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# A geographical comparison of mercury in seabirds in the eastern Canadian Arctic

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ABSTRACT

Mercury (Hg) is a potentially toxic metal ubiquitous in arctic biota. Livers of adult thick-billed murres (*Uria lomvia*) and northern fulmars (*Fulmarus glacialis*) sampled from several locations in the eastern Canadian Arctic during 2007–2008 were analyzed for total Hg in order to assess geographical patterns. Thick-billed murres were collected from five colonies (Coats Island, Digges Island, Akpatok Island, Prince Leopold Island, Minarets) and northern fulmars from two colonies (Prince Leopold Island, Minarets). Murres at the two high Arctic colonies of Prince Leopold Island and the Minarets had significantly higher (two-fold) Hg concentrations (4.13 ± 019 μg $g^{-1}$ dw and 4.41 ± 0.33 μg $g^{-1}$ dw, respectively) than at the three low Arctic colonies (colony means of 1.62, 1.99 and 2.15 μg $g^{-1}$ dw). The differences in Hg concentrations observed between high and low Arctic murre colonies may reflect a combination of different source regions for Hg, as well as a recent dietary shift among low Arctic murres. Fulmars from Prince Leopold Island had significantly higher Hg levels (6.99 ± 1.13 μg $g^{-1}$ dw) than those from the Minarets (3.42 ± 0.53 μg $g^{-1}$ dw) which may reflect different Hg deposition and methylation patterns on both summer and winter feeding areas. Although there is no evidence linking Hg to adverse population effects in either murres or fulmars at the colonies sampled, levels in some Canadian Arctic marine birds have increased over recent decades and, therefore, continued monitoring, particularly of the high Arctic colonies, is warranted.



## 1. Introduction

Mercury (Hg) is a highly toxic element (Dietz et al., 2013; Wiener et al., 2003) which is widespread in arctic biota, and has been increasing in marine birds and mammals in some regions of the Canadian Arctic over the past several decades (Braune, 2007; Braune et al., 2005b; Rigét et al., 2011). Methylmercury biomagnifies through the food chain (Atwell et al., 1998; Campbell et al., 2005) making those species feeding at high trophic positions more vulnerable to dietary Hg exposure. Seabirds such as thick-billed murres (*Uria lomvia*) and northern fulmars (*Fulmarus glacialis*) feed at relatively high trophic positions in arctic marine food webs (Atwell et al., 1998; Hobson et al., 2002) making them good sentinel species for a spatial analysis of Hg in the Canadian Arctic.

A spatial survey of contaminants in Canadian Arctic seabirds carried out in 1993 included thick-billed murres from four locations in the Canadian Arctic: two in the high Arctic, and two in northern Hudson Bay. That survey found that Hg concentrations were significantly higher in eggs of murres from the two high Arctic colonies than in those from the two low Arctic colonies sampled (Braune et al., 2002). Murre eggs sampled in 2003 at two of those same colonies also found Hg levels at the high Arctic colony were twice as high as those at the low Arctic colony (Braune et al., 2006).

As part of a recent study assessing changes in diets of arctic marine birds (Mallory et al., 2010; Provencher et al., 2012), adult thick-billed murres and northern fulmars were collected from several locations in the eastern Canadian Arctic during 2007–2008. Livers from those birds were analyzed to determine geographical variation in total Hg, with the expectation that birds at higher latitudes would have higher concentrations of Hg in their livers compared with those breeding at colonies farther south.

## 2. Materials and methods

### 2.1. Sample collection

During 2007–2008, adult thick-billed murres were collected from waters adjacent to five colonies in the eastern Canadian Arctic: Coats Island (62°98′N, 82°00′W), Digges Island (62°33′N, 77°35′W), Akpatok Island (60°58′N, 68°08′W), Prince Leopold Island (74°02′N, 90°00′W), and Akpait (also known as the "Minarets") (67°00′N, 61°80′W) on eastern Baffin Island (Fig. 1). Adult northern fulmars were collected from two areas: Prince Leopold Island and waters adjacent to the breeding colonies at the Minarets and Cape Searle (67°15′N, 62°35′W), about 30 km apart. Sampling details can be found in Provencher et al. (2009,

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2012) and Mallory et al. (2010). All birds were collected during the breeding season with the murres from Coats Island and the Minarets collected in late July–early August 2007, and the rest of the birds collected in August 2008. Liver and muscle were removed from five male and five female birds from each species and sampling location (except Coats Island). At Coats Island, only female murres were sampled in adequate numbers ($n = 5$ females). Liver and muscle samples were shipped to the National Wildlife Research Centre (NWRC) in Ottawa, Ontario, where they were homogenized and stored at −40 °C. Livers were stored in acid-rinsed polyethylene vials for subsequent mercury analysis and muscle was stored in acetone–hexane rinsed glass vials for subsequent stable-nitrogen isotope analyses. All birds were taken under appropriate research and collection permits.

### 2.2. Mercury analysis

Mercury (Hg) analyses were carried out at NWRC, Ottawa, Ontario. Liver homogenates were individually freeze-dried, weighed into nickel combustion boats, and analyzed for total Hg using an Advanced Mercury Analyzer (AMA-254) equipped with an ASS-254 autosampler for solid samples (see EPA Method 7473; Salvato and Pirola, 1996). The method employs direct combustion of the sample in an oxygen-rich atmosphere. Analytical accuracy was determined using three standard reference materials (DOLT-3 and TORT-2 obtained from the Canadian National Research Council; Oyster Tissue 1566b obtained from the National Institute of Standards and Technology) as well as 11 random liver samples analyzed in replicate. Recovery of reference materials was within the confidence interval of the certified values and the nominal detection limit for total Hg was 0.006 μg $g^{-1}$ dry weight sample.

