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MARINE DEBRIS: DEFINING A GLOBAL ENVIRONMENTAL CHALLENGE

(Prepared by STAP)

Scientific and Technical Advisory Panel

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A STAP ADVISORY DOCUMENT

Marine Debris:

Defining a Global Environmental Challenge

In the most remote places on Earth with few or no humans present such as here on St. Brandon's Islands in the middle of Indian Ocean one can find plastic debris
(Photo credit: Henk Bouwman)

Prepared for the Scientific and Technical Advisory Panel (STAP) of the Global Environment Facility by: **Richard C. Thompson** (University of Plymouth, UK), **Bruce E. La Belle** (California Environmental Protection Agency, USA), **Hindrik Bouwman** (STAP), and **Lev Neretin** (STAP)

Executive summary

Marine habitats worldwide are contaminated with man-made items of debris. Plastic items consistently represent the major category of marine debris by material type on a global basis. This debris is unsightly, it damages fisheries and tourism, kills and injures a wide range of marine life, causes severe navigational problems, has the potential to transport potentially harmful chemicals and invasive species and represents a threat to human health. This document examines the sources of this debris, identifies its impacts on marine ecosystems and economies, proposes a framework for responding to marine debris issues, and suggests potential GEF actions.

The evidence presented on global occurrence including accumulation in the areas beyond national jurisdiction, persistence, and transboundary sources, movements and impacts on marine biodiversity and ecosystems compounded by the emerging data on potential impacts on the fate of persistent organic pollutants and transfer of alien species, makes a strong case for considering marine debris as a global environmental problem.

The focus of this document is on land-based sources and types of debris which represent the major unaddressed debris components in many regions, but measures to address sea-based sources such as pollution from ships and abandoned, lost or otherwise discarded fishing gear while sector-specific can be treated with the same framework developed in the document. The problems of marine debris are now recognized internationally alongside other major global challenges facing marine environment such as loss of biodiversity, acidification, sea level rise to name a few. Current awareness and implementation of best practices in addressing the causes of marine debris are primarily centered on end-of-pipe solutions. However, there are considerable synergistic opportunities from tackling the issues of marine debris in terms of conserving habitats, biodiversity and fisheries, reducing our reliance on non-renewable resources, limiting global carbon emissions and waste flows.

The underlying causes that result in plastic debris entering the sea from the land lie within unsustainable production and consumption patterns, including the design and marketing of products globally with little regard for their environmental fate, their ability to be recycled in the locations, where sold, compounded by often inadequate waste management practices and irresponsible behavior. Often there is geographical separation between production in relatively developed economies and consumption/disposal which is global. From a life-cycle perspective, current linear use of plastics from production, through a typically short-lived single-usage stage to disposal is the main cause and, at the same time, the main opportunity to tackle the marine debris problem.

This STAP Advisory Document advocates the use of a regional approach oriented towards the needs and perspectives of the consumers and users of marine debris sources. Solutions should be identified through cooperation between industry, government and consumer and consider all five R's (Reduce, Reuse, Recycle, Recover, and Redesign) in a regionally relevant context. Potential actions to consider in this context encompass any or all parts of the supply and value chain and the full life cycle of the product. To consider these potential actions in relation to each other, STAP proposes a framework consisting of a series of key steps in order to achieve a reduction in the quantity of waste material being produced; it includes five steps: problem identification, stakeholder dialogue among supply chain entities, facilitation, identification of knowledge gaps, development of institutional mechanism and strategic planning.

STAP recommendations for the GEF:

1. The Global Environment Facility (GEF), the largest multilateral fund supporting measures improving the state of the global environment in the context of sustainable development, has a special opportunity and could play a leading role in global efforts to tackle the marine debris problem. As a cross-sectoral issue, most interventions aimed at marine plastic debris prevention, reduction and management fall under existing mandates of several GEF focal areas including International Waters, Climate Change, Biodiversity and Chemicals, Small Grants Program and the GEF Earth Fund and public-private partnership platforms, as well as new programmatic initiatives such as Management of Marine Areas Beyond National Jurisdiction (ABNJ).

2. STAP is encouraging GEF partners to *mainstream* interventions addressing marine debris into existing and planned GEF projects and programs, specifically projects supporting management of Marine Protected Areas and fish refuges, ecosystem-based management of ABNJ and Ecologically and Biologically Significant Areas or Vulnerable Marine Ecosystems, projects supporting activities aimed at the reduction of pollution sources from land-based activities, and projects and programs promoting the use of waste-to-energy technologies with plastics waste as a source category. Participants in the Small Grants Program in relevant countries are also encouraged to consider interventions aimed at marine debris prevention, reduction and management.

3. Given the limited resources available in the GEF and the global scale of plastic debris problem in the marine environment, STAP is advising the GEF Council and GEF partners to focus support in GEF-5 on two types of activities that serve as catalysts for actions and can generate sustainably global environmental benefits. These two types of activities are based on principles embedded in the framework on marine debris management introduced in the Advisory Document:

I) A project or program testing the life cycle approach to marine debris prevention, reduction, and management in one of the areas covered by the Regional Seas Conventions and Action Plans. Building on the existing baseline and institutions and mechanisms in the selected region, GEF investments could play a catalytic role in mobilizing public and private sector resources for specific market transformation in the production, consumption, and utilization of marine debris sources such as plastics.

II) By combining the efforts of the plastics production, packaging and retailer associations, civil society organizations, multilateral institutions, and utilizing opportunities provided by the Earth Fund platforms or similar private sector initiatives, the GEF could promote, facilitate or establish a global public-private partnership to transform single-use plastics packaging markets to more environmentally friendly alternatives on a global scale. Through this initiative, the GEF would build a strong partnership with the private sector to encourage innovation and to expand assistance to developing countries and countries with economies in transition seeking to transform their use and utilization of single-use plastics packaging to protect the global environment. This initiative would simultaneously help reduce reliance on non-renewable resource, reduce waste and carbon dioxide emissions.

Chapter 1: Why is marine debris a global problem?

1.1. Global distribution and composition of marine debris categories

Marine habitats are contaminated with man-made items of debris from the poles to the equator and from shorelines, estuaries and the sea surface to the depths of the ocean. While the types and absolute quantities vary, there is no doubt about the ubiquity of debris on a truly global scale (Barnes et al. 2009; Ryan et al. 2009). Such debris can be harmful to wildlife and to human health (Derraik 2002; Gregory 2009), it has the potential to transport organic and inorganic contaminants (Mato et al. 2001; Teuten et al. 2009), can present a hazard to shipping, and can be aesthetically detrimental (Mouat et al. 2010). In addition to having consequences for biodiversity and potential indirect effects on ecosystem goods and services, marine debris has direct negative economic impacts on recipient countries, particularly those which are, in effect, coastal countries (e.g., islands, or those for which coastal regions are main area of economic activity), including developing countries and countries with economies in transition (Kershaw et al. 2011).

Marine debris includes any form of manufactured or processed material discarded, disposed of or abandoned in the marine environment. It consists of items made or used by humans that enter the sea, whether deliberately or unintentionally, including transport of these materials to the ocean by rivers, drainage, sewage systems or by wind (Galgani et al. 2010)**.** While this definition encompasses a very wide range of materials, most items fall into a relatively small number of material types and usage categories. In scanning the literature including UNEP Regional Seas reports, scientific papers, and government reports, it is readily apparent that plastic items consistently rank as being among the most abundant types of marine debris on a global scale (see (Figure 1 and Table 1 for illustration from South African and South American beaches, respectively and Figure 2 for Europe) (Coe and Rogers 1997; Thompson et al. 2009a; UNEP 2009). This report will therefore give much of its focus to considering plastic debris in terms of sources and causes, accumulation and consequences, potential solutions and associated recommendations.

