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"Marine Debris — an Overview of a Critical Issue for Our Oceans"

What is Marine Debris?

Scientists generally define marine debris as any manufactured or processed solid waste material (typically inert) that enters the marine environment from any source (Coe & Rogers, 1997). Debris is more than an unsightly inconvenience for beach-bound vacationers or pleasure boaters; it's one of the world's most pervasive pollution problems affecting our oceans and inland waterways. It affects the economies and inhabitants of coastal and waterside communities worldwide. By the simple process of moving from ship to sea, storm sewer to surf, or hand to sand, any manufactured material can become marine debris. Cigarette filters and cigar tips, fishing line, rope and gear, baby diapers and nappies, six-pack rings, beverage bottles and cans, disposable syringes, tires – the litany of litter is as varied as the products available in the global marketplace, but it all shares a common origin. At a critical decision point, someone, somewhere, mishandled it – either thoughtlessly or deliberately.

Ocean dumping is not a new phenomenon. It has been a practice for centuries. While our habits haven't necessarily changed, the nature of marine debris has – dramatically. Over the past 30 to 40 years, organic materials (once the most common forms of debris) have yielded to synthetic elements, like plastics, as the primary material in solid waste. Durable and slow to degrade, items like beverage bottles, packing straps, tarps, and synthetic fishing line create a debris source with staying power. In addition, many of these items are highly buoyant, allowing them to travel in currents for thousands of miles, endangering marine ecosystems and wildlife along the way.

According to the United Nations Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP), land-based sources account for up to 80 percent of the world's marine pollution (GESAMP, 1991). Much of the debris reaches the ocean by beach-going activities, being blown into the water, or is carried by creeks, rivers, and storm drains/sewers to ocean areas. Other debris comes from activities on the water, including vessels (from small sailboats to large ships), offshore drilling rigs and platforms, and fishing piers.

While there are laws regulating the dumping of trash at sea and on shore, the global nature of debris, its inability to be confined within territorial boundaries, and the complexity of identifying debris sources have made effective laws difficult to draft and even harder to enforce.

What are the Sources of Marine Debris?

Determining where all of the debris originates is no easy task since trash and litter can travel long distances before being deposited on our shorelines or submerging to the bottom of the ocean, bay or riverbed. Marine debris researchers traditionally classify debris source as either *land-* or *ocean/ waterway-based*, depending on where it enters the water. Other factors such as ocean current patterns, climate and tides, and proximity to urban centers, industrial and recreational areas, shipping lanes, and commercial fishing grounds influence the type and amount of debris that is found in open ocean areas or collected along beaches and waterways – including underwater areas.

Land-based debris blows, washes, or is discharged into the water from land areas. Sources include recreational beach-goers and fishers; materials manufacturers, processors and transporters; shore-based

solid waste disposal and processing facilities; sewage treatment and combined sewer overflows; inappropriate or illegal dumping; and public littering. How these materials are transported is characterized with the following:

- *Sewer overflows & sewage treatment plants* – public wastewater treatment facilities are prohibited from discharging plastics into the marine environment. Under normal “dry weather” conditions, most wastes are screened out of sewage. Materials can bypass treatment systems and enter waterways during times when runoff from seasonal precipitation exceeds the handling capacity of the sewage treatment facility. Typical debris from these discharges includes tampon applicators, condoms, and syringes.
- *Shore-based Solid Waste Management Practices* – both legal and illegal waste handling practices contribute to the presence of marine debris. The inadvertent release of debris from coastal landfills and garbage from water transports; recreational beach and roadside litter; and the illegal dumping of domestic and industrial garbage into coastal and marine waters are practices contributing to the marine debris problem.
- *Indiscriminate Litter* – every piece of litter has a person’s face behind it. How people handle the packaging from convenience items, food wrappings, beverage containers, and a host of other materials, constitutes the foundation for one of the most pervasive pollution problems plaguing the world’s oceans and waterways.

