FACETS
a multidisciplinary open access science journal

REVIEW ARTICLE

Review of plastic pollution policies of Arctic countries in relation to seabirds

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Abstract

Marine plastic is a ubiquitous environmental problem that can have an impact on a variety of marine biota, such as seabirds, making it an important concern for scientists and policy makers. Although research on plastic ingestion by seabirds is increasing, few studies have examined policies and long-term monitoring programs to reduce marine plastic in the Arctic. This paper provides a review of international, national, and regional policies and long-term monitoring programs that address marine plastic in relation to seabirds in the Arctic countries: Canada, the Kingdom of Denmark (Greenland and the Faroe Islands), Finland, Iceland, Norway, the Russian Federation, Sweden, and the United States of America. Results show that a broad range of international, national, regional and local policies address marine debris, specifically through waste management and the prevention of pollution from ships. However, few policies directly address seabirds and other marine biota. Further, policies are implemented inconsistently across regions, making it difficult to enforce and monitor the efficacy of these policies given the long-range transport of plastic pollution globally. To reduce marine plastic pollution in the Arctic environment, pan-Arctic and international collaboration is needed to implement standardized policies and long-term monitoring programs for marine plastic in the Arctic and worldwide.

Key words: Arctic, marine debris, marine litter, plastic reduction policies, plastic pollution, seabirds

OPEN ACCESS

Citation: Linnebjerg JF, Baak JE, Barry T, Gavrilo MV, Mallory ML, Merkel FR, Price C, Strand J, Walker TR, and Provencher JF. 2021. Review of plastic pollution policies of Arctic countries in relation to seabirds. FACETS 6: 1–25. doi:10.1139/facets-2020-0052

Handling Editor: John P. Smol

Received: July 2, 2020

Accepted: September 29, 2020

Published: January 7, 2021

Published by: Canadian Science Publishing

1. Introduction

Plastic pollution in the marine environment has been reported as a problem for nearly half a century. It is now recognized as a serious threat to our marine ecosystems, including the remote Arctic (Carpenter and Smith 1972; Colton et al. 1974; Harper and Fowler 1987). Marine plastic can not only enter the Arctic through local sources such as communities, landfills, shipping, tourism, and fisheries (UNEP 2016; Hallanger and Gabrielsen 2018; Falk-Andersson and Strietman 2019; Halsband and Herzke 2019; PAME 2019), but also from southern areas via transport by ocean currents, wind, or biota (van Sebille et al. 2012; Cózar et al. 2017; Halsband and Herzke 2019). As a result of these multiple vectors, plastics have been reported within arctic beaches, snow, surface, sub-surface, and seafloor samples and in sea ice (Bergmann and Klages 2012; Obbard et al. 2014; Lusher et al. 2015; Bergmann et al. 2016, 2019; Cózar et al. 2017; Kanhai et al. 2018, 2020; Peeken et al. 2018; PAME 2019; Blinovskaya et al. 2020). Recently, microplastics have been found in amphipods (*Gammarus setosus*; Iannilli et al. 2019), blue mussels (*Mytilus edulis*; Sundet et al. 2016; Bråte et al. 2020), red king crabs (*Paralithodes camtschaticus*; Fuhrmann et al. 2016), and fish (Morgana et al. 2018), but plastics have been found in Arctic seabirds since the 1960s (Day 1980; Harper and Fowler 1987; PAME 2019; Baak et al. 2020).

Plastic pollution can have deleterious impacts on marine biota in a variety of ways, depending on consumer species and the shape, size, and type of plastic (Werner et al. 2016), but the most documented impacts are from ingestion and entanglement. However, there are more studies on plastic ingestion in seabirds reported in the literature (Wilcox et al. 2015; review by Baak et al. 2020) than studies on plastic entanglement in seabirds (Kühn et al. 2015; Ryan 2018). Marine mammals, seabirds, turtles, and fish can become entangled in fishing gear, rope, and plastic bags (Laist 1987, 1997; Walker and Taylor 1996; Provencher et al. 2017). If not directly causing mortality, marine plastic pollution may affect the fitness of individual organisms by compromising their ability to capture and digest food, reproduce, migrate, and (or) escape from predators (Secretariat of the Convention on Biological Diversity and the Scientific and Technical Advisory Panel—GEF 2012; Galloway et al. 2017). As plastics break down in the ocean, they become available to a broader range of marine organisms. Ingestion of microplastics can result in physical damage such as obstruction or internal abrasions (Wright et al. 2013). Further, when ingested, chemicals used in plastic production can be incorporated in the tissues of the animals (Tanaka et al. 2013, 2020; Rochman et al. 2014). In addition to physical effects, marine plastics can transfer chemicals to the marine environment or act as vectors for species, such as bryozoans, barnacles, polychaete worms, hydroids, and molluscs (Barnes 2002; Hermabessiere et al. 2017).

Seabirds play an important role in marine ecosystems and are thus important indicators of ecosystem health (Mallory et al. 2010; van Franeker et al. 2011) but are also culturally important for Indigenous peoples of the Arctic (Mosbech et al. 2018). Many Arctic seabird species are in decline (Paleczny et al. 2015; Goyert et al. 2018) due to threats such as overfishing of food sources, bycatch from fisheries, climate change, and pollution (Sullivan et al. 2006; Croxall et al. 2012), and plastic pollution may exacerbate this decline (Mallory et al. 2006). As plastic pollution continues to increase in the Arctic, seabirds and other marine biota will be at an increased risk of ingestion and entanglement (Kühn et al. 2015; Wilcox et al. 2015; Kühn and van Franeker 2020); thus, monitoring the prevalence of this pervasive environmental contaminant will be of increasing importance. Indeed, the Protection of the Arctic Marine Environment (PAME) is currently developing a Regional Action Plan on Marine litter that will address both sea and land-based activities, with a focus on Arctic-specific marine litter sources and pathways (PAME 2020). However, many countries lack the policy and monitoring programs to enable and enforce the prevention, reduction, and monitoring of marine plastic pollution.

