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# **A Survey of Marine Debris Management and Research**

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## **ABSTRACT**

Solid waste in the world's waters and solid waste that accumulates on the shorelines of waterways is known as marine debris. Marine debris has been recognized as a form of pollution for nearly 50 years and is a concern for the general public for aesthetic reasons and may also pose a human health and safety hazard. Marine debris can affect the tourism industry, especially the eco-tourism industry in the United States and internationally. The commercial fishing industry may also be affected by marine debris through habitat degradation and destruction. For over 20 years international treaties and U.S. federal legislation have regulated the discharge and disposal of debris at sea from ships. Plastics are not allowed to be disposed anywhere in the ocean. Despite international and federal legislation designed to prevent at-sea dumping, marine debris continues to be a major pollution issue. However, not all debris found in waterways and on the beaches comes from the ocean. Debris can be water-based (washed ashore) as a result of accidental or intentional dumping from ships or offshore gas/oil rigs at sea, or land-based (washed from the land) from litter, stormwater run-off and discharges. Research was completed to determine the status of marine debris management and research, while federal, state and local agencies that are currently addressing the issue of marine debris were examined.

## **INTRODUCTION**

Marine debris is often described as one of the most pervasive marine pollution problems because it is found from the most remote beach locations to the most visited beaches throughout the world. Even though it has been recognized as a marine pollution problem for many years, it has been less recognized as a solid waste problem. Despite extensive beach cleanup efforts by volunteers and municipalities, the problem has persisted as population and solid waste production continue to grow. The coasts are popular places to live both in the United States and internationally. The United States coastline population grows at a faster rate than the national average and is predicted to reach 165 million

people by 2015 (CMC, 2000a). Since humans cause marine debris, an increase in population will mean more stress to coastlines. A common perception is that the majority of marine debris originates from ships and offshore activities in the ocean. In actuality, only about 8% of the debris comes from ocean and inland waterway sources; the majority of debris comes from mismanaged solid waste on land (e.g. litter) (CMC, 2000b). A recent focus of marine debris research is to identify and target sources so that solutions to the problem can be developed through policy and education.

Marine debris is not only aesthetically displeasing as litter on beaches and shorelines, it may also cause harm to human health and the environment. The most widely known damage from marine debris is increased mortality of wildlife from entanglement or ingestion. At least 267 marine species have been affected by both entanglement and ingestion of marine debris including six of the seven species of sea turtles in the world, 44% of seabirds and 43% of marine mammals (MMC 1990; Farris and Hart 1995; Laist, 1996). The health and safety of beachgoers may also be affected by debris containing sharp glass, metal, or plastic.

A more recently discovered problem with marine debris, particularly in plastic resins and pellets, is the transport of toxic chemicals in the marine environment. PCBs (Polychlorinated Biphenyls), DDE (Dichlorodiphenyldichloroethylene) and nonylphenols were detected in polypropylene pellets off the coast of Japan (Mato et al., 2001). Although most plastic manufacturers have a zero discharge policy, and are not permitted to discharge pellets, they are still found in the environment (Gregory, 1999). Pellets can be accidentally released during manufacturing and transport and then, along with other litter, enter the oceans through storm drains, surface water runoff, streams, and river waters. Since compounds such as PCBs bioaccumulate, the transport of these toxic chemicals in the marine environment is a pathway that can affect wildlife and human health.

Marine debris is more than a nuisance. Marine debris can foul boat propellers, clog water intakes or block pumping systems. Lost fishing equipment (e.g. nets and traps) can “ghost fish,” or float in the ocean and continue to catch fish and kill wildlife. This can have an impact on the fishing and shellfish industry (Carr and Harris, 1996). Tourism can also be affected by marine debris and other litter. In the 1980’s, when large amounts of waste were found on coastlines (e.g. medical waste in New York), many communities lost millions of dollars from a drop-off in tourism, and increased beach cleanup maintenance (NRC, 1995). The success of beach tourism is an essential economic component to many communities, states and countries. Florida’s profit from tourism, in particular the booming eco-tourism market, is a primary source of income for the state. Beach visitors to Florida alone contributed 15.4 million dollars to the state in 1997 (Eco-tourism/Heritage Tourism Committee, 1997). A 1998 Florida Litter Study reported that among the general population and registered boaters in Florida, litter on the beach or in the water was identified as the third most important problem (behind water pollution from agriculture and industry) affecting Florida’s marine resources (FCSHWM, 1998).

