



INTERAGENCY REPORT ON MARINE DEBRIS SOURCES, IMPACTS, STRATEGIES & RECOMMENDATIONS

Interagency Marine Debris Coordinating Committee

August 2008

This Congressional Report was developed by the Interagency Marine Debris Coordinating Committee and produced by the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce to fulfill requirements of the Marine Debris Research, Prevention and Reduction Act, 33 U.S.C. 1954.

August 2008

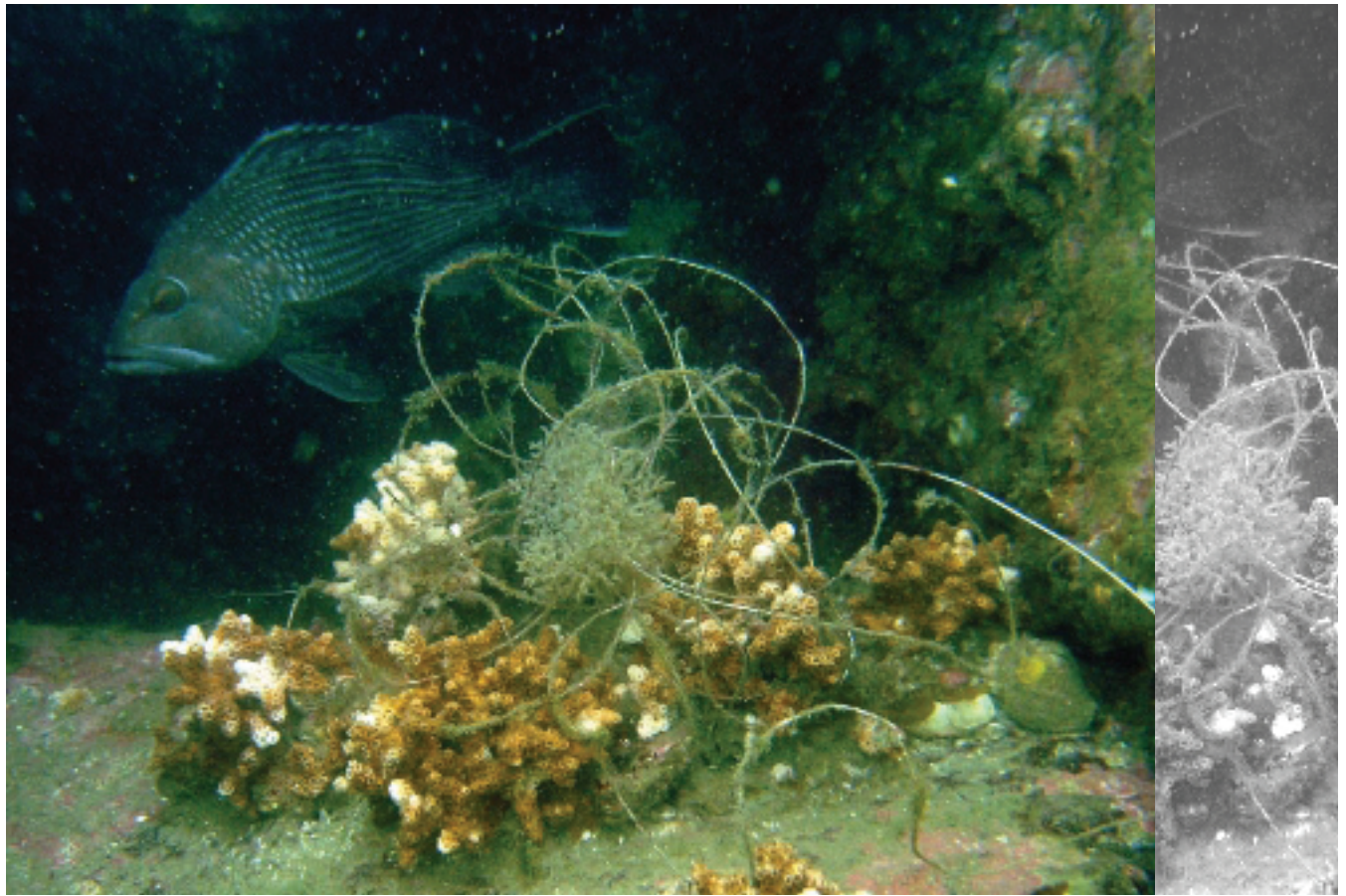


For citation purposes, please use:

National Oceanic and Atmospheric Administration. 2008
Interagency Report on Marine Debris Sources, Impacts,
Strategies & Recommendations. Silver Spring, MD. 62 pp

For information or copies, please contact:

NOAA Marine Debris Program
Office of Response and Restoration
National Ocean Service
1305 East West Highway
Silver Spring, MD 20910
301-713-2989
www.marinedebris.noaa.gov



**INTERAGENCY REPORT ON MARINE
DEBRIS SOURCES, IMPACTS, STRATEGIES
& RECOMMENDATIONS**

Interagency Marine Debris Coordinating Committee
2008

Report of the
INTERAGENCY MARINE DEBRIS COORDINATING COMMITTEE

Co-Chair, Department of Commerce, National Oceanic and Atmospheric Administration

Co-Chair, Environmental Protection Agency

Department of Defense, Navy

Department of Homeland Security, Coast Guard

Department of the Interior, Fish and Wildlife Service

Department of the Interior, Minerals Management Service

Department of Justice, Environment and Natural Resources Division

Department of State, Office of Marine Conservation

Marine Mammal Commission

United States Army Corps of Engineers

Coastal America (*Ex Officio*)

COMMITTEE MEMBERS

Holly Bamford, Ph.D.
 IMDCC Co-Chair
 Department of Commerce
 National Oceanic and Atmospheric Administration
 National Ocean Service

Molly Madden
 IMDCC Co-Chair
 Environmental Protection Agency
 Office of Water
 Oceans and Coastal Protection Division

Sarah Morison
 Department of Commerce
 National Oceanic and Atmospheric Administration

Mike Pletke
 Department of Defense
 Navy

David Major
 Department of Homeland Security
 Coast Guard

Mary Sohlberg (Alternate)
 Department of Homeland Security
 Coast Guard

Andrew Gude
 Department of the Interior
 Fish and Wildlife Service

Richard Clingan
 Department of the Interior
 Minerals Management Service

Holly Koehler
 Department of State
 Office of Marine Conservation

Bradford McLane
 Department of Justice
 Environment and Natural Resources Division

Mary Boatman (Alternate)
 Department of the Interior
 Minerals Management Service

Katherine Weiler
 Environmental Protection Agency
 Office of Water

Mike Simpkins
 Marine Mammal Commission

Patricia Mutschler
 United States Army Corps of Engineers

Megan Forbes
 IMDCC Executive Secretary
 Department of Commerce
 National Oceanic and Atmospheric
 Administration

William Nuckols
 Coastal America, *Ex Officio*

Acknowledgements

The Interagency Marine Debris Coordinating Committee would like to acknowledge the many people in addition to the IMDCC Committee members who provided outstanding input, support, editing, and review of this report throughout the entire process. We would first like to recognize Neal Parry, Interagency Report Coordinator, for his outstanding efforts in researching, drafting, and organizing the report, as well as working with and consolidating the many agency comments throughout this process. His role in the development and completion of this report was invaluable. We would also like to thank the many others who were involved in the development of the report, including Liz Shaner, David Redford, Leonard Pace, Libby Etrie, Courtney Arthur, and Bret Wolfe. A thank you also goes to editors Mary Swift and Kris McElwee for their review of the final drafts of the document and Carey Morishige for her assistance in document layout.

