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A Canadian policy framework to mitigate plastic marine pollution

Shauna Pettipas *, Meagan Bernier, Tony R. Walker

School for Resource and Environmental Studies, Dalhousie University, Halifax, NS, Canada

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ABSTRACT

Marine pollution from plastic debris is a global problem causing negative impacts in the marine environment. Plastic marine debris as a contaminant is increasing, especially in Canada. While the impacts of macroplastics are well known in the literature, there are relatively few policy studies related to mitigating microplastic toxicity in the environment. Despite overwhelming evidence of the threat of plastic in the marine environment, there remains inadequate or limited policies to address their mitigation, particularly microplastic debris. Existing policies for waste management, marine debris monitoring and awareness campaigns were evaluated from other jurisdictions. Policies and recommendations were developed for the Canadian context. Recommendations include improved practices for: (1) law and waste management strategies; (2) education, outreach and awareness; (3) source identification; and (4) increased monitoring and further research.

1. Introduction

Plastic marine debris pollution is a global problem causing negative impacts in the marine environment. Marine impacts include entanglement or entrapment of seals, turtles and seabirds, ingestion, habitat destruction, transport and bioaccumulation of contaminants [1–4]. Coastal economies may also be impacted with declines in tourism or increased cleanup costs. Fishing, aquaculture, and seafood industries may suffer from poor catches that require increased fishing effort [5]. Additionally, marine plastic pollution may decrease the esthetic appeal of coastal areas [3,6,7].

While societal benefits of plastics are unquestionable, they are highly durable, degrade slowly and create widespread environmental and waste disposal problems [8]. Macroplastics (>5 mm) enter the marine environment via rivers, poor waste management or by being simply dumped into the ocean [2,9]. Degradation of macroplastics into microplastics (<5 mm) has received increased attention recently [10]. Microplastics are the most abundant plastic in the ocean and exist in two forms, primary and secondary [4]. Primary microplastics are tiny plastic granules (e.g., scrubbers in cosmetics), while secondary microplastics are derived from degradation of macroplastics [8]. Marine microplastics are pervasive and ubiquitous with the potential to cause harm to biota [10–13].

1.1. Contaminants associated with plastic

Persistent organic pollutants (POPs) associated microplastics include polychlorinated biphenyls, polycyclic aromatic hydrocarbons, petroleum hydrocarbons, organochlorine pesticides, and bisphenol A [10,12]. POPs at low concentrations in the marine environment are sorbed onto microplastic litter and can accumulate at concentrations several orders of magnitude higher than in seawater [10]. Contaminants are subsequently transferred to marine biota most commonly through ingestion. When ingested by marine species, contaminated plastics present a pathway for POPs to enter the marine food web that can eventually be consumed by humans [12]. Although ingestion of contaminated microplastics by marine biota poses potential ecological risks through bioaccumulation, implications are still poorly understood, because few models exist to predict total pollutant loads introduced by microplastic debris into the marine environment [10]. Overall, the lack of scientific knowledge hinders management strategies or monitoring programs to mitigate marine plastic debris, and microplastics specifically [8,10–12].

The problem of plastic pollution in the oceans is undoubtedly a marine problem that has a land-based solution. Despite being an internationally recognized pollutant, supported by legislation to restrict macroplastic debris entering the marine environment, an estimated 10% (of global plastics), will enter the ocean [8]. However, there are currently no formal management strategies or policies that govern microplastic contamination [4,9].

* Corresponding author.
E-mail address: shauna.pettipas@gmail.com (S. Pettipas).

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1.2. Methodology and approach

In recent decades there have been a proliferation of monitoring studies related to marine debris, most of which comprise >70% plastic items [1,2,14]. A keyword search for "*marine debris*" in international journals such as, '*Marine Pollution Bulletin*' and '*Marine Policy*' yielded 1446 and 90 studies, respectively. While the impacts of macroplastics are well known in the literature, there are relatively few policy studies related to mitigating microplastic toxicity the environment.

Based on the apparent lack of policy studies aimed at mitigating plastic debris accumulating in the marine environment (particularly in Canada), this study was designed to assess current international and national management practices and policies, to better understand macro- and microplastic contamination in the Canadian marine environment. Recommendations for management strategies and policies concerning marine plastic contamination in the Canadian context were explored.

