Marine Habitat Use by Thick-billed Murres

2018 Field Season Report

Project Overview

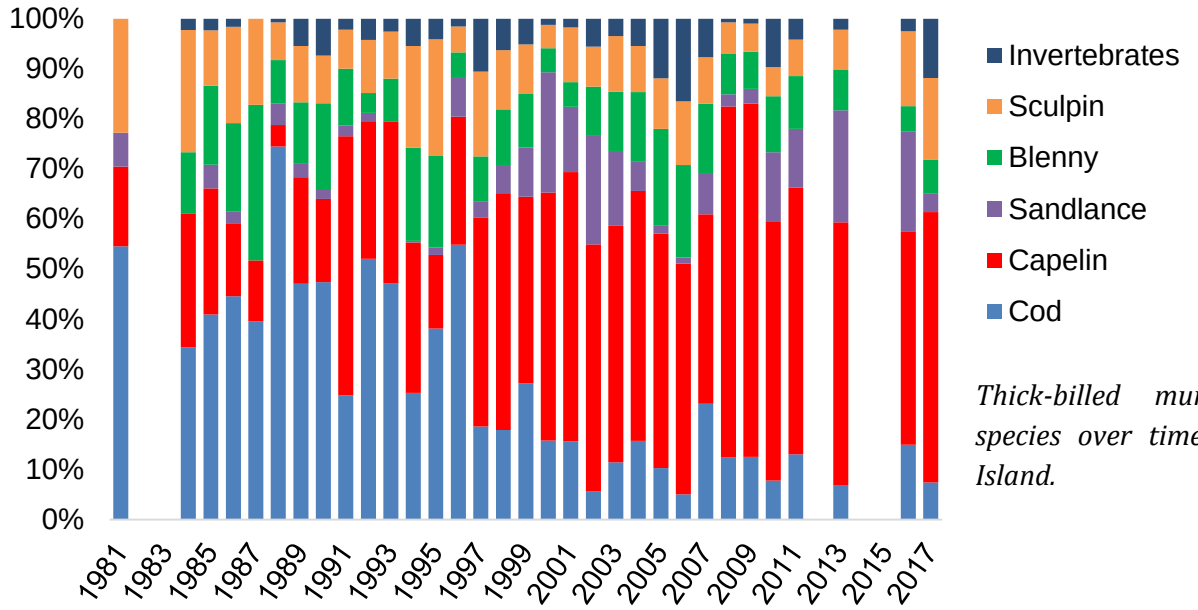
Recent increases in resource development activities are projected to increase shipping traffic in Canada's eastern Arctic marine regions. However there is often not enough information to properly assess potential ecological impacts of year-round shipping lanes on marine wildlife. Our goal is to work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

This year's sampling efforts were concentrated at Coats Island where Environment and Climate Change Canada has been recording the timing of breeding, reproductive success and diet of individual thick-billed murres on nesting study plots since 1981. This long term data set, together with new tracking technology and physiological approaches, is enabling us to establish an ecological baseline from which to assess potential future impacts of planned shipping activity and climate change on seabirds in the region.

Long Term Monitoring at Coats Island

Since Dr. Tony Gaston established the project in 1981, we have been collecting data on the timing of breeding, nestling diet and growth, and population size. Although the population had been growing since the start of annual censuses, since 2010 the counts have been lower than the long term average suggesting a decline. A similar decline is also being observed at the Digges Island colony, 200 km to the east. We therefore suspect that similar but as yet unknown factors may be negatively influencing both of these thick-billed murre colonies in Hudson Strait.

Documenting the type of prey that adults select to feed their chicks provides an indication of fish species that may be available to seabirds. 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.