## MANAGEMENT AND REGULATIONS

The management and regulatory framework for marine debris and the oceans is quite extensive. This section provides information on existing International and U.S. federal regulations, highlighting the regulations and current programs of various states. Since enforcement of these laws is not always easy, programs often address the behavior of individuals through awareness and education.

### International

In 1973 the International Maritime Organization (IMO) sponsored the International Convention for the Prevention of Pollution from ships where a Protocol was formed. In 1978 this Protocol, known as MARPOL, was modified. The international treaty is now known as MARPOL 73/78. The agreement has five Annexes addressing separate marine pollution issues. Annex V provides guidelines for ocean discharge of solid waste from ships and requires ports to provide reception facilities for solid waste that is prohibited from being disposed of at sea. Table 1 summarizes the at-sea garbage disposal regulations outlined in Annex V.

**Table 1. Summary of at sea garbage disposal regulations**

<b>Garbage Type</b>	<b>Outside Special Areas</b>	<b>In Special Areas</b>
Plastics - Include but not limited to synthetic ropes and fishing nets and plastic garbage bags	Disposal Prohibited	Disposal Prohibited
Floating dunnage, lining, and packing materials	Disposal prohibited less than 25 miles from nearest land	Disposal Prohibited
Paper, rags, glass, metal, bottles, rockery, and similar refuse	Disposal prohibited less than 12 miles from nearest land	Disposal Prohibited
All other garbage including paper, rags, glass, etc. comminuted or ground to fit through 25mm mesh screen	Disposal prohibited less than 3 miles from nearest land	Disposal Prohibited
Food Waste not comminuted or ground	Disposal prohibited less than 12 miles from nearest land	Disposal prohibited less than 12 miles from nearest land
Food Waste comminuted or ground to fit through 25 mm mesh screen	Disposal prohibited less than 3 miles from nearest land	Disposal prohibited less than 12 miles from nearest land
Mixed refuse types	When garbage is mixed with other harmful substances having different disposal or discharge requirements, the more stringent disposal requirements apply.	

Annex V also defines special areas where specific dumping restrictions apply. These special areas include the Mediterranean Sea area, the Baltic Sea area, the Red Sea area, the Gulfs area, the North Sea area, the Antarctic area, and the Wider Caribbean Region. Annex V came into effect on December 31, 1988 and covers 86% (96 countries) of the world's merchant fleet tonnage as of April 30, 2000 (Koehler et al., 2000). MARPOL 73/78 is a comprehensive international treaty, but implementation takes time and money.

Monitoring and enforcement on the vast waters of the oceans can also be costly and difficult.

Since marine debris is such a global problem, international conferences are held to discuss and address issues. Conferences began in 1984 with the Workshop on the Fate and Impact of Marine Debris in Honolulu, Hawaii. The next conference, The North Pacific Rim Fishermen's Conference on Marine Debris, was held in 1987 in Kailua-Kona, Hawaii. The Second International Conference on Marine Debris was held in Honolulu, Hawaii in 1989 and The Third International Conference on Marine Debris was held in Miami, Florida in 1994. The most recent conference (4<sup>th</sup>) was held in Honolulu, Hawaii on August 6 through 11 of 2000 with a focus on derelict fishing gear, which often causes marine life mortalities. Recommendations were made for legal and prevention measures, reducing impacts from gear, source identification, industry, monitoring and removal, education and outreach. This conference also brought the issues of marine debris to the forefront again.

## Federal

Table 2 contains a time line of the relevant regulations enacted by the United States that regulate marine debris directly or indirectly. The act that implemented Annex V of MARPOL in 1987 is the Marine Plastic Pollution Research and Control Act (MPPRCA) (PL 100-220). This act provides the regulations that govern solid waste management on all ships in U.S. waters and on all U.S. flagged ships.

