

Final report to the Nova Scotia Habitat Conservation Fund
submitted June 2016

Project title: The Geography of Diet: population impacts of food available to a generalist species, the Herring Gull (*Larus argentatus*)

Principal applicant: Dr. Tony Diamond, Atlantic Lab for Avian Research, UNB-Fredericton
Project manager: Kate Shlepr, Atlantic Lab for Avian Research, UNB-Fredericton

1) Project goals and objectives

We wished to understand how anthropogenic food subsidies impact the Herring Gull population in the Bay of Fundy. Following a successful pilot study in 2014, we proposed work at two gull colonies influenced differently by human activity. Combining GPS tracking, diet analysis, and field observations, we were able to identify point sources of anthropogenic food that are important to gulls, providing fine-scale data to inform our gull management efforts.

The goal of this project was threefold: 1) to quantify the relative reliance of a key ecosystem indicator species on anthropogenic food sources at the two largest gull colonies in the Bay of Fundy; 2) to identify and map point sources of anthropogenic food subsidies and quantify their relative importance; and 3) to demonstrate mechanisms for direct and indirect ecosystem impacts of anthropogenic food inputs (i.e., prevention of loss of significant habitats, including offshore islands and wetlands; and prevention of loss of biodiversity, including priority bird species, species at risk, and other rare taxa). This project will also shed light on avenues to mitigate impacts through discussions with industrial sector representatives, evaluation of existing regulations and best management practice guidelines for relevant industries, and identification of policy gaps. Our ultimate aim is to provide clear, quantitative information to relevant industrial sectors and those wildlife managers responsible for maintaining ecosystem health and biodiversity in the Bay of Fundy.

Objectives:

- Map foraging sites and rank the relative contribution of specific prey sources to gull diets at the two largest Herring Gull colonies in the Maritimes.
- Provide quantitative evidence of direct and indirect colony-level impacts of anthropogenic food subsidies.
- Begin the process of applying insights gained from analysis by hosting a collaborative review of current regulations and best management practice guidelines for relevant industry sectors. Update best management practice guidelines and inform and enable efforts to address and mitigate effects of anthropogenic inputs into the Atlantic ecosystem.
- Pilot methods and streamline logistics to inform the development of a comprehensive study of the broader implications of anthropogenic food subsidies for ecosystem function and health, introducing human health considerations. Specifically, this would involve the examination of the role of gulls and other bird species as vectors of habitat changing nutrients, contaminants, and disease.

2) Work completed to-date

Fieldwork took place during the gulls' breeding season, May-Aug. 2015, at the two largest Herring Gull colonies in the Maritimes: Brier Island, NS and Kent Island, NB (Fig. 1).