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

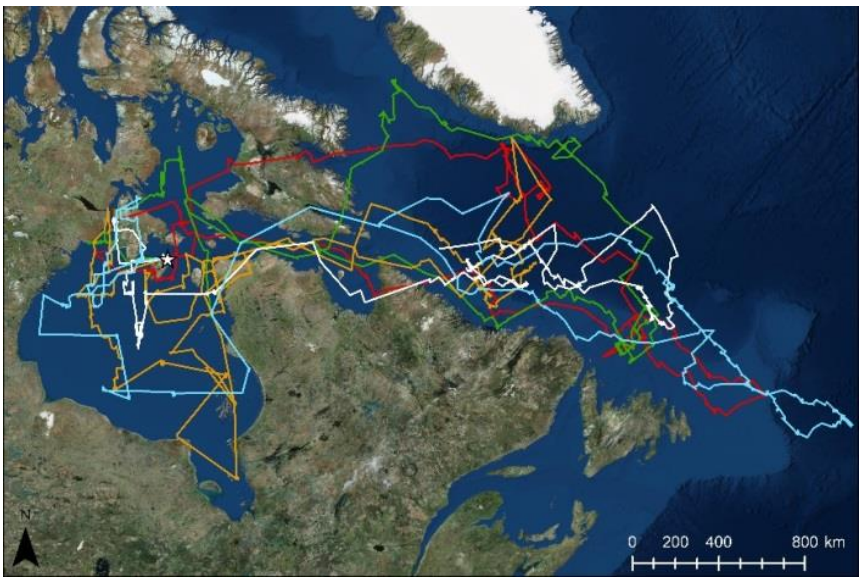
We found that reductions in summer sea ice were associated with fewer Arctic cod in chick diet. This shifting diet has not affected nestling growth, suggesting that adults are able to adjust their provisioning behaviour according to what is available in the ecosystem.

So far, reductions in summer sea ice have been limited to the low-Arctic. However, if the phenomenon keeps progressing northward, the patterns observed at Coats Island could also occur in the colonies found in mid and high-Arctic. With the shift of available resources 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 sand lance was more abundant.

Distribution, Habitat Use and Foraging Behaviour of Thick-billed Murres

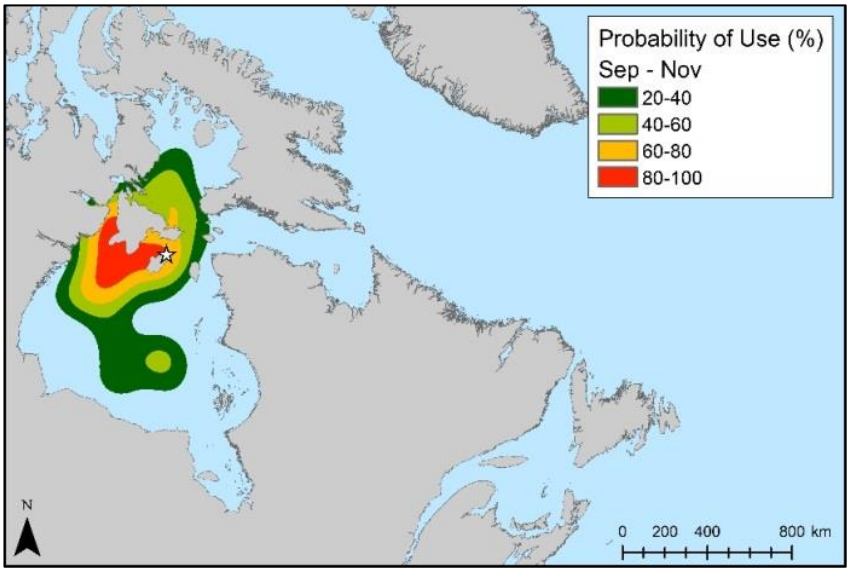
- Allison Patterson (Ph.D. candidate, McGill University)

In 2018, we retrieved 35 geolocators from thick-billed murres at Coats Island which were deployed on breeding murres in 2017. Each device was 3.6 cm long, weighed less than 6 g and was attached to a plastic metal band on the bird's leg. These geolocators recorded light levels, depth, temperature, and wet/dry state every 10 seconds for 12 months. Light levels can be used to estimate the location of tagged birds year-round. Tracking from multiple individuals can be combined to identify important areas for murres at different times of year.