**Table 2. Federal Marine Debris Regulatory Time Line (U.S. EPA, 1994)**

<b>Year</b>	<b>Act</b>
1972	Federal Water Pollution Control Act (FWPCA), as amended [Clean Water Act (CWA)] (33 USC 1251, 1262, 1311 et seq.)
1972	Marine Mammal Protection Act (MMPA) (16 USC 1361 et seq.)
1973	Endangered Species Act (ESA) of 1973, as amended (16 USC 1531 et seq.)
1976	Resource Conservation and Recovery Act (RCRA) (42 USC 6901 et seq.)
1982	Act to Prevent Pollution from Ships (APPS) (33 USC 1901 et seq.)
1987	Marine Plastic Pollution Research and Control Act (MPPRCA) (PL 100-220)
1987	Act to Study, Control and Reduce the Pollution of Aquatic Environments from Plastic Materials and other Purposes (Degradable Plastic Ring Carrier Law) (PL 100-556)
1987	Driftnet Impact Monitoring, Assessment and Control Act (PL 100-220, Title IV)
1988	Medical Waste Tracking Act of 1988 (Subtitle J of RCRA; 42 USC 6992 et seq.)
1988	Marine Protection, Research and Sanctuaries Act (MPRSA) of 1972 (Ocean Dumping Act), as amended [Ocean Dumping Ban Act (ODBA)] (33 USC 1401 et seq.)
1988	Shore Protection Act (SPA) (PL 100-688 Sections 4001-4204)
1988	The U.S. Public Vessel Medical Waste Anti-Dumping Act (PL 100-699 Sections 3101-3105)

MPPRCA also calls for reports to congress on methods to reduce plastic pollution and effects of plastics on the aquatic environment. The act requires the U. S. Coast Guard to regulate and monitor overboard disposal of solid waste under MARPOL Annex V. The act requires citizen pollution patrols (joint responsibility of NOAA, Coast Guard and EPA), public outreach, and citizen awards for reported violations. The act also requires adequate solid waste reception facilities at ports. Vessels over 26 feet in length must

display placards of waste discharge regulations. Vessels over 40 feet in length must also provide waste management plans and record all discharge and disposal of solid waste. Vessel solid waste records must be kept for two years and be available for inspection.

Since marine resources are so valuable to the U.S., they are heavily regulated with many federal agencies and organizations involved. One of the primary federal regulatory agencies is the U.S. Environmental Protection Agency (EPA). The EPA works closely with the non-profit organization Center for Marine Conservation (CMC) for debris monitoring and research. In addition the EPA and other federal agencies established a working group to monitor marine debris status and trends as directed by the MPPRCA (section 2204). The National Oceanic and Atmospheric Administration (NOAA) and the National Park Service (NPS) partnered to conduct a pilot study to develop standardized methods for quantifying marine debris. In 1990, the EPA was instructed by Congress to assess the effectiveness of marine debris legislation and other methods to control debris. The development of a national scientific methodology for surveying marine debris was a joint effort of the NOAA, NPS, CMC, U.S. Coast Guard (USCG), the Marine Mammal Commission (MMC), and selected scientists. The methodology was then reviewed by federal agencies that monitor marine debris.

## **State and Local**

State laws often indirectly regulate marine debris through litter laws and coastal and water protection laws (e.g. the California Coastal Act). In 1999, North Carolina increased the fines for littering, including requiring community service if the litter is more than 500 pounds, is a hazardous waste, or is discarded for commercial purposes (NC, 1999). Many states and cities also spend money on anti-litter campaigns and prevention of illegal dumping. In Florida, the cities of Gainesville, Jacksonville, and St. Petersburg spent \$602,000, \$3.3 million, and \$1.57 million, respectively, on cleanup, enforcement, and prevention of litter and illegal dumping in 1999. The majority of the money went to cleanup though (an average of 92%), while only 5% went to prevention, and 3% went to enforcement (FCSHWM, 2000).

A large portion of marine debris management is often organized at the state and local level. Forty-nine of the 50 states as well as the District of Columbia, American Samoa, Commonwealth of the Northern Marianas Islands, Guam, Puerto Rico, and the U.S. Virgin Islands participated in the 1999 International Coastal Cleanup (ICC) (CMC, 2000b). Even though the ICC is organized internationally by the CMC, it would not be successful without the state and local groups that assist in sponsoring the event. Many states also have organizations that participate in cleanups more often than once a year and others have adopt-a-beach programs that operate similar to adopt-a-road programs (i.e. an individual or organization becomes responsible for keeping that portion of the coast free of debris). For example, the California Coastal Commission (CCC) sponsors a year round Adopt-A-Beach program as well as Coastal Clean-up Days and then provides public awareness and education of the coast through a "Save Our Seas" school curriculum. The CCC has also published a *California Coastal Resource Guide* and a *California Coastal Access Guide* and operates a website on the internet (CCC, 1997).

Even land-locked states have marine debris cleanups. Arizona Clean and Beautiful (ACB), with support from the CMC, operates an adopt-a-shore program. Over 20 community affiliates focus on the state's network of creeks, mountain streams, rivers and lakes. ACB also sponsored the Arizona State University Litter Research Project. ACB conducts workshops on prevention of water pollution in partnership with federal, state and county groups that have jurisdiction over the Colorado River (CMC, 1998). Other states that have active programs to remove marine debris from their shores and coastlines include Alabama, Florida, Louisiana, Mississippi, New Hampshire, New Jersey, New York, North Carolina and Texas.

