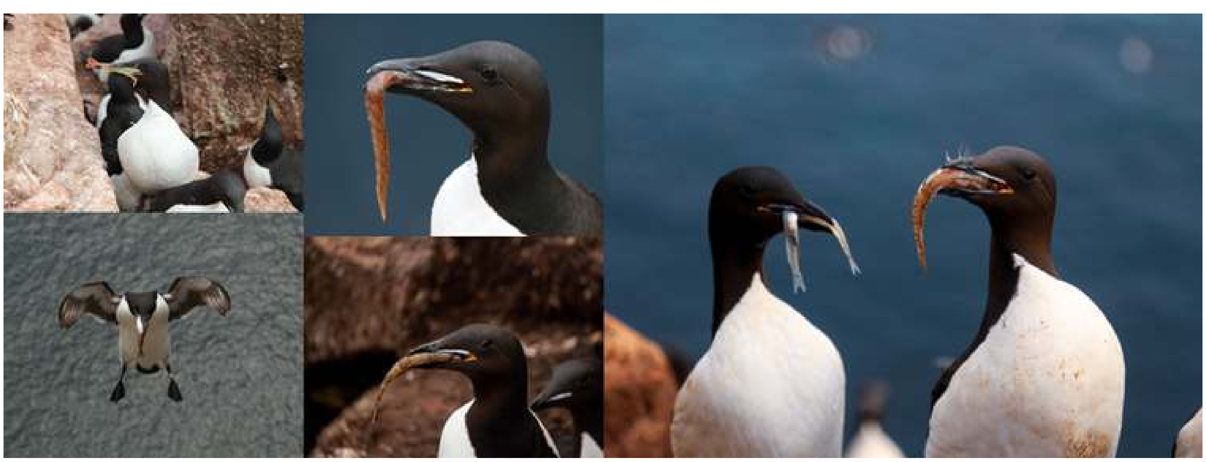
Deployments of GPS-accelerometers (AxyTrek™, Technosmart, 18 g, 1.9% of body mass and AxyTrek™, Technosmart, 9g, < 1% of body mass) at Coats Island during the summer 2023. We deployed 71 GPS during the incubation (left) and 95 during chick-rearing (right).

Examining Trophic Interactions in Changing Arctic Marine Ecosystems

Dr. Allison Patterson - Post-doctoral Fellow, University of Windsor with Dr. Oliver Love

Climate change is known to be warming ocean temperatures in the Arctic faster than anywhere in the world. The distribution and abundance of critical forage fish species like Arctic cod are strongly tied to ocean temperatures and sea ice. Many marine predators (fish, marine mammals, and seabirds) rely on Arctic cod as prey. However, shipping, commercial fishing, and other industrial activity in the Arctic is expected to increase as sea-ice cover declines, which could exaggerate the effects of climate change on marine predators.

Allison is using the feeding activity of seabirds to monitor changes in fish populations at remote sites in the Canadian Arctic. Vast distances and challenging ocean conditions in the Canadian Arctic make it difficult to monitor fish populations using traditional sampling methods. However, Arctic seabirds breed in huge colonies and these birds are 'sampling' fish every day when they fly to sea to feed themselves and their chicks. She is using tiny activity loggers to measure how much effort birds are expending to catch fish, and DNA metabarcoding of fecal samples to identify prey species they consume. With this information, Allison will determine if there are changes in the fish species available around murre colonies and if the relative abundance of forage fish species is changing in response to changing environmental conditions. This information can be used when planning for sustainable harvest of fisheries in the face of climate change and commercial activity in Canada's North.



Thick-billed murres bringing fish to feed chicks at the colony. Clockwise from top-left: shrimp, fish doctor, capelin and sculpin, daubed shanny, and Arctic cod.

