Northern fulmars as biological monitors of trends of plastic pollution in the eastern North Pacific

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Abstract

Marine plastic debris is a global issue, which highlights the need for internationally standardized methods of monitoring plastic pollution. The stomach contents of beached northern fulmar (Fulmarus glacialis) have proven a cost-effective biomonitor in Europe. However, recent information on northern fulmar plastic ingestion is lacking in the North Pacific. We quantified the stomach contents of 67 fulmars from beaches in the eastern North Pacific in 2009–2010 and found that 92.5% of fulmars had ingested an average of 36.8 pieces, or 0.385 g of plastic. Plastic ingestion in these fulmars is among the highest recorded globally. Compared to earlier studies in the North Pacific, our findings indicate an increase in plastic ingestion over the past 40 years. This study substantiates the use of northern fulmar as biomonitors of plastic pollution in the North Pacific and suggests that the high levels of plastic pollution in this region warrant further monitoring.

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1. Introduction

Since the 1950s, plastic production rates and input of plastic into the marine environment have increased dramatically and plastic is now recognized globally as a major form of marine pollution (Barnes et al., 2009; Moore, 2008; PlasticsEurope, 2010). Marine plastic pollution has significant environmental, economic, cultural, and aesthetic costs (see UNEP, 2009 for review). Of particular concern is the detrimental impact of plastic pollution on marine animals via entanglement or ingestion (Derraik, 2002; Gregory, 2009). Plastic ingestion can result in direct mortality or a range of sub-lethal effects such as gastrointestinal blockage, lacerations, reduced feeding (Laist, 1987; Ryan, 1988; Sievert and Sileo, 1993; Azzarello and Van Vleet, 1987), or absorption of toxic compounds (Mato et al., 2001; Teuten et al., 2009).

Although population level impacts of plastic entanglement and ingestion on marine taxa are not yet fully understood, to date over 260 species (including invertebrates, turtles, fish, seabirds and mammals) have been reported to ingest or become entangled in plastic debris (Boerger et al., 2010; Laist, 1997).

Plastic pollution is so pervasive that it is now found in every ocean of the world, including those formerly thought of as pristine, such as the Arctic Ocean and Southern Ocean (Provencher et al., 2010; Ainley et al., 1990). In 2009, the UNEP challenged the global community to improve methods to monitor trends in plastic pollution (UNEP, 2009). Although many countries have documented plastic debris in the marine environment, no standard technique has been used, and the lack of consistent methodology has made it difficult to monitor trends or to compare plastic pollution between different regions of the world (Ryan et al., 2009). This highlights the need for a reliable, internationally standardized method of monitoring trends in plastic pollution. One such method, which has been implemented with success in the historically polluted, industrial North Sea, uses mass of plastic ingested by beached northern fulmars (Fulmarus glacialis glacialis) as an indicator for tracking temporal and geographical trends in the abundance and composition of small-sized plastic pollution (van Franeker and Meijboom, 2002; van Franeker et al., 2011).

Northern fulmars are procellariid seabirds belonging to three subspecies (Fulmarus glacialis rogersii, F. g. glacialis, Fulmarus glacialis auduboni), each with distinct breeding locations and vast migratory ranges in the Northern Pacific, High Arctic and Northern Atlantic (Hatch and Nettleship, 1998). Northern fulmars are particularly suitable as biomonitors of trends in plastic pollution because, like many petrels, they forage exclusively at...