The legal framework that is applicable to marine plastic pollution is complex and consists of international, national, regional, and local policies that cover ocean- and land-based sources of marine plastic. Several review documents already exist for policies that directly or indirectly can be applied to mitigate the impact of marine plastic (Kershaw et al. 2013; Pettipas et al. 2016; Xanthos and Walker 2017; PAME 2019; Eriksen et al. 2020); however, none are specific to the Arctic. The United Nations Environment Programme (UNEP) recommended that current international and regional frameworks on marine plastic pollution be reviewed to identify gaps for policy improvement (UNEP 2016). Further, the Arctic Migratory Birds Initiative (AMBI) 2019–2023 workplan highlights the need for a review of policies within Arctic countries that address marine plastic to recommend future research and policy development in the region (CAFF 2019). The implementation of policy and long-term monitoring programs for marine plastic pollution in the Arctic region will facilitate our understanding of the impacts of plastic ingestion on Arctic species and allow us to compare plastic ingestion and entanglement across species, regions, and time.

We reviewed policies and long-term monitoring programs that address marine plastics in the eight Arctic Council countries: Canada, the Kingdom of Denmark (Greenland and the Faroe Islands), Finland, Iceland, Norway, the Russian Federation (hereafter Russia), Sweden, and the United States of America (US). We outline international, national, regional, and local policies on plastic pollution in the Arctic marine environment, identify gaps in these policies in relation to the Arctic and Arctic seabirds, and suggest actions for future policy development in the Arctic.

2. Methodology

The Arctic was defined following the Conservation of Arctic Flora and Fauna (CAFF) definition (Irons et al. 2015), which includes Greenland, the Faroe Islands, Iceland, Norway, Finland, Sweden, Russia, Canada, and the US, as well as the major seas in the Arctic: the Barents, Beaufort, Bering, Chukchi, East Siberian, Greenland, Kara, Norwegian, Labrador, and Laptev seas (**Fig. 1**; Environment Canada et al. 2008). Representatives from the governments of each country were contacted to request information on plastic pollution policies. To explore additional information, we used the Google Scholar search engine to retrieve records available up to March 2020. Search terms used were: "policy"; "legislation"; "monitoring"; "plastic"; "Greenland" (or Iceland or Norway or Finland or Sweden or Russia or Canada or the United States). Additionally, government and nonprofit organization websites for each Arctic country were searched using the search terms above, and representatives from these organizations were contacted directly for information regarding plastic pollution policy. Finally, all country representatives of the CAFF Circumpolar Seabird Expert Group were consulted to add any additional policies or programs for marine plastic pollution in the Arctic countries. Policy tools reviewed include a mix of legislative instruments (acts, regulations, legal frameworks, laws, and bylaws), hereafter "policies". Results that describe international, national, regional, and local policies or long-term monitoring programs relating to marine plastic pollution in the Arctic were included. We recognize that littering, in general, is prohibited in all regions in this review, we aim to capture policies that relate more to plastic pollution specifically and not littering generally. Results on how seabirds are addressed in these policies/legislations are summarized and discussed.

3. International plastic pollution policy

The prevention of plastic pollution entering the marine environment is a topic of priority across the globe. Indeed, Goal 14 of the 2030 agenda for Sustainable Development is to "conserve and sustainably use the oceans, seas and marine resources", and calls for actions that prevent and significantly reduce marine pollution of all kinds by 2025 (UN 2017). Consequently, there is a range of legally binding and nonbinding international conventions that directly or indirectly address marine debris (e.g., Kershaw et al. 2013; BRS Conventions 2019; PAME 2019). One of the first global treaties to protect the marine environment from human activities was The London Convention (IMO 1972) that came into force in 1975. This convention was followed by The International Convention for the Prevention of Pollution from Ships (MARPOL), the United Nations Convention on the Law of the Sea and The Basel Convention (**Table S1**), which together have formed the foundation of international regulations to reduce this environmental pollutant.

The protection of specific marine environments through regional regulations plays an important role in the concretisation of international regulatory frameworks. One of UNEP's most significant achievements is The Regional Seas Programme (launched in 1974), which, in co-operation with regional organizers, has implemented activities related to the prevention and reduction of marine debris that have been consolidated by legal frameworks, such as the regional sea conventions like

Fig. 1. Map of the circumpolar Arctic as defined by CAFF (Irons et al. 2015), including the major Arctic seas (Environment Canada et al. 2008) and an outline of the Arctic circle at 66°33′N. Sources: Arctic boundary from CAFF (caff.is/); basemap from Esri (esri.com).

the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR; **Table S1**). A list of international conventions with relevance to the Arctic that address the reduction of marine debris are presented in **Table S1** and signatory Arctic Countries are presented in **Table 1**.

Nongovernmental organizations (NGOs) also play an important role in creating awareness of marine debris. One example is the International Coastal Cleanup (ICC), from the US-based NGO, Ocean Conservancy, to remove marine debris from coastlines and to collect data on the amount and types of marine debris removed (Ocean Conservancy 2020). Another global initiative that aims at reducing plastic waste production and consumption is the Greenpeace Call for a Plastic-Free Future (Greenpeace 2020) based on Zero Waste Standards & Policies (ZWIA 2014). For example, in Russia, this initiative has resulted

Table 1. List of Arctic countries that have signed international policy frameworks to reduce marine plastic pollution.