We would also like to acknowledge the IMDCC executive committee, the Subcommittee on Integrated Management of Ocean Resources, for their review and approval of this document and the Joint Subcommittee on Ocean Science and Technology for their review. Finally, we would like to recognize the Interagency Committee on Ocean Science and Resource Management Integration members for their final review and approval of the report before final submission to the Office of Management and Budget and Congress.



List of Tables

		Page
Table 1	Significant sources of marine debris	18
Table 2	Federal authorities by agency that (1) specifically mention marine debris in the authority, (2) address sources and items that could become marine debris (e.g., plastic, fishing gear, garbage), and (3) address entities that may be impacted by marine debris. An “X” in the last column represents legislation that has any regulatory component. Appendix I includes detailed information on these authorities.....	30

List of Acronyms

APPS	Act to Prevent Pollution from Ships	IMO	International Maritime Organization
BHA	Boston Harbor Association	IOC	Intergovernmental Oceanographic Commission
CSO	Combined Sewer Overflow	IRT	Innovative Readiness Training
CZMA	Coastal Zone Management Act	JSOST	Joint Subcommittee on Ocean Science and Technology
DOJ	U.S. Department of Justice	MARPOL	International Convention for Prevention of Pollution from Ships
ENRD	Environment and Natural Resources Division	MPPRCA	Marine Plastics Pollution Research and Control Act
EPA	U.S. Environmental Protection Agency	MDRPRA	Marine Debris Research, Prevention, and Reduction Act
ESA	Endangered Species Act	MMC	Marine Mammal Commission
EU	European Union	MMS	Minerals Management Service
FWS	U.S. Fish and Wildlife Service	NAS	National Academy of Sciences
ICC	International Coastal Cleanup	NMDMP	National Marine Debris Monitoring Program
IMDCC	Interagency Marine Debris Coordinating Committee		

NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NSC	Northwest Straits Commission
NWHI	Northwestern Hawaiian Islands
OCS	Outer Continental Shelf
PSA	Public Service Announcement
RCRA	Resource Conservation and
RINA	Registro Italiano Navale Group
SCAT	Shoreline Cleanup and Assessment Technique
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific, and Cultural Organization
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard

Table of Contents

1.0	Executive Summary	12
2.0	Introduction	14
2.1	Overview	14
2.2	History of Federal Marine Debris Coordination	15
2.3	Interagency Marine Debris Coordinating Committee.....	16
2.4	Charge to the IMDCC.....	16
3.0	Sources of Marine Debris.....	18
3.1	Land-based Sources	19
3.2	Ocean-based Sources.....	20
4.0	Ecological, Human, and Economic Impacts	23
4.1	Ecological Impacts.....	23
4.2	Human Impacts.....	25
4.3	Economic Impacts.....	25
5.0	Current Actions	27
5.1	Education and Outreach.....	28
5.2	Legislation / Regulation / Policy.....	30
5.3	Incentive Programs	35
5.4	Enforcement	37
5.5	Cleanups.....	39
5.6	Research.....	40
5.7	Technology Development.....	42
5.8	Fostering Coordination	43
6.0	Recommendations.....	45
6.1	Education & Outreach	46
6.2	Legislation / Regulation / Policy.....	46
6.3	Incentive Programs	46
6.4	Enforcement	47
6.5	Cleanups.....	47
6.6	Research.....	47
6.7	Technology Development.....	48
6.8	Fostering Coordination	48
APPENDIX I : Detailed Description of Authorities as Related to Marine Debris.....		49
Literature Cited.....		59
Photography Credits and Captions.....		63



Section 1.0 Executive Summary

For the purposes of this document, the Interagency Marine Debris Coordinating Committee (IMDCC) considered persistent solid man-made debris from both land-based and ocean-based sources and its adverse impacts on the marine environment and navigation safety.¹

Marine debris can degrade ocean habitats, endanger marine and coastal wildlife, interfere with navigation, result in economic losses, and threaten human health and safety. Sources of marine debris are wide ranging. Marine debris can originate from ocean-based sources, such as a ship that loses its cargo, and land-based sources, such as material that runs off of the landscape into rivers and oceans. The nature, type, and impacts, however, are similar regardless of where the debris originates. Research indicates a broad range of ecological, human health and safety, and economic impacts.

There are many challenges to addressing the issue of marine debris. The vast number of possible sources both on land and at sea, as well as the potential for debris to travel far from its origin and persist in the ocean for years complicates prevention efforts. Successful prevention also depends on changing attitudes and behavior which can be difficult if the public and relevant stakeholders do not understand the links between their actions and marine debris. Despite existing regional and species specific studies, gaps in knowledge remain and limit a complete characterization of the marine debris issue and its ecological, human, and economic impacts.

¹ The United States Coast Guard (USCG) and National Oceanic and Atmospheric Administration (NOAA) have been tasked through the Marine Debris Research, Prevention, and Reduction Act (33 U.S.C. 1954) with jointly developing, in consultation with the IMDCC, a definition of marine debris for the purposes of the aforementioned Act. USCG and NOAA have not finalized a definition of marine debris as of the completion of this document in June 2008. Any description of marine debris in this document is intended only to assist readers of this document to better understand the issue of marine debris. It is not intended that any description of marine debris in this document be proposed as a legal definition.

Existing legislation, policies, and regulations address marine debris both directly and indirectly; however, the number of agencies and mixture of federal, state, and local authorities requires extensive coordination to be effective.

In recognition of the complexity of the marine debris issue, the IMDCC was reconvened as recommended by the Administration's 2004 Ocean Action Plan. The IMDCC was formally established by statute through the Marine Debris Research, Prevention, and Reduction Act in order to coordinate a comprehensive program of marine debris research and activities among federal agencies. The IMDCC is charged to submit to Congress a report that identifies: sources of marine debris; the ecological and economic impact of marine debris; alternatives for reducing, mitigating, preventing, and controlling the harmful affects of marine debris; the social and economic costs and benefits of such alternatives; and recommendations to reduce marine debris both domestically and internationally.

This report fulfills the charge given to the IMDCC. The report describes sources and impacts of marine debris, as well as the challenges associated with their characterization. Also discussed are the alternatives, or current activities, to address marine debris that have occurred over the past 20 years, including activities recommended in the report of the 1988 Interagency Task Force on Persistent Marine Debris. Finally, this report contains 25 recommendations intended to guide the Federal government's strategies on marine debris (See Section 6, "Recommendations," on page 45).

The recommendations presented in this report are designed to be broad in scope, with the intention that federal agencies work collaboratively through the IMDCC to develop more detailed priorities and action plans to implement these recommendations. In addition to having a federal-level focus, these recommendations also attempt to address the different agency mandates and policies associated with issues related to marine debris reduction and prevention. While the recommendations are general in nature, individual agencies are expected to lead coordinated efforts and work together to enhance and develop existing capacities so that individual agency efforts can work to address collective needs, threats, and challenges. Federal agencies are further encouraged to enhance their efforts to provide technical and educational materials to state, local, tribal and non-governmental entities.