Scope of the problem

Plastics are incredibly durable and represent a ubiquitous category of marine debris. While data on temporal trends are variable, there is evidence that despite efforts to remove debris from the marine environment and legislation to restrict dumping at sea, quantities of marine litter are increasing (Barnes et al. 2009; Thompson et al. 2004). Of particular concern is the accumulation of Abandoned, Lost or Otherwise Discarded Fishing Gear (ALDFG) from at sea disposal, and in particular fishing nets which continue to catch fish long after they have become marine debris. Often plastics-based ALDFG threatens marine habitats, fish stocks and is also a concern for human health (Macfadyen et al. 2009).

Because of their buoyancy and durability, plastic items can travel substantial distances; plastics from cargo lost from ships have, for example, been reported over a decade later more than 10,000 km from the point of loss. Hence, in addition to shoreline or near-shore impacts, marine debris can have long-term impacts in the open ocean (Barnes et al. 2009). Ocean modeling indicates that floating marine debris originating from the western coast of South America, French Polynesia, New Caledonia, Fiji, Australia, and New Zealand not only fouls the coastlines of nations and archipelagos in the region where released, but much of it is pushed by wind and currents to the South Pacific subtropical gyre where it accumulates. A recent high profile publication in the journal *Science* presented over 20 years of data clearly demonstrating that some of the most substantial accumulations of debris are now in oceanic gyres far from land (Law et al. 2010). Therefore, marine debris, and in particular plastic debris, represents a growing transboundary global problem that recognizes no national borders and spread from coasts to open ocean in Areas Beyond National Jurisdiction (ABNJ).

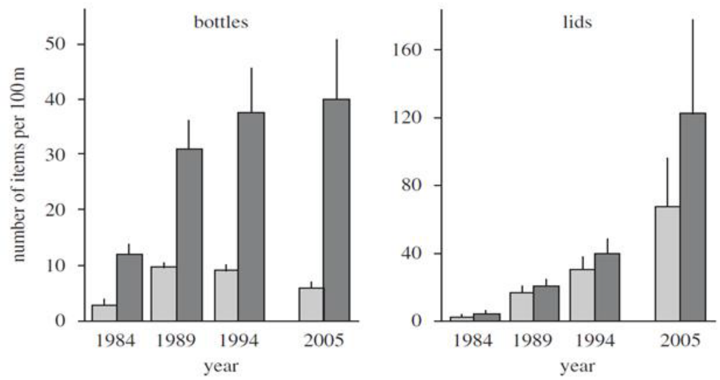

Figure 1. Trends in the abundance of plastic bottles and lids (bars show mean ± standard error) on South African beaches. Light grey bars – data fro m 36 beaches with regular municipal cleaning programmes; dark grey bars – data from 14 beaches with no formal cleaning programmes (Ryan *et al.* 2009).

Table 1. Ten most common items collected in South America during the 2005 International Coastal cleanup. Each item is shown as a percentage of related sources of litter with the combined percentages for the top ten items shown by country at the base of the table (Source: UNEP 2009).

Panamá		Colombia*		Ecuador		Perú		Chile	
Percentage of related sources of litter									
Beverage plastic bottles	11.8	Beverage plastic bottles	20.6	Cigarettes / filters	55.5	Beverage plastic bottles	41.4	Bottle caps and other containers	38.7
Bags	10.6	Beverage glass bottles	16.6	Bottle caps and other containers	8.4	Bags	10.3	Beverage plastic bottles	30.9
Clothes	10.2	Bottle caps and other containers	12.8	Bottle caps and other containers	6.4	Bottle caps and other containers	7.1	Cigarettes / filters	8.4
Cups, plates and utensils	8.6	Bags	12.2	Bags	4.8	Cups, plates and utensils	4.1	Food wrappings	4.4
Beverage glass bottles	7.4	Plastic joints	8.4	Food wrappings	3.9	Clothes	3.0	Bags	4.1
Beverage cans	6.5	Clothes	4.7	Rope	2.9	Toys	2.6	Plastic joints	2.8
Bottle caps and other containers	6.4	Cups, plates and utensils	4.2	Cups, plates and utensils	2.9	Cigarettes / filters	2.5	Beverage glass bottles	1.4
Food wrappings	6.2	Food wrappings	3.7	Beverage glass bottles	2.3	Plastic straws and swizzle sticks for drinks	2.5	Chlorine bottles and other cleaning articles	1.1
Plastic joints	4.1	Beverage cans	3.1	Plastic joints	1.7	Diapers	2.3	Cigarette packs and wrappings	0.9
Oil bottles	2.9	Plastic straws and swizzle sticks for drinks	2.7	Plastic straws and swizzle sticks for drinks	1.6	Beverage cans	2.2	Building materials	0.9
Total	**74.7**	**Total**	**89.0**	**Total**	**89.2**	**Total**	**78.0**	**Total**	**93.6**

** Data reference for San Andrés, Colombia (Caribbean island)*
Source: Ocean Conservancy

Marine debris, and in particular the accumulation of plastic debris, has been identified as a global problem alongside other issues key of our time including climate change, ocean acidification and loss of biodiversity (Sutherland et al. 2006; Sutherland et al. 2009; UNEP 2011a). This report sets out to indicate some of the solutions, and in doing so, aims to highlight the potential synergies and benefits that can be achieved by tackling the underlying causes of marine debris. These include economic benefits for industry, for developed and emerging economies, benefits for fisheries and for biodiversity together with considerable potential to reduce global carbon emissions.

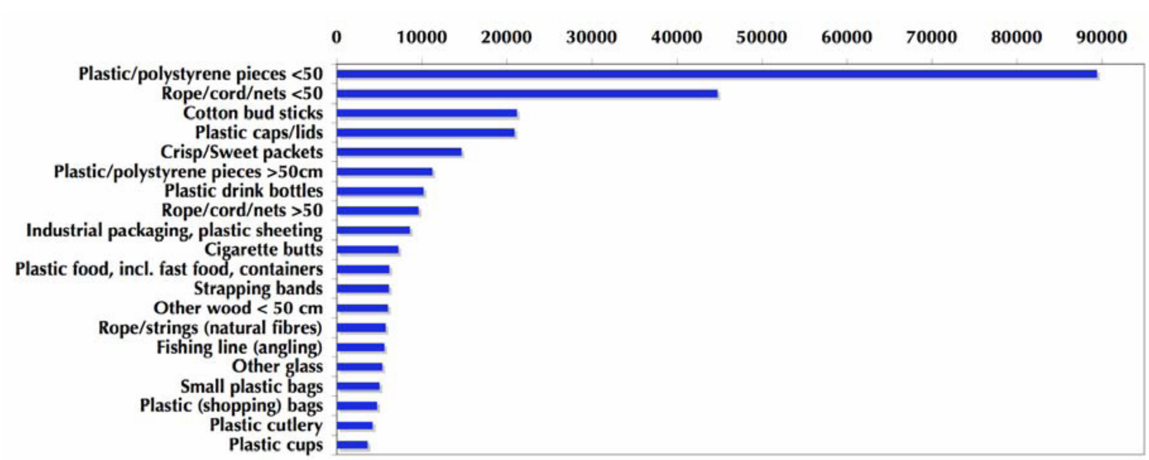

Figure 2. Combined data showing total number of items of marine debris from 100m sections of selected reference beaches in Europe examined between 2001 and 2006. Note the prevalence of plastic items as a major component of marine debris. These trends are broadly consistent across regions and at a global scale. The analysis was based on data from 609 surveys made in eight countries – Belgium, Denmark, Germany, The Netherlands, Portugal, Spain, Sweden and the United Kingdom (51 regular reference beaches altogether). (Source: OSPAR 2007).

1.2. Marine debris and global ecosystem impacts

More than 260 species are already known to be affected by marine debris through entanglement or ingestion (Figures 3 and 4). Ingestion by birds, turtles, fish and marine mammals is well documented and can be fatal. A wide range of plastic types are involved and the species affected range from entanglement of cetaceans in rope and netting, suffocation of birds and turtles by plastic film to ingestion of microscopic fragments of plastic by fish and invertebrates (Derraik 2002; Gregory 2009; Laist 1987). Small particles are of concern because they may be ingested by a wide range of organisms and could have adverse physical effects, for example by disrupting feeding and digestion (Barnes et al. 2009; GESAMP 2010).