International framework	Canada	Faroe Islands	Greenland	Finland	Iceland	Norway	Russia	Sweden	US
Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972 (London Convention) and its 1996 Protocol (London Protocol)	X	X	X	X	X	X	X	X	X
International Convention for the Prevention of Pollution from Ships (MARPOL)	X	AM	X	X	X	X	X	X	X
Helsinki Commission (HELCOM)	—	—	—	X	—	—	X	X	—
Global Convention on the Conservation of Migratory Species of Wild Animals (Bonn/CMS)	—	X	X	X	—	X	—	X	—
United Nations Convention of the Law of the Sea (UNCLOS)	X	X	X	X	X	X	X	X	—
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (Basel Convention)	X	X	X	X	X	X	X	X	—
Convention on Biological Diversity (CBD)	X	X	X	X	X	X	X	X	X[a]
The Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR)	—	X	X	X	X	X	—	X	—
United Nations Fish Stocks Agreement (UNFSA)	X	X	X	X	X	X	X	X	X
Honolulu Strategy	X	—	—	X	X	X	X	X	X
The 2030 Agenda for Sustainable Development—Sustainable Development Goals (SDGs)	X	—	—	X	X	X	X	X	X
Food and Agriculture Organization of the United Nations (FAO) Voluntary Guidelines on the Marking of Fishing Gear	X	AM	—	X	X	X	X	X	X
International Maritime Organization (IMO) Action Plan to Address Marine Plastic Litter from Ships	X	AM	X	X	X	X	X	X	X

Note: AM, Associate Member.
[a]Nonratified.

in many leading commercial networks considerably reducing the use of disposable plastic bags (Greenpeace 2018).

4. Plastic pollution policy in the European Arctic

European Arctic countries consist of the Kingdom of Denmark (Greenland and the Faroe Islands), Finland, Iceland, northern parts of Norway, Sweden, and part of Russia (see detailed information regarding Russia below). Finland and Sweden are members of the European Union (EU) whereas Greenland, the Faroe Islands, Iceland, Norway and Russia are not (European Union 2020). Treaties ratified by the Kingdom of Denmark are automatically extended to Greenland and the Faroe Islands unless the ratification is accompanied by a declaration or other statement that the treaty does not extend to these regions. However, since Greenland and the Faroe Islands are both self-governing Arctic regions within the Kingdom of Denmark, they are considered separately for the remainder of this review. Iceland and Norway are part of the European Economic Area (EEA) and are thus also obliged to both follow and report on some of the objectives covered by EU Directives (EFTA 2020), for example, the Waste Framework Directive (**Table S2**).

4.1. European Union policies

In September 2019, more than 100 European companies and organisations signed the Declaration on European Circular Plastics Alliance (EC 2019), committing to using 10 million tonnes of recycled plastic in new products by 2025. This commitment to addressing plastic pollution is reflected in a wide range of EU policies focused on marine debris in terms of its sources and impacts (EC SWD 2012, 2018; Kershaw et al. 2013). The first EU legislative instrument related to the protection of marine biodiversity was the Marine Strategy Framework Directive (**Table S2**). Several other EU initiatives have also been adopted in recent years including the European Strategy for Plastics in a Circular Economy (EC SWD 2018), which aims to transform the design, production, use, and recycling of plastic products in the EU and the Single-Use Plastics Directive (effective from July 2021), banning the use of certain single-use plastic products (**Table S2**). Further, in April 2019 the ministers of environment and climate of the Nordic countries approved a Nordic Declaration, which calls for a global agreement to more effectively and comprehensively address marine plastic litter and microplastics (Nordic Co-operation 2019).

A list of legally binding instruments in the EU that relate to the prevention and control of marine debris is presented in **Table S2**.

4.2. Greenland

4.2.1. Legal frameworks and strategies

The Government of Greenland (Naalakkersuisut) is responsible for marine areas within three nautical miles of the coastline, which includes all inland seas such as fjords and bays. The Danish Government is responsible for the marine environment from the three nautical mile border up to 200 nautical miles from the baseline (i.e., the Exclusive Economic Zone). Greenland has entered into various international agreements to minimize plastic pollution in the marine environment (**Table 1**). In addition, Greenland has implemented national policies and regulations to combat marine pollution and waste management issues (**Table S3**).

The Ministry of Nature and Environment is working on an action plan to reduce the consumption of plastic and to clean up abandoned or lost fishing gear throughout Greenland. The draft of the Naalakkersuisut's action plan for reducing the consumption of plastic "Less plastic in nature" has been submitted for a public hearing process (Government of Greenland (Naalakkersuisut) 2020). In 2018, the Inatsisartut (Parliament of Greenland) established an Environmental Fund (Miljøfonden), to improve plastic recycling and fisheries waste management programs which in 2019, one million Danish Kroner were allocated to address plastic pollution and another one million Danish Kroner were allocated to clean up abandoned or lost fishing gear (Government of Greenland (Naalakkersuisut) 2019).

In Greenland, municipalities are responsible for waste management. Thus, together with the Government of Greenland, municipalities are working on optimizing solutions for incineration, disposal, sorting, and recycling of waste. Plastic waste management (i.e., sorting and recycling) is a relatively new focus in Greenland and action plans are currently in preparation (Poulsen 2020).

4.2.2. Long-term monitoring programs

There are few long-term monitoring programs for marine plastic pollution in Greenland. Yearly surveys on several beaches were initiated in 2016 as part of the Danish financed SUMAG-project and are planned at least until 2021 with the aim of determining baselines and starting trend analyses on the amount, accumulation, and sources of plastic (Strand et al. 2018). The monitoring data have also been uploaded to the OSPAR database for beach litter monitoring data. There are no established long-term monitoring programs for plastic ingestion by seabirds in Greenland, but northern fulmar (*Fulmarus glacialis*) stomachs were examined twice in 2016 and 2017 according to the OSPAR monitoring guideline (Strand et al. 2018) and these studies will be repeated in the near future. In addition, intact stomach samples from northern fulmars collected in West Greenland in 2000 and stored in the Arctic tissue bank at Aarhus University have also been examined for comparison. Plastic ingestion has also been examined opportunistically in thick-billed murres (*Uria lomvia*), common eider (*Somateria mollissima borealis*), king eider (*S. spectabilis*), and little auks (*Alle alle*; Falk and Durinck 1993; Pedersen and Falk 2001; Provencher et al. 2014; Amélineau et al. 2016).