A comprehensive approach to the issue of marine debris is organized around four main themes: (1) prevention; (2) response to debris already in environment; (3) research and development; and (4) cross-theme (i.e., coordination). The IMDCC's recommendations are organized by the following subsets of these themes:

1. Marine debris prevention through education and outreach, legislation/regulation/policy, and incentive programs.
2. Response to debris already in the environment through enforcement and cleanups.
3. Research and technology development to assess next steps, address gaps, reduce or prevent material from entering marine system, and mitigate impacts.
4. Cross-theme efforts that foster coordination among federal agencies and other government and non-governmental partners to share information, coordinate efforts, and implement actions to prevent, reduce, or mitigate impacts of marine debris.

The IMDCC and its member agencies are committed to a collaborative approach to marine debris and to the implementation of these recommendations. The IMDCC intends to develop an action plan for the implementation of these recommendations. The IMDCC will report on progress with these recommendations as part of the IMDCC's regular progress report to Congress.



Section 2.0 Introduction

2.1 Overview of Issue

Marine debris can injure and kill marine wildlife, degrade ocean habitats, interfere with navigation safety, cause economic loss to shipping, fishing, and coastal communities, and pose a threat to human health. These adverse impacts have been documented all over the world. From fishing nets to medical equipment to food packaging, many man-made persistent objects play key roles in supporting the economy and protecting human health. However, when these same objects are abandoned or even disposed of improperly, they may enter the marine environment and become marine debris. As consumption and use of these objects increases globally, the challenge of containing and properly managing them becomes even greater, regardless of whether these materials enter the marine environment directly from activities on the water or indirectly from activities on land.

The problem of marine debris can be dealt with effectively only by ensuring a comprehensive approach that is local in scale and global in scope, directed at source prevention, and establishes an educated community that can be empowered to action. While it is important to address marine debris already present in the environment, such as through beach cleanups or preventing entanglements of marine wildlife, this is not the only type of strategy and action that should be taken. An effective response must be comprehensive and include research, prevention, and reduction. Ultimately, any successful solution requires a mobilization of public and stakeholder actions resulting in a change in attitudes and practices that will prevent marine debris at its many sources. Developing such public concern and behavior change requires educating the public and specific audiences about the causes, impacts, and both the global scope and local relevance of marine debris, as well as providing the tools necessary to reduce and prevent debris at its source. In this report, the Interagency Marine Debris Coordinating Committee recommends a comprehensive strategy to address marine debris that relies on a coordinated approach among existing and new partners to support actions at many levels. This strategy is an integral step towards solving the marine debris problem.

2.2 History of Federal Marine Debris Coordination

Since the early 1970s, numerous federal programs have been created to address various aspects of the marine debris problem. However, these programs have been scattered among agencies that have markedly different mandates and authorities.

Coordination among these numerous programs has always been challenging.

It was not until the mid-1980s that the Federal government attempted to address the marine debris problem holistically. Events such as the extensive marine debris wash-ups along New Jersey and New York beaches in 1976 and 1987 spurred the Administration and Congressional leaders in 1987 to recognize the need to assess the problems caused by persistent marine debris.

- ◆ The White House Domestic Policy Council formed an “Interagency Task Force on Persistent Marine Debris” in 1987 to develop a report that assessed the need for research, reduction measures, and alternative actions to address the problem of plastic marine pollution. That report was completed in 1988 and included 23 recommendations focused on federal leadership, education programs, regulations, research, beach cleanups, and monitoring.

- ◆ In 1987, the Marine Plastics Pollution Research and Control Act (MPPRCA) was passed to amend the Act to Prevent Pollution from Ships (APPS), which implements the International Convention for the Prevention of Pollution from Ships (MARPOL) Annex V.

- ◆ MARPOL Annex V sets forth regulations for the prevention of pollution by garbage from ships, and among other things, prohibits discharge of all plastics by ships into the sea. In addition, the MPPRCA authorized the U.S. Environmental Protection Agency (EPA), the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Coast Guard (USCG) to conduct

programs that engaged volunteer groups to help monitor, report, cleanup, and prevent ocean and shoreline plastic pollution.

Since the release of the 1988 Task Force Report, federal agencies have implemented some of the report’s recommendations for additional research, monitoring, and removal, as well as to foster stewardship of the oceans.

- ◆ The EPA created its Marine Debris Program, which supports projects to investigate and address sources and transport of marine debris, such as a plastic pellet containment study. The EPA also initiated the Combined Sewer Overflows Studies Program, the Harbor Studies Program, the Storm Drain Sentries Program, and the National Marine Debris Monitoring Program, which was administered by Ocean Conservancy through a grant from EPA to determine marine debris status and trends on beaches in the United States.

- ◆ NOAA created the Marine Entanglement Research Program to support projects evaluating adverse impacts of persistent marine debris on the marine environment, as well as to develop educational materials for local coastal communities. NOAA also organized four international marine debris conferences between 1984 and 2000 and led the interagency derelict net cleanup from the Northwestern Hawaiian Islands starting in 1996. USCG prepared regulations to implement MARPOL Annex V in 1989.

- ◆ Many other federal agencies established marine debris reduction and educational activities and projects to help address the marine debris problem. Although individual agencies created and continued programs to address marine debris, the Task Force did not maintain formal ongoing coordinating meetings. However, informal interagency workgroups did meet periodically to discuss domestic and international activities for marine debris.

2.3 Interagency Marine Debris Coordinating Committee

In 2004, the topic of marine debris came to the forefront again with the release of the *U.S. Commission on Ocean Policy Report: An Ocean Blueprint for the 21st Century*. An entire chapter was dedicated to discussing the impacts of marine debris on the environment.

The Commission recommended that the Federal government take action to address the problem by recreating an interagency committee to unite all appropriate federal agencies on this issue.

In response to the Report, the Administration released the 2004 Ocean Action Plan and reestablished the Task Force, which was renamed the Interagency Marine Debris Coordinating Committee (IMDCC). The IMDCC's mandate was soon codified with the passage of the Marine Debris Research, Prevention, and Reduction Act of 2006 (Act), which amended the Coordination section of the MPPRCA.

◆ The role of the IMDCC is to consider and address any abandoned or uncontrolled solid material that is introduced into the ocean and coastal environment or the Great Lakes and poses a potential adverse impact to the environment, human health, safety, economy, or other resources.

◆ The objective of the IMDCC is to coordinate a comprehensive program of marine debris research, prevention, reduction and removal activities among federal agencies, in cooperation and coordination with non-governmental organizations, industries, universities, research institutions, states, tribal governments, and other nations, as appropriate.

◆ The Act also established a reporting requirement for the IMDCC that includes submitting this report to Congress on marine debris impacts and strategies, followed by progress reports to Congress every two years on the implementation status of the strategies and recommendations presented herein.

2.4 Charge to the IMDCC

The IMDCC was charged by the Act to address in this report:

- (i) the sources of marine debris;
- (ii) the ecological and economic impact of marine debris;
- (iii) alternatives for reducing, mitigating, preventing, and controlling the harmful effects of marine debris;
- (iv) the social and economic costs and benefits of such alternatives; and
- (v) recommendations to reduce marine debris both domestically and internationally.

In response to the first (i) and second (ii) charges, the IMDCC reviewed a number of recently published studies of sources of marine debris and impacts of marine debris on organisms, ecosystems, and the economy.

◆ The IMDCC also discussed how changes in society and the use of so-called disposable materials can affect the amount of marine debris produced by various sources. For example, recent increases in the use of persistent synthetic materials such as plastics demonstrate the importance of monitoring and controlling the full “life cycle” of these products, including production, distribution, use, disposal, and handling of the materials throughout all phases.