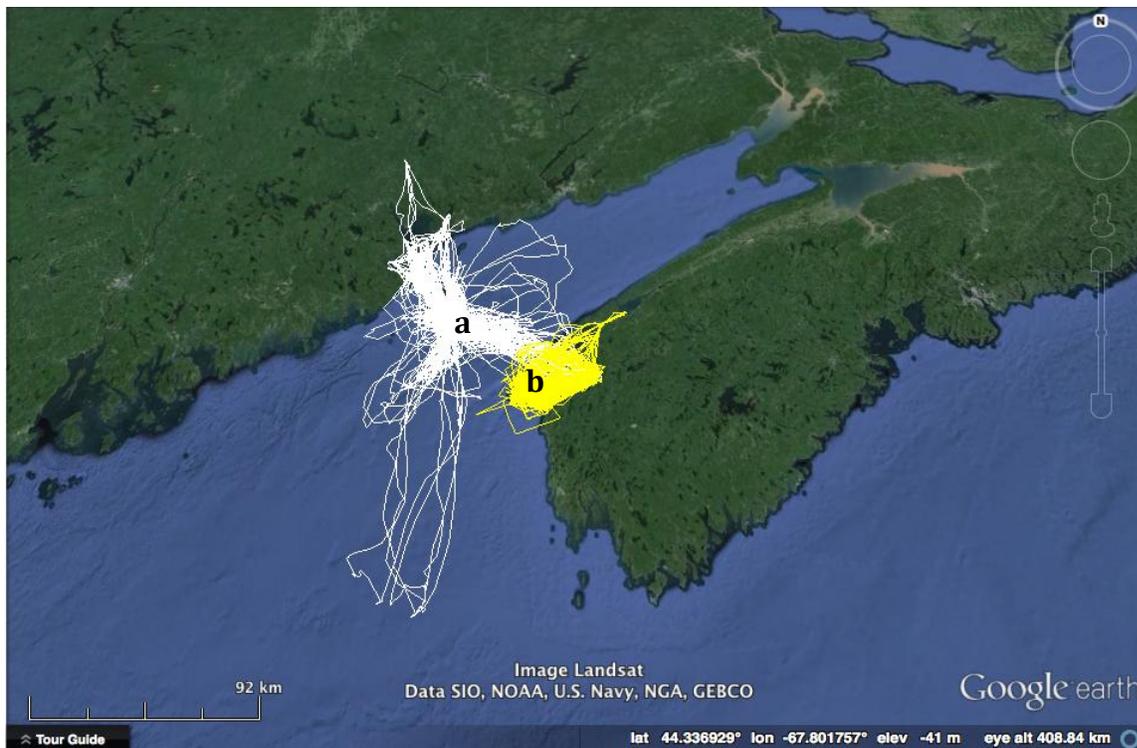


Figure 1. Gull movement during the breeding season by gulls nesting at our study locations, Kent Island, NB (colony centre=**a**) (n=11) and Brier Island, NS (colony centre=**b**) (n=19).

As planned, we used a variety of methods including GPS tracking, dietary isotope sampling, and nest monitoring for reproductive output. Achieved sample sizes listed by method are as follows:

	<u>Brier Is., NS</u>	<u>Kent Is., NB</u>
GPS tags deployed 2014-2015 (number of locations):	19 (129,000)	11 (53,000)
Individuals sampled for isotopes:	43	36
Number of nests monitored:	32	38

From Aug. 2015 to now (Jun. 2016) we have conducted lab analyses of the isotope samples, analyzed GPS tracking data, and discussed our findings with colleagues and collaborators. Shlepr will publish this project's findings as part of a Master's thesis by early 2017.

3) Results

Brier Island is near many fish processing plants and the highest per capita animal husbandry operations (including mink farms, where gulls are known to congregate) in the Maritimes. The 2014 pilot on Brier Island suggests most gulls nesting on Brier exploit these anthropogenic food sources throughout the breeding season.

We had initially predicted Kent Island to be outside the range of most anthropogenic sources of food, but discovered this not to be true—the aquaculture and fishing industries, as well as the Nova Scotia mink industry, provide a predictable source of sustenance to gulls nesting on Kent Island. For example, 5 of the 11 gulls tagged on Kent Island visited NS mink farms between May and July 2015. The tracking data also suggest that fishery discards and aquaculture pellets are a main source of food for some individuals, though we are waiting for data from the isotope lab to confirm this finding. Preliminary dietary isotope results confirm that Kent Island gulls have a predominantly marine-based diet as compared to the terrestrial-sourced food eaten by gulls from Brier Island (Fig. 2).

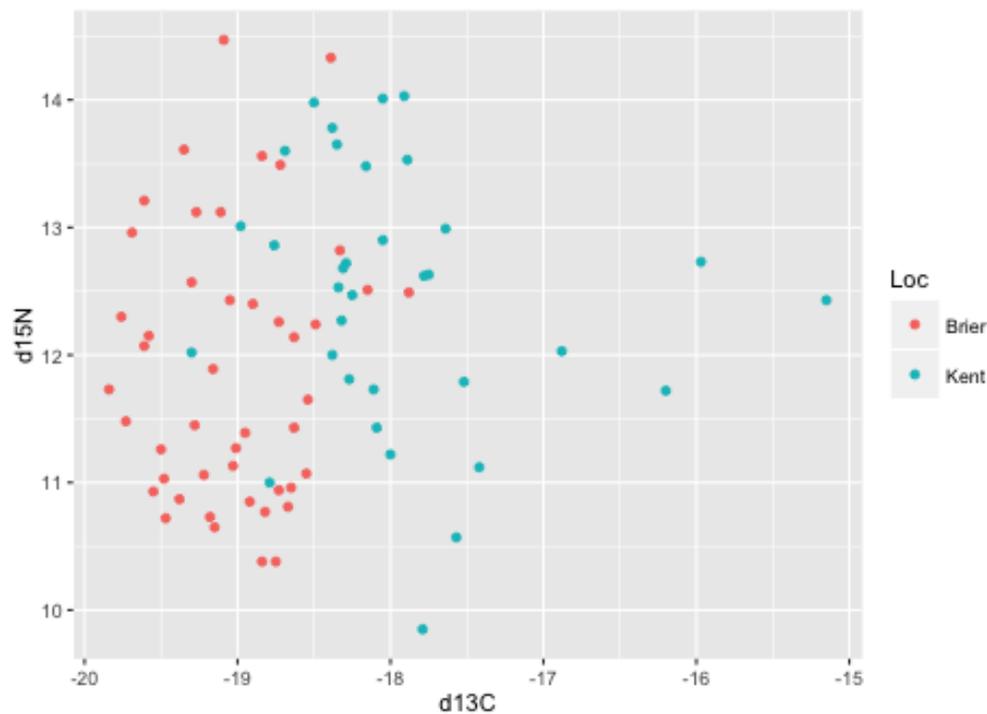
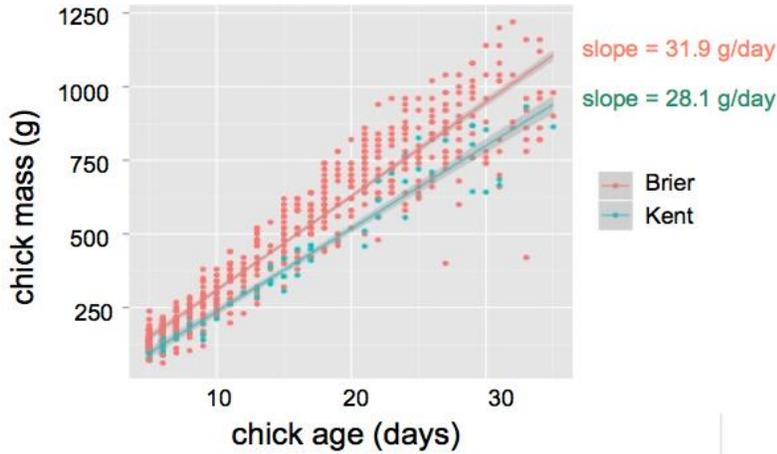
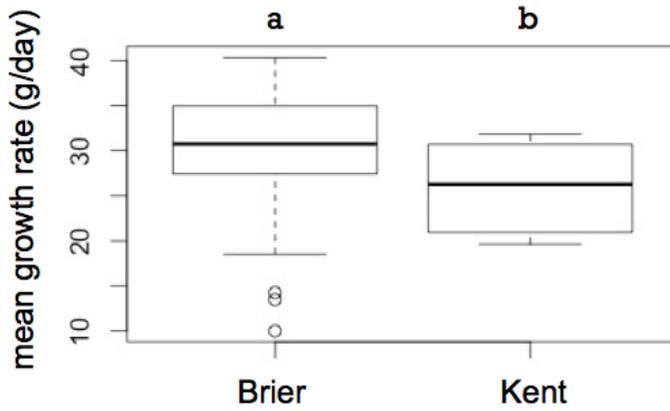


