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Marine debris: a persistent and emerging threat to antarctic ecosystems

Submitted by ASOC

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Marine Debris: A Persistent and Emerging Threat to Antarctic Ecosystems

Submitted by ASOC[1]

Abstract

CCAMLR has had success in tackling marine debris from local sources in the Southern Ocean; however it remains a persistent threat. Current understanding of the distribution and impacts of marine debris, particularly in pelagic areas, is limited. This is particularly concerning, as recent evidence suggests that microplastic concentrations in the Southern Ocean are higher than previously thought, and that they are from local and international sources.

Knowledge of the impacts of debris, particularly microplastics, in Antarctic ecosystems is understudied. Combatting the problem of microplastics in the Southern Ocean will require a collaborative effort between CCAMLR and other Antarctic Treaty System bodies, notably the CEP, introducing new mechanisms instruments to mitigate local sources of microplastics. These may be from both shipping activity and untreated greywater from Antarctic bases.

This paper outlines the significant gaps in knowledge of the spatial distribution of marine debris in the Antarctic relative to the rest of the world. ASOC proposes that offshore and sediment monitoring of marine debris is needed, particularly to investigate the trend of heightened microplastic concentrations in areas of high human activity in the Antarctic. Understanding of the ecological impacts of this debris is also limited, and avenues to assess these impacts on the population and community levels should be explored. CCAMLR has the capacity to detect and monitor the impacts of marine debris on populations, and could set an example for other management bodies seeking to reduce the impacts of this problem on marine species.

Overview

Marine debris is defined as 'any anthropogenic, manufactured or processed solid material discarded, disposed of, or abandoned in the marine and coastal environment' [1]. Marine debris in the Southern Ocean constitutes an array of items, including lost fishing gear and line, plastic bags and bottles. It also includes the microplastics that result from the fragmentation of larger debris items over time, and may include the microplastics from untreated greywater, such as microplastics in toothpastes and soaps, or the microfibers that are washed off synthetic fabrics in laundry. All types of marine plastics are regarded as a major threat to marine biodiversity. Due to their relative abundance – making up approximately 80% of marine debris [2], and the chemical nature of plastics; marine plastic debris poses a far greater threat to marine life around the world than other debris types [3]. Marine plastics are commonly categorized by size: microplastics (items less than 5mm in length), mesoplastics (5mm-2cm) or macroplastics (>2cm) [4]. They are categorized in this way as microplastics have a different spatial distribution than macroplastics in the environment, and pose different threats to marine biodiversity.

Research has been conducted in many of the world's oceans to identify where marine debris accumulates, and where it comes from. Marine debris overwhelmingly follows the systems of ocean currents, drops to the seafloor, or accumulates in coastal areas adjacent to its sources [2,4,5]. Most of marine debris found has been sourced on-land [2] from coastal urban areas and river mouths [6]. However, once in the ocean, these items can be widely distributed by ocean currents and persist in the marine environment for hundreds of years [5]. Plastic items do not degrade, but fragment into smaller plastic particles [7]. This means that there is a growing number of microplastics in the oceans from the fragmentation of macroplastics.

The impacts of marine debris on animals is documented in all the world's oceans, including the Southern Ocean [3]. Fish, birds and mammals have all been found to have ingested plastics, or been entangled in debris, in the Southern Ocean [8, 9, 10]. This is a potentially serious and growing threat

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to marine conservation. Microplastics have been found to carry toxic bacteria and chemicals between ecosystems [11]. They have been eaten by zooplankton, and accumulate in the marine foodweb [12].

CCAMLR conservation measures [13] and other complementary agreements [14] have successfully banned the disposal of plastics in the Convention Area and Antarctic Treaty Area, and responded to the impacts of continued entanglement of wildlife by restricting the use of packaging bands [13]. However, the new problem of local microplastic input from Antarctic bases and shipping activity, and international dispersal, needs to be addressed through collaboration with the CEP and the establishment of new conservation measures to mitigate the input of microplastics into the CCAMLR area. The cleanup of non-fishing items also needs to be addressed, as domestic waste and packaging has found to be the bulk of marine debris items found in shore-based monitoring [15].

In the Southern Ocean, there has been limited research into the distribution and impacts of marine debris [16]. Marine debris of all sizes has been found in the Southern Ocean [17]. Entanglement of seals [8,18] and seabirds [9], as well as the ingestion of plastic by Antarctic toothfish [10] have been documented. Despite mitigation strategies to minimize marine debris through CCAMLR [13], MARPOL [14] and the Antarctic Treaty regulation [19], there is evidence that marine debris remains problematic within Antarctic waters, and assessments on the distribution, sources and impacts of this debris are needed.

The distribution and abundance of marine debris in the Antarctic

When studying marine debris, the core questions of where debris accumulates, how it moves with ocean currents, and where it comes from are critical in the mitigation and clean-up of pollution. The presence of macro-, meso- and microplastics have been documented in both the sub-Antarctic and Polar regions of the Southern Ocean. Macroplastics in the Southern Ocean are found to be made up of mostly domestic waste, such as beverage cups, polystyrene and food wrappers, as well as long-line fishing gear [15, 20]. Sub-Antarctic islands have been subject to shoreline marine debris surveys, and have shown frequency deposition of marine debris along shores [15, 21]. It is known that macroplastics accumulate in gyre systems around the world [5], as well as in complex coastlines [22] and areas of high shipping activity [5]. There is a lack of calibrated research of offshore marine debris surveys to identify these trends in the Antarctic.