4.3. The Faroe Islands

4.3.1. Legal frameworks and strategies

The Faroe Islands is a self-governing region within the Kingdom of Denmark and thus legislates and governs independently in a wide range of areas, such as the conservation and management of living marine resources and the protection of the environment. The Faroe Islands have entered into various international agreements to minimize plastic pollution of the marine environment (**Table S2**). Additionally, the Faroe Islands have a set of national laws and regulations to combat marine debris and waste management issues (**Table S3**). General waste management is determined by municipalities, and the Ministry of the Environment has made proposals to reduce plastic pollution, but otherwise waste management facilities have their own systems for recycling plastic (Poulsen 2020).

4.3.2. Long-term monitoring programs

There is currently no long-term monitoring of marine plastic pollution in the Faroe Islands, nor is there long-term monitoring for plastic pollution in seabirds. However, plastic ingestion by seabirds has been examined in northern fulmars (van Franeker 2012; van Franeker and Save the North Sea (SNS) Fulmar Study Group 2013; Trevail et al. 2014) and their main predator, the great skua (*Stercorarius skua*; Hammer et al. 2016). In addition, a recent study assessed whether the use of opportunistic sampling of northern fulmar fledglings hunted as a traditional food resource could be a potential monitoring strategy in the Faroe Islands. The study indicated that plastic ingestion by northern fulmar fledglings was at a similar rate as adults, suggesting that parents do indeed regurgitate plastic as a food source for chicks (Ask et al. 2020). Further, in the OSPAR monitoring database, there are beach litter data from a single beach in the Faroe Islands, surveyed in 2002–2006.

4.4. Iceland

4.4.1. Legal frameworks and strategies

Iceland is not an EU Member, but as an EEA member, has implemented several EU regulations related to waste management (**Table S2**). Additionally, Iceland has national policies and regulations to combat plastic and waste management issues (**Table S3**). For example, it is prohibited by law to abandon fishing gear lost at sea (*Act No. 57/1996*). Further, fishing gear is among the materials included in *Act No. 162/2002* (on processing fees) that encourages reuse and recycling. A draft for a national action plan on plastic pollution was presented to Parliament in 2019, which contains proposals for the prevention, sorting and recycling of plastic (Poulsen 2020).

4.4.2. Long-term monitoring programs

Iceland has been monitoring marine debris on beaches according to the OSPAR monitoring guidelines since 2016 (OSPAR 2010) and in northern fulmar stomachs since 2018 (Snæþórsson 2018, 2019). Before this, plastics in northern fulmar stomachs were opportunistically sampled, also following the OSPAR monitoring guidelines (e.g., Kühn and van Franeker 2012). In 2018, a project on the extent of microplastic pollution in mussels in selected locations was initiated to lay a foundation for similar research on microplastic in the marine ecosystems of Iceland (Halldórsson and Guls 2018). Further, in the OSPAR monitoring database there are beach litter data from six shoreline locations in Iceland surveyed since 2016.

4.5. Norway

4.5.1. Legal frameworks and strategies

Norway is not an EU Member, but as an EEA member, has implemented several EU regulations related to waste management (**Table S2**). Additionally, Norway has national policies and regulations to address plastic and waste management issues (**Table S3**). Norwegian laws and regulations are generally designed to prevent littering by addressing waste management in various industries (**Tables S2** and **S3**). Norway is a contracting party of the OSPAR Convention and is thus obliged to take the necessary measures to protect the northeast Atlantic marine environment (**Table S1**). Norway is also using an integrated marine management regime to achieve good environmental status, for all its sea areas (the Barents Sea, the Norwegian Sea, and the North Sea and Skagerrak). The goals for marine debris differ slightly in the three marine areas; however, the overall objectives are similar, with plans to avoid the negative impacts on the environment from marine debris.

4.5.2. Long-term monitoring programs

Norway has been mapping marine debris in seabeds since 2005 under the MAREANO programme (MAREANO 2020) and monitoring and reporting marine debris on beaches since 2011 following the OSPAR guidelines. Since 2010, the Norwegian–Russian ecosystem survey in the Barents Sea has surveyed marine plastic from bycatch and trawls. In 2019, the joint Russian–Norwegian Environmental Commission established a project on marine litter and microplastics. The aim of the project is to exchange knowledge on the occurrence and effects of marine litter and microplastics in the Barents Sea, including effects on seabirds. The project will also exchange relevant information on regulations and measures to reduce and prevent plastic pollution.

For seabirds, the Norwegian authorities have been monitoring plastic pollution in northern fulmar stomachs in the North Sea area in the framework of OSPAR since 2002 (Dehnhard et al. 2019a). Northern fulmars from northern Norway are investigated in the same manner but not obtained regularly. Possibilities for a regular, noninvasive monitoring of plastic ingestion by seabirds in mainland Norway and Svalbard were discussed at a workshop in 2019 (Dehnhard et al. 2019b), but such a monitoring has not been implemented to date. Further, systematic monitoring of presence/absence and type of plastic integrated in seabird nests has been conducted during the 2019 breeding season at several colonies in mainland Norway and Svalbard for multiple seabird species including the Atlantic puffin (*Fratercula arctica*), European shag (*Phalacrocorax aristotelis*), black-legged kittiwake, herring gull (*Larus argentatus*), great-black backed gull (*L. marinus*), and common eider (*Somateria mollissima*; N. Dehnhard, personal communication, 2020).