A literature review was conducted to assess current management frameworks and policies. Potential limitations and issues associated with marine plastic (both macro- and microplastic) contamination were highlighted using monitoring studies from across Canada. Based on this preliminary assessment, recommendations were made to support current and future policy on national and regional plastic management strategies. Recommendations to mitigate plastic marine pollution include improved practices for: (1) law and waste management strategies; (2) education, outreach and awareness; (3) source identification; and (4) increased monitoring and further research.

2. Current international policy frameworks for macro- and microplastic contamination

Environmental impacts of macroplastics are well known, with established programs designed to remove macroplastics from beaches, waterfronts, and oceans [1,3,6,15]. However, there are major gaps of scientific knowledge, hindering the development of management strategies for microplastics due to the limited number of studies [8,10–12]. While management strategies for macro- and microplastics are lacking in Canada [4,9], a few global initiatives do exist that further knowledge on plastic contamination, disposal, and pollution prevention. However, because plastics are globally persistent, development of both international and regional management strategies are required to address the issue.

2.1. Prevention of pollution from ships

Although legislation aimed at preventing disposal of waste at sea is limited, the International Convention for the Prevention of Pollution of Ships (MARPOL) Annex V prevents pollution of plastic waste by ships through international agreements and domestic legislation [13]. Some countries have their own domestic legislation (e.g., *US Marine Plastic Pollution Research and Control Act*), requiring all waste to be disposed of or recycled properly on shore, according to local waste management plans [16]. Many ports across North America have also adopted the *Green Marine* environmental program, requiring participants to provide adequate reception facilities at ports for ship generated waste [17]. In addition, shipowners are encouraged to adopt best management practices and implement effective solutions to reduce, reuse and recycle ship generated garbage. Walker et al. [6] found that ~70% of marine debris found in Halifax Harbor was derived from land-based sources, rather than ship-based sources.

2.2. United Nations Environment Programme and National Oceanic and Atmospheric Administration

The United Nations Environment Programme (UNEP) governs the Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities, which provides a mechanism for development and implementation of initiatives to address transboundary issues [9,18]. Microplastic and other marine debris issues are addressed by this program. Additionally, UNEP collaborates with the International Oceanographic Commission of the United Nations Educational, Scientific, and Cultural Organization to develop guidelines to monitor marine litter [9].

The National Oceanic and Atmospheric Administration (NOAA) and UNEP developed the UNEP Honolulu Strategy after the Fifth International Marine Debris Conference in March 2011 [3]. The Honolulu Strategy is a global tool with two purposes: (1) to describe and catalyze the multi-pronged and holistic response required to solve the problem of marine debris; and (2) to guide monitoring and evaluation of global progress on specific strategies at different levels of implementation-including local, national, regional, and international efforts and achievements. The strategy has three main goals to reduce pollution from marine debris:

- Reduce amount and impact of land-based litter and solid waste introduced into the marine environment;
- Reduce amount and impact of sea-based sources of marine debris including solid waste; lost cargo; abandoned, lost, or otherwise; discarded fishing gear; and abandoned vessels introduced into the sea; and
- Reduce amount and impact of accumulated marine debris on shorelines, in benthic habitats, and in pelagic waters [3].

The Honolulu Strategy is a framework that can be adapted and implemented worldwide to develop different programs and region specific measures [3]. Examples of region-specific programs developed from this framework include United States Environmental Protection Agency (USEPA) Marine Debris Strategy, and the Global Partnership on Marine Litter (GPML). The USEPA Marine Debris Strategy focuses on three main objectives: land-based prevention, ocean assessment and cleanup, and land-based reduction of marine debris [19]. GPML is a "voluntary open-ended partnership" and outlines seven objectives guided by the Honolulu Strategy with the goal of reducing and managing marine debris [18]. An online Marine Litter Network, demonstration projects, and public-private partnerships have been initiated to implement GPML.

2.3. Non-governmental organizations (NGOs)

Some NGOs also monitor marine debris and promote waste management education practices. The 5 Gyres institution focuses on impacts of plastic marine pollution in five subtropical ocean gyres where plastic accumulates to investigate distribution of microplastics and associated POPs [9]. Through scientific research and community engagement, the institution's goal is to raise awareness and develop solutions through a variety of social media [20].

The Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) is an organization that "advise[s] the UN's system on the scientific aspects of marine environmental protection" [21]. GESAMP has developed ecological quality standards and outlined standards that vary between countries. Clean Seas Coalition targets Californian seas and beaches, including the North Pacific Gyre. This gyre is the biggest ocean garbage patch in the world. The coalition includes a variety