Some coastal states have completed local studies on marine debris issues. In 1997, a study was conducted to characterize and mitigate marine debris in the Gulf of Maine. This report examined data on the distribution of marine debris in the Gulf of Maine and the effectiveness of policy responses. The two main objectives of the study were to develop a historical "baseline" for marine debris distributions in the Gulf of Maine and to review existing debris reduction and prevention policies in the Gulf and elsewhere. The purpose of the report was to provide guidance for future efforts to address the problems of marine debris in the Gulf of Maine. The report concluded that a lack of data made it difficult to establish successes or failures of specific approaches to marine debris. However, it did appear that the deposit/refund policies for beverage containers reduced associated marine debris in Massachusetts and Maine (Hoagland and Kite-Powell, 1997).

Among Florida's marine debris efforts, a clean marina program has recently been implemented. Florida has the largest number of marine facilities in the country, estimated at approximately 1860 marinas and 370 boatyards. Proper solid waste management at the facilities is important and addressed by this program. The goal of the program is to provide education to boatyards, marinas and boaters to prevent pollution. Marinas can become designated a "Clean Marina" if the proper environmental guidelines and best management practices are followed, including the Marina Environmental Measures (MEMs). Partners on the project include the Florida Department of Environmental Protection Agency-Law Enforcement Branch (operates the program) in cooperation with the Marine Industries Association of Florida, marine professionals throughout Florida and the U.S., Florida SeaGrant, Boat US/Clean Water Trust, International Marina Institute, the Florida Council of Yacht Clubs and local agencies. By developing private and governmental partnerships that work towards debris prevention, the Florida Clean Marina program is a good example of a proactive approach.

## **SOURCES AND AMOUNTS OF MARINE DEBRIS**

Monitoring marine debris began soon after it was recognized as a pollution issue. The purpose of monitoring is to 1) provide information on the type and quantities of marine debris, 2) provide insight into problems and threats associated with a specific area, 3) to assess the effectiveness of appropriate legislation and coastal management policies, 4) to identify sources of marine debris and 5) to explore public health issues and increase public awareness of marine debris and the condition of the coastline (Rees and Pond,

1995). There are several ways of assessing marine debris. The first method is to take a percentage of the types and quantities of solid waste generated by ships and pleasure craft; however, this method does not include land-based debris generation. The second method is to examine the types and amount of floating debris in an area and extrapolate. The third method is to conduct a beach survey and examine the types and quantity of solid waste that washes ashore. Each method may be valid, as long as the objectives of the study are clearly established (Rees and Pond, 1995).

The largest source of data on marine debris sources and amounts is kept by the Center for Marine Conservation (CMC). CMC organizes and conducts the annual International Coastal Cleanup (ICC) day whereby volunteers all over the world remove debris from coastal and inland shorelines, recording information on the quantity and nature of the marine debris. The program is also designed to educate the public on marine debris issues and effect positive change resulting in the reduction and eventual elimination of marine debris pollution. The ICC has been held annually since 1986 and cumulatively has involved over 3,000,000 volunteers in over 100 countries bordering each major body of water on Earth.

The interpretation of marine debris data results collected during CMC's ICC events should be viewed with caution because of the lack of scientific protocol. During each annual beach cleanup, a volunteer's main concern is picking up litter and debris, not necessarily recording the data accurately. Also, the locations for beach cleanups are not randomly selected but often chosen because they are easily accessible. The ICC volunteers do utilize a standardized data card to record the marine debris they find and collect. This card is then returned to the CMC for entry into their database. Although the protocol is standardized, it still does not have quality assurance and control measures. Even so, the extensive beach cleanup work completed and data collected during the ICC events gives an indication of the magnitude and nature of marine debris.

As a result of over ten-years of annual beach cleanups conducted by CMC, it has been determined that marine debris can be categorized into three generalized sources: land-based, ocean/waterway-based, and general sources. Land-based sources are related to littering, beach users, surf fishing, picnics, landfills, manufacturing plants, sewage treatment plants, storm drains, and combined sewage overflows (CSOs). Ocean/Waterway-based sources of debris include littering (from piers/docks/boats), recreational boating, recreational fishing (from piers/docks/boats), commercial fishing, merchant vessels, military/research vessels, and offshore oil/gas platforms. Other items are classified as general source items because they cannot be traced to a specific activity or sole source. The types of debris in each source are outlined in Table 4.