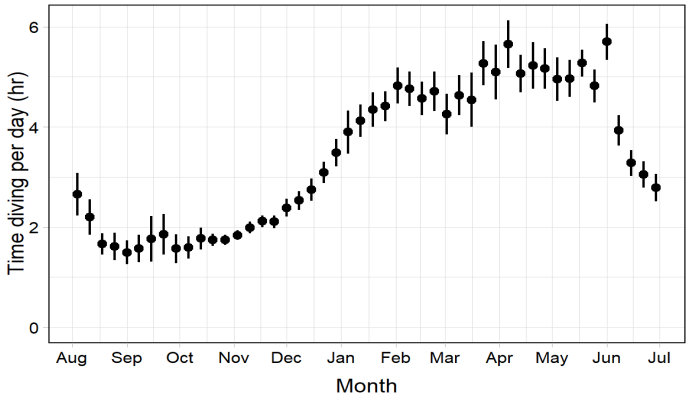


The year-round movements of five thick-billed murres from Coats Island, tracked using geolocators. Each colour represents the movements of an individual bird. The white star shows the murre colony at Coats Island, NU, where murres were tagged.

Expected probability of use by thick-billed murres from Coats Island during the post-breeding period (Sep-Nov), based on the five tracks shown in above figure. Red and orange show the areas most intensely used by murres between breeding and migration. The white star shows the murre colony at Coats Island, NU, where murres were tagged.



Additionally, measurements of depth, temperature, and wet/dry state can be used to quantify foraging murre behaviour throughout the year. This behavioural information will be combined with location estimates to identify critical non-breeding habitat for thick-billed murres and determine times of year and locations when murres are most vulnerable to environmental change and human activity. An additional 46 geolocators were put out on murres at Coats Island in 2018 to expand this year-round tracking project over multiple years.



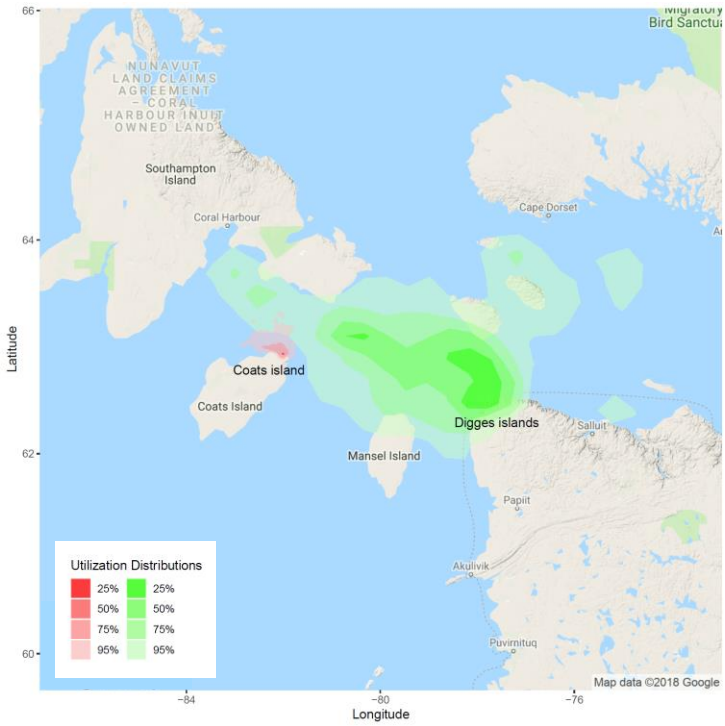
Average time spent diving per day for 31 thick-billed tracked from Aug 2017 to June 2018.

Foraging range of Thick-Billed Murres at Digges Island

- Thomas Lazarus (Ph.D. candidate, McGill University)

In 1963, Professor Philip Ashmole proposed that large seabird colonies could deplete forage fish in their vicinity, creating a "halo" of drastically reduced food availability near the colony. As a result, seabirds would be expected to increase their foraging range to access sustainable food sources over time, suggesting that foraging range depends not only on prey distribution but also on time of year and colony size. In other words, if Ashmole's halo hypothesis is correct, ecological impact assessments could be biased by the timing and duration of a study and/or by the size of the colony considered.

