

Marine debris occurrence and treatment: A review



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ABSTRACT

Marine debris produces a wide variety of negative environmental, economic, safety, health and cultural impacts. Most marine litter has a very low decomposition rate (as plastics, which are the most abundant type of marine debris), leading to a gradual, but significant accumulation in the coastal and marine environment. Along that time, marine debris is a significant source of chemical contaminants to the marine environment. Once extracted from the water, incineration is the method most widely used to treat marine debris. Other treatment methods have been tested, but they still need some improvement and so far have only been used in some countries. Several extraction and collection programs have been carried out. However, as marine debris keep entering the sea, these programs result insufficient and the problem of marine debris will continue its increase. The present work addresses the environmental impact and social aspects of the marine debris, with a review of the state of the art in the treatments of this kind of waste, together with an estimation of the worldwide occurrence and characteristics.

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1. Introduction

“Marine litter is defined as any persistent, manufactured or processed solid material discarded, disposed or abandoned in the marine and coastal environment” [1,2]. It consists of items that have been made or used by people and deliberately discarded into the sea or rivers or on beaches; brought indirectly to the sea with rivers, sewage, storm water or winds; accidentally lost, including material lost at sea in bad weather (fishing gear, cargo); or deliberately left by people on beaches and shores [3].

The presence of marine debris is a cause for concern due to several reasons. It is known to be harmful to organisms and to human health [1,4–6], it has potential to increase the transport of organic and inorganic contaminants [7–11], it presents a hazard to shipping, and it is aesthetically detrimental, and thus generating negative socio-economic consequences [12].

Litter can easily be mistaken as food by animals and cause health complications or even death. Many studies have investigated the ingestion of plastic items by marine animals, including fish [13], cetaceans [14], turtles [15] or seabirds [16,17]. Fishing gear can become ocean pollutant as a result of accidental losses or dumping. Entanglement in abandoned fishing gear is another important threat not only for marine mammals [18,19], but also for benthic biota [20].

The economic impact of marine debris is noticeable. At beaches, marine debris causes aesthetic problems, especially in tourist areas where they generally lead to a decline in tourist traffic and oblige the concerned municipalities to substantial cleaning costs. At sea, floating marine debris endanger the maritime traffic. Small items can block propellers and collisions are always possible with larger debris. In addition, litters trapped by fishing nets is becoming a recurring issue for fishermen [21]. A diagram that represents the lifecycle of marine debris is shown in Fig. 1 (adapted from [22]): the produced plastic discards are accumulated during a period of time in the beaches and float or are washed to the seabed by water columns, suffering a fragmentation. The fate of the plastic is then its collection (via more encouraging), its decomposition (that will last hundreds of years) or ingestion by marine organisms. From this figure, it is important to note that the startup of new policies managing the discards is the only practical route for combating marine litter problem.

The material most commonly found in marine debris are glass, metal, paper and plastic (OSPAR, 2007), and, according to the publish literature, it is clearly apparent that, globally, plastic items are consistently the most abundant type of marine debris [3,23–26].

1.1. Plastics in marine debris

Plastics are synthetic organic polymers that are malleable and can be molded into solid objects of diverse shapes. In addition, they are strong, lightweight, durable and inexpensive [27], properties that make them suitable for the manufacture of a wide range of products.

The main reason why plastics are hazardous to the marine environment is their resistance to degradation. The natural decomposition of plastic items in the sea occurs in an exceedingly long time, usually estimated between hundreds and thousands of years [28], therefore, plastics accumulate in the marine environment and persist for decades [29]. Chemical contaminants such as polychlorinated biphenyls (PCBs) and dioxins are released into the sea during this degradation. Furthermore, plastic items are fragmented into small pieces, becoming plastic micro-particles (with a diameter of less than 5 mm) [30], which are ingested by animals, thus being very harmful to marine life [31,32].

Plastics have existed only for around a century [33], but since the development of the plastics industry, plastic products are the most abundant around the globe, hence representing 60–80% of the total marine debris [34]. A compilation on the proportion of plastics found in the marine debris was done 15 years ago [4]. Table 1 presents new data on the same subject published from then. An average value of > 65% of plastics in the rubbish is found, denoting the importance of controlling the plastic deposition in all places around marine environment, such harbors, beaches, and those from the fishing and recreational activity.

1.2. Composition of the plastic marine debris

The most commonly used plastics are Polyethylene, Polypropylene and polyethylene terephthalate, therefore, they are the most frequently found in the marine environment too [35–37]. Table 2 presents the data found in literature about the distribution of different types of plastics in the marine litter collected. It is important to note the very important and unexpected amounts of cellulose acetate (CA) used in cigarette filter manufacture that has been signaled as a very important problem in oceans.

2. Quantities of collected marine debris

Until the 1970s, there were no scientific texts speaking about ocean pollution by plastic waste. More than forty years later, still

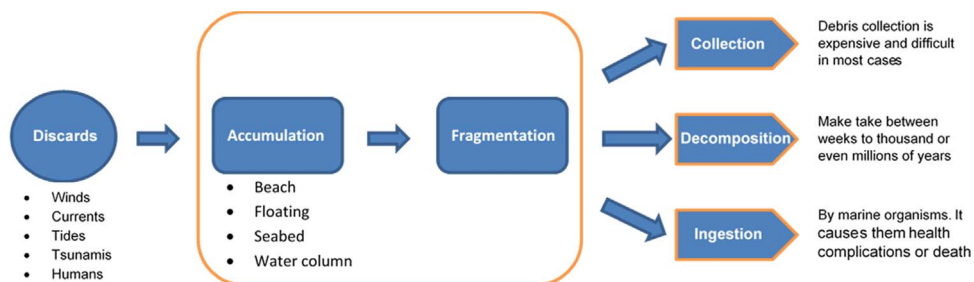


Fig. 1. Typical lifecycle of marine debris.

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