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RESEARCH ARTICLE

MARINE LITTER AND ITS IMPACTS ON FISHERIES

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ABSTRACT

Marine debris includes all objects found in the marine and coastal environment. Any object which is discarded, disposed of or abandoned that enters the coastal or marine environment can also be classified as marine debris. Some of commonly occurring items are plastics, electronic material, glass pieces, metals, Rubber and many such objects. The typical character of marine debris is that they are non-degradable and buoyant. These two characters make them enter different realms of the marine environment where they remain for a very long period interfering with the life of biota. Human beings are the main source of marine debris. Marine debris poses threats to boaters and fishers and can affect important fish habitats, nursery and breeding grounds. It poses real threats to ocean ecosystems, marine life and human health and safety. The two primary problems which marine debris pose to marine life are entanglement and ingestion. The International Convention for the Prevention of Pollution from Ships (MARPOL) is an international treaty which prohibits the disposal of plastics anywhere in the ocean and restricts the disposal of most other types of solid waste.

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INTRODUCTION

Marine litter is an environmental, economic, human health and aesthetic problem. It poses a complex and multi-dimensional challenge with significant implications for the marine and coastal environment and human activities all over the world. These impacts are both cultural and multi-sectoral, rooted primarily in poor practices of solid waste management, a lack of infrastructure, various human activities, an inadequate understanding on the part of the public of the potential consequences of their actions, the lack of adequate legal and enforcement systems and a lack of financial resources. Marine litter is found in all the oceans of the world, not only in densely populated regions, but also in remote areas far from obvious sources and human contact. Every year marine litter takes an enormous social and economic toll on people and communities around the world. The persistence of marine litter is the result of a lack of coordinated global and regional strategies and of deficiencies in the implementation and enforcement of existing programmes, regulations and standards at all levels – international, regional and national.

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Marine Litter: The international definition of marine litter, as defined by the United Nations Environment Program is "any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment. Marine litter 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" (UNEP, 2005).

Types of marine litter: The majority of marine litter consists of synthetic materials such as plastic, metal, glass and rubber. Internationally 84.1% of the total marine litter found within the coastal area (in 76 countries) could be separated into ten key items including smoking materials, food and beverage containers and other various types of packaging, which by material mainly consist of plastic (Ocean Conservancy, 2008).

General grouped materials
Specific type by materials

Plastics: Plastics cover a wide range of synthetic polymeric materials (such as polypropylene, polyethylene, polyvinyl

chloride, polystyrene, nylon, and polycarbonate) (National Research Council, 1994 in OSB, 2008). Plastics can include moulded, soft, foam, fisheries related equipment (nets, ropes, buoys, monofilament line, light sticks), and smoking related items (cigarette butts, lighters, and cigar tips), micro plastic particles, beverage bottles, bags, food wrappers, bottle caps, and toys (UNEP, 2005b). Plastics as a result of their buoyancy accumulate on the sea surface and are often washed ashore (Thompson *et al.,* 2009). Plastics comprise 50–80% of marine litter; stranded on beaches, floating on the ocean surface and on the seabed (Gregory and Ryan, 1997, Derraik 2002, Barnes, 2005, Barnes et al. 2009).The lifetime of plastics is estimated between 100-1000 years depending on the properties of the polymer and the environment it is exposed to, with increasing depth, oxygen concentrations and temperatures are low and light is absent, which further increase their lifetime (Galgani *et al.,* 2010).

Other synthetic materials

Other synthetic materials are similar to plastic in that they are used in a wide range of products, are often cheap to produce and lightweight and thus are common marine litter items. These include glass such as light globes, fluorescent globes and bottles; rubber including tyres, balloons and gloves; and metal including drink cans, aerosol cans, foil wrappers and disposable barbeques. These items can undergo fragmentation over long time periods and often do not completely biodegrade (OSB, 2008).