4.6. Finland

4.6.1. Legal frameworks and strategies

Finland is a member of the EU; thus, regulations and decisions automatically become binding on the date they enter into force and EU directives must be incorporated into their national legislation. Legally binding instruments relating to the prevention of litter entering the ocean in the EU are listed in **Table S2**. Finland's marine coastline borders the Baltic Sea, and since Finland is a contracting party in the Convention on the Protection of the Marine Environment of the Baltic Sea Area—also known as the Helsinki Convention—originally signed in 1974, Finland implements the regional action plans and the other requirements of the Baltic Marine Environment Protection Commission (HELCOM), including the necessary measures to protect the marine environment as agreed on in the Regional Action Plan on Marine Litter (HELCOM 2015; **Tables 1** and **S1**). Further, Finland is a contracting party of the OSPAR Convention (**Table S1**).

4.6.2. Long-term monitoring programs

Finland does not have coastline bordering the Arctic Ocean; thus, analysis of long-term monitoring programs has not been conducted for this region. In the Baltic Sea, the national monitoring program of Finland implements the requirements of the EU Marine Strategy Framework Directive.

4.7. Sweden

4.7.1. Legal frameworks and strategies

Sweden is a member of the EU; thus, regulations and decisions automatically become binding on the date they enter into force and EU directives must be incorporated into their national legislation. Legally binding instruments relating to the prevention of litter entering the ocean in the EU are listed in **Table S2**. The Swedish Baltic Sea coastline extends from the northernmost part of the Bothnian Bay to the Skagerrak coastline and thus is not part of the CAFF region. However, Sweden is a part of HELCOM (**Tables 1** and **S1**) and is thus working to protect the marine environment of the Baltic Sea from pollution. Further, Sweden is a contracting party of the OSPAR Convention and is thus obliged to take the necessary measures to protect the northeast Atlantic marine environment (**Table S1**).

4.7.2. Long-term monitoring programs

Sweden does not have coastline bordering the Arctic Ocean; thus, analysis of long-term monitoring programs has not been conducted for this region. In the Baltic Sea, the national monitoring program of Sweden implements the requirements of the EU Marine Strategy Framework Directive.

4.8. Russia

4.8.1. Legal frameworks and strategies

Russia does not specifically address marine plastic pollution in federal policy or legislation. However, marine debris is an integral part of waste management legislation, and there are various policies that regulate the production and consumption of consumer and industrial waste from both land- and ship-based sources. For example, the main federal legislation that addresses waste management is the law “On production and consumption of wastes” (1998), which primarily addresses land-based sources of waste (**Table S3**). Further, because Russia is a party to the MARPOL convention, regulations under Annex V were implemented as a law (MNRE 2019). Following MARPOL, the Fishery Fleet Instructions on Preventing Pollution from Ships (1994), which focuses on preventing pollution from fishing vessels, and the Compulsory Regulations on Sea Ports (2007), which addresses the prevention of pollution from ships (**Table S2**), were developed to combat marine pollution, including plastic pollution. Finally, the impacts of marine plastic pollution were recently added to the agenda of the Ministry of Natural Resources and Ecology within the frame of the working program of the Joint Russian–Norwegian Environmental Commission, thus marine plastic pollution policy in Russia is expected to increase.

Regionally, Russia is a party to conventions such as HELCOM (Baltic Sea), the Framework Convention on the Protection of the Black Sea Against Pollution (Bucharest Convention 1992), and the Framework Convention for the Protection of the Marine Environment of the Caspian Sea (Tehran Convention 2003). Further, the Administration of seaports, under the instruction of the State Marine Pollution Control, Salvage and Rescue Administration, developed the Shipboard Waste Management Plans that specify waste management policy for each port (**Table S3**). These plans include waste collection and disposal but do not directly address plastic pollution. Additionally, the National Ecology Project (NEP 2018), led by the Ministry of Natural Resources and Environment (MNRE), plans to implement waste management programs to reduce the production and consumption of waste in Russia. The MNRE is working to improve waste management in 15 Specially Protected Areas (SPAs; one of which is in the Russian Arctic), where solid waste (including plastic) collection systems and education programs will be implemented (MNRE 2018). This project is expected to expand to all SPAs in the future.

4.8.2. Long-term monitoring programs

To date, there are currently no long-term monitoring programs for marine plastic pollution in the Russian Arctic. However, there are several regional studies that monitor marine plastic pollution. For example, the State Oceanographic Institute of Roshydromet, as part of the GEF/UNDP-EMBLAS international project on the Black Sea (EMBLAS project 2020), monitors plastic pollution in the marine environment (EC 2013). Moreover, as part of HELCOM (HELCOM 2015) and the UNEP NOWPAP (Northwest Pacific Action Plan) Regional Marine Litter Action Plan (NOWPAP 2011), marine plastic pollution is surveyed in the Baltic Sea and Far East seas, respectively. The longest series are available for the Russian part of the Sea of Japan, where marine debris has been monitored since 1998 (microplastics since 2014), primarily as a research initiative of the Far Eastern Federal University using the framework of ICC and NOWPAP. A Marine litter database is established and a microplastics database is developing (i.e., Okhotkina et al. 2020). In past years, collaboration has extended to the Arctic region (Blinovskaya and Gavrilo 2020; Blinovskaya et al. 2020). As mentioned above in the Norwegian section on long-term monitoring, in 2019, the joint Russian–Norwegian Environmental Commission established a project on marine litter and microplastics. The project will also exchange relevant information on regulations and measures to reduce and prevent plastic pollution. Finally, Russia and Norway are working together to assess marine plastic pollution in the Barents Sea and Kara Sea (see section 4.5.2).