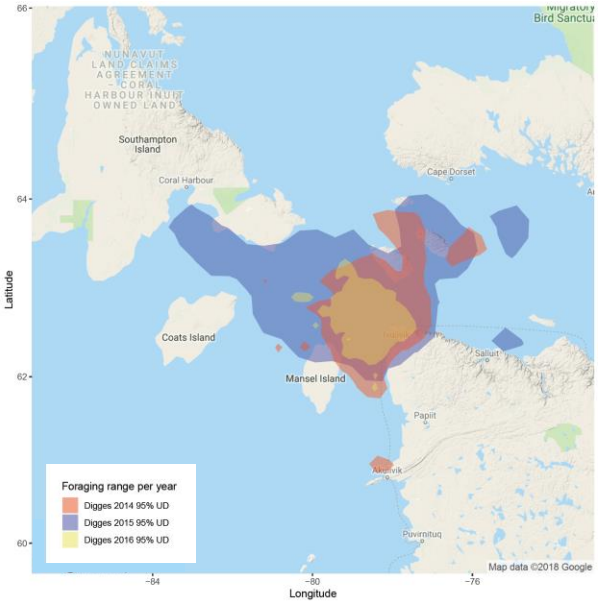
To test Ashmole's halo hypothesis, intense sampling effort on thick-billed murres was completed at both Coats Island and Digges Island seabird colonies. The thick-billed murre colony at Digges Island is about 10 times larger than the colony at Coats Island, allowing us to make comparisons between colonies of different sizes. From 2014 to 2016, we deployed over 250 GPS loggers on individual murres.



Estimated foraging range of Digges (green) and Coats (red) islands in 2015.

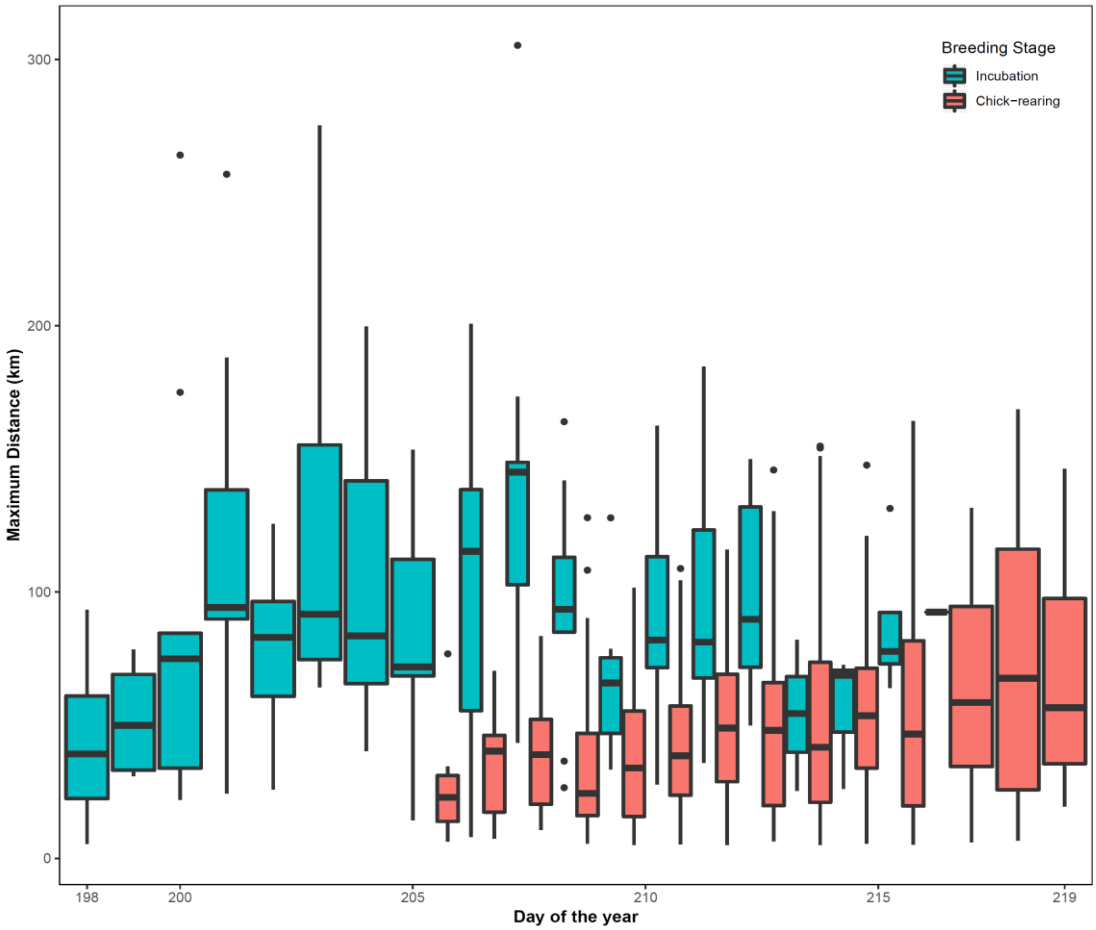
GPS data from 2015 support Ashmole's halo hypothesis: colony size seems to influence foraging range, creating a larger prey depletion halo. The Digges Island foraging range in 2015 was 35 times larger than that of Coats Island. One bird from Digges Island even foraged 300 km away from its colony, foraging within the Coats Island's foraging range. Since larger colonies forage further away from their colony, they also sample prey from a much larger area, suggesting that larger colonies should be selected for large-scale studies (*e.g.* studies on contaminants). In addition, the study area used for investigating local disturbances that could affect a seabird colony should be increased for larger colonies.