Semi-degradable

Processed timber such as pallets, crates and particle board, and paper and cardboard items such as cartons, cups and bags, also contribute to marine litter but is found in much smaller quantities than synthetic materials. This may be due to a shorter residence time in the marine environment as they are relatively quick to bio- and photo-degrade, thus their accumulative impact on the environment, society and economy may be much less (Velander and Mocogni, 1998; UNEP, 2005; Galgani *et al.,* 2010).

Textiles

Textiles also constitute as marine litter including clothing, shoes, and furnishings. The specific impacts of these items are unknown, but are generally considered of lesser importance than other synthetic materials (Velander and Mocogni, 1998; UNEP, 2005b; Galgani *et al.,* 2010).

Specific type by source

Sewage Related Debris: Sewage related debris (SRD) is discharged to the marine environment directly through domestic outfalls and combined sewer overflows (CSOs) or indirectly via rivers or other water courses. SRD includes cotton bud sticks, nappies, tampons, condoms, human waste (faeces) and sanitary products.

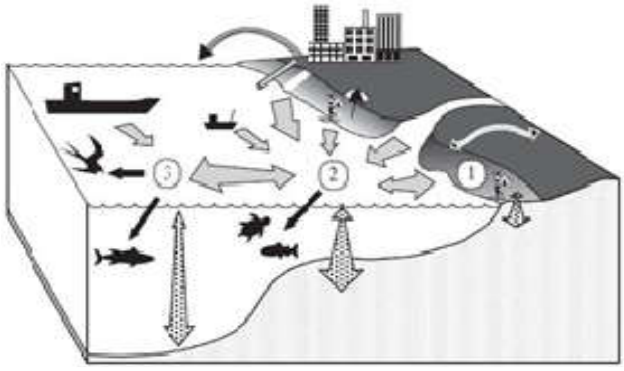
Derelict Fishing Gear: Derelict fishing gear (DFG) refers to nets, lines, bait boxes, floats, creels, and other recreational or commercial fishing equipment that has been lost, abandoned, or discarded in the marine environment. Modern gear is generally made of synthetic materials and metal. It can persist for a very long time within the marine environment (Velander and Mocogni, 1998).

Other groupings by function include

- Beverage/food packaging such as bottles, cans, lids, food wrappers and containers and disposable cups, plates, straws and utensils.
- Household items such as clothing, furniture, appliances, light bulbs and computers.
- Manufacturing and transportation-related wastes such as shipping containers and their contents, resin pellets, barrels, drums, shipping pallets, plastic sheeting and strapping bands.
- Smoking-related wastes such as cigarette filters, packaging, cigar tips and disposable lighters.

Life cycle of marine litter

Marine litter is in dynamic flux between the land and ocean interface, with several types and states of material (Cheshire *et al.,* 2009).Flux rates between different sources and sinks can be measured directly (observation of amounts of material being transported) or indirectly (inferences based on changes in the amounts of litter in each pool over time). This can aid long-term management strategies, with better control of input sources leading to reduced influx rate and accumulation in the system (Cheshire *et al.,* 2009).



The sources, pathways and sinks for marine litter. Sources include wind-blown litter (curved arrows), waterborne litter (grey arrows), vertical movement of litter through the water column (including suspension and seabed – sinks; stippled arrows), and ingestion by marine organisms (black arrows). Sinks include shallow coastal areas 1.Continental shelf 2. Open Ocean 2 and 3 include litter suspended in the water column. (Ryan *et al.,* 2009)

Source of marine litters

Human beings are the main source of marine debris. Debris can come directly from land based sources or from people who use the marine ecosystem for livelihood (fishers, navigators etc) and for recreation (tourists). Lack of proper disposal of wastes in the coastal and marine ecosystem can lead to marine debris.

Land based waste can become marine debris /litter due to

- Careless discard of household wastes in coastal areas.
- Discard of waste/trash on the beaches by coastal residents as well a tourists disposal or storage.
- Careless disposal of trash from many land based activities, including picnicking and waterside sporting events.
- Debris items from common public use areas such as parking lots, foot paths, and streets being blown, swept or washed into storm drains, which then empty untreated into the ocean.
- Improper disposal of packaging materials.
- Intentional release of waste from shore-based solid waste disposal and waste processing facilities and sewage overflows.