◆ In many ways, marine debris sources are a societal problem that often reflects a lack of knowledge regarding the impacts of marine debris and appropriate disposal practices, a general lack of interest in following the appropriate practices, or an inability to follow appropriate practices if infrastructure is missing or costs are too high. Both lack of knowledge and lack of interest can be addressed by ensuring that all members of our society are educated regarding the correct practices as well as the potential impacts of inappropriate disposal.

The IMDCC reviewed existing programs and projects currently being conducted by or in part by the Federal government with partners

to determine alternatives for addressing marine debris (iii) and the benefits of such alternatives (iv). The IMDCC recognized that a clear explanation of the economic costs and benefits of current alternatives to reduce, prevent, and remove marine debris from our environment is still lacking. This type of analysis is difficult to conduct and requires cost-benefit data not currently available.

◆ Types of data that would be needed include overall socio-economic impact, the value of resources being impacted, the cost of removal technologies and restoration requirements, and the total amount of marine debris in the environment. Also missing is an understanding of the location, source, and impacts of submerged debris.

◆ A number of efforts have been conducted for beach and shoreline monitoring. However, limited research has been completed to determine how the presence of debris on the seafloor impacts submerged habitats, corals, seagrass, fish migration, and other living marine resources. Likewise, few data exist to quantify the amounts, types, and impacts of debris on the surface and in the water column in the open ocean.

◆ Gaps in marine debris research, monitoring, costs, and benefits need to be filled in order to conduct a proper cost and benefit analysis.

Overall, the recommendations (v) laid out in the report are general in nature to encompass the breadth and responsibilities of each agency and department dealing with the marine debris issue. Many recommendations also seek to fill the gaps and data need identified in other parts of this report.

Recommendations are focused around four themes encompassing several topic areas:

(1) marine debris prevention through education and outreach, legislation/regulation/policy, and incentive programs;

(2) response to debris already in the environment through enforcement and cleanups;

(3) research and technology development to assess next steps, address gaps, reduce or prevent material from entering the marine system, and mitigate impacts; and

(4) cross-theme efforts that foster coordination

These recommendations can be best implemented through a focus on sustained, collaborative efforts in which agencies work in conjunction with each other and with non-federal entities to address common goals. The IMDCC intends to develop an action plan that will prioritize and track implementation of these recommendations to ensure a coordinated effort toward a cleaner, debris-free environment.



Section 3.0 Sources of Marine Debris

People and their actions, whether intentional or accidental, are the source of most marine debris. For this reason, it is important to identify and target the specific locations or types of activities that generate and convey materials that ultimately become marine debris. Marine debris originates from two sources: actions that take place on land (land-based sources) and those that take place in the marine environment (ocean-based sources) (Table 1).

Table 1. Significant sources of marine debris.

Land-based Sources of Marine Debris	Ocean-based Sources of Marine Debris
Municipal Landfills	Merchant shipping, ferries and cruise liners
Transport of litter and waste (on land or waterways)	Fishing vessels
Storm water discharge	Public vessels
Industrial and manufacturing	Private vessels
Litter and waste generated in coastal and inland zones from improper waste management	Offshore oil and gas platforms, and drilling rigs
Natural events	Aquaculture installations
	Natural events

The National Marine Debris Monitoring Program (NMDMP), which monitored debris on beaches in the United States, found that land-based sources are responsible for approximately 49 percent of marine debris items along beaches, while ocean-based sources are responsible for approximately 18 percent of debris. The remaining shoreline debris, about 33 percent, was identified as general source debris because it could come from either land- or ocean-based sources (Sheavly 2007). Plastic bottles and bags constituted the vast majority of general source items found in the NMDMP shoreline study.

◆ It is important to note that these results do not consider floating and submerged marine debris in both the nearshore and open-ocean environments, and the relative importance of various sources of this unaccounted debris may differ from that suggested by debris found on beaches.

◆ Because of ocean transport mechanisms, it can be very difficult to determine the source of marine debris, which is one reason for this general source category of marine debris.

An example of general source debris cycling in the open ocean is a location called the North Pacific Subtropical Gyre (Gyre). The Gyre is made of the North Pacific, California, North Equatorial, and Kuroshio currents, along with atmospheric winds. Persistent and pervasive marine debris from both land- and ocean-based sources around the Pacific Rim aggregates in the currents of the Gyre. This debris can remain in the Gyre for many years, becoming what is known as legacy debris. It is difficult to determine the age, origin and source of legacy debris. At certain times of the year, convergence zones in the Gyre can move southward, depositing debris onto parts of the Hawaiian Islands.

Regardless of whether debris originates on land or at sea, the nature, type, and impacts of debris are similar and persistent.

3.1 Land-based Sources

Land-based sources of marine debris may originate from coastal areas or farther inland. Waterfront areas, including beaches, piers, harbors, riverbanks, marinas, and docks, are common land-based sources of marine debris.

Debris also can originate from the compounded effects of material from many diffuse sources that is carried by precipitation runoff into waterways and, ultimately, to the ocean.

Debris can be the result of improper trash disposal, improper handling of materials, or inadequate reception facilities for waste. Litter, regardless of whether it is purposely or accidentally discarded or lost, has the potential to become marine debris.

Fishing gear, monofilament line, and other fishing-related items may also be introduced into the marine environment from waterfront areas and fishing piers (Yoshikawa and Asoh 2004).

Rising populations in coastal areas have increased the potential for marine debris introduction.

Improperly disposed trash can wash into streams, combined sewer systems, and separate storm sewer systems (e.g., storm drains) and eventually be carried into coastal and ocean waters.

◆ Combined sewer systems are older sewer systems that combine sewage and stormwater runoff into the same infrastructure. These systems can become overwhelmed during periods of heavy rain, and everything in the pipes, including street litter and sewage-related items (e.g., condoms, tampons, syringes), is diverted away from the treatment plant to the nearest receiving waters (EPA 1993a).

◆ Municipal separate storm sewer systems (MS4s) also have the potential to transport materials that may become marine debris as these systems often do little more than convey precipitation runoff down the storm drain and into the nearest surface water, bringing with the

runoff all the remnants of human activity from around that storm drain.

The growth in coastal population has also required expansion of waste repositories such as landfills and transfer stations.

◆ Overused and poorly managed landfill and transfer stations often can result in increased marine debris. Trash that is improperly covered during transport or deposition into landfills can be carried by wind into the marine environment or into other aquatic systems that transport the trash to the marine environment.

Industrial facilities are another source of land-based marine debris. By-products from production, particularly persistent synthetic materials such as plastics, may become marine debris when dropped, washed, or blown away during transport to or from the factory or during production.

◆ While this was particularly true in the past during transport of pre-production plastic resin pellets, implementation of best management practices by industry has helped reduce this source of marine debris (ACC and SPI 2007). EPA worked with the plastics industry to assess the release of these pellets to determine how they entered the environment (EPA 1993b).

◆ An effective example of industry best management practices is Operation Clean Sweep, developed by the Society of the Plastics Industries, Inc., in partnership with EPA.

Natural events such as tornadoes, floods, tsunamis, and hurricanes can all create large amounts of debris washed from near-shore areas that may end up in the marine environment. The high winds, waves, and storm surges produced by these natural events cause land-based items to be introduced into the aquatic environment.