Figure 3. a) Turtle entangled in plastic rope in Caribbean (photo: UNEP-CAR/RCU, 2008); b) Entanglement of a seal at Gweek Seal Sanctuary in Cornwall (photo by Caroline Curtis; source: OSPAR 2009).

Of the 120 marine mammal species listed on the IUCN Red List 54% are known to have been entangled in or have ingested plastic debris; 34 out of 34 green turtles and 14 of 35 seabirds found along the southern Brazilian seacoast, had ingested debris, with plastic being the main ingested material. In addition to ingestion and entanglement, beach debris that had washed up from River Asi, an international river passing through Lebanon, Syria and Turkey, has been shown to adversely affect the ability of green turtle hatchlings to reach the sea on the Samandag coast in Turkey (Ozdilek et al. 2006). If the plastic particles break down into nano-sized particles, they may impact the bottom of the food web upon which the ocean and global climate depend. It has been reported in a laboratory study, for example, that nanopolystyrene beads can inhibit photosynthesis and cause oxidative stress in algae (Bhattacharya et al. 2010).

Evidence of harmful effects of plastic on wildlife is mostly restricted to observations on individual specimens that have become entangled in or have ingested plastic debris. There is as yet little evidence of effects on assemblages of species although concerns have been raised about potential consequences for ecosystem-wide impacts and ecosystem goods and services. Population level data for Northern Fulmar, *Fulmarus glacialis*, have shown that over 95% of birds washed ashore dead contained plastic in their gut, with many individuals having substantial quantities of plastic (Barnes et al. 2009; Van Franeker et al. 2005).

Plastic debris has also been implicated in the transport of non-native invasive species which can raft considerable distances on floating debris. Over 150 multi-cellular species have been reported associated with plastic debris, the majority being hard shelled species including bivalve mollusks, barnacles, tube worms, bryozoans, hydroids and coralline algae; and there is evidence that items of plastic washed ashore are often fouled by non native species. Some species of *Vibrio* bacteria was shown to grow preferentially on plastic particles in the ocean. While it is unknown whether those found can cause disease, the finding is of potential concern. There is also the potential for "rafting" on plastic debris to facilitate transport of species across boundaries of water masses that might otherwise be relatively impenetrable (Derraik 2002; Gregory 2009; Laist 1987).

While the most visible types of plastic debris are large derelict fishing gears, bottles, bags, and other consumer products, much of the debris collected during survey trawls consists of tiny particles or "microplastic" (Thompson et al. 2004). This material has been defined as pieces or fragments less than 5*mm* in diameter (Arthur et al. 2009). A horizon scan of global conservation issues recently identified microplastic as one of the top global emerging issues (Sutherland et al. 2009). Microplastic is formed by the physical, chemical and biological fragmentation of larger items, or from the direct release of small pieces of plastic from industrial spillage of pre-production pellets and powders, and microscopic plastic particles that are used as abrasive scrubbers in domestic cleaning products and industrial cleaning applications such as shot blasting of ships and aircraft (Barnes et al. 2009). Plastic items fragment in the environment because of exposure to UV light and abrasion, such that smaller and smaller particles form, though this material does not biodegrade (Roy et al. 2011). The quantity of fragments is therefore expected to increase in the seas and oceans. Fragments as small as 2µm have been identified from marine habitats around Singapore (Ng and Obbard 2006), but due to limitations in sampling and analytical methods the extent to which this type of debris has fragmented into nanoparticle-size pieces is unknown. Microplastics have accumulated in the water column, on the shoreline and in subtidal sediments (Barnes et al. 2009; Thompson et al. 2004).

As colloidal size particles, nanoplastic particles could be subject to different vertical transport mechanisms than larger fragments and more work is needed to understand the potential sinks where this material will accumulate (Hansell et al. 2009). However, there is already clear evidence that small plastic fragments are the most common size fraction reported in oceanic gyres in the Pacific and Atlantic, with some of the highest densities being reported in the open ocean rather than in coastal waters adjacent to population centers. In some locations the abundance of small fragments in the water column is increasing (Law et al. 2010).

There is concern that small plastic fragments might present a toxicological challenge. Plastics contain a variety of potentially toxic chemicals that are incorporated during manufacture (monomers and oligomers, bisphenol-A (BPA), phthalate plasticisers, flame retardants and antimicrobials). There is evidence regarding the potential for these chemicals be released to humans from plastic containers used for food and drink, plastic in medical applications, and in toys (Koch and Calafat 2009; Lang et al. 2008; Meeker et al. 2009; Talsness et al. 2009), and so there is the potential that these substances might also be released if plastics are ingested by marine organisms (Oehlmann et al. 2009; Teuten et al. 2009). While exposure pathways have not been determined, chemicals used in plastics such as phthalates and flame retardants have been found in fish, sea mammals, mollusks and other forms of marine life. This raises concerns about a potential for toxic effects. For example, BPA, for which there is evidence from laboratory studies of adverse effects on a variety of aquatic organisms, may enter the marine benthic environment from plastics that settle to the bottom of the sea. Phthalates have been shown in laboratory studies to have adverse effects on aquatic organisms (Oehlmann et al. 2009). While a direct link between plastic marine debris and adverse effects on populations of marine organisms would be very difficult to demonstrate experimentally, if such effects were to occur they would be no way of reversing or remediating them due to the nature of marine debris accumulation in the environment (GESAMP 2010; Thompson et al. 2009b).

Studies in Japan demonstrated that plastic debris can absorb persistent organic pollutants (POPs) from the ocean water and that within a few weeks these substances can become orders of magnitude more concentrated on the surface of plastic debris that in the surrounding water column (Mato et al. 2001; Teuten et al. 2007; Teuten et al. 2009). At present our understanding about the potential for plastics to adsorb, transport and release chemical contaminants is limited. Basic thermodynamic equilibrium calculations indicate that over large ocean areas (e.g., between the tropics and the Arctic) transport of POPs adsorbed to plastics is insignificant compared with long-range transboundary fluxes with air and ocean waters (Gouin et al. 2011). However there are concerns that for shorter distances and timeframes, plastics may short-circuit the long-term equilibrium processes resulting in increased exposure. There are concerns that as plastic particles become re-distributed in the water column and sediments they may carry adsorbed chemicals with them. There is also concern that if a marine organism ingests plastic particles with adsorbed POPs, the POPs may subsequently be released into the gut (Teuten et al. 2007; Teuten et al. 2009).

It is often difficult to separate marine debris impacts from a range of other anthropogenic factors influencing marine ecosystems but it is important to acknowledge marine debris as an important additional degradation agent. Addressing the impacts of marine debris on biodiversity will often be impractical using the same approaches adopted to reduce other human impacts such as over-exploitation and disturbance. The latter can be relatively efficiently regulated through the use of marine reserves, protected areas and integrated coastal zone management. The potential for plastic debris to travel considerable distances and to accumulate in habitats far from its point of origin presents a distinct challenge that is difficult if not impossible to resolve once the debris is adrift. Conservation methods based on spatial planning will be ineffective to deal with plastics debris in many settings. As such, prevention at source is the key to mitigating increases in marine debris.

1.3. Social-economic impacts of marine debris

Fishing, transportation and tourism sectors, as well as governments and local communities, suffer from the negative economic and financial impacts of marine debris (Brink et al. 2009; Mouat et al. 2010). Of particular concern, the costs associated with plastic and other marine debris are often borne by those affected by, rather than those causing, the problem.