Fishers can add to marine debris,

- When they throw pieces of torn / broken net or monofilaments or plastic food wraps, floats etc while in the sea or on the shore
- Nets which are torn and which cannot be retrieved when it gets entangled while fishing are discarded in the ocean itself. This is very harmful and can lead to ghost fishing.

Navigators / Boaters /Tourists can add to marine debris by:

- Tourists who go for boating or people who use coastal waterways for navigation including boaters contribute to the debris problem when they throw trash such as food wrappers, plastic bags etc.

Impacts of marine debris

Environmental Impacts

Marine debris poses threats to boaters and fishers and can affect important fish habitats, the nursery and breeding grounds. It poses real threats to ocean ecosystems, marine life and human health and safety. The two primary problems which marine debris pose to marine life are

Entanglement and ingestion

Entanglement can occur accidentally, or when the animal is attracted to the debris as part of its normal behaviour or out of curiosity. For example, an animal may use a piece of marine debris for shelter, as a plaything, or as a source of food (if other plants and animals are already trapped in the debris or if the debris resembles prey that is a normal part of its diet). Fish and crustaceans (such as lobsters and crabs) are frequently caught in lost or discarded fishing gear, in a phenomenon known as ghost fishing.

Entanglement is harmful to wildlife for several reasons

- It can cause wounds which can lead to infections
- It can cause strangulation or suffocation
- It can impair ability to swim, which can become fatal

Fishes and other marine animals may ingest (or swallow) marine debris accidentally or they may feed on debris mistaking it for food. Ingestion can lead to starvation or malnutrition if the ingested items block the intestinal tract and prevent digestion, or accumulate in the digestive track. In Mangalore, an examination of the guts of oil sardine and mackerel revealed nylon ropes of length 1 mm to 4 mm. Sardines and mackerel being plankton feeders, it could have accidentally ingested along with the plankton. UNEP has estimated that in the Central Pacific there are 3 kg of marine litter for every kilogram of plankton. Off Mangalore, it was estimated that at present there are 0.00168 kg of plastic for every kg of plankton. Plastic covers are often mistaken for the feed of turtles as it resembles jellyfish, a food item of turtles. Experimental trawling in grounds off Mangalore also indicated the presence of marine litter.

Secondary pollutant

The increased fragmentation of in-situ plastic litter items, can lead to the production of micro plastics and chemicals (Thompson *et al.,* 2009). Micro-plastics also enter the oceans, from commercial activities (cleansing and air blasting) where they are used as 'scrubbers' (Derraik 2002; Thompson et al 2009). Micro-plastics and associated chemicals are transferred to the aquatic food web and up trophic levels, from their ingestion by marine species such as mussels and pose a significant threat to a wider range of organisms due to their size (Thompson *et al.,* 2004; Barnes et al 2009). In addition, micro-plastics concentrate organic pollutants such as PCBs, and DDE (Barnes *et al.,* 2009; Moore, 2008). This enables these pollutants to enter living organisms and food webs.

Benthic Habitats

Physical damage to benthic habitats can include abrasion, scouring, breaking and smothering (Sheavly and Register, 2007). The smothering of benthic organisms on the seafloor is due to reduced oxygen in sediments caused by litter, which prevents gas exchange between overlying waters. This can lead to changes in the composition of biota on the seafloor.

Ecosystem deterioration

The pressures of marine litter add to other anthropological stressors in the marine environment, such as over-fishing, coastal development, ocean acidification and pollution events (Derraik, 2002).This amalgamation of environmental stressors

may combine to cause ecosystem deterioration (either in the short or long term) and reduce ecosystem resilience to withstand large perturbations in the environment, such as climate change (ICC, 2009).

Social impacts

Public Health Issues

Beached marine litter such as broken glass, medical waste, fishing line, and discarded syringes can harm beach users as well as the risks associated with the leaching of poisonous chemicals. Sewage related debris is particularly harmful and is considered a potential biohazard and may act as a vector for viruses and bacteria.