People also generate marine debris at sea. ***Ocean/waterway-based*** identified contributors are commercial fishing vessels; merchant, military, and research vessels; recreational boats and cruise ships; and offshore petroleum platforms and associated supply vessels. Debris can end up in the water due to accidental loss or system failure; historical waste management practices; or illegal disposal and indiscriminant littering. How these materials are transported is characterized with the following:

- *Commercial Fishing* – commercial fishing activities introduce marine debris into the ocean and waterways through intentional disposal by discarding ship-generated trash overboard and by not retrieving excess gear; and through unintentional loss when gear wears out and is lost while deployed or the equipment operator makes a mistake and the gear breaks loose. Commercial fishing is associated with debris items such as nets and ropes, salt treatment bags, bait boxes and bags, fish baskets or totes, fish and lobster tags, and gill-net or trawl floats.
- *Recreational Boaters* – some boaters discard trash overboard containing food wrappers, beverage containers, various bags and monofilament fishing line and other related fishing gear.
- *Merchant, Military, and Research Vessels* – large vessels with extensive crew typically carry supplies for several months resulting in the daily production of solid wastes related to galley and operational activities and materials used to cover containers and supplies and unsecured materials on deck can get loose and be blown overboard into the water. The maritime and waste management industries have conducted research to develop ways to handle and store wastes aboard ships for long voyages between port calls.
- *Offshore Petroleum Platforms and Supply Vessels* – maritime activities related to undersea exploration and resource extraction contribute to the marine debris problem. Similar to galley- and operational-type wastes associated with large vessels, activities on an oil/gas platform can result in the improper handling of trash generated from daily operations such as hard hats, sheeting, computer supplies, survey materials, as well as typical human-related trash produced by platform and supply vessel crews.

What are the Impacts of Marine Debris?

Aesthetically, marine debris looks terrible and can have a major effect on the tourist industry in coastal

communities. Marine debris can pose human health and safety concerns. Serious injury can occur by stepping on a sharp piece of glass or metal, or worse yet, a discarded syringe. More importantly, thousands of marine animals die each year from becoming entangled in debris or from consuming it, thinking that it is food. When marine debris gets caught in propellers, motors, and other machinery of commercial and recreational boats and ships, consumers pay more for products and services at the marketplace. Many debris items such as syringes, condoms, and tampon applicators are visual indicators of more serious water quality issues of sewage contamination.

- *Human Health and Safety*

Items such as broken glass, medical waste, rope, and fishing line pose immediate risks to human safety. Discarded syringes, condoms, and tampon applicators can indicate more serious water quality concerns that affect human health. Swimmers, divers and snorkelers can become entangled in submerged or floating debris. Medical and personal hygiene debris often enters the waste stream through direct sewage outflows or inadequate sewage treatment systems. These items can indicate the presence of invisible pathogenic pollutants such as streptococci, fecal coliform, and other bacterial contamination. Consumption or contact with water polluted with these pathogens could result in infectious hepatitis, diarrhea, bacillary dysentery, skin rashes, and even typhoid and cholera.

- *Aesthetic and Economic Impacts*

Litter makes shorelines unattractive and hazardous, and can inhibit tourism. Marine debris is not only ugly and dangerous; it can also deplete a coastal community's finances, with increased beach maintenance costs. The indirect costs, though, are perhaps even greater. Its presence discourages people from partaking in coastal activities, such as recreational fishing, boating, swimming, or beach going. It even repels tourists from visiting coastal areas. Most coastal communities rely on seaside businesses, and the clientele that support them, for their economic survival. Clean and safe beaches promote tourism and economic health. Dirty, hazardous beaches do just the opposite.