Influence of Genetic Diversity and Immune Traits on Reproductive Success

Marianne Gousy-Leblanc - Ph. D. Candidate, McGill University with Dr. Kyle Elliott and Dr. Vicki Friesen

Understanding the genetic basis of fitness variation in a population is an important objective for ecologists. Yet the association between genetic diversity and fitness based on neutral loci are sometime very weak and inconsistent. Relationships vary among taxa due to the confounding effects of population demography and life history. However, fitness-diversity relationships are likely to be more consistent for genes known to influence phenotypic traits, such as immune-related genes—especially when considering breeding partners directly. Immune-related genes, such as Toll-like Receptors (TLRs), can be important genes for individual fitness as they are central components of the vertebrate immune system, and they play an essential role in resistance to parasites and disease.

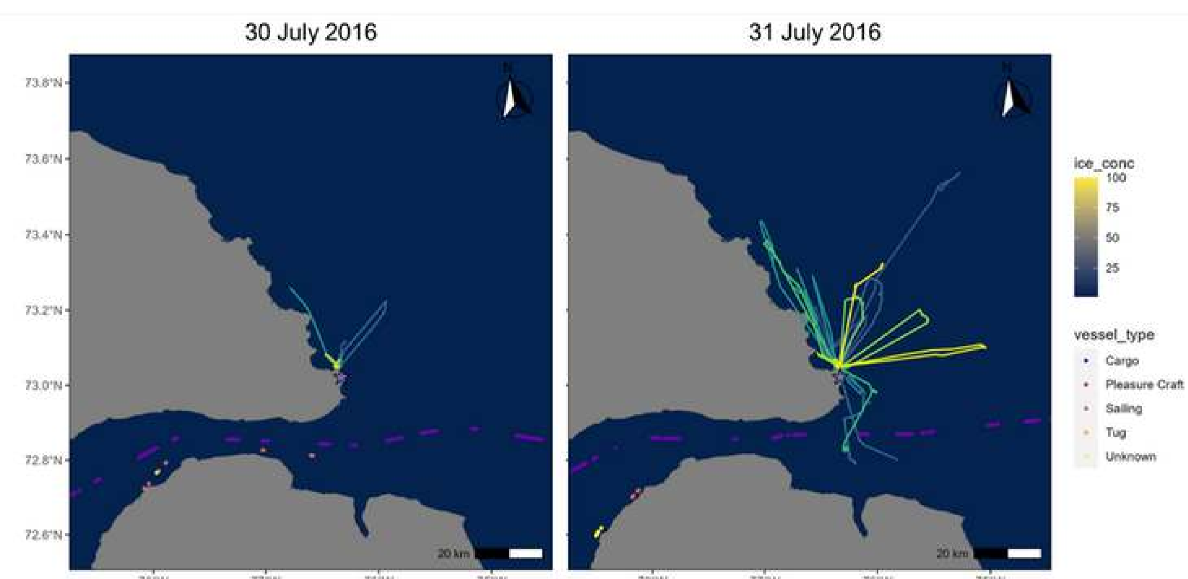
TLRs, have a direct effect on the survival and reproductive success of individuals. Heterozygosity at these genes is often correlated with high pathogen resistance, and some studies reported associations between immune genetic diversity and reproductive success. This will be particularly important in species with high parasite load, such as murres at Coats Island, where many birds fail breeding in years of high mosquito prevalence. Parental genetic similarity could also negatively impact reproductive success in monogamous species with long-term pair-bonds, as mate choice may strongly affect reproductive success throughout an individual's lifetime. Using long-term data (20 years) on breeding success of individuals and breeding pairs at Coats Island, Marianne will evaluate the relationships between both neutral genetic variation and functional variation (four TLRs loci) with reproductive success in thick-billed murres. This project will help to understand variation in breeding success and how individuals select their partner in long-lived species.