Sewage Related Debris

One of the main sources of SRD is from combined sewage overflows and constitutes sanitary products such as nappies, baby wipes and needles (Sheavly and Register, 2007). SRD may present serious water quality concerns as with the presence of these items there is increased risk of bacterial (e.g. E. coli) and viral contamination of surrounding coastal waters. Indeed consumption of or contact with contaminated water can pose a risk of contracting hepatitis, cholera, typhoid, diarrhea, bacillary dysentery and skin rashes.

Human entanglement

Entanglement can also pose a serious threat to recreational users, particularly for swimmers, snorkelers and SCUBA divers who can become entangled in submerged or floating debris, such as fishing nets and ropes. According to the British Sub-Aqua Club, approximately one or two entanglement incidents occur each year in the UK and are potentially life-threatening, usually involving monofilament netting (Fanshawe and Everard, 2002; Mouat *et al.,* 2010).

Navigational hazards: Non-military

Marine litter poses navigational hazards to all kinds of vessels (submarines, passenger ferries, fishing vessels) and can result in serious consequences, including loss of life (Allsopp *et al.,* 2006; Chivers and Drew 2005; Macfadyen *et al.,* 2009). The main risks to navigation from marine litter (particularly during poor weather conditions) include:

- Fouling and entanglement of a vessel's propeller in derelict fishing gear: reducing stability and the ability to manoeuvre.
- Blockage of water intakes by plastic bags.
- Subsurface debris can foul anchors and equipment deployed from trawlers and research vessels.

Threats to fishermen

Threats to fishermen can include the snagging of fishing gear on marine litter, increasing the risk of capsize, and in some circumstances resulting in loss of life. (Edwards, 1995; Olin *et al.,* 1995).

Agriculture

The transfer of litter between the land and sea can also be reversed where beached marine litter is windblown back ashore, affecting coastal communities. This has been shown to damage the property and equipment including stock fencing. Other impacts include harm to livestock through ingestion and entanglement and the resulting economic impact to the land owner/farmer.

Coastal industries

Marine litter has been shown to impact upon industry such as coastal power stations via blockages in intake pipes (Fanshawe and Everard, 2002). Thus screening is required along with automated clearance mechanisms and manual labour to clear blockages. Regular clearances are necessary thus contributing to overall running costs.

Recreational activities

The marine and coastal zones offer the opportunity for many social and recreational activities such as swimming, diving, boating, and recreational fishing. The accumulation of marine litter can act as a strong but subjective deterrent from these activities (Ballance *et al.,* 2000; Sheavly and Register 2005).

Aesthetic and non-use value

Marine debris is an eyesore along shorelines around the world. It degrades the beauty (aesthetics) of the coastal environment and in many cases may cause economic loss if an area is a popular tourist destination.

Economic impact of marine litter

Marine litter has a substantial direct and indirect impact upon the country's economy. For several years policy makers and communities have experienced the problem of marine litter on beaches, waterways, bays and ports and the subsequent impacts on a range of economic activities. Marine litter is a serious non-point source pollution problem that is pervasive, and impacts users of the marine in several ways. Of these, the direct impacts are the most obvious, from local authorities responsible for clean-up activities, the loss of tourism expenditure or shifts in tourism activity, and the loss of vessel activity as a result of propeller fouling or bringing up litter in fishing nets. Indirect impacts can also be substantial and occur from a decline in the environmental quality of the coast that can cause losses in amenity and resulting losses in property values, opportunity costs and civic pride.