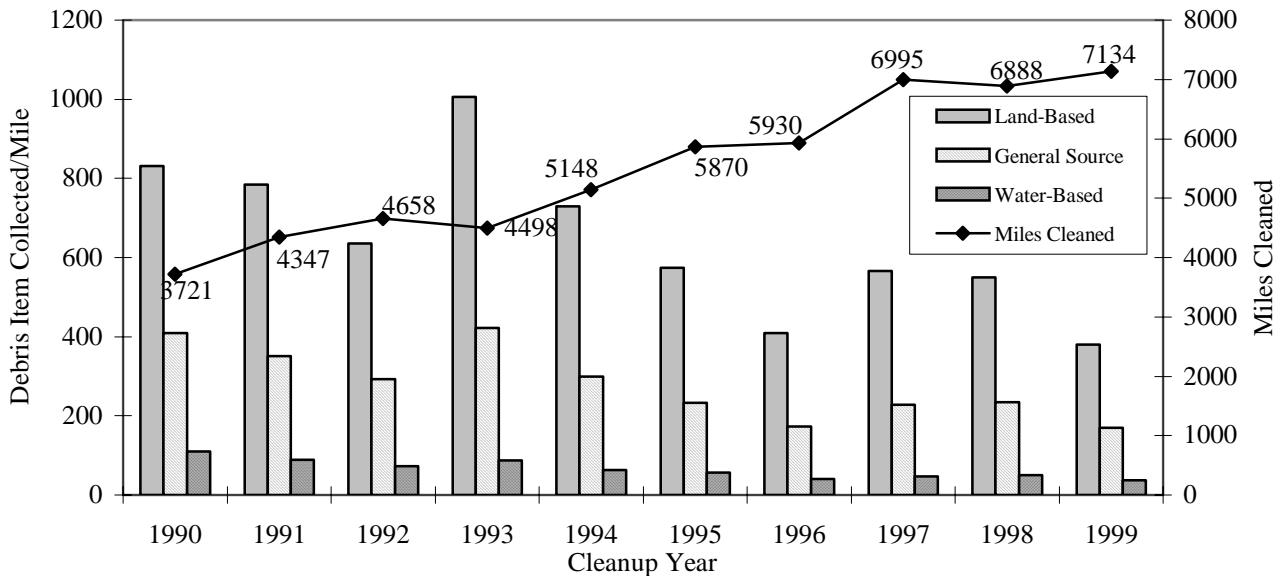
**Table 4. Source and Types of Marine Debris (Barr, 2000)**

Sources	Types
Land-Based	food bags/wrappers (plastic), beverage bottles (plastic), caps, lids (plastic), cigarette butts, cigarette lighters, cups, utensils (plastic), diapers, six-pack holders, straws, syringes, tampon applicators, toys, cups (foamed plastic), fast food containers, plates (foamed plastic), beverage bottles (glass), balloons, condoms, bottle caps (metal), aerosol cans, beverage cans, pull tabs, wire, paper bags, cups (paper), newspapers/magazines, plates (paper), lumber pieces, and clothing/pieces.
Ocean/Waterway-Based	Bags for salt used by shrimpers to separate shrimp (plastic), trash bags (plastic), bleach, cleaner bottles, milk/water gallon jugs, oil, lube bottles, buckets, fishing line, fishing lures, floats, fishing nets, hard hats, light sticks, pipe thread protector, rope, sheeting longer than 2 ft (plastic), strapping bands (plastic), vegetable sacks, "write protection" rings from computer tape spools, buoys, egg cartons (foamed plastic), meat trays, fluorescent light tubes, light bulbs, gloves (rubber), food cans, crab/lobster traps (metal), crab/lobster traps (wood), crates, and pallets.
General	other plastic bags, other plastic bottles, plastic pieces, sheeting 2 ft or shorter (plastic), other plastic items, packaging material (foamed plastic), foamed plastic pieces, other foamed plastic items, food jars (glass), other bottles/jars (glass), glass pieces, other glass items, tires, other rubber items, other cans, 55 gallon drum - rusty, 55 gallon drum-new, metal pieces, other metal items, cardboard, cartons, paper pieces, other paper items, and other wood.