There are currently no long-term monitoring programs for plastic ingestion by seabirds in Russia. However, research on plastic pollution ingestion by seabirds in the Russian Arctic is increasing (Weslawski et al. 1994; Golovnyuk et al. 2019; Zelenskaya 2019; Solovyeva et al. 2020). In November 2019, the "Plastic pollution & seabirds in the Russian Arctic: State of knowledge, information exchange, possibilities for collaboration" workshop, organized under CAFF and AMBI, was the first workshop focusing on the impacts of marine plastic on seabirds and is thus an area of development for Russia.

5. Plastic pollution policy in the North American Arctic

5.1. Canada

5.1.1. Legal frameworks and strategies

At the national level, the Government of Canada has established over 10 federal Acts that govern marine debris, which enable the Canadian government to set regulations and guidelines to reduce, prevent, and research marine debris. These policies largely address marine debris by prohibiting the deposition of waste in the marine environment, but also address land-based sources and lost or discarded fishing gear (**Table S3**). At the national level, the only ban on plastic pollution that currently exists is the *Microbeads in Toiletries Regulations* (2017), which prohibits the manufacturing and distribution of cosmetics that contain microbeads. However, the Canadian government recently announced that single-use plastics (e.g., plastic bags, straws, and other single-use plastics deemed "harmful" to the environment, although the list of items has not been finalised) will be banned across Canada as early as 2021 (Government of Canada 2020). However, as a result of concerns over safety during the COVID-19 pandemic, some plastic bag bans in other regions of Canada (e.g., Newfoundland) are being delayed (Silva et al. 2020). Further, after calls from scientists and other groups (Rochman et al. 2013), the Canadian government is set to list plastics as a toxic substance under the *Canadian Environmental Protection Act* (Government of Canada 2019a), which will allow the government to regulate certain plastic products under this Act (Blaze Baum 2020). In anticipation of this, the Canadian government released a science assessment on plastic pollution in 2020 (ECCC and Health Canada 2020).

To address marine debris in the Canadian Arctic, Canada has established the federal *Arctic Waters Pollution Prevention Act* (Government of Canada 2019b), which prohibits the deposition of waste in Arctic waters (or land where waste may enter Arctic waters), which includes Canada's three Arctic territories (Nunavut, Northwest Territories, and Yukon). These territories also have policies that govern solid waste and other contaminants at the regional level, where the deposition of waste into marine waters without a permit is prohibited in all three territories (**Table S3**).

In terms of seabirds, there is no Canadian legislation that directly addresses marine plastic pollution in relation to seabirds. The *Migratory Birds Convention Act* (Government of Canada 2017) prohibits the deposition of a substance into waters that is harmful to migratory birds, and though seabirds are migratory, and plastics can be harmful to seabirds (Kühn et al. 2015), this legislation does not directly protect seabirds from plastic pollution.

In addition to legislation on marine plastics, there are also nationwide strategies in place to combat this environmental problem. For example, Canada created the Ocean Plastics Charter (ECCC 2018) to commit G7 countries to take action on plastic pollution. This charter outlines various targets, including the goal to recover 100% of all plastics by 2040. Additionally, the charter calls for other nations to implement these objectives, and of the Arctic countries, the EU (Greenland, Faroe Islands, Finland and Sweden) and Norway have signed the charter (at the time of this study). In line with the Ocean Plastics Charter, the Canadian Council of Ministers of the Environment (CCME) developed the Canada-wide Strategy on Zero Plastic Waste, which outlines Canada's goal of zero plastic waste and a circular economy: to keep plastics in the economy and out of the environment (CCME 2018). The CCME, in collaboration with organizations and stakeholders, developed the Canada-wide Action Plan on Zero Plastic Waste (CCME 2019), which aims to reduce the negative environmental impacts of plastic pollution through pollution prevention (reduction) and improved recovery (increased recycling rates) (Walker and Xanthos 2018). Though not legally binding, this action plan encourages government, industry, and citizens to collaborate on this issue, and progress will be reported regularly. Phase two of this action plan (due to be released in 2020) will focus on preventing plastic pollution in the ocean and other waters. Finally, the Government of Canada created the Canada Plastics Science Agenda (CaPSA), which highlights priority science areas required to address the issue of plastic pollution in Canada (ECCC 2019). Under theme one, CaPSA identifies the need for harmonized and standardized methodology for data collection to ensure data are comparable across species and areas, and it also indicates the need to identify sources and pathways of plastics in the environment. In theme two, CaPSA identifies the need to assess the effect of plastic on human health, wildlife, and the environment.

5.1.2. Long-term monitoring programs

The prevalence of plastic ingestion by seabirds in the Canadian Arctic has been relatively well-studied (Mallory et al. 2006, 2008; Provencher et al. 2009, 2010, 2014; Poon et al. 2017; Avery-Gomm et al. 2018). However, there remains no coordinated monitoring programs for plastic ingestion and entanglement by seabirds despite calls for national monitoring programs (Provencher et al. 2015) and recommended standardized methods (van Franeker et al. 2011; Provencher et al. 2017, 2019).

5.2. United States

5.2.1. Legal frameworks and strategies

The US Environmental Protection Agency (EPA) is responsible for regulating waste management in the US and setting standards for strategies and implementation of waste management practices. The US has a variety of national policies that address marine debris, such as the *Marine Debris Research, Prevention and Reduction Act* (2006), the *Maritime Pollution Prevention Act* (2008), and the *Save Our Seas Act* (2018; **Table S3** for complete list). These Acts enable research, monitoring, reduction, and prevention of marine debris. At the national level, the only ban on plastic pollution that currently exists is the *Microbead Free Waters Act* (2015), which prohibits the manufacturing and distribution of cosmetics that contain microbeads (United States Congress 2015). Following recommendations from the EPA, each state has the authority to introduce its own rules and regulations for waste management. At a local level, Alaska (the only US state in the Arctic), has various municipal bans on plastic bags, and a state-wide legislation pending (Baglaws.com n.d.), but no other legislation that specifically addresses plastic pollution.