- *Wildlife Entanglement and Ingestion*

Many forms of marine debris – including derelict fishing gear – pose numerous threats to wildlife. Debris that entangles a living creature can hamper its mobility, prevent it from eating, or suffocate it. Some types of debris can inflict lethal cuts and wounds. Monofilament line, fishing nets and ropes, six-pack rings, and packing strapping bands are some of the more harmful culprits related to entanglements. Birds, for example, often become entangled in trash they have selected for nesting. According to the U.S. Marine Mammal Commission, 136 marine species have been reported in entanglement incidents, including six species of sea turtles, 51 species of seabirds, and 32 species of marine mammals (Marine Mammal Commission, 1996). Debris that has wrapped around limbs, and fins can cause circulation loss and amputation, especially as the animal grows. Animals slowed down by trailing debris are more vulnerable to predators. Heavy, large plastic sheets and other large debris smother or trap benthic-dwelling animals and drown those that must rise to the surface to breathe.

Ingested, debris can lead to strangulation or digestive problems. The Marine Mammal Commission also reports that ingestion incidents have been documented in six of seven species of sea turtles, 111 out of the world's 312 species of seabirds and 26 species of marine mammals. Sea turtles confuse floating trash and food bags with jellyfish, one of their favorite treats. Seabirds, too, are vulnerable to the unintentional ingestion of debris because of their indiscriminant eating habits. Many animals cannot regurgitate an item once it has been swallowed, and it often becomes lodged in their throats and digestive tracts. Debris that will not pass out of the stomach gives a false sense of cessation, causing some animals to stop eating, and slowly starve to death.

Derelict Gear and Animal Entanglement

Derelict fishing gear also plays another role in animal entanglement in the phenomenon known as

ghostfishing. Various forms of derelict gear and nets can unfortunately continue to perform their original function in the water, even if fishermen are no longer handling them. Once these materials are out of the control of the fishermen, they can inflict serious damage to unsuspecting fish, turtles, marine mammals, and sea birds as they float freely within the water column, are carried by the currents, or get caught up on coral reefs.

Though there is increasing recognition of the problem of “ghost fishing” few studies have been conducted since 1994 (Laist and Liffmann, 2000). The biological impacts of marine debris on coral reefs may be considerable resulting in long-term impacts to the biota and unknown degrees of recovery (Chiappone, White and Miller, *In Press*). Limited evidence from studies conducted in Atlantic areas suggests that discarded gear may be responsible for significant losses of some commercially valuable fish and crab species (Laist, 1997). Ghost nets are perpetual “killing machines” that never stop fishing (Esteban, 2002). Worldwide, this phenomenon is having an impact on the sustainability of already stressed fisheries. Lost fishing gear costs money to replace and can take a hefty toll on the marine environment and its inhabitants.

- *Habitat Destruction & Alien Species Introduction*

Debris affects the water quality of aquatic habitats and causes physical damage such as covering coral reefs and smothering sea grass beds. Derelict fishing gear in the form of nylon ropes, nets, and fishing line once entangled in coral reefs and other benthic communities can cause significant damage, with effects that can last for many years. Ropes and nets, twisting and moving by currents and tides, abrade, scour, break and destroy living corals once entangled in the benthic habitat. Ensnared debris may also cause increased siltation and turbidity blocking essential sunlight or smothering sea grasses.

Additionally, marine debris floating for great distances may be a transportation source for invasive species. Marine debris drifting on ocean currents eventually become home to entire communities of encrusting and attached organisms. Drifting debris become living rafts capable of carrying potentially harmful, non-native species of animals and plants to the far corners of the ocean.

- *Vessel Damage*

Derelict fishing gear in the form of nets and ropes, invisibly floating just below the water’s surface, can cause significant risks to vessel operations. Nets, ropes and other derelict gear have been documented to entangle vessel propellers and rudders resulting in costly repairs, significant loss of operational time, and endangering boater and crew safety. One of the most common causes of burned-out water pumps in recreational boats is the result of plastic bags clogging and blocking water intakes. A burned-out water pump in a recreational boat results in costly engine repairs and disablement of the vessel if the problem occurs at sea. The true scope and frequency of damaging encounters between debris and commercial/recreational vessels is difficult to calculate as most incidents go unreported.