The U.S. ICC data (1990-1999) shows that the break down of sources of marine debris is primarily consistent. Land-based sources of debris have ranged from 60-70 % of total debris items collected each year. General sourced items have ranged from 25-30% and Ocean/Waterway-based sources have ranged from 4-8% of total debris items collected each year. Figure 1 presents the relative contributions of the three sources of marine debris as well as an overview of the past ten years of ICC data collected in the U.S. The figure shows how the event has grown over the years (evidenced by the increase in miles cleaned) and that the data collected suggest that progress is being made in reducing marine debris (evidenced by a general decrease in debris items collected per mile).

In 1993, volunteers cleaned and surveyed 4,498 miles of shoreline resulting in 1515

**Figure 1. Sources and Number of Debris Items per Mile**

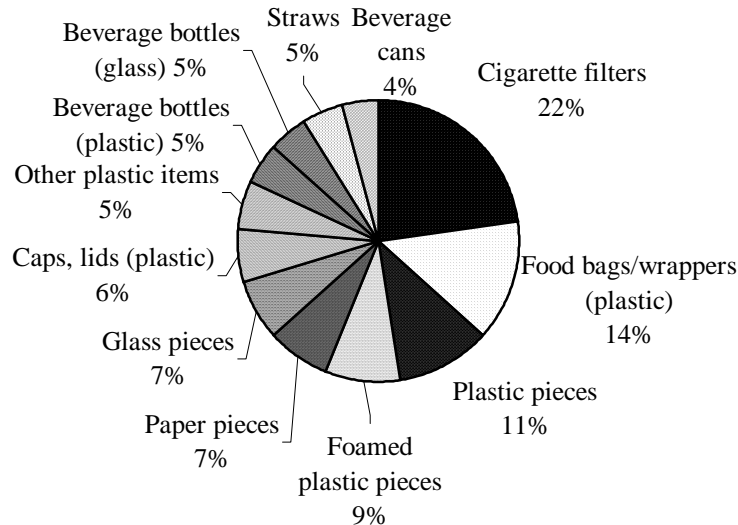


debris items collected per mile. By 1999, volunteers had cleaned over 7,000 miles of shoreline and were reporting only 587 debris items per mile (Barr, 2000). The ICC data also provides a snapshot of the composition of marine debris. The ICC data collection card separates the listing of debris items by material composition (i.e. plastic, foamed plastic, glass, rubber, metal, paper, wood, cloth). In examining data compiled from 1988 to 1998, plastic consistently constituted the greatest percentage of all debris found in the U.S. Plastic items composed an average of approximately 60% of all items found during the annual ICC beach cleanups and surveys. In 1997, five regions reported plastic percentages above the worldwide average: the Black Sea (82.53%), the Indian Ocean (69.99%), North Sea (65.79%), Wider Caribbean (64.27%), and the Pacific Ocean (62.95%). Central Europe reported the lowest plastic percentage with 42.79% (CMC, 1997). The calculations for percent composition of plastics do not include the numbers of cigarette filters found during the ICC surveys. Cigarette filters are considered a plastic item, however, their great abundance skews the percent composition information if their numbers were to be included.

Paper, metal, and glass make up nearly equal percentages of the marine debris waste stream from 1988 to 1998. Paper constituted an average of 11.4%, metal constituted an average of 10.3%, and glass constituted an average of 10.7% of all items. Wood, rubber, and cloth comprised the lowest percentages of the composition and were closely grouped from year to year from 1988 to 1998. Wood constituted an average of 2.8%, rubber constituted an average of 2.2%, and cloth constituted an average of 1.3% of all items. In 1999, 4,250 tons of debris (a total of 7.9 million items) were picked up from coastlines and shores during the three-hour ICC event.

Each year, as a component of the ICC marine debris reports, CMC compiles a list of the twelve most abundant debris items collected along the world's shorelines, waterways, and underwater. The list known as the "Dirty Dozen" and remained relatively consistent over the past ten years. Cigarette filters are consistently the most abundant debris items collected each year. Though wrapped in paper, the filter fibers are made of cellulose acetate, a synthetic polymer, and are therefore classified as a plastic. Figure 2 presents the percent composition of the twelve most abundant items found on land and underwater during the 1999 ICC.