Influence of Sea Ice and Shipping on the Foraging Ecology of an Arctic Seabird

Alyssa Eby - Ph. D. Candidate, McGill University with Dr. Kyle Elliott and Dr. Grant Gilchrist

Climate change can result in sea ice loss in Arctic regions. This can directly impact ice-associated species including marine mammals and seabirds. Sea ice loss has also resulted in increased shipping in Arctic regions. Ships can create substantial underwater noise pollution which could negatively impact marine wildlife that communicate and/or forage in underwater soundscapes, such as marine mammals, seabirds, and fish. Thick-billed murres (*Uria lomvia*), an Arctic seabird, are likely to be impacted by changing ice conditions, as one of their prey items, Arctic cod (*Boreogadus saida*) is also associated with ice. Additionally, Arctic cod have been found to alter movements in the presence of ships, therefore shipping could influence murre foraging behaviour by affecting their prey.

This study aims to quantify the impacts of sea ice and shipping on thick-billed murres by combining high-resolution sea ice data from the Canadian Ice Service, shipping intensity measured from Automatic Identification System data on ships, and murre foraging movement measured from GPS data collected by Alyssa during the breeding season (July-August). Sea ice and shipping data will be overlaid with seabird movement data to relate ice concentration and shipping intensity at foraging locations. From this Alyssa can explore whether murres preferentially select foraging areas in higher sea ice concentration and/or away from high intensity ship traffic.

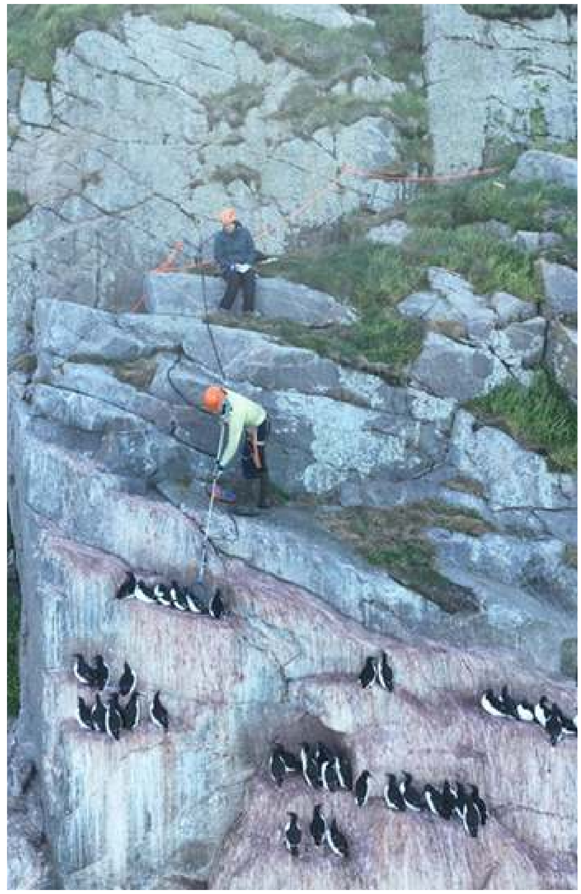


Thick-billed murre foraging trips (yellow, green, and blue lines) from Cape Graham Moore colony (purple star) on Bylot Island, NU. Shipping traffic (purple, pink, orange, and yellow dots), and sea ice concentration on July 30th and July 31st 2016

Uses of Thermosensitive PIT Tags in a Cold-Specialist Bird

Eliane Miranda - M. Sc., McGill University with Dr. Kyle Elliott and Dr. Emily Choy

With increasing temperatures in the Arctic, cold-adapted species such as murres may find it increasingly challenging to reproduce and survive. Eliane is investigating the deployment of thermosensitive PIT tagging as a viable method to monitor seabird reproduction and fitness. Like a regular PIT tag, they automatically identify an individual but new models also record internal temperature of the bird when activated. This technology provides accurate internal temperatures without being impacted by environmental conditions or by repeated handling. Eliane's work focusses on thick-billed murres that have a low maximum body temperature of 43.3°C, which sometimes results to mortality due to heat stress on days of 21°C, especially during incubation when they are under high energetic demands. High temperatures have historically caused breeding failures at the Coats Island Thick-billed Murre colony, and it is likely to have a growing impact with projected increases in temperatures. Using a combination of weather station data, thick-billed murre models with iButton loggers, and analyses of imagery, Eliane aims to determine factors that contribute to microclimate variation throughout the colony and influence internal body temperatures.