When considering data from other years, thick-billed murre foraging range appears to be highly variable. As such, ecological impact assessments should include data from several years to account for this high variability. So far, differences in ice conditions seem to be the best explanation of this variability. In the context of climate change, it appears that thick-billed murre foraging range could shrink with the decrease of sea ice coverage. This is concerning from a conservation point of view, as a small-scale localized disturbance (*i.e.* oil spill) could potentially impact one million birds if it occurs at a time when their foraging range is at its smallest.



Estimated foraging range of Digges from 2014 to 2016.

Data suggest that foraging range increases over the course of the breeding season, which supports the "progressive local depletion hypothesis" by Ashmole. The trend is consistent within incubation and chick-rearing, with the foraging range declining between the two breeding stages as adults have to return to the colony regularly to feed their chicks. As such, ecological impact assessments should also consider studying both incubation and chick-rearing.



Maximum distance from colony while foraging over time, separated by breeding stage.

Using energetic physiology to assess success of thick-billed murre foraging strategies

- Alyssa Eby (M.Sc. student, University of Windsor)

To determine flexibility in foraging strategies of thick-billed murres we deployed 60 GPS accelerometers during the incubation period. Blood samples and mass were also taken before and after GPS deployments to measure indicators of body condition. From the blood samples we will measure corticosterone (a stress hormone regulating energy expenditure), energetic metabolites (non-esterified fatty acids, beta-hydroxybutyrate, and triglycerides), and stable-isotopes to determine the success of each foraging trip and infer diet (prey items). Triglyceride levels are related to fat-deposition, whereas, non-esterified fatty acids and beta-hydroxybutyrate levels are related to fasting and energy expenditure. If a trip is successful, *i.e.* the individual successfully located and consumed prey, we expect to see low corticosterone levels, a decrease in non-esterified fatty acid and beta-hydroxybutyrate levels, and an increase in triglyceride levels and mass. If a foraging trip is less successful, *i.e.* the murre did not successfully locate and consume prey, we expect to see an increase in corticosterone, non-esterified fatty acid, and beta-hydroxybutyrate levels, and a decrease in triglyceride levels and body mass.

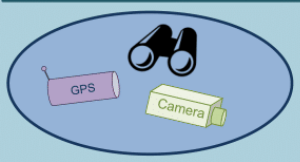
In addition to assessing success of foraging strategies and estimating diet, we will measure environmental conditions (sea ice concentration, sea surface temperature, and chlorophyll-a concentrations) throughout the season to determine how changing environmental conditions may impact foraging behaviour and fitness of thick-billed murres. In the upcoming year we plan to deploy GPS accelerometers during the incubation and chick-rearing period to investigate resource allocation, *i.e.* the amount of time spent foraging for self-feeding versus chick-feeding in breeding thick-billed murres.

The formation of foraging aggregations in a highly social seabird, the thick-billed murre (*Uria lomvia*), at small and large scales

1 The thick-billed murre is an extremely social seabird of the Arctic. It is an obligatory colonial breeder, with sometimes more than a million individuals gathering during breeding in close vicinity to each other.

