



Baseline

Levels of ingested debris vary across species in Canadian Arctic seabirds

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ABSTRACT

Plastic debris has become a major pollutant in the world's oceans and is found in many seabird species from low to high latitudes. Here we compare levels of plastic ingestion from two surface feeders, northern fulmars (*Fulmarus glacialis*) and black-legged kittiwakes (*Rissa tridactyla*), and two pursuit diving species, thick-billed murren (*Uria lomvia*) and black guillemots (*Cephus grylle*) in the Canadian High Arctic. This is the first report quantifying plastic ingestion in kittiwakes in this region, and as predicted, kittiwakes and fulmars had higher frequency of plastic ingestion than guillemots and murren. Despite this, amounts of plastic ingested by birds remain lower than regions farther south.

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Plastic debris has become ubiquitous in the world's oceans and is classified by the United Nations Environment Program as one of the most critical emerging threats (Barnes et al., 2009; UNEP, 2014; Wilcox et al., 2015). Marine litter is mostly comprised of plastic debris, with plastics accounting for up to 95% of debris in some areas, and plastic concentrations increasing in oceans worldwide (Moore, 2008). Plastics found in the sea can be categorized into two major types: industrial and user plastics. Industrial plastics refer to raw plastics in the form of pellets that are shipped to factories for additional processing (Azzarello and Van Vleet, 1987). User plastics refers to all other types of plastics used in commercial goods such as toys, plastic bags, ropes, bottles, etc. (Azzarello and Van Vleet, 1987). Oceanic plastic debris poses a significant threat to marine wildlife via entanglement and ingestion, with seabirds being particularly vulnerable (Azzarello and Van Vleet, 1987). Known effects of ingested plastics on seabirds include gastrointestinal blockage (Azzarello and Van Vleet, 1987), reduced storage volume of the stomach (Ryan, 1988), and uptake of hazardous chemicals (Ryan, 1988; Teusen et al., 2009). Seabirds were first reported to ingest plastic by the scientific community in the 1960s (Harper and Fowler, 1987). Plastic ingestion occurs in at least 40% of the world's seabird species, with plastic debris found in species inhabiting equatorial to polar waters (Kühn et al., 2015).

Seabirds are particularly useful organisms to understand the pervasiveness of plastic debris in the marine environment because they forage over large distances, making them likely to encounter and ingest

marine plastic debris that they may mistake for prey (Derraik, 2002). In environments such as the Canadian Arctic where research is logistically challenging, seabirds offer an effective alternative to monitoring marine plastic pollution over costlier methods such as ship-based surveys (Ryan et al., 2009).

In many regions of the world, plastic ingestion varies with foraging modes in seabirds (Azzarello and Van Vleet, 1987; Ryan, 1987a; Moser and Lee, 1992). Seabirds can be classified into three main foraging types: surface feeders, plungers and pursuit divers (Ashmole, 1971). Surface feeders are more susceptible to ingesting plastic as the majority of plastics float and accumulate at the water surface (Moser and Lee, 1992; Robards et al., 1995). In particular, birds of the order Procellariiformes such as fulmars, albatrosses, shearwaters and storm-petrels have the greatest tendency to accumulate plastics (Azzarello and Van Vleet, 1987; Moser and Lee, 1992; Robards et al., 1995). Diving birds exhibit a lower incidence of plastic ingestion than surface feeders even when foraging in the same area (Robards et al., 1995; Provencher et al., 2009, 2010).

Although foraging mode influences degree of plastic accumulation in seabirds, there are few data comparing species with different foraging strategies in the Canadian Arctic. Four common species that may ingest plastic in this region include two surface feeders, the northern fulmar (*Fulmarus glacialis*) and black-legged kittiwake (*Rissa tridactyla*), and two diving birds, the thick-billed murre (*Uria lomvia*) and the black guillemot (*Cyphus grylle*; Gaston et al., 2012). Both fulmars and murren from the Canadian Arctic are known to ingest plastic (Provencher et al., 2015), and plastic ingestion by fulmars is used as an Ecological Quality Objective (EcoQO) for marine debris in the North Sea (van Franeker

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Contaminants In Canadian Seabirds A State Of The Environment Report

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Contaminants In Canadian Seabirds A State Of The Environment Report:

