



Baseline

Organohalogen contaminants and total mercury in forage fish preyed upon by thick-billed murres in northern Hudson Bay



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ARTICLE INFO

Key Words:

Hudson Bay
Fish
Thick-billed murre
Halogenated compounds
Mercury
Biomagnification factors

ABSTRACT

Twelve marine fish species collected from a thick-billed murre (*Uria lomvia*) breeding colony in northern Hudson Bay in the Canadian Arctic during 2007–2009 were analyzed for legacy organochlorines (e.g. PCBs, DDT), polybrominated diphenyl ethers (PBDEs), perfluorinated carboxylates (PFCAs) and sulfonates (PFASs), and total mercury (Hg). No one species of prey fish had the highest levels across all contaminant groups analyzed. For the two pelagic fish species sampled, concentrations of the major organochlorine groups (e.g. Σ_{21} PCB, Σ DDT, Σ CHL, Σ Cbz), Σ PBDE, Σ PFCA and Hg were consistently higher in Arctic cod (*Boreogadus saida*) than in capelin (*Mallotus villosus*). Biomagnification factors from whole fish to thick-billed murre liver across all species were generally higher for Σ_{21} PCB and Σ DDT. Σ PBDE did not biomagnify.

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Bioaccumulation and biomagnification of environmental contaminants have been reported for a number of arctic marine food webs, including the Canadian Arctic (e.g. Atwell et al., 1998; Campbell et al., 2005; Fisk et al., 2001a; Hargrave et al., 1992; McKinney et al., 2012; Muir et al., 1988; Powley et al., 2008; Tomy et al., 2004, 2009). To date, only a few studies have looked at contaminants in the marine food webs of Hudson Bay. Mercury was recently examined in a Hudson Bay marine food web with a focus on zooplankton (Foster et al., 2012), and Kelly et al. (2008, 2009) examined concentrations of PCBs, organochlorine pesticides (e.g. *p,p'*-DDE, mirex, dieldrin, *trans*-nonachlor, hexachlorobenzene, β -HCH), brominated flame retardants (BFRs) such as the polybrominated diphenyl ethers (PBDEs), as well as per- and poly-fluoroalkyl substances (PFASs) in an eastern Hudson Bay food web. However, to our knowledge, no study has examined contaminants in prey of seabirds breeding in Hudson Bay.

The thick-billed murre (*Uria lomvia*) is a circumpolar seabird which breeds only in the Arctic and sub-Arctic (Gaston and Hipfner, 2000), with large populations in the eastern Canadian Arctic including Hudson Bay (Gaston and Hipfner, 2000). Thick-billed murres feed on small fish and large zooplankton (Gaston and

Hipfner, 2000; Provencher et al., 2012), foraging at depths down to 150 m (Elliott et al., 2009b; Falk et al., 2000). Arctic cod (*Boreogadus saida*) was, until recently, the main prey of thick-billed murres breeding in the Canadian Arctic (Davidson et al., 2008; Gaston and Bradstreet, 1993) and, until the mid-1990s, was the most common prey item found in the diet of nesting murres throughout the Canadian Arctic (Gaston and Jones, 1998). However, dietary studies have shown that there has been a shift from Arctic cod and benthic fish species to capelin (*Mallotus villosus*) and sand lance (*Ammodytes* spp.) in the diet of thick-billed murres at Coats and Digges Islands in northern Hudson Bay between 1980 and 2002 (Gaston et al., 2003, 2012).

Food delivered by adult thick-billed murres to nestlings is carried externally in the bill so that it arrives at the colony essentially whole and readily identifiable (Elliott and Gaston, 2008; Gaston et al., 2003). For a variety of reasons, food brought back to the colony is sometimes left uneaten on the breeding ledges (Elliott and Gaston, 2008). These abandoned prey items present an ideal opportunity to evaluate the contaminants in a variety of small forage fish inhabiting the waters of northern Hudson Bay.

The objectives of this study were to (i) report on concentrations of several persistent halogenated compounds such as PCBs, legacy organochlorine pesticides (e.g. DDT, chlorobenzenes, chlordanes), BFRs including the PBDEs, major bioaccumulative PFASs [perfluorinated carboxylates (PFCAs) and perfluorinated sulfonates (PFASs) including perfluorooctane sulfonic acid (PFOS)] as well as their

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precursors [fluorotelomer alcohols (FTOHs), fluorotelomer unsaturated acids (FTUCAs), perfluorosulfonamides (FOSAs)] and total mercury (Hg) in fish delivered to nestlings of thick-billed murres breeding at Coats Island in northern Hudson Bay, and (ii) compare biomagnification factors (BMFs) from fish to thick-billed murre among contaminant groups.