◆ After the 2004 Indian Ocean tsunami, smothering by debris was a principal cause of damage to coral (Wilkinson et al. 2006).

◆ The amount of marine debris resulting from

the hurricane season of 2005 along the Gulf of Mexico coast provides a strong example of the potential source contribution that a natural event can have on the marine environment. In the Sabine National Wildlife Refuge in Louisiana alone, an estimated nine million cubic yards of debris were spread over 1,770 acres of marsh (FWS 2006). To address submerged debris in traditional fishing grounds, Congressional funding was appropriated to NOAA to survey with side scan sonar over 700 square nautical miles from September 2006 to September 2007. In the nearshore waters of Alabama, Mississippi, and portions of eastern Louisiana, nearly 5,000 objects were located, with some areas having a density of up to 200 objects per square nautical mile (NOAA 2007a).



3.2 Ocean-based Sources

In the ocean, vessels of various sorts and structures are all potential vectors for the introduction of debris into the marine environment. Even with strict adherence to environmental regulations, marine debris can still enter the marine environment from vessels at sea through accidental loss, especially in inclement weather.

All vessels have the potential to adversely impact the aquatic environment by improperly disposing of their trash at sea. The type, magnitude, and impacts of vessel-generated marine debris differ according to vessel size, purpose, and their respective enforcement and compliance regimes. However, all vessels under United States jurisdiction are subject to the discharge regulations established under the Act to Prevent Pollution from Ships (APPS), which include the prohibition of disposal of plastic at all distances from shore; a prohibition against the disposal of any type of garbage within three miles of shore; and 12- and 25-mile minimum distance requirements for the disposal of other types of garbage.

◆ Fishing vessels may introduce marine debris into the ocean environment when items such as nets, traps, monofilament, lines, light sticks, and floats are lost or discarded at sea.

Derelict fishing gear either lost at sea or improperly disposed of by fishing vessels is of particular concern.

◆ In the Pacific, this type of debris can get trapped in the North Pacific Subtropical Gyre and accumulate along convergence zones that can transport debris to the remote islands of the Papahānaumokuākea Marine National Monument. From 1996 to 2007, 570 metric tons of derelict nets were removed from the Monument, which are known to act as a repository for marine debris (NOAA 2007b). These nets can come from all areas of the Pacific Rim, get caught in the convergence zone, potentially stay in the convergence zone for many years, and end up in the Monument.

◆ Other related items, such as light sticks, buoys, and rope particularly constructed of plastic also demonstrate persistence in the marine environment. In a 16-year study (Morishige et al. 2007) at French Frigate Shoals Tern Island (Papahānaumokuākea Marine National Monument), 23 percent of the total items collected in this study originated from the maritime industry.

Large, heavily regulated vessels such as cruise ships and cargo carriers are a potential vector for the introduction of marine debris. Due to their size, these ships are subject to Port State Control compliance inspections and garbage record book requirements, in addition to all regulations placed on smaller vessels. Each industry's potential contribution to marine debris is influenced by the ship's purpose (the carriage of crew or cargo).

◆ Cruise ships carry significantly more passengers and crew than cargo carriers; therefore, cruise ships are more likely to create a larger proportion of domestic waste.



◆ Cargo ships may lose cargo or cargo containers at sea as a result of severe weather or poor loading practices. One study indicates that global cargo losses during 2006 totaled nearly 2,500 containers (*American Shipper* 2007). Geography is another key factor; some cruise ships operate in environmentally sensitive habitats such as Caribbean islands or the Inside Passage of

Alaska where marine debris may have a more significant impact (Butt 2007).

◆ Both the cargo and cruise industries have initiated programs to minimize the impact of their activities. In order to eliminate (to the maximum extent possible) the disposal of MARPOL Annex V wastes at sea, some cruise ships have voluntarily developed advanced programs for waste minimization, waste reuse and recycling, and waste stream management. Best practices to minimize container loss overboard are due to be published in 2008 and distributed to containership owners and operators (*Lloyd's List* 2008).

Recreational vessels are also a potential source of ocean-based marine debris.

Vessels over 26 feet are subject to a MARPOL placarding requirement, and vessels over 40 feet must maintain a garbage management plan. Recreational fishing gear and domestic waste are likely components of marine debris contribution from these vessel types.

Oil and gas platforms are another ocean-based source of marine debris. This can be the result of improper disposal of wastes or equipment, or loss during heavy weather.

◆ The Minerals Management Service (MMS) has regulations, policies, and programs in place to reduce, eliminate, and remove debris emanating from facilities and operations under the agency's jurisdiction. However, heavy weather events demonstrate that government oversight and intervention, as well as industry best practices, cannot completely prevent the introduction of debris from regulated facilities.

◆ In 2005, the offshore oil and gas industry lost 117 platforms on the Outer Continental Shelf, and dozens more were significantly damaged as a result of Hurricanes Katrina and Rita.

An additional source of marine debris is derelict or abandoned vessels and off-shore materials and equipment (e.g., research buoys, cables, aquaculture

infrastructure). In high-wave conditions from surf, severe storms events or tsunamis, these vessels or structures can be broken up and strewn across the ocean floor, adversely affecting habitat and navigational safety. In pristine coral reef habitats, the iron enrichment from metal debris has been demonstrated to lead to algal blooms and to upset the ecological balance of the reef (Green et al. 1997).



Section 4.0 Ecological, Human, and Economic Impacts

Regardless of origin, debris entering the aquatic environment can have significant impacts on ecology, human health and safety, and the economy. The impact of marine debris varies in scope and intensity depending on the type of debris (e.g., plastic bags, miscellaneous plastics, derelict fishing gear, or shipping containers) and its location (e.g., floating in shipping lanes or sitting on sensitive habitats).

4.1 Ecological Impacts

Marine debris can cause adverse impacts on aquatic ecosystems, such as coral reefs, wetlands, fish habitats, beaches, and migratory species breeding grounds and pathways. Marine debris can impact species directly, such as through entanglement or smothering of species, or indirectly, such as through changes to habitat. Ecological impacts can also vary depending on the type of marine debris.

Derelict fishing gear can cause numerous impacts on habitats and fisheries. For example, derelict gear can damage coral reefs by smothering, breaking apart, or abrading corals (Chiappone et al. 2005; Donohue et al. 2001; Asoh et al. 2004). Derelict gear can also result in “ghost fishing,” which occurs when marine species become trapped in lost or abandoned pots or nets that continue to catch prey without being retrieved by fishermen to harvest (Matsuoka et al. 2005; Pawson 2003; Bullimore et al. 2001). Ghost fishing does not discriminate: local and migratory species including those protected under the Endangered Species Act (ESA) may be impacted (Seitz and Poulakis 2006).



Marine debris of many types can entangle marine species by encircling or ensnaring the animals. The entanglement can occur accidentally or when an animal is attracted to the debris as part of normal behavior or out of curiosity. Animals may incur lacerations or other wounds from debris, potentially leading to infection and debilitation (Page et al. 2004).

- ◆ When marine species become entangled within debris, their mobility is limited. Constricted movement may inhibit the animal's ability to collect food or breathe and can lead to starvation, suffocation, exhaustion, and increased predation.

It is typical for marine animals such as the endangered Hawaiian monk seal to investigate foreign items in their local marine habitat, which can lead to injury, drowning, or suffocation in nets, line (including monofilament), straps, or plastic items (Boland and Donohue 2003; Henderson 2001).