### 2.3. Stable-nitrogen isotope analysis

Stable-nitrogen isotope analyses for the murre samples were carried out at the University of Ottawa's G.G. Hatch Stable Isotope Laboratory, Ottawa, Ontario, and for the fulmars, at the University of New Brunswick, Fredericton, New Brunswick. Muscle samples were homogenized, freeze-dried and lipids removed using 1:1 DCM/hexane for the murre samples and 2:1 chloroform/methanol rinses for the fulmar samples. Stable-nitrogen isotope assays were performed on 0.7 mg of freeze-dried sample encapsulated in tin. Samples were analyzed using a Vario EL III Elemental Analyser (Elementar, Germany) interfaced with a Delta XP Plus Advantage continuous-flow isotope ratio mass spectrometer (Thermo, Germany) coupled with a ConFlo II (Thermo, Germany). Data were normalized using international standards for calibration, and quality control was maintained through sample duplicates. Measurements are reported in standard δ notation in parts per thousand ($^{o}/_{oo}$) relative to the AIR international standard. Analytical precision, based on repeat measures of an internal standard (C-55), was $\pm 0.2^{o}/_{oo}$.

### 2.4. Data treatment

Statistical tests were performed using Statistica for Windows Version 7.0 (StatSoft Inc., Tulsa, OK) with a significance level of $p < 0.05$. T-tests were used to compare Hg levels between males and females for each species and sampling location, as well as test for differences in concentrations

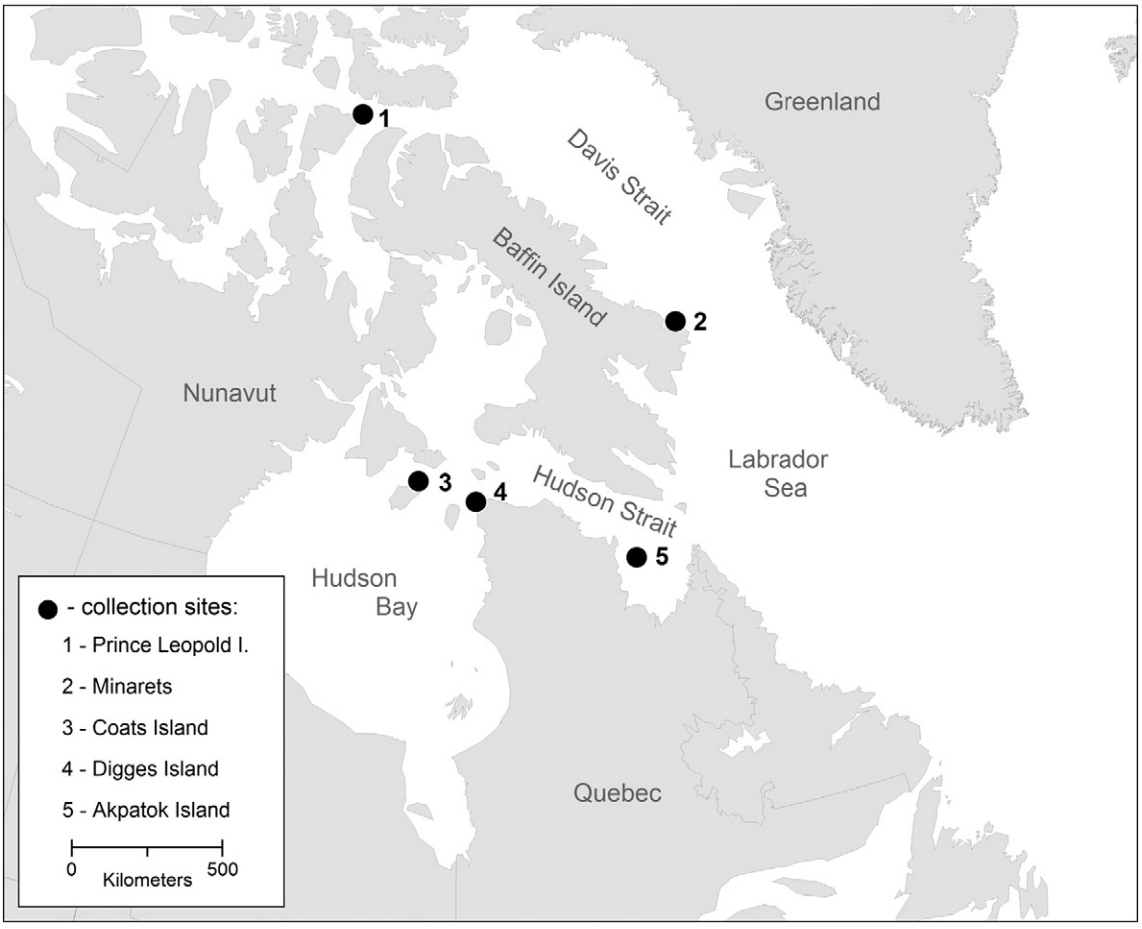


**Fig. 1.** Sampling locations for thick-billed murres and northern fulmars in the Canadian Arctic.