Can Marine Debris be Prevented, Reduced, and Controlled?

Marine debris is one of the most pervasive and *solvable* pollution problem plaguing the world’s oceans and waterways. Successful management of a pollution problem requires that there is a comprehensive understanding of the nature of the pollution form. Strategies for identifying the types, sources, amounts, interactions, and key user-groups form the foundation of a pollution prevention initiative. Strategies for assessment (local and regional monitoring efforts and networks) and public education and outreach programs must be developed. Relevant laws and policies for pollution control, as well as government and private regulation and enforcement strategies are required. The management of marine debris requires additional considerations related to geographic and ecological indices including wind and current patterns and special habitats (e.g. sea grass beds and coral reef systems) in coastal areas; population densities, cultural and social issues, access to and interactions with various government, business and industry constituents, and solid waste management entities.

- *Monitoring and Education/Outreach Programs*

On December 31, 1987, the United States ratified Annex V of the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78). Annex V prohibits the at-sea disposal of plastic wastes and regulates the distance from shore that ships may dump all other solid waste materials. Annex V became effective on December 31, 1988. The Marine Plastic Pollution Research and Control Act (MPPRCA) of 1987 (Public Law 100-220, Title II) is the U.S. implementing the legislation for Annex V and extends the dumping regulations to vessels in all navigable waterways of the United States.

Recognizing the need for public education and involvement in solving the marine debris problem, Section 2204 of the MPPRCA, requires the Administrator of the U.S. Environmental Protection Agency (EPA), the Administrator of the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Coast Guard to conduct a public education program in the marine environment. Section 2204 also directs the Administrator of the EPA, along with the Secretary of Commerce, and the U.S. Coast Guard to conduct a program to encourage the formation of volunteer groups to assist in the monitoring, reporting, cleanup, and prevention of ocean and shoreline pollution. These policies form the base of the primary marine debris programs being conducted by The Ocean Conservancy domestically and globally.

The Ocean Conservancy has evolved into an authority on marine debris following its initial efforts in the early 1980's in the tracking of incidental takes of marine mammals, sea turtles, and birds in fishing gear and a 1985 study of plastic marine garbage. The resulting report, *Plastics in the Ocean: More Than a Litter Problem*, was the first to identify plastics as a significant marine debris hazard. Congress has enacted laws to limit the dumping of garbage from boats and to help control land-based sources of marine debris, such as stormwater systems and combined sewer systems. Citizens have also made great efforts in fighting this problem through beach cleanups and debris monitoring activities across the country and all over the world.

International Coastal Cleanup (Global)

Since its first beach cleanup in 1986 in Texas, The Ocean Conservancy and its international and domestic partners have developed the International Coastal Cleanup (ICC) into a global effort devoted to the marine environment. The first campaign engaged 2,800 volunteers who filled 7,900 trash bags with 124 tons of debris from 122 miles of Texas shoreline. Cumulatively, since the ICC began, it has included all 55 U.S. states and territories and 130 countries bordering every major body of water on the planet. In developing and developed nations; in frigid, temperate, and tropical climates; and in time zones that span the globe, nearly six million people have collected more than 97 million pounds of debris from over 146,000 miles of shoreline (The Ocean Conservancy, 2004)!

One of the primary goals of the International Coastal Cleanup is to trace pollution to its source and work to prevent it from occurring. To this end, volunteers record debris information using a standardized data card first developed in 1986 by The Ocean Conservancy. Data compiled from annual beach cleanups have been used to identify the types, sources and activities that produce the debris found worldwide along beaches and waterways. The Ocean Conservancy revised and updated the cleanup data card in 2000 to reflect a revised approach for accessing marine debris.