- ◆ In the Northwestern Hawaiian Islands between 1982 and 2006, 268 entanglements of the endangered monk seal were documented (NOAA 2007c).

This figure likely underestimates actual entanglement rates because it only reflects those seals that became entangled but were still mobile enough to reach shore at a time of year when humans were able to find them.

Although large debris items, such as derelict fishing gear, can have severe and highly visible impacts, smaller debris items such as bottle caps, lighters, and plastic pieces are also hazardous to wildlife.

- ◆ Seabirds are known to ingest small debris items along with their food (Dickerman and Golet 1987; Harrison et al. 1983). Northern fulmars and other marine birds which ingest plastic debris do not have the capacity to regurgitate the indigestible material (Mallory et al. 2006).

- ◆ Ingestion of marine debris can lead to starvation or malnutrition because the ingested items may collect in the animal's stomach and lessen the desire to feed. In addition, ingestion of sharp objects can damage the mouth, digestive tract, or stomach lining and cause loss of nutrition, infection, starvation, and even death (Derraik 2002; Redford et al. 1997). Ingested items also can block air passages and cause suffocation.

- ◆ Ingestion can occur accidentally, but often animals will feed on marine debris because it resembles their food (Gramentz 1988). For example, sea turtles have been known to ingest plastic bags in the marine environment instead of their target prey, jellyfish (Carr 1987). In a study of green sea turtles, 23 of 38 animals were shown to have ingested anthropogenic debris (Bugoni et al. 2001).

An indirect impact of marine debris on shoreline habitats occurs on beaches as a result of debris reduction and removal efforts. Mechanical beach raking, accomplished with a tractor or human labor, is used to remove debris from the shoreline and can help to remove floatable material from beaches and marine shorelines. However, beach raking can also be harmful to aquatic vegetation, nesting birds, sea turtles, and other types of aquatic life.

- ◆ A study by the U.S. Fish and Wildlife Service (FWS) on the effect of mechanical beach cleaning on threatened piping plovers found that such practices harmed nesting birds by destroying potential nesting sites, crushing nests

and chicks, and removing the natural wrack-line feeding habitat. To minimize this impact, FWS (1996) suggested that beach raking should not be conducted during nesting season.

Storm events, such as hurricanes and tsunamis, can mobilize legacy marine debris, altering the species impacted as the location or depth of the debris is changed. In addition, as the material is mobilized, habitats can be impacted by the kinetic energy of the debris. Marine debris can also indirectly damage the environment if it causes vessel accidents that spill oil or hazardous materials.

4.2 Human Impacts

Marine debris can also endanger human health and safety.

Certain types of marine debris such as fishing nets and lines can impact vessel movement and navigation by wrapping around boat propellers, disabling the vessel, and ultimately endangering human lives. In 1993, derelict fishing gear contributed to the sinking of the Korean passenger ferry M/V Seo-Hae, which resulted in the deaths of numerous passengers (Cho 2006).

Recreational boaters have also been subject to stranding due to engine fouling from plastic bags blocking intake valves or derelict fishing nets or lines becoming entangled around propellers. Vessels may directly strike floating or submerged marine debris, which may lead to human injury or severe damage to the vessel.

Human impacts from marine debris also may occur from direct contact with sharp debris objects, such as broken glass, rusted metal, or medical debris, on beaches or the ocean floor.

◆ In the late 1980s, beaches in New York and New Jersey were closed to protect the public from medical waste, including syringes and bandages from hospitals that washed ashore.

Humans also may be directly impacted by marine debris when, for example, scuba divers become

entangled in lost or abandoned fishing line and nets. While this is a rare occurrence, entangled divers can be seriously injured or killed.

4.3 Economic Impacts

Marine debris can have substantial economic impacts. Although lack of comprehensive economic assessments limits the ability to estimate the overall economic impact of marine debris, evidence of economic losses for specific cases is available.

◆ Direct economic losses from marine debris can be measured in different ways, including analysis of impacts on tourism, losses in catch revenues, loss of fishing gear, damaged vessels, and human injuries.

Marine debris can be detrimental to the tourism industry by creating unsightly, dangerous beaches.

Beach closures, often a direct result of marine debris, can have particularly serious economic ramifications in coastal areas dependent upon tourism (Oigman-Pszczol and Creed 2007). In addition, the costs associated with cleanups and proper disposal of debris can be significant.



◆ Cleanup-related costs may include the cost of restoring the habitat impacted by marine debris, beach cleanup costs, the costs to clean piers, harbors, marinas, docks, and other waterfront

areas, and the costs associated with at-sea cleanups.

Environmental contamination from debris in the marine environment, both onshore and in local fish habitats, can also have significant economic impacts.

◆ Loss in tourism was estimated to be between \$706 million and \$2,977 million (in 2008 US\$) as a result of medical debris wash-ups in New Jersey in 1988 (Ofiara and Brown 1999).

Commercial fishery revenues may be adversely impacted due to bycatch of target fish or shellfish in lost nets or other types of “ghost” fishing gear.

◆ An estimated 200,000 pounds of Dungeness crab are killed in derelict crab pots every year in Puget Sound, an amount worth approximately \$335,000 (June 2007). Within the European Union, it is estimated that 1,500 demersal cod/turbot gillnets are lost each year in the Baltic Sea fishery, removing anywhere from 0.01 to 3.2 percent of the commercial harvest (Brown et al. 2005). Such bycatch not only reduces the standing stock of fish or shellfish available to a fishery but also can reduce reproductive capacity and thereby the long-term viability of the stock.

Vessels adversely impacted by marine debris may incur economic costs. As described earlier, marine debris has the potential to disable vessels through collisions, or by wrapping around propellers or blocking intakes.

In 1992 Japan estimated their fishing industry spent US\$4.1 billion in boat repairs resulting from damage caused by marine debris (Proceedings of the International Conference, 2000).

In addition to property damage, marine debris can cause lost opportunity costs.

◆ For example, fishermen can lose opportunities to fish if they are forced to stop operations as a result of entanglement or vessel damage incurred from marine debris. This opportunity cost can have a range of economic impacts on communities dependent on fishing revenues. Additionally, it can impose costs to locate, mark and remove debris that could pose a hazard to navigation.



Section 5.0 Current Actions

The Marine Debris Research, Prevention, and Reduction Act mandates the Interagency Marine Debris Coordinating Committee to report on alternatives or current actions intended to reduce, mitigate, prevent, and control the harmful effects of marine debris. Actions described in this section come from those in the 1988 Interagency Task Force on Persistent Marine Debris Report (DOC et al., 1988), as well as other actions that have been undertaken by a variety of IMDCC agencies, state coastal zone managers, non-governmental organizations, and local entities over the past 20 years.

These actions are existing measures that are intended to address marine debris in the environment. Many of these actions have been in place for years, while others are relatively new concepts recently put into practice. As a means of organization, actions were classified into four themes:

1. marine debris prevention;
2. response to debris already in the marine environment;
3. research and development of new methods to understand debris impacts and movement; and
4. cross-theme efforts to foster coordination.

Theme 1: Prevention

Preventing the introduction of debris into the marine environment remains the most elusive component of mitigating the impacts of marine debris. Activities intended to enhance and promote the prevention of marine debris include robust education and outreach campaigns, development and application of appropriate policies, and creation of appropriate incentive programs.

5.1 Education and Outreach

Education and outreach campaigns have been successful in influencing the human behavior that creates marine debris.