**Figure 2. The Twelve Most Abundant Items Collected during 1999 ICC**



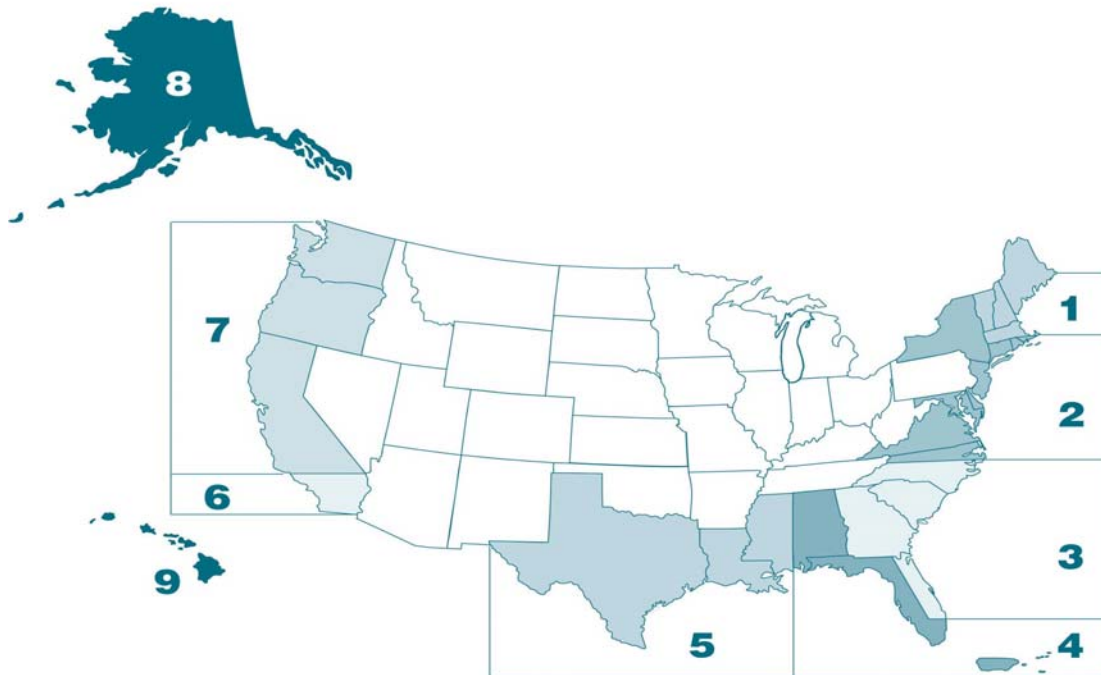
Few scientific marine debris studies have attempted to address the types and quantities of marine debris on a large scale. The majority of the scientific studies have been either a regional or local in scope (Rees and Pond, 1995). CMC's National Marine Debris Monitoring Program (NMDMP) is the first marine debris study to be conducted in the U.S. that is truly national in scope. The NMDMP, coordinated by CMC with funding from the EPA is a scientifically valid marine debris study examining the occurrence of thirty specific marine debris items that occur on the U.S. coastline. The program is designed to address two specific questions: Is the amount of debris on our coastlines decreasing and what are the major sources of the debris.

The establishment of NMDMP monitoring sites began in the spring of 1996 after a 5-year pilot program was designed by a working group composed of representatives from CMC, EPA, NOAA, the NPS, and selected researchers. Based on the results of the pilot program, the workgroup concluded that the goal of the NMDMP should be to measure a 30% change in 30 selected marine debris items on the U.S. coastal shorelines, with a Type I error rate of 0.10 and power of 0.84 which will require the monthly sampling of 20 beach sites per 9 coastal regions (total 180), for a five-year period (Ribic 1991, Ribic et al. 1992). In 1996, the NMDMP began with 40 randomly selected marine debris-monitoring sites along the Gulf of Mexico. Over the past four years, the NMDMP has expanded its coverage to over 130 sites located along the East, West and Gulf Coasts including Alaska, Hawaii, Puerto Rico and the U.S. Virgin Islands.

For the NMDMP, the U.S. coastline has been divided into 9 regions (Figure 3) based on available information on the types of marine debris found there and the prevailing currents. Twenty marine debris-monitoring sites per region are randomly selected from a

comprehensive list of beaches that fit the NMDMP criteria. Each beach must be of low to moderate slope, composed of sand to small gravel, have a length of at least 500 meters (1/3 mile), have clear direct access to the sea (not blocked by breakwaters or jetties) and must be accessible to volunteers year round. Beaches are also selected that will not impact any endangered or protected species such as sea turtles, sea birds, marine mammals, and sensitive beach vegetation. At each designated study site, trained volunteers conduct beach cleanups and marine debris surveys every 28 days.