The ICC data card now includes 42-specific debris items and groupings targeting the dominant debris-producing activities and sources. Information is grouped by the behavior associated to its debris presence, be it recreational, beach-going activities, smoking-related activities, ocean and waterway activities, activities associated with legal or illegal dumping, or activities resulting from improper disposal or handling of medical or personal hygiene materials. The new data cards allow for the recording of specific debris items that are indicative of the activities and sources producing the debris. The result is a unique continuing global database of information collected at every cleanup around the world. Data from the cleanup provides the framework for action at all levels of government to limit marine debris and to educate the public about litter and pollution prevention. Information on the ICC, including data and

contacts for local cleanup activities are posted on a special website www.coastalcleanup.org managed by The Ocean Conservancy.

National Marine Debris Monitoring Program (U.S.)

The Ocean Conservancy, through a multi-year cooperative agreement with the U.S. Environmental Protection Agency, developed and field-tested a scientific, marine debris monitoring program for the United States with the objective of assessing the effectiveness of current marine debris legislation as mandated by the Marine Plastic Pollution Research and Control Act (MPPRCA) of 1987 (Public Law 100-220, Title II, section 2204). The development of the research protocol was based initially on data from the International Coastal Cleanup and other marine debris research conducted to assess the accumulation rates, types and amounts of debris dependent on their geographical location, oceanographic and meteorological conditions, and proximity to land-based or ocean-based sources. As a result, nine regional designations were developed for the monitoring program based on prevailing current patterns, marine debris information, and logistics.

The National Marine Debris Monitoring Program (NMDMP) has been successfully developed and field-tested utilizing a national network of 700 trained volunteers, monitoring 130 sites in 21 coastal U.S. states and two territories (Puerto Rico and U.S. Virgin Islands). The results of this five-year study will provide the required data needed to scientifically assess the status of marine debris trends and sources in the United States. Data collected through the National Marine Debris Monitoring Program is posted with an interactive, ArcView GIS-compatible database for public access through The Ocean Conservancy's website (www.oceanconservancy.org/nmdmp).

▪ *Engage Relevant Stakeholders*

To effectively manage the reduction and control of marine debris and its impacts on the environment, key stakeholders must be engaged. This list of potential "players" is long and wide as it encompasses a true cross section of society – public and private. A sample listing would include: local citizens; governments, agencies and authorities (national, regional, and municipal); organizations (international/ national, civic, religious, nongovernmental, and consumer); institutions (research, education, and medical); businesses (hotels and restaurants, outdoor recreation, manufacturers, and vendors); and industries (fisheries, tourism, waste management, and dive) form a significant part of the coalition needed to tackle the marine debris issue.

There are key audiences related to commercial fishing and derelict gear issues. The core of this group consists of fishers ranging from single, subsistence individuals who may or may not own their own boats to crews on large trawlers. Business and industry associated with equipment and boat manufacturing and marketing are part of this audience as they are responsible for the production and sales of the materials used by fishers. Individuals who are part of the fish processing industry including marketing are also part of this group. And last, but not least, are the governmental regulatory and resource management entities, which are needed to complete the overall framework of this issue.

▪ *Implement Legislation and Enforce Regulations*

Laws exist on land and at sea related to litter and debris, as well as other pollution forms. The problems exist and continue due to human-influenced activities that result in pollution being introduced into the environment. Additional regulations may indeed help to reduce the problem, if these rules are abided by – this is often not the case. Environmental stewardship as well as penalties and enforcement are all essential to any pollution prevention effort. The current laws relevant to the marine debris issue are:

1972 London Dumping Convention (LCD)

The Convention of the Prevention of Marine Pollution by Dumping of Wastes and other Matter, also known as the London Dumping Convention (LCD), entered into effect in 1975 and is administered under the United Nations by the International Maritime Organization (IMO). This treaty established

permitting requirements for the disposal of wastes into the sea and functions as the global instrument to control marine pollution from dumping dredge spoils, sewage sludge and other types of land-based wastes. Under international law, waste materials carried out to sea for disposal are distinguished from those generated during ship operations.

MARPOL 73/78

The IMO also manages the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78), which provides a comprehensive approach to dealing with ocean dumping by creating international guidelines to prevent ship pollution. MARPOL has six annexes, covering oil discharge (I), hazardous liquid control (II), hazardous material transport (III), sewage discharge (IV), plastic and garbage disposal (V), and air pollution (VI).