The most obvious impacts are economic, such as loss of fishing opportunities due to time spent cleaning litter from nets, propellers and blocked water intakes and multiple impacts on subsistence livelihoods. For instance, fouling of the nets of subsistence fishermen in Jayapura, Irian Jaya province, Indonesia, with plastic bags was serious enough to reduce catch rates and result in lost revenues. It has been estimated that the damage from marine debris on fishing, shipping, and tourism industries in the APEC region is US$1.265 million annually. Marine debris costs the Scottish fishing industry are around US$16 million per year, the equivalent of 5% of the total revenue of affected fisheries. There are additional negative consequences for aquaculture. Marine debris is also a significant ongoing navigational hazard for shipping, as reflected in the increasing number of coast guard rescues to vessels with fouled propellers. In the United Kingdom for example there were 286 such rescues in 2008, at a cost of up to US$2.8 million. Cleanups of beaches and waterways can be expensive. In the Netherlands and Belgium, approximately US$13.65 million per year is spent on removing beach litter. Cleanup costs for municipalities in the United Kingdom have increased by 38% over the last ten years, to approximately US$23.62 million annually and it is estimated that removing litter from South Africa's wastewater streams would cost about US$279 million per year.

A further consideration is aesthetic damage caused by marine debris. Litter affects the public's perception of the quality of the environment. This, in turn, can lead to loss of income to tourism, and in some cases by national economies dependent on tourism. A model of the value of beach quality in Dalian, China, for example, gives an estimation of coastal beach quality improvement of RMB¥168 (about US$26) per person (Brink et al. 2009; Kershaw et al. 2011; Mouat et al. 2010).

In contrast, there are environmental and economic advantages associated with waste minimization achieved through material reduction, re-use and recycling. For example, where plastics are recycled to produce goods that would otherwise have been made from new (virgin) polymer, this will directly reduce oil usage and emissions of greenhouse gases associated with the production of the virgin polymer (less the emissions owing to the recycling activities themselves). One of the key benefits of recycling plastics is to reduce the requirement for plastics production (Hopewell et al. 2009; Thompson et al. 2009b; WRAP 2006; WRAP 2008). In terms of energy use, recycling has been shown to save more energy than that produced by energy recovery, even including the energy used to collect, transport and re-process the plastic. Life-cycle analyses (LCA) have also been used for plastic recycling systems to evaluate the net environmental impacts and these find greater positive environmental benefits for mechanical recycling over landfill and incineration with energy recovery. It has been estimated that PET bottle recycling gives a net benefit in greenhouse gas emissions of 1.5 tonnes of CO2-e per tonne of recycled PET as well as reduction in landfill and net energy consumption. An average net reduction of 1.45 tonnes of CO2-e per tonne of recycled plastic has been estimated as a useful guideline to policy. A recent LCA showed that using 100% recyclable PET bottle instead of a virgin PET bottle will reduce the full life-cycle emissions from 446 to 327 g CO_2 per bottle or 27% per cent relative reduction in carbon emissions (Hopewell et al. 2009; Thompson et al. 2009b).

Chapter 2: How to address the marine debris problem?

2.1. Major causes (=sources and processes) of marine debris

Some of the major sources of marine debris are well described, and include sewage and run-off related debris, materials from recreational/beach users, and materials lost or disposed of at sea from fishing activities (such as ALDFG) or shipping. Debris originating from the land is either transported by storm water, via drains and rivers toward the sea, or is blown into the sea from the land (Macfadyen et al. 2009; Ryan et al. 2009). Extreme weather events such as hurricanes, extreme floods and rain are important pointed sources of marine debris from/to the sea. Sea-based sources of debris represent additional, and in some regions, substantial sources of debris. The dumping of waste at sea is regulated by many agreements and conventions and while there are problems with enforcement, reductions in the amount of debris from ship-based activities have been reported in some regions. Two commonly used tools in reducing ship-based sources of marine debris are the use of appropriate educational materials (e.g., multilanguage posters and video footage), and the availability of appropriate and convenient port reception facilities for waste from ships (Mouat et al. 2010; Thompson et al. 2009b).

ALDFG represents a problematic aspect of sea-based sources of the marine debris. It undermines fisheries management and threatens biodiversity. ALDFG can have significant negative economic, ecological and public health effects including habitat destruction through abrasion or smothering, macrofaunal entanglement, ingestion, and prolonged ghost fishing. Increases in the scale of fishing operations, universal use of synthetic materials and expansion of fishing into the deep-seas and ABNJ have increased these impacts (Macfadyen et al. 2009). ALDFG has been recognized internationally as a major problem. Proposals for addressing the problem have been made at the level of the United Nations General Assembly (UNGA) and its specialized agencies and programmes including the Food and Agriculture Organization of the United Nations (FAO), the United Nations Environment Programme (UNEP), the International Maritime Organization (IMO), and the Conference of the Parties of the Convention on Biological Diversity (CBD COP). There have also been regional calls to address ALDFG. Initiatives to reduce ADLFG are crucial and implementation principles are generally similar to measures addressing land-based sources of debris such as discarded consumer goods and packaging (prevention, mitigation, removal and awareness raising), but there are many important sector-specific issues[1].

The main focus of this document is to consider the most appropriate solutions to address key *land-based* sources and types of debris which represent the major unaddressed components of debris in many regions. The underlying causes that result in debris entering the sea from the land are broad, spanning production, use and disposal of the items that become marine debris. Hence the problems and the solutions have origins not only in coastal communities, but also far inland. They are rooted in production and consumption patterns, including the design and marketing of products internationally without regard for their environmental fate or ability to be recycled in the locations where sold; as well as within inadequate waste management practices and irresponsible behavior. In addition, there can be considerable geographical separation between production, which is typically centered in relatively developed economies, and consumption/disposal which is global. Another important factor is that despite the durability of plastics, approximately 30% of all global production (estimated at about 260 million tonnes annually) (PlasticsEurope 2008; Thompson et al. 2009c) are single use plastic items or packaging discarded within a year or so of production (Figure 5).

[1] For more information and measures to reduce ADLFG, please refer to the document MacFadyen et al. (2009) available at: http://www.fao.org/docrep/011/i0620e/i0620e00.htm

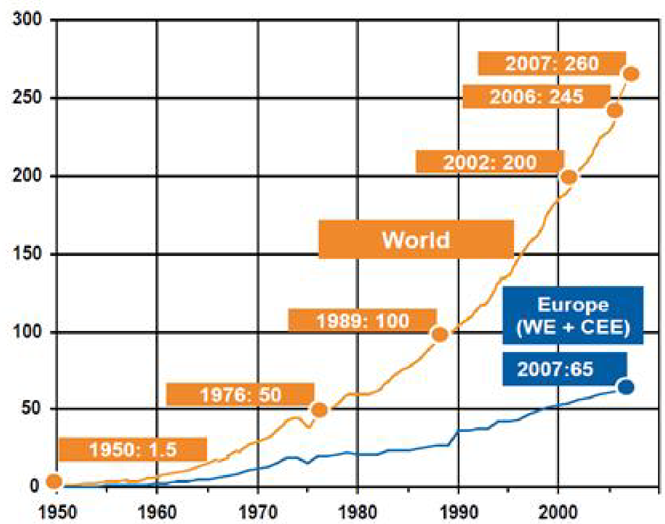

Figure 5. Global and European production of plastics (millions tones per annum) from 1950 to 2007. Data include thermoplastics, polyurethanes, thermosets, elastomers, adhesives, coatings and sealants and PP-fibers. Not included are PET-, PA- and polyacryl-fibers (source: Plastics Europe, 2008).

Plastic production continues to grow at about 9% annually. Developed countries of Europe, Northern America and Japan account for about 60% of global production and have the highest plastics consumption per capita rates of about 100-130 kg/yr per capita. The demand and consumption of plastics in the developing countries on all continents is rapidly growing driving shift in production and conversion of plastics from developed to developing countries. The highest potential for growth is in the rapidly developing countries of Asia; CEIT countries in Europe have also some of the highest growth rates in plastics consumption (Figure 6). Current consumption of plastic similar to production shows an exponential increase with more plastics being produced in the first decade of the present century than in the entire preceding century (Thompson et al. 2009c).