2 While murres are also known to form aggregations at sea when foraging, it is unclear how and at what scale these groups are formed, nor do we know why murres remain social far from the colony.

3 We used direct observations as well as miniature data-loggers (GPS and camera) to learn more about these at-sea aggregations.

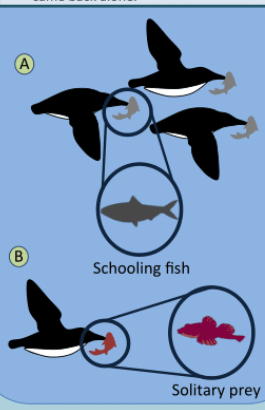


4 Revealed

Murres return to the colony to feed their chicks with a single prey item.

A Adults returning with a schooling fish came back in groups at the colony

B Those preying on solitary prey items came back alone.

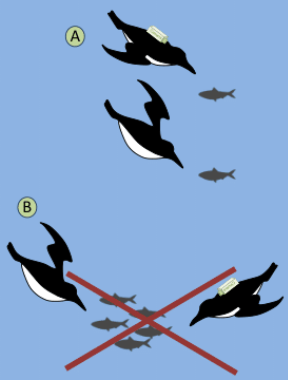


5 Camera

Revealed

A Murres often dove in close proximity of each other.

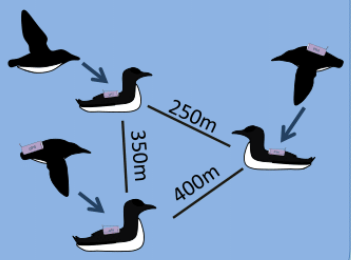
B Species like penguins attack and surround schools in synchrony with other members of the same species to increase capture efficiency. We did not observe this behaviour in murres.



6 GPS

Revealed

We detected large scale concentrations of murres in the ocean. Murres forming these type of aggregations did not depart from the colony at the same time, and therefore simply converged to a foraging hotspot.



Discussion

The formation of aggregations when preying on schooling fish suggests that there is a benefit for murres to forage in groups when feeding on this type of prey. As camera loggers did not detect direct cooperation, such as murres surrounding schools, it is likely that benefits rather come from an increased detection of prey when foraging in groups. At large scales, murres (or groups of murre) converge to the more productive areas. While murres might find these hotspots independently, it is plausible that they cue on the presence of other murres to locate the productive area.

For more info:

Brisson-Curadeau, É., Gilchrist, H. G., Takahashi, A., Dutilleul, P., & Elliott, K. H. (2018). The formation of foraging aggregations in a highly social seabird, the thick-billed murre (Uria lomvia), at small and large scales. *Marine Biology*, *165*(10), 170.

Link to the article:
https://rdcu.be/838Q

Canada Research Chair in Arctic Ecology

Recent Peer Reviewed Publications

Braune, B.M., Jacobs, S.R., and A.J. Gaston. 2018. Variation in organochlorine and mercury levels in first and replacement eggs of a single-egg clutch breeder, the thick-billed murre, at a breeding colony in the Canadian Arctic. *Science of the Total Environment* 610-611:462-468.

Brisson-Curadeau É, Bird, D., Burke, C., Fifield, D.A., Pace, P., Sherley, R.B., and K.H. Elliott. 2017. Seabird species vary in behavioural response to drone census. *Scientific Reports* 7:17884.

Brisson-Curadeau, É., Gilchrist, H.G., Takahashi, A., Dutilleul, P., and K.H. Elliott. 2018. The formation of foraging aggregations in a highly social seabird, the thick-billed murre (*Uria lomvia*), at small and large scales. *Marine Biology* 165:170.

Cunningham, J.T., Le Vaillant, M., Gaston, A.J., Ropert-Coudert, Y., Kato, A., Jacobs, S.R., and K.H. Elliott. 2017. Reduced activity in middle-aged thick-billed murres: evidence for age related trends in fine-scale foraging behaviour. *Animal Behaviour* 126:271-280.

Elliott, K.H., Linnebjerg, J.F., Burke, C., Gaston, A.J., Mosbech, A., Frederiksen, M., and F. Merkel. 2017. Variation in growth drives the duration of parental care: a test of Ydenberg's model. *American Naturalist* 189: 526-538.