Annex V is of particular importance to the maritime community (shippers, oil platforms, fishers, boaters, and cruise lines), because it prohibits disposal of plastic at sea and regulates disposal of other garbage at sea. Under Annex V, garbage includes food and domestic and operational waste – excluding fresh fish – generated during normal vessel operations and liable to be disposed of continuously or periodically. Annex V also requires ports and terminals to provide garbage reception facilities for boats/ships. Ships of signatory nations must abide by Annex V regulations at all times, in all waters; ships from non-signatory nations must abide by Annex V while in a signatory's waters. To cite a vessel for illegally discharging garbage or plastics into the sea, an individual must see the event and report, or provide sound evidence, that such a discharge occurred. As a result, many pollution violations go unreported or are never fully pursued due to lack of evidence. As of October 31, 2003, 118 countries have ratified Annex V. MARPOL has hopefully helped to reduce the amount of trash on the beaches and oceans of the world.

MARPOL “Special Area” Designations

MARPOL has designated “Special Areas” as locations where, due to the site's unique oceanographic, ecological, all overboard discharges of garbage (except ground-up food wastes) are prohibited. Food wastes may not be discharged within 12 nautical miles of the nearest land in Special Areas. To date, MARPOL has designated nine Special Areas – Mediterranean Sea; Baltic Sea; Black Sea; Red Sea; Persian Gulf; Gulf of Aden; North Sea; Antarctic area; and the Wider Caribbean (including the Gulf of Mexico). However, for the designation to take effect, an “Area” needs to prove it has adequate waste reception facilities at ports to handle the increased volume of trash from ships now prohibited from dumping in the area. So despite their status, many “Special Areas” are not yet treated as such.

Cartagena Convention

The 1987 Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region – known as the Cartagena Convention – is the only legally binding environmental treaty for governing marine debris in the Wider Caribbean. The Convention and its Protocols constitute a legal commitment by participating governments to protect, develop, and manage their common waters individually or jointly. It requires adopting measures to prevent, reduce, and control pollution from ships, dumping, seabed activities, land-based activities, and airborne pollution. Ratified by 20 countries, the Convention governs the marine environments of the Gulf of Mexico, the Caribbean Sea, and certain areas of the Atlantic Ocean.

▪ Business/Industry Involvement

A review of the available data and other information on the debris found worldwide indicates that the dominate types and sources of debris are related to the indiscriminate littering of convenience food and beverage packaging (cans, bottles, food wrappers, plates and eating utensils), and the remnants of smoking activities (cigarette filters, cigar tips, product packaging, and disposable lighters). Another significant source of debris has also been identified with the presence derelict gear – nets, rope, fishing line, floats, buoys, and various traps. Much of the debris found worldwide is attributable to what we

consume related to food, beverages, smoke, and what we use in transporting ourselves over the sea and what materials we harvest from the sea. Businesses and industries affiliated with the aforementioned products and services have a critical role in debris management and abatement. Without their involvement and support in this issue, the long-term prognosis will be bleak.

So why is marine debris still an issue?

The reason why marine debris is still an issue is because we continue doing the things that produce marine debris. Even though we know where debris comes from and how it gets into the environment, we continue to facilitate its reoccurrence. There are alternatives to some of the materials and products that have been developed that are less invasive to the environment, but not all have been successfully integrated them into the economic mainstream. There are laws and regulations that have been implemented, but frequently enforcement and compliance are inadequate. We do need to further develop strategies and opportunities for adopting behaviors and activities that will help to reduce marine debris from identified sources. Ongoing efforts to abate this problem through governments and the public and private sectors must continue, targeting those behaviors and activities that have been shown to result in the deposition of debris into the environment. Reducing and controlling the presence of marine debris is a significant, but doable challenge that must be accomplished if we are to conserve ocean resources.

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