5.2.2. Long-term monitoring programs

Seabirds have been examined for plastics in Alaska since the late 1970s (Day 1980; Robards et al. 1995; Vlietstra and Parga 2002; Bond et al. 2010; Yamashita et al. 2011; Tanaka et al. 2013), but there are no coordinated long-term monitoring programs for plastic ingestion and entanglement by seabirds in this region. However, the US has citizen science monitoring programs, such as the National Oceanic and Atmospheric Administration (NOAA) Marine Debris Monitoring Program (MDP) and the Coastal Observation and Seabird Survey Team (COASST) that monitor marine plastic pollution on beaches. The NOAA MDP monitors the amount and type of marine debris in coastal areas in North America (including locations in Alaska) and uses these data to track the progress of marine debris prevention initiatives in these regions (NOAA 2020). Similarly, COASST engages citizen scientists in monthly surveys of marine debris and beached birds in coastal areas, with recent efforts in Alaska (COASST 2020).

Elsewhere in the US, there are established plastic pollution monitoring programs such as San Francisco Bay Microplastics Project (5 Gyres Institute 2020) that collect data on sources and pathways of microplastics in the region and uses these data to make policy recommendations in the area (Box and Cummins 2019). Though these projects are not based in the Arctic, they could be used as a guideline to develop similar monitoring programs in Alaska.

6. Discussion

Marine plastic is an increasing global issue that can impact a variety of marine biota (Laist 1987, 1997; Provencher et al. 2017; Hallanger and Gabrielsen 2018), making it an important concern for scientists and policy makers worldwide. To address this environmental problem, various policies and programs have been implemented to prevent, reduce, and monitor plastic in the marine environment. In the Arctic, there is a broad range of international, national, regional and local policies and legislation that include marine debris, addressing both its sources and impacts in this region (**Tables S1**–**S3**). This includes a range of policy tools that largely address waste management and pollution from ships, but not the conservation of seabirds and other wildlife.

Internationally, the Global Convention on the Conservation of Migratory Species of Wild Animals and the Convention on Biological Diversity encourage parties to address marine debris and its impact on migratory species and marine and coastal biodiversity (**Table S1**). However, while these types of international forums are important to encourage global coordination and action, these frameworks do not necessarily outline specific actions for countries to adopt to address plastic pollution in seabirds or other wildlife, and instead are designed to serve as frameworks for countries to adapt according to their own specific issues. Regionally, the OSPAR Convention (**Table S1**) is the only policy (as of March 2020) that specifically addresses seabirds, where plastic ingestion in northern fulmars is monitored and used as an indicator of the marine environment (OSPAR 2010). The OSPAR Maritime Area consists of five regions in the northeast Atlantic (including an Arctic region which constitutes approximately 40% of this area). However, the monitoring of plastic ingestion by northern fulmars is mainly occurring in the Greater North Sea area to date.

Among the Arctic countries, Greenland, the Faroe Islands, Finland, Iceland, Norway, and Sweden have signed the OSPAR Convention, but Norway and Iceland are the only countries that have implemented the plastic pollution OSPAR seabird monitoring component. While other Arctic countries have applied the protocol opportunistically (e.g., Canada; Poon et al. 2017), these studies are not a part of a coordinated national policy or long-term monitoring programs. Though these opportunistic studies contribute to our understanding of plastic ingestion by Arctic seabirds, they cannot be used to assess temporal trends of plastic pollution in Arctic ecosystems due to small sample sizes, lack of repeat sampling at the same site, and large intervals between sampling periods (Poon et al. 2017; Baak et al. 2020). Further, a lack of standardized methods makes it difficult to compare impacts across seabird individuals and populations. This reinforces the need for long-term monitoring programs on plastic ingestion by seabirds in the Arctic to track trends in plastic pollution and the potential effects on seabird populations. Further, the development of a shared database (e.g., the International Council for the Exploration of the Sea's Marine Environment database used by OSPAR, HELCOM, and other expert groups) for securing long-term monitoring data with proper quality control and assurance procedures would be needed for improving pan-Arctic assessments.

Long-term monitoring programs are imperative to determine the efficacy of policy through temporal changes in marine plastic pollution. For example, the effectiveness of reducing single-use plastic bags varies, ranging from 33% to 96% depending on the policy (Schnurr et al. 2018). Xanthos and Walker (2017) noted that because policy announcement occurs months or years before implementation, monitoring of marine plastic can be conducted pre- and postimplementation to determine if these policies are positively impacting marine ecosystems. For example, after MARPOL was enacted to reduce pollution from ships, the proportion of industrial pellets in seabirds from the South Atlantic and Indian Oceans decreased, suggesting that these policies are beneficial (Ryan 2008). Similarly, through OSPAR, van Franeker and the Save the North Sea (SNS) Fulmar Study Group (2013) determined that the number and mass of industrial plastics are decreasing in northern fulmars since the 1980s when monitoring started. However, despite declines in industrial pellets, seabirds are vulnerable to ingesting other types of marine plastic, such as hard plastic fragments, soft plastic packaging, balloons, and foamed plastics like polystyrene (Ryan 2008; Kühn and van Franeker 2012; Roman et al. 2019), and in the North Sea the ingestion of user plastics has increased or remained stable over time (van Franeker et al. 2011). Though there are currently few policies that address marine plastic in seabirds, any policy that effectively prevents, reduces, or removes plastic in the marine environment will subsequently reduce plastic in Arctic seabirds.