2.2. Key challenge: how to stop marine debris entering marine and freshwater environment?

A key challenge in addressing the problems associated with marine debris is in broadening the range of available management measures. At present these are predominantly ‘end of pipe’ responses, rather than preventative. The most commonly used approaches vary regionally, but include educational notices about the problems of dumping and littering, provision of litter bins on beaches, port reception for waste from ships, and extensive clean-up campaigns on shorelines and at sea (Figure 7). These measures are important, but in relation to ever increasing global and regional trends in the quantity of plastics waste being produced, it becomes clear that a paradigm shift is required in the way we address this global problem.

2.3. Introducing a need for paradigm shift: Marine debris in a broader context of sustainability and green economy

As noted above, from a life-cycle perspective linear use of resource from production, through a typically short-lived usage stage to disposal, is a central underlying cause of marine debris (Thompson et al. 2009b). The quantity of debris is related to economic productivity, since this will be paralleled by the quantity of end-of-life material generated; which will in turn either become waste disposed via landfill, incineration (Figure 7), or release as debris to the natural environment. While the trends in quantity of debris are parallel with economic growth, the pathways which cause debris to enter the environment are transboundary and global.

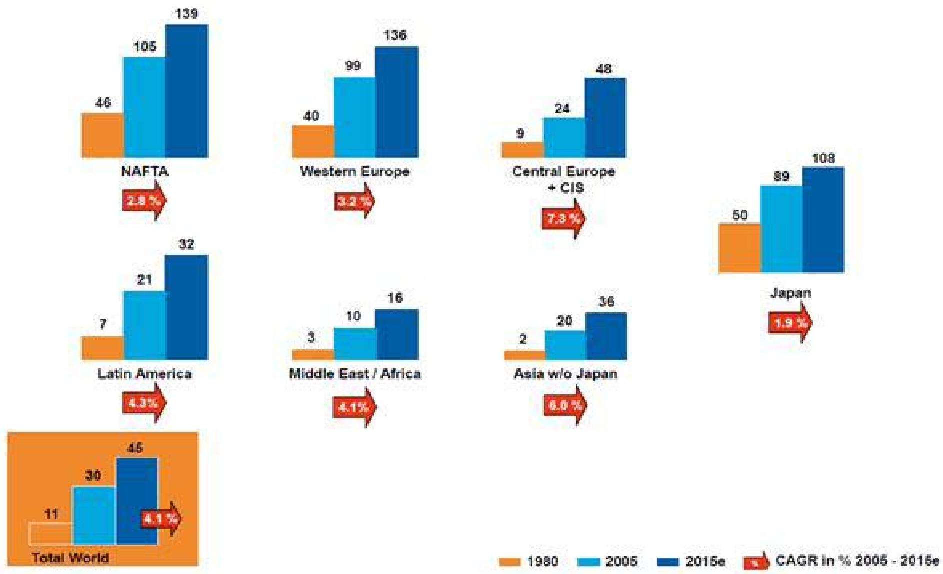

Figure 6. Plastic demand by converters shown by region expressed as values in kg/yr per capita, together with predicted increase by 2015. Most significant growth is anticipated in Asia and Eastern Europe. (source: Plastics Europe 2008).

If there are manufactured products and associated packaging there is a potential source of debris. Much of the current production and consumption lacks long-term sustainability because the amount of raw materials and our capacity to deal with waste are finite (Barnes et al. 2009; Thompson et al. 2009b). Recognition that marine debris is not merely a waste management issue is also fundamental to addressing the underlying causes of this debris. As such, solving the marine plastic debris problem through a full life-cycle approach is one of the potential testing grounds for the green economy concept: using fewer resources per unit of economic output, and reducing environmental impact of any resources that are used or economic activities that are undertaken without compromising growth. Applied to plastics, this means promoting structural economic changes that would generate production of environmentally friendlier alternatives, reduce plastics consumption and increase recycling and reuse, promote investments in alternative conversion technologies and new materials and products, and support an enabling environment including capacity building, new regulations and standards (Thompson et al. 2009b).

The greatest progress in this regard can be made by simultaneously focusing on *the direct* problems associated with marine debris. For example; plastic items are often designed in developed countries for single-use without consideration of their impacts on marine ecosystems and coastal tourism. Such impacts may have a disproportionate effect on less developed nations or regions that often lack the funding, infrastructure, or space for integrated materials and waste management. Consideration of the sustainability of production and end-of-life disposal of the items produced should be incorporated the product design phase, rather than when an item becomes waste. In essence, consideration of material reduction, re-use and recycling from product design through to the end of its life, would not only contribute towards sustainability, but would also directly reduce the quantity of waste that requires disposal and hence the potential for this waste to become marine debris.

Figure 7. Illustrative examples of coastal clean-up activities across UNEP Regional Seas: A, India; B. Japan; C. Greece; D. Yemen; E. Djibouti and F. Australia. (A. Marine litter in the South Asian Seas Region, South Asia Co-operative Environment Programme 2007; B-E. UNEP 2009; F., Macfadyen and Huntingdon, 2009).

An illustration of the paradigm shift in material use required is provided by considering production use and disposal of plastics which are currently the main component of marine debris. Plastics are lightweight, durable and inexpensive; plastic products bring undoubted benefits to society in medical, educational, and transport applications. Global production of plastics accounts for around 4% of world oil production in the products themselves and a further 4% in the energy required for this production. Given the increasing demand for domestic production and import of plastics packaging with increasing economic development, it is not surprising that plastic often constitutes more than 70% of the marine debris reported.

Yet plastics are inherently very recyclable, have considerable potential to turn end-of-life items back into new items. However, there is little economic incentive to recycle when the costs of producing a new plastic bottle are less than that of recycling that same bottle, hence the need to revamp economic systems and incentives. Recognizing the value of end-of-life plastics as a raw material for new production not only reduces waste in the environment, it incentivizes careful disposal as opposed to littering, reduces reliance on non-renewable oil and gas resources and is and as a whole would generate multifaceted global environmental benefits and benefit economies (Thompson et al. 2009b).

Figure 7. An open waste dump in Chile (source: UNEP, 2009).

2.4. Introducing a conceptual framework for marine debris prevention

While the marine debris problem has transboundary and global sources and causes, the types and quantities of litter, and their impacts, have strong regional components. Numerous relatively generic approaches have been identified to reduce the amount of debris produced, to better manage the waste that is produced and to remove from aquatic habitats the waste that has accumulated. The three R's – *reduce, reuse, recycle* are widely advocated to reduce the quantities of waste and especially plastics packaging waste we generate (Figure 8 a-c). To be effective we need to consider the interconnectivity between three R's in combination with each other and together with a fourth 'R', *energy recovery*. Indeed we also need to consider a 5th 'R', Redesign, including both molecular redesign via green chemistry approaches, as well as product redesign with greater resource efficiency in mind as an emerging and potentially very important strategy. Hence, the three R's become five: 'reduce, reuse, recycle, recover and redesign'.

There are opportunities to '*reduce'* usage of raw material by down-gauging (Figure 8, a) and opportunities to '*reuse'* plastics, for example in the transport of goods at an industrial (pallets, crates; Figure 8, b) and a domestic (carrier bags) scale. However, there is limited potential for wide-scale reuse of packaging because of the substantial back-haul distances and logistics involved in returning empty cartons to suppliers. Some of the energy content of plastics can be '*recovered'* by incineration and non-combustion technologies, and through approaches such as co-fuelling of kilns, this can be reasonably energy-efficient but multiple trade-offs have to be accounted for before such decisions are made. Combustion of marine debris plastics may result in the formation of chlorinated dioxins and furans and other persistent toxic compounds such as brominated dioxins[2]. While energy recovery for certain types of debris have benefits compared to disposal to landfill, energy recovery does not reduce the demand for raw material used in plastic production, hence it is considered less energy efficient than product recovery via recycling.