Figure 2. $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ ratios for samples of blood taken from Herring Gulls during incubation (May–Jun. 2015) from Brier Island, NS and Kent Island, NB. Low $\delta^{13}\text{C}$ values tend to indicate a more marine-based diet.

Alternative foraging strategy may have real evolutionary implications if differences in foraging cause differential reproductive outputs. Preliminary analysis of the 2015 nest monitoring data show that Brier Island gulls raise heavier, faster growing chicks than do breeders on Kent Island (Fig. 3). There is also limited evidence (statistically non-significant) that adult gulls from Brier Island are in slightly better physical condition (higher weight-to-size ratio) during incubation as compared to their Kent Island neighbours (Fig. 4).



a.



b.

Figure 3. Scatterplot (a) and boxplot (b) comparing the mean linear chick growth rate of the Brier Island and Kent Island colonies in 2015. Letters above bars indicate significant differences in mean growth rates (t-test; $p = 0.017$; $n_{\text{Brier}} = 80$, $n_{\text{Kent}} = 10$).

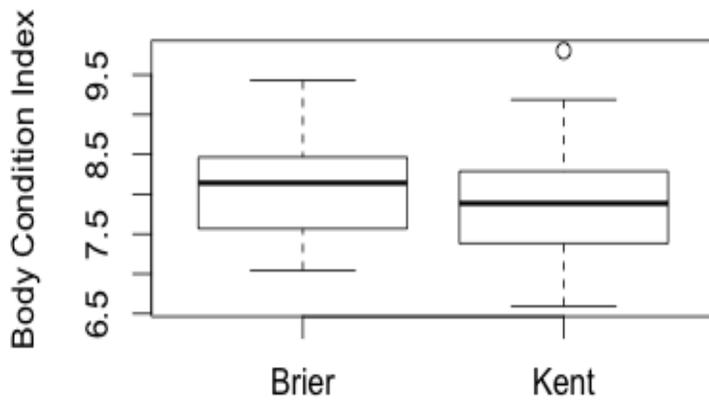


Figure 4. Body Condition Index (mass / head size) of adult Herring Gulls nesting on Brier Island, NS and Kent Island, NB (t-test; $p=0.177$; $n_{\text{Brier}}=43$, $n_{\text{Kent}}=31$).

4) Achievements and lessons learned

Objective: Map foraging sites and rank the relative contribution of specific prey sources to gull diets at the two largest Herring Gull colonies in the Maritimes; and;

Objective: Provide quantitative evidence of direct and indirect colony-level impacts of anthropogenic food subsidies.