Marine litter in gulf of mannar (GOM)

The Gulf of Mannar (GoM) is referred as the Biologist's paradise because of the rich marine ecosystem with nearly 3600 species of living flora and fauna, apart from the seasonally migrating marine mammals like whales, dolphins, Dugongs and turtles. It is unique because of the presence of coral reefs, seagrass beds and mangroves, which act as spawning and feeding grounds and as shelter for many species

of economically important finfish and shellfish. In recent years, this unique paradise is facing a lot of disturbance and threats due to anthropogenic and natural interference on the resources (Sacratees and Karthigarani, 2008). Marine litter has become one of the problematic concerns in the Gulf of Mannar. Quantification, source and impact of marine litter in the Gulf of Mannar, India were surveyed from March 2006 to February 2008 (S. Ganesapandian, S. Manikandan and A.K. Kumaraguru, 2011). Occurrence of Shoreline marine litter during the Southwest monsoon period was the maximum and the cool winter period was the minimum. The maximum shoreline marine litter was 94-95 items of 5,409-6,588 g and the minimum shoreline marine litter was 42 items of 2,088 g. Eight percent of the total litter included only three major items, viz., Plastic (48%), polystyrene (18%) and cloth (15%). Fishing represented the largest source, Tourism/recreation was the second and Sewage Related Debris (SRD) was the third common source of marine litter (S. Ganesapandian, S. Manikandan and A.K. Kumaraguru, 2011).

Examples of serious incidents of plastic ingestion by cetaceans

- One sperm whale of 38 examined from a mass stranding in Oregon had 1 litre of tightly packed trawl net in its stomach.
- A pygmy sperm whale that came ashore in Texas had 'pounds of plastic bags clogging its stomach chambers'.
- A Pacific white---sided dolphin from Long Beach, California, had a stomach that half full of four plastic bags, two plastic bottle caps and various organic materials.
- A study of the stomach contents of 23 cetaceans stranded in the Canary Islands between 1996 and 2006, found five animals with plastic debris in their stomachs with the bigger plastic items inside the deep--- diving squid---feeding whales.

Relevant legislation and coastal management policies

- Several international agreements prohibit dumping of garbage at sea, regulate transport of hazardous waste and control land based sources of marine pollution. These include MARPOL- International Convention for the Prevention of Marine pollution from ships, The London dumping Convention and protocol and Basel Convention (Convention on the Trans-boundary movements of Hazardous Wastes and their Disposal).
- Several regional agreements address marine debris include CCAMLR (Commission for the conservation of Antartic marine living resources), OSPAR (The convention for the Protection of the Marine environment of the North-East Atlantic) and the NorthWest Pacific action plan (NOWPAP).
- Several Regional Fisheries Management Organisations (RFMOs) have adopted resolutions or recommendations on marine debris. These include Indian Ocean Tuna Commission (IOTC), The Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean (WCPFC) and Inter-American Tropical Tuna Convention (IATTC).
- FAO's Code of Conduct for Responsible Fisheries addresses lost or abandoned fishing gear.

Measures to prevent marine litter

Changing the behavior that causes marine debris to enter the environment is the only way to control marine debris. There are several designed to bring awareness to and alleviate the problem of marine debris. The International Convention for the Prevention of Pollution from Ships (MARPOL) is an international treaty which prohibits the disposal of plastics anywhere in the ocean and restricts the disposal of most other types of solid waste. All categories of water and shore users should make concerted efforts to prevent debris entering the sea.

Coastal Households and Others

- Use fewer disposable bags when shopping or carry your own reusable ones.
- Dispose of all trash in the proper receptacles and ensure that it is not blown or washed away.
- Take yur trash home with you while using a beach, park or playground.
- Get involved in cleanups in your area and encourage others to help keep the beaches and oceans clean
- Should not throw fishing nets or fishing traps/pots in the sea even if they are torn or broken

Conclusion

The present situation in the GOM is not that bleak. However, it may become a threat in due course. Although litter density found in the GOM appears to be very low compared to that of other regions of the world, these results should take into consideration the fact that litter is highly variable in time and space and differences among the sampling procedures employed can lead to different results. Most marine litter consists of non-biodegradable materials especially plastic items which degrade slowly. So a continuous input of large quantities of these items can result in a gradual build-up in the marine and coastal environment. Monitoring marine litter is essential for the provision of reliable information about the effectiveness of action taken to reduce marine litter in the marine and coastal environments.

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