[2] Due to these negative impacts, combustion of plastics debris could be a very serious environmental issue in developing countries if done unregulated or poorly regulated. While the exemption continues under the Stockholm Convention for POPs, which allows the recycling of POP BDEs, the plastic production chain continues to be contaminated with brominated POPs which end up in plastic marine debris. Many of the resultant PBT byproducts of plastic incineration already contaminate and damage the marine environment and food chain. Any specific disposal technology chosen should not create additional environmental problems such as increased emissions of POPs.

There is now a strong evidence base to indicate that significant potential lies in increasing our ability to effectively '*recycle*' end-of-life plastic products. Although thermoplastics have been recycled since the 1970's, the proportion of material recycled has increased substantially in some countries in recent years. The recycling message is simple: both industry and society need to see end-of-life plastic as a raw material rather than waste. Greatest energy-efficiency is achieved where recycling diverts the need for use of fossil fuels as raw materials (Figure 8 c); good examples being the recycling of polyethylene terephthalate (PET) bottles into new ones (closed-loop recycling) (Hopewell et al. 2009).

Figure 8. Solutions to marine debris include: (a) measures to reduce the production of new plastics from oil, here an example showing how small changes in product packing reduced the weight of packaging required by 70% while (b) re-useable plastic packing crates have reduced the packaging consumption of the same retailer by an estimated 30,000 tonnes per annum; (c) recycling, here bales of used plastic bottles have been sorted prior to recycling into new items, such as plastic packaging or textiles. Measures to reduce the quantity of plastic debris in the natural environment include: (d) educational signage to reduce contamination via storm drains and (e) via industrial spillage together with (f) booms to intercept and facilitate the removal of riverine debris (photographs a and b, and associated usage statistics) courtesy of Marks and Spencer PLC; (c) courtesy of P. Davidson WRAP; (d and e and f) courtesy of C. Moore, Algalita Marine Research Foundation) (source: Thompson *et al.*2009)

Historically, the main considerations for the design of plastic packaging have been getting goods safely to market and product marketing. There is an increasing urgency to design plastic products, especially packaging, for material reduction and high end-of-life recyclability. The physical and intellectual capital that went into the design and production of the plastic item should be seen as a valuable resource not to be squandered. Public support for recycling is high in some countries (57% in the UK and 80% in Australia), and consumers are keen to recycle; but the small size, the diversity of different symbols to describe a product's potential recyclability, together with uncertainties as to whether a product will actually be recycled if collected, can hinder engagement. In addition, recycling requires significant investment infrastructure for collection, transport, sorting, and management of the recyclable items. While such infrastructure can be economically feasible in developed nations, it may not be feasible or cost-effective for developing countries. Molecular *redesign* of plastics (the 5th R) has become an emerging issue in green chemistry that should be incorporated within the design and lifecycle analysis of plastics. In this context, green chemists aspire to design chemical products that are (i) fully effective, yet (ii) have little or no toxicity or endocrine disrupting activity; (iii) that break down into innocuous substances if released into the environment after use; and/or (iv) are based upon renewable feedstocks, such as agricultural wastes. One of the fundamental factors limiting progress on all other R's, is that the design criteria used to develop new monomers have rarely included specifications to enhance reusability, recyclability or recovery of plastic once it has been used. Typically, such assessments have only been made after a product has entered the marketplace and been recognized as having unintended consequences (Thompson et al. 2009b).

Specific examples are illustrated in Figure 8. Such actions will only succeed if they are based on regional priorities, and oriented towards the needs and perspectives of the consumers/users in the affected regions and nations. Solutions should be identified through cooperation between industry, government and consumer and consider all five R's in a regionally relevant context. Potential actions to consider in this context encompass: (i) any or all parts of the supply and value chain, and the full life cycle of the product from educating users (Figure 8 d and e); (ii) collecting and remove debris from the environment (Figure 9 f); and (iii) measures to reduce the production of waste or improve the design of the product itself.

A framework suggested in this document (Figure 9) requires a series of key steps in order to achieve a reduction in the quantity of waste material being produced and should be applied at the regional level:

1) Identify key, regionally-specific, aspects of marine debris that are particularly problematic, clarifying the needs and perspectives of the consumers/users in the affected regions and nations and selecting these as priorities for action (e.g., plastic bottles, fishing gear, fast food packaging, etc.);
2) Organize a dialogue among key stakeholders in the supply chain including producers (or importers), the users (be they members of the public or commercial sector), those responsible for end of life handling of waste products, non-governmental organizations;
3) Provide facilitators for the dialogue who are proficient in the necessary evidence related problems identified, the various steps in the supply chain and the actions that might be available to help address the problem;
4) Identify research / information gaps (if any) required;
5) Establish institutional mechanisms and devise appropriate strategies and action plans together with policy-makers in the affected nations.

It is evident from the UNEP Regional Seas reports that problems of marine debris vary on a regional basis, as do the potential solutions. The starting point is clearly to identify a specific problem in terms of the types of marine debris of concern (consumer waste, industrial waste, and packaging). A clear evidence base relating to the problem should be established, and it is essential that this considers all stages in the supply chain relating to the item(s) of debris: where and in what quantities are they made, for what purpose, what is the lifespan and what are the local options at the end of life.

The next step is to bring together the key players in the supply chain, and organize an evidence-based dialogue aiming at the identification of ways to reduce the accumulation of debris. This could be a reduction in production of the waste, a reduction in the need for the material that becomes the waste, and/or a better approach to dealing with the end-of-life material in order to prevent it from accumulating. There may be some potential gaps in the evidence base requiring research and development and time needed to address such gaps should be considered. The next step would be to facilitate the most desirable options via a range of implementation strategies such as public awareness, development incentives and regulation. Finally it is crucial to measure success via monitoring of both changes in the scale of the marine debris problem identified at the outset, and assessment of the effectiveness of the individual implementation strategies and action plans. Raising awareness is a cross-cutting activity that will facilitate the development and implementation of all elements of the framework.

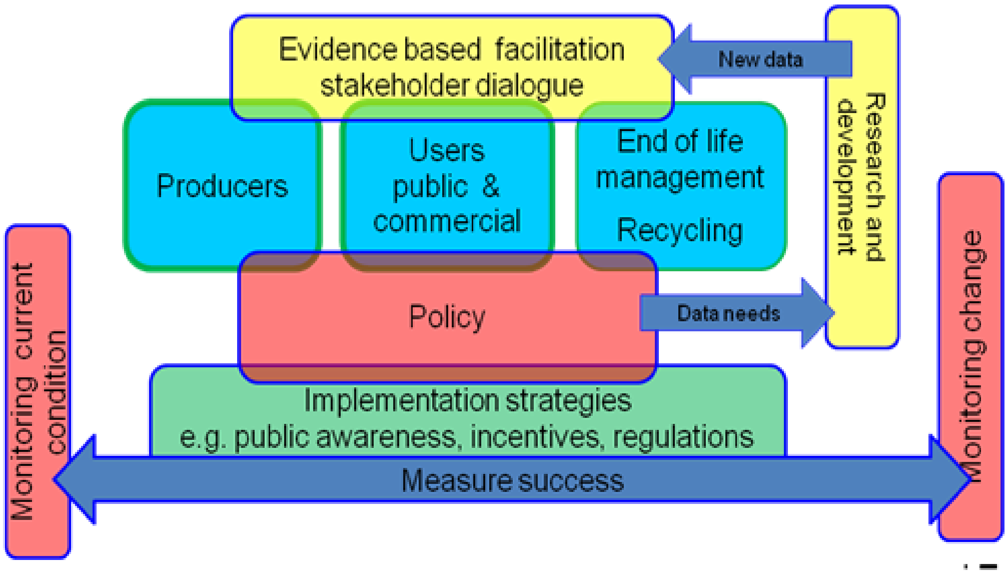

Figure 9. A framework describing key stages to tackle specific marine debris priorities on a regional basis.