Microplastics have been found in the Ross Sea [11] and in the greater Southern Ocean; in some areas concentrations are comparable to the Northern Hemisphere [14]. Microplastics from the fragmentation of macroplastics, local sources and ocean transport are present around the Antarctic continent [11]. Of interest are trends showing increased concentrations of microplastics off Antarctic bases that release untreated greywater into the environment, as well as in regions of heightened shipping activity [11]. Microplastics are buoyant and can be transferred from surface ocean mixing at a much greater level than previously thought [23]. This means that the Antarctic can be exposed to external input of microplastics [14]. Surveying the concentrations and potential sources of microplastics is critical for the mitigation of further pollution of the Southern Ocean.

Research into the concentrations of marine debris in the Antarctic has been limited, often to observations in tandem with different scientific investigations, or shore-based marine debris surveys. Shore-based debris surveys have been shown to be a better indicator of the landscape's capacity to catch debris, rather than the concentrations of debris in the ocean [24]. The marine debris surveys on sub-Antarctic islands do not record the temporal or spatial scale of these surveys, and as such provide poor indications of the concentrations of marine debris in the adjacent oceans [15]. Therefore, offshore surveys, and sediment profiles of marine debris of all size categories are recommended. It is important to utilize existing knowledge of marine debris to prioritize potential areas of accumulation for research: gyre systems, areas with human activity, and complex coastlines.

The impacts of marine debris on Antarctic Ecosystems

Macroplastics pose risks to large invertebrates and marine vertebrates, namely through entanglement and ingestion. When wildlife become entangled in marine debris, their movement is inhibited, and the debris has the potential to strangle or deform animals if it is wrapped around their bodies [3]. This can

be lethal, through strangling or drowning in debris if animals are so tangled they cannot move. It also has sub-lethal impacts, as entanglement can inhibit movement and cause pain, reducing an animal's ability to move, hunt or migrate [3]. Although long-line fishing gear is documented to be relatively less abundant [15], entanglement in such gear is one of the greatest threats for marine wildlife [3]. Better assessments of lost fishing gear and its retrieval can assist in estimating the impacts of long-line fishing gear on Antarctic ecosystems.

Ingestion of plastics pose a risk to animals, particularly those with longer digestive tracts, and with limited capacity for regurgitation [25]. Plastic can remain and accumulate in the stomachs of vertebrates, suppressing appetite. This can lead to slower growth rates in animals, and starvation. Ingestion has remained a persistent threat to many species of seal and birds, and has been documented in a single Antarctic toothfish [8, 9, 10]. CCAMLR does have mitigation strategies for macroplastics in place [13], but these mitigation strategies are inadequate to eliminate the entanglement and ingestion of debris [15].

Microplastics are regarded as an increasing threat to biodiversity worldwide. There is evidence to suggest that microplastics can accumulate up the food chain [26]. The key issues of microplastics is that ingestion and entanglement has been shown to be lethal to zooplankton [12], and has potential impacts through the food web; also, as microplastics travel from northern waters to the Southern Ocean, they may act as a vector for disease [27].

Marine plastics have been found to be lethal, or have sub-lethal impacts on individuals of many marine species. One of the challenges of global marine debris research is to assess the impacts of marine debris on a population level [28]. This is proving difficult, as the impacts of marine debris are more often stressors for individuals, and mortality or reproductive limitations from marine debris is difficult to attribute [26]. Currently, literature reviews [26] and expert elicitation [29] have been the key means to assess the impacts of marine debris on populations. Due to its large area of governance and existing systems of ecosystems monitoring, CCAMLR has the capacity to develop databases of debris-wildlife interactions, and document the impacts of this debris on populations. This could directly assist in the conservation of Antarctic wildlife, and develop strategies for the conservation of marine life around the world.

Recommendations for SC-CAMLR and CCAMLR Members

It is recommended that CCAMLR and related bodies or CCAMLR Members, as relevant:

- Initiate collaborative research to assess the distribution, abundance and potential sources of marine debris including microplastics in the CCAMLR area, drawing from existing knowledge about where it accumulates in oceanic and coastal systems in other parts of the world.
    - Engage with organizations with expertise in marine debris to ensure the best available knowledge about assessing the distribution of debris is used.
- Monitor the impacts of micro and macro debris on marine vertebrates, invertebrates and zooplankton and the efficacy of Conservation Measures [16] to reduce these impacts.
    - Research to review the impacts of both macro and micro debris, on populations and communities, to be used as a case study for the rest of the world.
    - Obtain better estimates of lost longline gear from CCAMLR fisheries, along with retrieval rates.
- Establish new measures to detect, monitor and reduce the impact of all debris, particularly microplastics. Consider how to monitor microplastics in MPAs. Collaborate with the CEP to come up with a joint approach to assess, monitor and prevent the input of local sources of microplastics.
- Cooperate with other organisations, particularly IAATO and the IMO, to eliminate local inputs of microplastics and other debris items.

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