Importantly, policies on plastic pollution vary widely across Arctic countries. Given that plastic pollution is subject to long-range transport, this inconsistency across the region is likely to reduce efficacy of actions to reduce plastic pollution and to monitor changes over time. Therefore, for policies to be more effective, pan-Arctic coordination is required so that similar programs can be implemented in a coordinated manner. This cooperation could be facilitated at a regional level (i.e., the Arctic Council), or at the international level in a forum in which many of the Arctic countries are already engaged (i.e., UNEP).

Plastic pollution has negative impacts on Arctic biota, which are already vulnerable to a variety of environmental threats (i.e., climate change, habitat destruction, chemical pollutants). Given that northern fulmars have been effectively used in the North Sea to track trends in plastic pollution, future policies should not only include actions to reduce plastic pollution in the environment but also ensure that an environmental indicator, such as seabirds, be included in policy development as a monitoring tool. The OSPAR protocol has been implemented in the Arctic (Iceland, with ad hoc sampling that uses the protocol in Canada, Greenland, and the Faroe Islands). While many regions of the Arctic are not a part of the OSPAR area, a similar protocol could be adopted at the pan-Arctic level to harmonize with ongoing OSPAR efforts.

Importantly, while many policies do not include seabirds, many of the policies that were reviewed can benefit seabird populations. For example, several countries have policies that address abandoned, lost, and discarded fishing gear. In Iceland, there is a fee associated with the purchase of fishing gear (*Act No. 162/2002*) that is waived when this gear is recycled, and now the fishing industry recycles up to 90% of disused gear (Clean Nordic Oceans 2019). While plastic pollution from fishing efforts may not directly relate to plastic ingestion in seabirds, reports from other regions have demonstrated that seabirds can be particularly vulnerable to lost, discarded, or abandoned fishing nets (i.e., ghost nets; Huin and Croxall 1996; NOAA 2015; Hallanger and Gabrielsen 2018) through entanglement (Ryan 2018). While there is very little information on how Arctic-breeding seabirds are affected by ghost nets and other abandoned, lost, or discarded fishing gear, it is likely that these negatively affect seabirds in the Arctic through either ingestion or entanglement, and that any actions to reduce this type of plastic pollution will benefit seabird populations.

Approximately 80% of marine plastic pollution comes from land-based sources (Jambeck et al. 2015; Falk-Andersson and Strietman 2019). Though human and industrial activities are lower in the Arctic compared with southern areas (UNEP 2016, 2018), wind and ocean currents transport this debris from these areas to the Arctic (Cózar et al. 2017). This highlights the need for both pan-Arctic and international collaboration to implement and enforce marine plastic policies and programs. We recognize that plastic waste management can be difficult to implement in developing countries; thus, it is good practice for developed countries to include provisions to developing nations in marine plastics policy. For example, Canada is providing CAD $100 million to help developing countries reduce plastic waste in oceans and coastal areas (Government of Canada 2020). Similarly, Norway has provided approximately USD $200 million on The Norwegian Development Program to Combat Marine Litter and Microplastics, to help prevent and reduce the extent of marine litter from large sources in developing countries in the period 2019–2022 (Government of Norway 2018).

7. Conclusions

Though many Arctic countries have marine plastic policies in place, few directly address plastic ingestion monitoring for seabirds despite the increasing levels of plastic in seabirds across the Arctic (Provencher et al. 2009; Kühn et al. 2015; Kühn and van Franeker 2020). Importantly, though not directly addressing seabirds, policies on prevention, reduction and removal of plastic in the marine environment can also help reduce plastic impacts on seabirds. Marine plastic should be addressed by all levels of government. However, marine plastic policy and programs in the Arctic are implemented inconsistently across regions, and until the completion of the Arctic Council Regional Action Plan on Marine Litter, there is no pan-Arctic framework to address marine plastic pollution. Further, there is a lack of enforcement and follow-up monitoring, making it difficult to determine effectiveness of these policies. To curb this environmental contaminant, pan-Arctic and international collaboration are needed to implement consistent policies and programs. Additionally, international standardized research and monitoring programs for marine plastic are required to inform these decisions and facilitate comparisons across regions.

Acknowledgements

We thank Maria Pettersvik Arvnes, Amalie Ask, Katrín Sóley Bjarnadóttir, Andreas Haugaard Christensen, Nina Dehnhard, Laura Dukowski, Geir W. Gabrielsen, Ingeborg Hallanger, Sjúrður Hammer, Andrew Horan, Marthe Margrethe Haugen, Hermanni Kaartokallio, Margaret McCauley, Peter Murphy, Caitlin Owen, Eirik Drabløs Pettersen, Elisabet Rosendal, Mia Rönkä, Kine Øren, and and members of the Conservation of Arctic Flora and Fauna (CAFF) Circumpolar Seabird Expert Group for useful comments and for contributing information on legal frameworks. This work was supported by the Arctic Council Project Support Instrument (PSI), managed by the Nordic Environment Finance Corporation (NEFCO) and the CAFF working group of the Arctic Council. JEB was supported by a Natural Sciences and Engineering Research Council scholarship at Acadia University.

Author contributions

JFL, JEB, TB, MVG, MLM, FRM, CP, JS, TRW, and JFP conceived and designed the study. JFL, JEB, TB, MVG, MLM, FRM, CP, JS, TRW, and JFP contributed resources. JFL, JEB, TB, MVG, MLM, FRM, CP, JS, TRW, and JFP drafted or revised the manuscript.

Competing interests

Mark Mallory is on the Editorial Board.

Data availability statement

All relevant data are within the paper and in the Supplementary Material.

Supplementary material

The following Supplementary Material is available with the article through the journal website at doi:10.1139/facets-2020-0052.

Supplementary Material 1

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