On both Brier Island, NS and Kent Island, NB, we successfully issued GPS loggers, collected dietary isotope samples, and monitored nests as planned. We are currently analyzing these data, and will publish the results as part of Shlepr's Master's thesis in early 2017.

Objective: Begin the process of applying insights gained from analysis by hosting a collaborative review of current regulations and best management practice guidelines for relevant industry sectors. Update best management practice guidelines and inform and enable efforts to address and mitigate effects of anthropogenic inputs into the Atlantic ecosystem.

Our project involved a total of 27 collaborators from 16 government, academic, industry and non-profit organizations. Nearly half of these partnerships (n=11) were established during the course of this project (2015-2016). Most notably, we have made contact with a number of mink, fisheries, and animal waste industry representatives. These representatives are aware of our research, and in some cases have contributed the samples that made our project possible. We believe this type of working relationship will provide the foundation to host future conversations about best management practice guidelines.

We planned to share our research in a variety of venues in order to open discussion in the communities directly affected by our work, to educate up-and-coming professional biologists, and to communicate project results to the scientific community at-large. Support from NSHCF was formally acknowledged in each instance. Outreach events, presentations, and papers so far include:

Apr 2015. *The Geography of Diet: behavioural and population effects of food resources available to a generalist species, the Herring Gull.* UNB Graduate Research Conference, Fredericton, NB.

Jun 2015. Teaching day to Bowdoin College undergraduates. Kent Island, NB.

Aug 2015. Sights and Sounds of Brier Island—NCC community event. Westport, NS.

Aug 2015. *Is food a limiting factor for herring gulls in the Bay of Fundy?* Waterbird Society annual meeting, Bar Harbor, ME.

Oct 2015. *From natural history to ecology: Understanding gull declines in Atlantic Canada.* Presentation to UNB undergraduates, Fredericton, NB.

Oct 2015. *Spatio-temporal patterns of foraging by Herring Gulls at Brier Island, NS: Evidence of elevated reliance on anthropogenic food sources.* Avens Restoration Working Group, Wolfville, NS.

Oct 2015. *The ‘Gull Problem’ Revisited: Mink farms and other sources of anthropogenic food have attracted gulls to human populated areas in Atlantic Canada.* Atlantic Society of Fish and Wildlife Biologists annual meeting, Cape Breton, NS.

Jan 2016. *Foraging Ecology.* Atlantic Canada Seabird Working Group meeting, Sackville, NB.

Jun 2016. *A Dilemma in Environmental Ethics: What is the ecological role of the ‘nuisance’ Herring Gull in our Bay of Fundy?* Bay of Fundy Ecosystem Partnership workshop, Fredericton, NB.

In Press. Diamond, A. W. and K. R. Shlepr. *Big Meadow Gulls.* Annual Report of Research and Monitoring in the Greater Kejimikujik Ecosystem 2015. Mersey Tobeatic Research Institute, Kempt, NS.

Objective: Pilot methods and streamline logistics to inform the development of a comprehensive study of the broader implications of anthropogenic food subsidies for ecosystem function and health, introducing human health considerations. Specifically, this would involve the examination of the role of gulls and other bird species as vectors of habitat changing nutrients, contaminants, and disease.

We have built a strong relationship with individuals at Fern Hills Institute for Plant Conservation, Mersey Tobiatic Research Institute, the Canadian Wildlife Service, and others involved in the Big Meadow bog restoration on Brier Island, which is a project aimed at preserving and creating habitat for globally rare flora such as the Eastern Mountain Avens (*Geum peckii*). Restoration biologists believe that nutrient loading by the gulls has caused change in the bog in the last 50 years, and have expressed their support for continued research of the gulls on Brier Island. As a first step, Environment Canada and Fern Hills Institute supported contracts for Shlepr and one other to conduct gull monitoring on Brier Island in Summer 2016. The hope is to expand our understanding of the role that gulls play as vectors for nutrients, contaminants, and disease at both a local and a broad scale.

5) Recommendations for future work

--Mine the GPS data already collect. This project yielded 182,000 GPS locations from 30 individuals at two Herring Gull colonies. We have attempted to yield basic information about foraging behaviour and feeding destinations, but much is to be learned about nest attendance patterns, inter-sex difference in movement, temporal changes in foraging behaviour, and wintering strategies.

--Build on newly established partnerships with industry. We established contacts and opened conversation with a dozen industry representatives, but future work should share this project’s final results, and should seek solutions to problems in gull population management.

--Explore the evolutionary consequences of alternative foraging strategies. Our work draws a correlation between feeding habits and reproduction, but empirical testing is needed to elucidate this relationship. In particular, work should be done on the energetics of particular alternative foraging strategies.

--Use GPS data to inform the Big Meadow bog restoration on Brier Island. Restoration biologists predict that gulls will be displaced as a result of the bog restoration, but information about gull movement from the GPS loggers could help predict and then measure the actual outcome.