These campaigns remain necessary given the influence of people's attitudes and practices on the accumulation of marine debris.

The target audience for education programs spans the entire spectrum from schoolchildren to seniors and people engaged in activities ranging from leisure to professional pursuits.



Outreach campaigns, particularly those developed in conjunction with the media and those that are sustained for a longer period of time, have been effective in highlighting both successes and areas where additional work is necessary.

Education and outreach campaigns about marine debris have been developed both by and for multiple stakeholders. The majority have focused

on a particular target audience.

Different perceptions of marine debris by user groups ranging from producers to transporters to product users necessitate targeted campaigns. In addition, national and international campaigns provide broad information on marine debris as a global issue and address the need to prevent further pollution and remove debris already in the coastal and marine environment.

A variety of mechanisms, both specific and general, have been employed. These included signage, national programs, public service announcements (PSAs), and television commercials.

◆ An example of a national outreach and education message is the six-pack ring campaign that increased public awareness in the late 1970s when environmentalists began calling attention to the problem of marine debris. The emphasis on six-pack rings is an example of eco-activism exemplified in John Javna's 1990 book *Fifty Simple Things You Can Do to Save the Earth*, in which cutting up six-pack rings was cited as Simple Thing #2. This book, along with extensive media attention, brought about national awareness regarding the need to cut six-pack rings to prevent wildlife entanglements if the rings enter the marine environment.

Another effective national media campaign was the partnership between Keep America Beautiful and the Ad Council to dramatize how litter and other forms of pollution hurt the environment and how individuals have the responsibility to help protect the environment.

◆ This national media campaign began on Earth Day, 1971, when a PSA featuring Native American actor Chief Iron Eyes Cody and the tagline, "People start pollution. People can stop it," aired for the first time. During the height of the campaign, Keep America Beautiful reported receiving more than 2,000 letters a month from people wanting to join their local team. By the end of the campaign in 1983, Keep America Beautiful local teams had helped to reduce litter by as much as 88 percent in 300 communities, 38 states, and several countries.

The Storm Drain Sentries Campaign, started in 1992, was another outreach effort to prevent floatable debris from being washed down storm drains. This campaign, which involved more than 90 organizations and 34 states, stenciled educational messages on almost 355,000 storm drains in the United States and Canada by 2002.

Providing the link between individual actions and potential environmental impacts can be an effective outreach method.

There is significant potential for outreach that links prevention of marine debris with better handling of waste, such as through increased recycling and proper covering of waste during transport and deposition into landfills.

Outreach activities also can facilitate the transfer of experimental and proven measures among stakeholders, as well as the exchange of relevant information on best management practices.

New and innovative opportunities to prevent the introduction of marine debris also can benefit from outreach at the early stages of development to increase public awareness of these opportunities. This has been done through state and non-profit web sites.

◆ The State of Florida has promoted its Monofilament (fishing line) Recovery and Recycling Program via the internet. Federal agencies also have developed programs to educate employees.

◆ As part of the Minerals Management Service (MMS) marine debris awareness effort, oilfield personnel are educated about the dangers caused by marine debris and methods to prevent it. MMS also encourages operators to develop waste management plans, record trash and debris, and conduct operations in a safe and environmentally sound manner to prevent accidental losses of trash and debris.

5.2 Legislation / Regulation / Policy

Federal, state, and local governments are able to develop and implement legislation and policies to mitigate the impacts of marine debris, prevent its introduction, and reduce the amount of debris that is already in the marine environment. A table of existing federal authorities identifies those that explicitly state marine debris in the authority, address sources and items that may become marine debris, or address entities that may be impacted by marine debris (Table 2).

Table 2. Federal authorities by agency that (1) specifically mention marine debris in the authority, (2) address sources and items that could become marine debris (e.g., plastic, fishing gear, garbage), and (3) address entities that may be impacted by marine debris. An X in the last column represents legislation that has any =regulatory component. Appendix I includes detailed information on these authorities.

Authority	Explicitly states marine debris in the authority	Authorities that address sources and items that may become marine debris	Authorities that address entities that may be impacted by marine debris	Regulatory
Marine Debris Research, Prevention and Reduction Act, 33 U.S.C. 1951 et seq.	NOAA, USCG			
Coral Reef Conservation Act of 2000, 16 U.S.C. 6401 et seq.	NOAA			
Coastal Zone Management Act of 1972 (P.L. 92-583; 16 U.S.C. 1451 et seq.), as amended. (Specifically the Reauthorization Amendments of 1990, 16 U.S.C. 1455b)	NOAA	NOAA, EPA		
Marine Plastic Pollution Research and Control Act 33 U.S.C. 1914 - 1915	EPA, NOAA	EPA, NOAA, USCG		
Driftnet Act Amendments of 1990, 16 U.S.C. 1826		NOAA, FWS, DOS		X

Authority	Explicitly states marine debris in the authority	Authorities that address sources and items that may become marine debris	Authorities that address entities that may be impacted by marine debris	Regulatory
Marine Protection, Research and Sanctuaries Act, 33 U.S.C. 1401–1445		EPA		X
Shore Protection Act, 33 U.S.C. 2603		EPA, USCG		X
Clean Water Act, 33 U.S.C. 1251-1385, including 33 U.S.C. 1346(f) as amended by Beaches Environmental Assessment and Coastal Health Act of 2000, Pub.L.No. 106-284, (114 Stat. 876)		EPA, USACE		X
Resource Conservation and Recovery Act, 42 U.S.C. 6901-6992k		EPA		
Pollution Prevention Act of 1990, 42 U.S.C. 13101–13109		EPA		
Act to Prevent Pollution from Ships (APPS), 33 U.S.C. 1901 et seq. as amended by the Marine Plastic Pollution Research and Control Act		USCG		X
Rivers and Harbors Act of 1899, 33 U.S.C. 401 et seq.		USACE, USCG		X

Authority	Explicitly states marine debris in the authority	Authorities that address sources and items that may become marine debris	Authorities that address entities that may be impacted by marine debris	Regulatory
Amended Section 2 of the Flood Control Act of 1954, Sec. 208		USACE		
Outer Continental Shelf Lands Act, 43 U.S.C. 1331 et seq. and Amendments 43 U.S.C. 1801 et seq.		MMS		X
Energy Policy Act of 2005, 42 U.S.C. 15801 et seq.		MMS		X
Magnuson-Stevens Fishery Conservation and Management Act, 16 U.S.C. 1801 et seq.		NOAA	NOAA	X
National Marine Sanctuaries Act, 16 U.S.C. 1431 et seq.		NOAA	NOAA	X
National Wildlife Refuge System Administration Act of 1966 & National Wildlife Refuge System Improvement Act of 1997, 16 U.S.C. 668dd			FWS	
Anadromous Fish Conservation Act, 16 U.S.C. 757a et seq.			FWS	
Endangered Species Act of 1973, 16 U.S.C. 1531 et seq.			NOAA, FWS	X

Authority	Explicitly states marine debris in the authority	Authorities that address sources and items that may become marine debris	Authorities that address entities that may be impacted by marine debris	Regulatory
Marine Mammal Protection Act, 16 U.S.C. 1402			NOAA, MMC, FWS	X



Marine debris is explicitly addressed in the Marine Debris Research, Prevention and Reduction Act (MDRPRA), the Coral Reef Conservation Act, Coastal Zone Management Act, and the Marine Plastic Pollution Research and Control Act (33 U.S.C. 1914).