By way of example if plastic bottles represent a key problem the solutions may differ between regions recognizing that proposed measures should aim at input reduction. A region and its nations may place an emphasis on market forces (inherent recycling value of end of life material), market incentives (recycling incentives, extended producer responsibility), rethinking the product/market (reusable bottles, light-weighting of bottles), or some combination of these approaches, depending on the region's needs and capabilities. If capacity for recycling is readily available then the following might be appropriate a) producers design for end of life recyclability, b) suppliers identify material using recycled content and with high end of life recyclability and inform consumer choice, (c) educators inform consumers about good practice, and (d) recycling infrastructure is established. Conversely in regions where recycling is less feasible, the focus might be toward material reduction, material re-use, and development of a cost-effective strategy for waste management either to landfill and/or energy recovery.

For debris in the open ocean in ABNJs it will be harder to reach back up the supply chain, and in this case it may be that response initially be focused on 'end of pipe' approaches such as removal of debris together with education campaigns as the most realistic options. In the longer term, reductions in inputs of debris achieved in inshore waters on a regional basis should also reduce the quantity of debris entering ABNJ. As modeling and sampling data continue to clarify how materials from different on-shore sources contribute to marine debris in the ocean proper, the regional approach provides a useful framework for identifying priorities for action and potential solutions to this problem.

Chapter 3: Existing global frameworks as the basis for GEF's response

The global importance afforded by states to the marine debris problem is reflected in resolutions by the UN General Assembly on oceans and the law of the sea. At the latest 65th session, the UN General Assembly urged states to support measures aimed at prevention, reduction, and pollution control of any source of marine debris. A resolution called on states to cooperate regionally and sub-regionally to implement joint prevention and recovery programs for marine debris (A/65/L.20).

There are multiple global legal instruments and voluntary agreements aimed at the prevention and management of marine debris, both on land and sea. Currently, the most applicable overarching legal framework addressing marine debris is provided by the United Nations Convention on the Law of the Sea (UNCLOS). It entered into force in 1994 calling for the protection of the entire marine environment from all sources and types of marine pollution, including marine debris. UNCLOS does not directly address the issue of terrestrial waste reduction, except Article 207 calling on states to pass national legislation combating pollution from rivers, estuaries, and pipelines. Among more specific agreements regulating different sources of marine debris at the sea are:

- The International Convention for the Prevention of Marine Pollution from Ships (MARPOL) and its Annex V prohibiting at-sea pollution by all plastics and restrictions on at-sea discharge of garbage from ships.
- The London Convention for the Prevention of Marine Pollution by Dumping of Wastes and other Matter and its 1996 Protocol.
- Current IMO efforts are underway on the revision of MARPOL Annex V provisions aimed at prohibiting almost any garbage discharges from ships at the sea, on tackling the inadequacy and upgrade of port reception facilities and development the port reception facilities database as a module of the Global Integrated Shipping Information System.
- Two new standards relevant to marine debris are expected to be introduced soon by the International Organization for Standardization (ISO): ISO 21070: Shipboard Waste Management Standard and ISO 16304: Port Reception Facility Standard.
- Certain provisions (Annex IX wastes containing Annex I materials) of the Basel Convention on the trans-boundary movements of hazardous wastes and their disposal are applied to marine debris wastes.
- While the Convention on Biological Diversity (CBD) has not yet adopted specific guidance addressing the impacts of debris on marine biodiversity, the Convention does have an overarching framework for addressing threats to marine biodiversity. Decision X/29 on marine and coastal biodiversity adopted at CBD COP-10 calls on states and other relevant entities to assess and monitor the impacts and risks of human activities on marine and coastal biodiversity, mitigate the negative impacts and risk of human activities to the marine and coastal biodiversity, and adopt complementary measures to prevent significant adverse effects by unsustainable human activities to marine and coastal areas, especially those identified as ecologically or biologically significant. Aichi Biodiversity Targets 7 and 11 are generally applicable in the context of marine debris impact on coastal and open ocean biodiversity.

- The Convention on the Conservation of Migratory Species of Wild Animals (CMS) will consider for adoption specific resolution on marine debris submitted by Australia at the next COP meeting (CMS/StC37/21).

Among prominent global soft legal instruments with specific provisions for marine debris are:

- The Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities (GPA) created by the Washington Declaration in 1995 and putting, *inter alia*, priority on addressing land-based sources of marine debris emphasizing implementation at the regional level.
- The UNEP Global Initiative on Marine Litter provides a platform for the management of this problem. Regional Seas Conventions and Action Plans are main partners in implementing this Initiative. Through a range of activities aimed at the assessment on distribution and sources of marine debris, preparation of Regional Action Plans and management initiatives, twelve Regional Seas programmes (Conventions and Action Plans) took part in the Global Initiative including Baltic Sea, Black Sea, Caspian Sea, East Asian Seas, Eastern Africa/West Indian Ocean, Mediterranean, Northeast Atlantic/OSPAR, Northwest Pacific/NOWPAP, Red Sea and Gulf of Aden, South Asian Seas, Southeast Pacific/SPREP, and the Wider Caribbean/CEP.
- Marine debris is put as a thematic focus of Global Partnership on Waste Management currently under development by UNEP (http://www.unep.or.jp/ietc/SPC/activities/GPWM/Framework.asp).
- The FAO Code of Conduct for Responsible Fisheries encourages states to tackle issues addressing requirements of the MARPOL. FAO Committee on Fisheries (COFI), the only intergovernmental forum on fisheries, regularly considers marine debris issues associated with fisheries activities, specifically abandoned, lost or otherwise discarded fishing gear (ALDFG).
- ALDFG issue is also considered by the UN Fish Stocks Agreement in force since 2001, and by a number of soft law agreements such as the 1991 Voluntary Guidelines for the making of fishing gear, and 2011 International Guidelines for bycatch management and reduction of discards.

The above review presents several applicable instruments and frameworks at the global level. There are hundreds of legal, regulatory and management initiatives at the regional, national, sub-national and community levels. Notably but not exhaustively:

- The development of marine debris indicators for the European Commission Marine Strategy Framework Directive. The EU is currently discussing a pilot project in the Mediterranean that would provide alternative income to local fishermen through buy-back of collected marine debris;
- For more than 10 years a Practical Integrated System for Marine Debris in South Korea is a successful national example of the integrated and highly sophisticated infrastructure project addressing the marine debris issue using a life-cycle approach from identification, waste prevention, deep survey and removal and marine debris treatment and recycling (Jung et al. 2010);
- Other notable examples include marine debris work undertaken by NOAA and its partners in the United States; Waste and Resources Action Programme of the UK and others;

- Dozens of initiatives on marine debris including plastics are implemented by industries such as Operation Clean Sweep reducing losses of resin pellets by American and British plastics industries, Waste Fishing Gear Buy-Back Project in Korea;
- Expand-Away-from-Home Access initiative promoting recycling in the State of California and Keep America Beautiful Initiative in the USA;
- Collection of discarded fishing gear on some Southern African coasts, and many others.

The recently concluded 5th International Marine Debris Conference in Honolulu, Hawaii, (attended by more than 400 participants from 38 countries) reflected and manifested the global importance and the increasing awareness of the global community on the impacts of marine debris on the environment and response measures (http://www.5imdc.org/). The meeting culminated in the adoption of the Honolulu Commitment and launching of the Global Declaration on Marine Debris Solutions by the American Chemistry Council and Plastics Europe, representing 47 world plastics organizations from 29 countries. A Honolulu Strategy: A strategic framework for the prevention, reduction, and management of marine debris is currently being developed to be the first integrated global framework document dedicated entirely to the marine debris.