Reading RFID tags on thick-billed murres

A weather station set up on a blind

Dealing With the Heat: Assessing Heat Stress in an Arctic Seabird

Fred Tremblay - M. Sc., McGill University with Dr. Kyle Elliott and Dr. Emily Choy

Effects of climate change on Arctic endotherms have focused primarily on indirect (food web) effects. Because Arctic animals often have low heat dissipation capacity, the direct effect of warming (overheating) may impact them strongly. Fred used 3D printing, infrared imagery and surface temperature loggers, to develop 3D printed biophysical models to assess thick-billed murres' operative temperature (integrated temperature of the thermal environment as perceived by an individual) near their southern range limit at Coats Island, NU.

At this sub-Arctic colony, murres experience temperatures above 21.2 °C. They increase evaporative water loss rates, on 61% of the days on average (range : 24 – 85%) with their operative temperatures ranging from 5.5 °C to 46.5 °C even though ambient temperature never exceed 23.8 °C. Exposure to heat stress was not uniform across the colony. Murres experienced daily evaporative water loss ranging from 3.79 % to 4.61 % of body mass with EWL rates ranging from 1.29 g h-1 to 2.18 g h-1. She found that smaller individuals experienced higher rates of evaporative water loss. Overall, measures of operative temperature were consistently higher than ambient temperature, highlighting the need to consider operative temperature when studying heat stress. Fred showed that biophysical models are useful, non-invasive tools to study the effects of heat stress and can help predict how animals will react to Arctic warming.

Infrared imagery of a thick-billed murre

Top: Deploying 3D biophysical models to record operative temperature. Bottom: Cleaning 3D biophysical murre model.

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STUDENTS AND POST DOCS

Dr. Allison Patterson

(Post-doctoral Fellow 2022-2024, University of Windsor) is studying how marine climate influences trophic interactions between seabirds and their prey (Weston Family Award in Northern Research - Postdoctoral Level).

Alyssa Eby

(Ph.D. 2021-2025, McGill University) is studying the impacts of changing sea ice conditions and shipping on the foraging ecology and nutritional state of thick-billed murres (Ph.D. Weston Family Award in Northern Research).

Marianne Gousy-Leblanc

(Ph. D. 2021-2025, McGill University) is studying the importance of partnership and mate choice on reproductive success in thick-billed murres (Natural Sciences and Engineering Research Council of Canada).

STUDENTS AND POST DOCS

Éliane Miranda

(M. Sc. 2022-2024, McGill University) is examining heat stress in a cold adapted seabird (Social Sciences and Humanities Research Council - Canada Graduate Scholarship).

Fred Tremblay

(M. Sc. 2020-2022, McGill University) researched the impact of heat stress on Arctic seabirds (Natural Sciences and Engineering Research Council - Canada Graduate Scholarship).

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.

RESEARCH PARTNERS AND FINANCIAL SUPPORT

Our research at Coats Island is a combined effort of many people and organizations. Dr. Kyle Elliott (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 Seabird 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. The Coats Island crew included Josiah Nakoolak, Allison Patterson, Alyssa Eby, Marianne Gousy-Leblanc, Éliane Miranda, Kyle Elliott, Joshua Henschell, Sasha Yasinski, Alex Turmaine, Ana Morales and Isobel Phoebus. The Cape Graham Moore crew included Allison Patterson, Alyssa Eby, Brian Malloure, and Douglas Noblet. Photos are provided by Douglas Noblet, Alyssa Eby, Marianne Gousy-Leblanc and Eliane Miranda.

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

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