**Figure 3. National Marine Debris Monitoring Regions**



- Region 1: U.S.-Canada border to Provincetown, MA
- Region 2: South of Cape Cod, MA to Beaufort, NC
- Region 3: Morehead City, NC to Port Everglades, FL
- Region 4: Port Everglades, FL, Puerto Rico, U.S. Virgin Islands to Gulf Shores, AL
- Region 5: Dauphin Island, AL to U.S.-Mexico border
- Region 6: U.S.-Mexico border to Point Conception, CA
- Region 7: North of Point Conception, CA to U.S.-Canada border
- Region 8: Alaska (southern coast and Aleutian Islands)
- Region 9: Hawaiian Islands

Data are recorded on the NMDMP data card by the volunteer survey teams. Information is recorded on thirty specific debris indicator items grouped into three general categories of debris (ocean-based, land-based, and general sources) as outlined in Table 5. The thirty specific items listed on the data card will provide the information to measure the changes and trends in the marine debris on the U.S. coastline. Additional items may be tracked

that are specific and meaningful to local regions (e.g. plastic mesh bait bags in New England, fluorescent light tubes in the Gulf of Mexico). The data collected by each volunteer survey team are sent back to CMC's Office of Pollution Prevention and Monitoring in Virginia Beach, Virginia where the data is incorporated into the national database.

**Table 5. Items Recorded for NMDMP**

<b>Ocean-Based</b>	<b>Land-Based</b>	<b>General Source</b>
1. Gloves	15. Syringes	24. Plastic bags (<1 meter)
2. Plastic sheets (≥1 meter)	16. Condoms	25. Plastic bags (≥1 meter)
3. Light bulbs/tubes	17. Metal beverage cans	26. Strapping bands (open)
4. Oil/gas containers (>1 quart)	18. Motor oil containers (1 quart)	27. Strapping bands (closed)
5. Pipe-thread protectors	19. Balloons	28. Plastic beverage and food bottles
6. Nets (≥5 meshes)	20. Six-pack rings	29. Plastic bleach/cleaner bottles
7. Traps/pots	21. Straws	30. Other plastic bottles.
8. Fishing line	22. Tampon applicators	
9. Light sticks	23. Cotton swabs	
10. Rope (≥1 meter)		
11. Salt bags		
12. Fish baskets		
13. Cruiseline logo items		
14. Floats/buoys.		

As with any scientific study, quality assurance (QA) is practiced to ensure that all data collected is reproducible and comparable. Each monitoring site Survey Director is directed to follow QA procedures during the survey set-up, volunteer training, and data collection. Throughout the course of each year of the study, Survey Directors are instructed to randomly select four dates on which to conduct a QA procedure. The QA procedure requires the Survey Director to follow behind volunteers taking note of any debris items that were overlooked. Collected debris is re-inspected and a new data card is completed with "QA" labeled on top. The original data card and the QA data card are returned to CMC for a calculation of percent error.

The data analysis at the end of the five-year study will yield a more in-depth understanding into the nature and trends of marine debris in the U.S. Data will be examined both on a national and regional basis. The program is currently in the final stages of establishment of marine debris monitoring sites and the training of volunteers. The initial analysis will begin on a regional basis upon completion of the first five years of data collection. The data can be analyzed on a national level once all nine regions have been established and operating together for a five-year period. Once five years of data collection on a national level is complete, analysis will begin to examine trends in marine debris as well as an examination of the major sources of the debris.

## **CONCLUSIONS AND FURTHER STUDY**

The marine debris pollution problem has been widely recognized on all levels of jurisdiction, international, federal, state, and local. Though the problem has been recognized and work has been conducted, marine debris still persists today. Marine debris has primarily just been “cleaned up” in the past and more recently specific sources of the debris have been identified. Cleanups have illustrated that the debris comes primarily from the land and not the ocean. Though ocean-based forms of debris (e.g. large nets and monofilament fishing line) are fairly low in occurrence in most areas, they should not be ignored. Ocean-based debris potentially pose some of the severest threats of entanglement for wildlife and can cause major habitat degradation. A national scientific study, the NMDMP, is being conducted by CMC to determine trends and changes in marine debris. It is clear that as populations continue to grow along coastlines and fishing and tourism remain important to coastal communities, the marine debris issue will merit attention. Future research should focus on finding the most prevalent and destructive sources, treating the problem at the sources through examining solid waste practices and changing peoples behaviors. Since enforcement of regulations is often difficult, ways of changing people’s behavior through other means (e.g. education, incentives) should be investigated.

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## **KEY WORDS**

Marine Debris

Litter

National Marine Debris Monitoring Program

Coastline solid waste management