A State of the Environment Fact Sheet, 1990 **Rapport Sur L'état de L'environnement**, 1988 **Chlordane in the Marine Environment of the United States** Gary Shigenaka, 1990 Understanding Atmospheric Change Henry Hengeveld, 1994-04 Addresses two major environmental issues associated with the earth's atmosphere global warming and the depletion of the atmosphere's ozone layer Begins with an assessment of how the atmosphere naturally influences the earth's climate and how that climate has behaved in the past It also deals with the potential depletion of the upper atmosphere's protective ozone layer The final chapter considers the linkages between these two issues other atmospheric pollution problems and human behavior and examines what is being done and must be done to respond both nationally and internationally 40 charts maps and tables Emphasis on Canada **Browsing Science Research at the Federal Level in Canada** Brian B. Wilks, 2004-01-01 Wilks provides a historical background list of publications and description of activities for most of the major science initiatives undertaken at the federal level He surveys a wide range of government documents and monographic and serial science collections used by both faculty and students **The State of Canada's Climate** D. W. Gullett, Walter Skinner, Canada. Atmospheric Environment Service, Canada. Environment Canada, 1992 This report examines the historical and geographical pattern of temperature variation in Canada during the past 100 years and indicates whether or not the changes observed represent a statistically significant trend *The State of Canada's Climate* Canada. Environment Canada, 1995 **The State of Canada's Environment, 1996** Canada. Environment Canada, 1996 The State of Canada's Environment 1996 is Canada's third national state of the environment SOE report As such it continues the ongoing evolution in national environmental reporting that began several decades ago The goal remained the same as it had been for the 1991 report that is to provide timely accurate and accessible environmental information integrated with socioeconomic factors to improve decision making and support progress towards sustainability Preface Chemical Contaminants in Canadian Aquatic Ecosystems D. M. Whittle, Jonathan Burton Bramwell, Canada. Department of Fisheries and Oceans, 1998 This report focuses on those chemicals that persist in the Canadian environment and that are accumulated by aquatic organisms It summarizes scientific information collected previously with emphasis on Canadian research findings published in the last decade The first part of the report introduces the general features of aquatic ecosystems and provides basic information on the fate and effects of chemical contaminants The second part reviews contaminant related issues for the following geographic areas Atlantic marine ecosystems including the St Lawrence Bay of Fundy and general north west Atlantic freshwater ecosystems including the Great Lakes and inland waters the Arctic marine ecosystem and Pacific aquatic ecosystems including the British Columbia coastal ecosystem the open coast and some of the major rivers All chapters discuss the major contaminant issues important oceanographic or limnological features biological resources and sources of contaminants as well as contaminant trends distribution and effects Current and emerging chemical contaminant issues and

associated research topics are summarized at the end of each chapter The third part is an overall assessment of current knowledge of chemical contaminants and their effects on fish and fish habitat and identifies major current and emerging contaminant issues confronting Canada s fish and fish habitat The Resource Guide to Indicators ,1998 **State of the Environment in the Atlantic Region** Peter B. Eaton,Canada. Environment Canada. Atlantic Region,1994 Overview of the environment of the Atlantic Provinces at a particular time The report identifies problem areas describes important conditions and trends and outlines the direction in which the region is headed environmentally The central theme of the report is the relationship between human activities and environmental quality human health and the economy The concept of sustainability is explored both in terms of ecosystem sustainability and the long term sustainability of the current use of the environment and its resources The report describes the environmental resource base including ecozones demographics air water land and wildlife the stresses including acid rain dioxins and furans wildlife and fish habitat and environmental impact assessment and a diagnosis for sustained use of air water land special places and species and energy A glossary is included **Government of Canada Publications, Quarterly Catalogue** ,1993 **Databases for Environmental Analysis** Statistics Canada. National Accounts and Environment Division,Canada. State of the Environment Reporting,1992 **The State of Canada's Environment** ,1991 Second national state of the environment report addressing the questions of what is happening in Canada s environment why it is happening why it is significant and what Canadians are doing about it The report is divided into five parts dealing with perceptions of the environment and the dangers inherent in our tendency to look at the world in terms of human economic models exploring the state of particular environmental components and the major sectors of human activity describing six regional case studies addressing six important environmental issues and discussing the concept of sustainable development and its implications for Canada s future Canada's National Report Canada,1991 In June 1972 the United Nations Conference on the Human Environment was held in Stockholm Sweden to stimulate international interest and awareness of global and international environmental issues Its further purpose was to begin the process of developing solutions based on a new and better understanding of the issues in part brought about by the conference Introd Canada and Marine Environmental Protection:Charting a Legal Course Towards Sustainable Development David VanderZwaag,1995-07-26 This thought provoking book analyzes key principles of sustainable development and their implications for ocean law and policy including integration precaution pollution prevention polluter pays public participation community based management and international equity The author summarizes participation in global and regional agreements and arrangements for protecting the marine environment and suggests future directions for global regional and national legal systems For example national law reforms include establishing a coastal zone management framework developing a process for designating and managing marine protected areas adopting a precautionary approach in decision making recasting the public trust doctrine **Environmental Reviews** ,2004 **Understanding Atmospheric**

Change Henry Hengeveld, Canada. Environment Canada, 1995 Toxics Steve Bliven, 1998 **Microlog, Canadian Research Index**, 1992 An indexing abstracting and document delivery service that covers current Canadian report literature of reference value from government and institutional sources

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