Representative samples of small fish were collected opportunistically from the breeding ledges of thick-billed murres at Coats Island (62°98'N, 82°00'W) in northern Hudson Bay, Nunavut, Canada, during 2007–2009 (Fig. 1). Species sampled included Arctic cod, capelin, sand lance, Atlantic poacher (*Leptagonus decagonus*), Arctic shanny (*Stichaeus punctatus*), daubed shanny (*Leptoclinus maculatus*), banded gunnel (*Pholis fasciata*), fish doctor (*Gymnelis viridis*), fourline snake blenny (*Eumesogrammus praecius*), Arctic staghorn sculpin (*Gymnancanthus tricuspis*), other sculpin (*Triglops* spp.) and snailfish (*Liparis* sp.). Arctic cod and capelin are categorized as being pelagic, sand lance as benthopelagic, and the rest as benthic species (Froese and Pauly, 2013). Fresh fish collected from the ledges were identified and measured as described by Elliott and Gaston (2008). Samples were washed, individually wrapped in foil, placed in plastic bags and frozen at -20 °C in the

field before being shipped to the National Wildlife Research Centre (NWRC), Ottawa, Ontario, where they were stored at -40 °C prior to chemical analysis.

Fish were analyzed for various persistent organohalogen pollutants and total Hg either individually or as composite samples (pools) comprised of 2–8 fish (see Table S1). Pooled samples were created by taking equal aliquots from each fish. In some cases, only sagittal sections were available after the other half of the fish was used for other analyses but it was assumed that the sagittal sections were representative of the whole fish.

Homogenized samples were analyzed for organochlorines (OCs) including chlorobenzenes (ΣCBz = 1,2,4,5-tetrachlorobenzene, 1,2,3,4-tetrachlorobenzene, pentachlorobenzene and hexachlorobenzene), hexachlorocyclohexanes (α -, β - and γ -hexachlorocyclohexane), chlordane-related compounds (ΣCHL = oxychlordane, *trans*-chlordane, *cis*-chlordane, *trans*-nonachlor, *cis*-nonachlor and heptachlor epoxide), DDT and its metabolites (ΣDDT = *p,p'*-DDE, *p,p'*-DDD and *p,p'*-DDT), octachlorostyrene (OCS), mirex, photomirex, dieldrin and PCB congeners (ΣPCB). Of the 74 PCB congeners analyzed, only 21 congeners were detected: 31/28, 44, 52, 66, 70/76, 74, 95, 99, 101/90, 110, 118, 138, 149, 151, 153, 179, 180 and

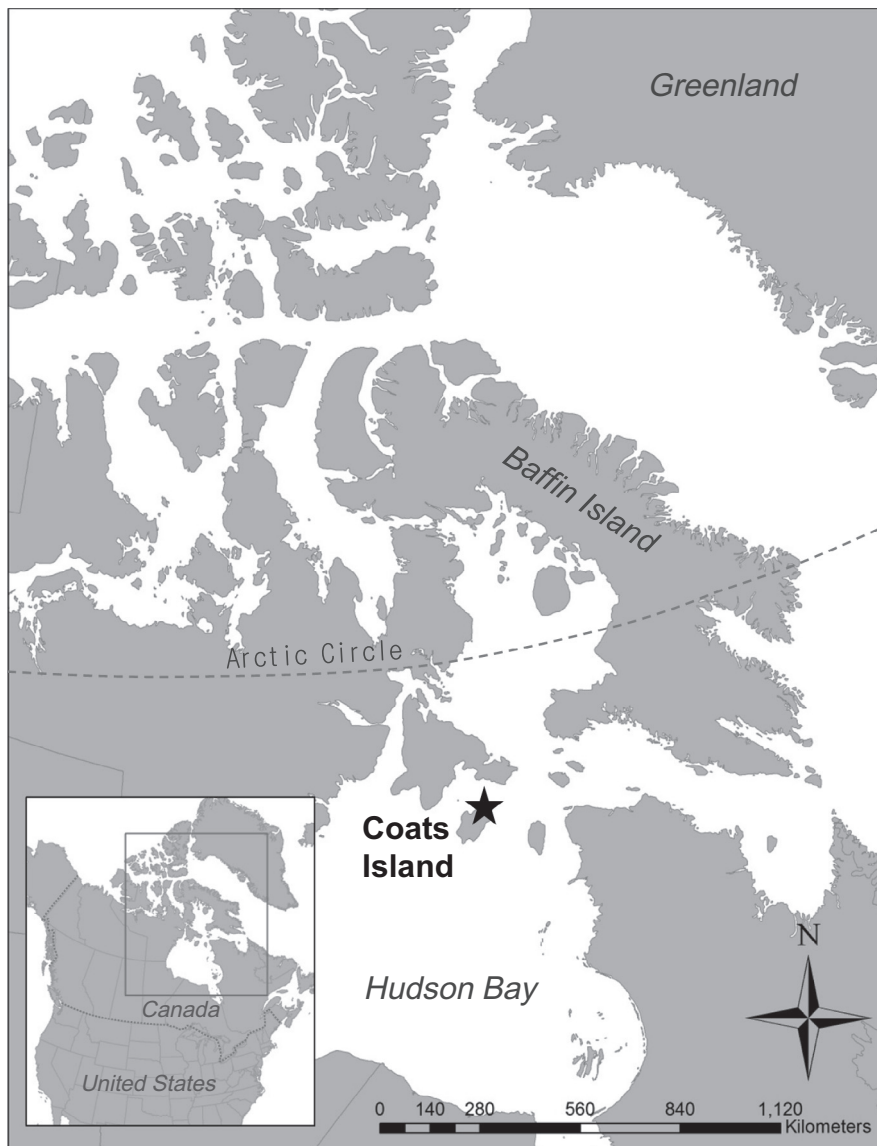


Fig. 1. Location of study site in northern Hudson Bay.

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