Góngora, E., Braune, B.M., and K.H. Elliott. 2018. Nitrogen and sulfur isotopes predict variation in mercury levels in Arctic seabird prey. *Marine Pollution Bulletin* 135: 907-914.

Mallory, M.L., Gaston, A.J., Provencher, J.F., Wong, S.N.P., Anderson, C., Elliott, K.E., Gilchrist, H.G., Janssen, M., Lazarus, T., Patterson, A., Pirie-Dominix, L., and N.C. Spencer. 2018. Identifying key marine habitat sites for seabirds and sea ducks in the Canadian Arctic. *Environmental Reviews* (in press).

Mallory, M.L., Gilchrist, H.G., Janssen, M., Major H., Merkel, F., Provencher, J.F., and H. Strøm. 2018. Financial costs of conducting science in the Arctic: examples from seabird research. *Arctic Science* 4: 624-633.

Patterson, A., Gilchrist, H.G., Chivers, L., Hatch, S.A., and K.H. Elliott. 2018. A comparison of techniques for classifying behaviour from accelerometers for two species of seabird. *Ecology & Evolution* (in press).

Sorenson, G.H., Dey, C.J., Madligner, C.L., and O.P. Love. 2017. Effectiveness of baseline corticosterone as a monitoring tool for fitness: a meta-analysis in seabirds. *Oecologia* 183:353-365.

Wong, S., Gjerdrum, C., Gilchrist, H.G., and M. Mallory. 2018. Seasonal ship activity risk to seabirds in Hudson Strait and near Baffin Island, Canada. *Ocean and Coastal Management* 163:339-351.

Yurkowski, D.J., Auger-Méthé, M., Mallory, M.L., Wong, S.N.P., Gilchrist, H.G., Gaston, A.J., Gagnon, F., Derocher, A.E., Richardson, E., Lunn, N.J., Hussey, N.E., Marcoux, M., Togunov, R., Fisk, A.T., Harwood, L.A., Dietz, R., Rosing-Asvid, A., Born, E.W., Mosbech, A., Fort, J., Iacozza, J., Brown, T.M., Westdal, K.H., Orr, J., Leblanc, B., Kessel, S.T., Blanchfield, P., Davis, S., Maftei, M., Spencer, N., McFarlane-Tranquilla, L., Montevecchi, W.A., Bartzen, B., Dickson, D.L., Anderson, C., and S.H. Ferguson. Abundance and species diversity hotspots of tracked marine predators across the Arctic. *Diversity and Distributions* (in press).

Recent Popular Press

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.

2018 Student Contributions

Dr. Emily Choy (Post-Doctoral Fellow, McGill University) is studying relationships between physiological strategies and foraging movements in thick-billed murres to provide an energetics framework for understanding the movement patterns of marine predators in relation to shipping routes in Hudson Bay.

Dr. Sarah Wong (Post-Doctoral Fellow, Acadia University) is using at-sea surveys to identify seasonal areas of high seabird density in relation to current and future shipping activity in the waters of Hudson Strait and east Baffin Island.

Thomas Lazarus (Ph.D. 2015-2019, McGill University) is studying the at-sea distribution of thick-billed murres to map their energy intake hotspots at sea.

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.

Shannon Whelan (Ph.D. 2017 – 2021, McGill University) is studying individual variation in 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.

Alyssa Eby (MSc 2018-2020, University of Windsor) is studying the relationship between blood metabolites and movement behaviour in thick-billed murres.

Esteban Góngora (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.

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. We particularly thank Dr. Tony Gaston whose helpful insights continue to benefit the Coats Island program in numerous ways.

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, Redha Tabet, Sam Richard, Sarah Poole, and Kyle Elliot. Logistical support and local expertise was provided by Jupie Angootealuk and Josiah Nakoolak from Coral Harbour. Pictures were provided by Alyssa Eby 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, Baffinland Iron Mines Corporation, the PEW Charitable Trusts, Mitacs, Polar Knowledge Canada, ArcticNet, Polar Continental Shelf Program (PCSP), University of Windsor, McGill University, NSERC, Bird Studies Canada, Wildlife Habitat Canada Murre Fund and the Northern Contaminants Program.

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