A wide range of non-governmental organizations (NGOs) are focusing efforts on marine debris prevention, reduction, and clean-up including Algalita Marine Research Foundation, 5 Gyres Initiative, International Coastal Cleanup by Ocean Conservancy, Project Kaisei, Plastic Pollution Coalition, Surfriders and many others. The International Coastal Cleanup by Ocean Conservancy is the largest global volunteer effort to clean-up beaches, but also to address the sources and distribution of marine debris globally.

While there is a broad range of global instruments addressing the issue from sectoral, land-based or sea-based perspectives, few are effective. Marine debris present in the ocean remains an increasingly significant global environmental problem. The issue is complex and extends beyond the jurisdictional authority of any one country, institution or global entity to address. The fundamental problem is a disconnect between responses aimed at addressing the causes of marine debris and efforts addressing the impacts of marine debris. While the main cause of most of the plastic debris in the marine environment is a result of unsustainable production, consumption and poor waste management patterns on land and falls under sub-national jurisdiction, the global regulatory frameworks described above and relevant national obligations are almost entirely applied to maritime issues when discarded items have already become debris or waste (Leous and Parry 2005). The lack of overarching jurisdictional responsibility in any single agreement for the entire life-cycle chain from production to disposal to clean-up is compounded by the lack of enforcement in existing regulations and lack of standards for more sustainable plastics production and consumption activities. This may partially be explained by the lack of economic and financial incentives, though, in contrast, more efficient production processes can actually lead to economic savings for companies, and economic incentives for recycling plastic waste can be instituted by governments. The root cause of plastic pollution in the marine environment can be turned into an economic opportunity. Reducing raw materials usage through green design alternatives, more sustainable consumption, and improved options for re-use, re-cycling and zero waste management - all support green economy goals and help to reduce marine debris. Greening of the waste sector will offer multiple opportunities beyond positive impacts on marine debris prevention such as economic and environmental benefits of recycling, development of waste-to-energy markets and technologies, reductions in GHG emissions, job creation, and others (UNEP 2011b).

Waste management practices on land will always be insufficient to solve the marine debris problems because this approach does not take into account solutions upstream of waste management such as green design of environmentally friendly alternatives to plastics[3] and clean-up activities of accumulated marine debris along the coasts, in the open ocean or settled on the seafloor. Nor does it provide a feedback loop to assess the effectiveness of applied measures in reducing the amount of debris in the marine environment. An effective framework should be designed with results-based management approaches. It should recognize the priority needs and perspective of the local stakeholders (consumers/users) in the affected regions and nations, and then bring these stakeholders together to identify solutions across the entire life cycle of the materials that become marine debris. Some of these key stakeholders include producers, distributors, consumers, and waste management practitioners as well as tourism officials, tourist industries, and researchers studying the impacts of marine debris on ecosystems, economies, and societies.

Chapter 4: STAP's recommendations for GEF response

This paper argues for considering marine debris as a global environmental issue because of its

- global occurrence including in ABNJ,
- persistence,
- transboundary nature of debris sources, movement and impacts,
- significant impacts on global marine organisms and biodiversity, and
- emerging evidence of its potential impacts on the fate of persistent organic pollutants and transfer of alien species.

The Global Environment Facility (GEF), the largest multilateral fund supporting measures improving the state of the global environment in the context of sustainable development, has a special opportunity and is well positioned to play a leading role in global efforts to tackle the marine debris problem. As a cross-sectoral issue, most interventions aimed at marine plastic debris prevention, reduction and management fall under the mandate of several GEF focal areas including International Waters, Climate Change, Biodiversity and Chemicals, as well as public-private partnership based Earth Fund and the Small Grants Program.

- In the Biodiversity Focal Area, marine debris measures will contribute to more effective management of coastal and near-shore protected area networks and interventions that address the issue of invasive alien species.
- In the International Waters Focal Area, measures addressing marine debris fall under several strategic objectives supporting multi-state cooperation to rebuild marine fisheries and reduce pollution of coasts and Large Marine Ecosystems and promotion of learning and targeted research needs for ecosystem-based, joint management of transboundary water systems.

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[3] Bio-based and "biodegradable" plastics are important innovations, but there is no single plastic polymer available that is subject to degradation under in situ conditions existing in the marine environment. Polylactic acid-based lids, polyhydroxyalkanoates-based bags, and corn starch based trash bags can degrade completely in the enclosed composting facility only, while oxodegradable and UV-degradable bags, low-density polyethylene plastic bags, sugar cane lids, and Kraft paper do not. Furthermore, currently available degradable plastics can contaminate the existing plastic recycling streams (Song et al. 2009).

- A new area for the GEF, effective management of Marine Areas Beyond National Jurisdiction (ABNJ) could address marine debris, particularly AFDLG, as activities supporting Regional Fisheries Management Organizations to protect deep-sea species, marine biodiversity, and seamount habitats through the application of ecosystem-based approaches and use of conservation tools such as MPAs and spatial management tools.
- At least two strategic objectives of Climate Change Focal Area supporting (i) demonstration, deployment, and transfer of innovative low-carbon innovative technologies and (ii) promotion of energy efficient, low-carbon transport and urban systems, could explore multiple opportunities offered by plastics waste-to-energy solutions.
- Finally, the Chemicals Focal Area provides an opportunity to support the demonstration of a "zero waste" concept when applied to plastics debris, particularly important in coastal cities. Where feasible and synergies with POPs focal area can be demonstrated, GEF support for economic incentives aimed at prevention and collection of solid waste will have positive impacts on marine debris problem. Targeted investments at the source of plastics debris will also address the reduction in the long range transport of inherent and acquired pollutants, including POPs and heavy metals, as these contaminants can travel long distances, pollute, and affect areas far from their production and use.
- Public-private partnerships such as the Earth Fund initiative (or its equivalent) could be used for testing, demonstration and deployment of new technologies and practices supporting development of degradable in the marine environment polymer alternatives to oil-based plastics[4] or technology demonstrations for removal of plastic debris from pelagic environments and from the bottom of the sea.

1. STAP is encouraging GEF partners to *mainstream* interventions addressing marine debris into existing and planned GEF projects and programs, specifically projects supporting management of Marine Protected Areas and fish refuges, ecosystem-based management of ABNJ and Ecologically and Biologically Significant Areas or Vulnerable Marine Ecosystems, projects supporting activities aimed at the reduction of pollution sources from land-based activities, and projects and programs promoting the use of waste-to-energy technologies with plastics waste as a source category. Participants in the Small Grants Program in relevant countries are also encouraged to consider interventions aimed at marine debris prevention, reduction and management.

2. Given the limited resources available in the GEF and the global scale of plastic debris problem in the marine environment, STAP is advising the GEF Council and GEF partners to focus support in GEF-5 on two types of activities that serve as catalysts for actions and can generate sustainably global environmental benefits. These two types of activities are based on principles embedded in the framework on marine debris management introduced in the Advisory Document:

   I) A project or program testing the life cycle approach to marine debris prevention, reduction, and management in one of the areas covered by the Regional Seas Conventions and Action Plans. Building on the existing baseline and institutions and mechanisms in the selected region, GEF investments could play a catalytic role in mobilizing public and private

[4] Plastic Debris X Challenge initiative was proposed by X-Prize Foundation and GEF could explore multiple opportunities to engage with the X Prize Foundation in these efforts.

sector resources for specific market transformation in the production, consumption, and utilization of marine debris sources such as plastics.

II) By combining the efforts of the plastics production, packaging and retailer associations, civil society organizations, multilateral institutions, and utilizing opportunities provided by the Earth Fund platforms or similar private sector initiatives, the GEF could promote, facilitate or establish a global public-private partnership to transform single-use plastics packaging markets to more environmentally friendly alternatives on a global scale. Through this initiative, the GEF would build a strong partnership with the private sector to encourage innovation and to expand assistance to developing countries and countries with economies in transition seeking to transform their use and utilization of single-use plastics packaging to protect the global environment. This initiative would simultaneously help reduce reliance on non-renewable resource, reduce waste and carbon dioxide emissions.

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