◆ MDRPRA, the act pursuant to which this report was prepared for submittal to Congress, is intended to help identify, determine sources of, assess, reduce, and prevent marine debris and its adverse impacts on the marine environment and navigation safety. The IMDCC, originally established under 33 U.S.C. 1914, is re-established under the MDRPRA.

◆ The Coral Reef Conservation Act section 207(b)(3) authorizes the provision of assistance to states for the removal of marine debris from coral reefs to conserve living marine resources

◆ Under section 309(a)(4) of the Coastal Zone Management Act (CZMA), states are eligible to receive grants to reduce marine debris. None of these authorities that explicitly mention marine debris are regulatory in nature.



Although the term “marine debris” is not used in other regulatory contexts, federal authority does exist for the regulation of certain items that may be or have the potential to become marine debris.

◆ Section 13 of the Rivers and Harbors Act declares it unlawful to discharge refuse from shores, wharfs, and other areas into any navigable water and “into any tributary of any navigable water from which the same shall float or be washed into such navigable water”; it also prohibits the deposit of certain items on the banks of navigable waters where those items are likely to be washed away (33 U.S.C. 407). The Rivers and Harbors Act also gives USACE and USCG authority to respond to marine debris large enough to pose a hazard to navigation.

◆ The Act to Prevent Pollution from Ships or APPS (33 U.S.C. 1901 et seq.), as amended by the Marine Plastic Pollution Research and Control Act, regulates the discharge of garbage from ships, including section 8(a), the prohibition against the discharge of plastic into the ocean or navigable waters (33 U.S.C. 1907(a)).

◆ Dumping of waste at sea is regulated under Title 1 of the Marine Protection, Research, and Sanctuaries Act (33 U.S.C. 1411-1421).

◆ Transportation and reception of municipal and commercial wastes in coastal waters is regulated under the Shore Protection Act.

Authorities like the Clean Water Act, Resource Conservation and Recovery Act (RCRA), and the Pollution Prevention Act of 1990 do not specifically state marine debris but include standards applicable to the control of land-based sources of marine debris.

◆ Although the term is not explicitly used, marine debris is a focus of section 406(f) of the Clean Water Act. Section 406(f), as amended by the Beaches Environmental Assessment and Coastal Health Act of 2000, directs EPA to provide technical assistance to states and local governments for the assessment and monitoring of floatable material, which is a term used interchangeably with marine debris in EPA’s guidance document that resulted from this section of the Clean Water Act.

◆ The Pollution Prevention Act, unlike the Clean Water Act and RCRA, is not a regulatory statute in that it does not impose obligations on non-federal entities.

Several of these federal prevention or reduction statutes are administered by states with federal authorization, such as the CZMA grant activities, the Coastal Zone Act Reauthorization Amendments of 1990 related to coastal non-point sources of pollution, the RCRA solid waste management programs, and the Clean Water Act discharge permitting program.

◆ Other examples of state and local activity include but are not limited to the enforcement of litter laws, state fishery regulation, derelict vessels, waste regulation, beach ordinances, and fees and prohibitions related to certain items which may become marine debris.

As requirements and practices may change from locality to locality, the potential for variation creates a greater need for federal, state and local coordination if efforts to prevent and reduce marine debris are to be consistent and viable. Currently, there is no comprehensive understanding of all state authorities relating to marine debris and items that may become marine debris.

There are a number of pieces of federal legislation with indirect linkages to marine debris that address entities that may be impacted by marine debris.

◆ For example, the ESA could be used to address marine debris through recovery plans for endangered species. This was used for monk seals, for which the plan states “continuing actions to remove marine debris and reduce mortality of seals due to entanglement” (DOC 2007).

In addition, under the Magnuson-Stevens Fishery Conservation and Management Act, which governs fishery management, Regional Fishery Management Councils and the National Marine Fisheries Service have implemented fishery management measures that address the issue of ghost fishing, either by reducing the potential for it or by mitigating the harm it may cause to living

marine resources.

◆ Several fisheries that use pots or fish traps are required to have escape mechanisms and biodegradable panels to reduce the potential of ghost fishing if gear becomes derelict. A review of the legislation in Table 2 reveals a diverse set of mandates that incorporate some regulatory requirements. Evaluating these authorities can demonstrate a number of areas where agencies can work together and review these authorities to determine whether any of these may provide opportunities for combating marine debris and its impacts to marine resources. A more detailed list of these legal authorities and how they relate to marine debris are listed in Appendix I.



5.3 Incentive Programs

Incentive programs provide unique motivation for stakeholders to engage in addressing the impacts of marine debris. These programs, however, are not stand-alone and typically are implemented in conjunction with other prevention efforts.

Incentives, such as implementation of a deposit-free or deposit-refund framework in port reception facilities, may enhance waste management practices by ports and reduce incentives for vessels to dump waste at sea (Georgakellos 2007).

◆ NOAA, the National Fish and Wildlife Foundation, and Covanta Energy Corporation created in 2007 a partnership program called Fishing for Energy to reduce the amount of unused fishing gear in the community and marine environment. The project provides a place for the fishing community to dispose at no cost any old or derelict fishing gear recovered while at sea. This program eases the burden on fishermen caused by the high costs associated with disposing of old fishing gear in a landfill. The project is modeled on a successful waste for energy multi-partner project in Hawaii.



Another form of incentive programs targets marinas and encourages these marinas to advocate environmental friendly practices. In the United States and abroad, green marina programs have been seen as a voluntary, incentive-based method for decreasing the environmental impact of marinas and watercraft.

◆ For example, a public-private partnership between the National Park Service (NPS) and the District of Columbia was initiated to assist marina and boatyard owners, operators, and concessionaires in voluntary stewardship (NPS

2001).

◆ The Maryland Department of Natural Resources (2002) similarly developed a Clean Marina Initiative for marina operators. The Blue Flag Programme, based in Europe, certifies marinas and beaches as sustainable.

◆ The U.S. Department of Transportation (2002) reported that a typical one-week cruise ship voyage generates approximately 210,000 gallons of sewage, one million gallons of graywater (from sinks, showers, and laundry), over 130 gallons of hazardous waste, over seven metric tons of solid waste, and 25,000 gallons of oily bilge water.

◆ To encourage a reduction in some of these wastes, the international operational company Registro Italiano Navale Group (RINA) has developed the “Green Star Design” program which is awarded to ships that address requirements found in MARPOL Annex I, IV, V, and VI. Although these requirements and incentives address more than just marine debris, this program demonstrates a possible approach to vessel-based incentive programs.

Incentive programs for passengers on cruise ships and other vessels may encourage citizens to report illegal activities and act as “whistle blowers.” Under the Act to Prevent Pollution from Ships, people who provide information leading to a conviction may be rewarded up to one half of any resulting fine amount.

◆ In a 1993 case against Princess Cruises, individuals who videotaped and reported the illegal dumping of plastic garbage bags were awarded half of the \$500,000 fine.

Initiatives designed and implemented by states have proven effective in mitigating marine debris.

◆ The Washington State Department of Fish and Wildlife operates the “Derelict Fishing Gear Removal Project,” in which mariners report derelict fishing gear online or via telephone. The Project’s “no fault” approach is focused on

removing lost and abandoned fishing gear, not on assessing blame.

Incentive programs may also address prevention on land. A September 2007 *New York Times* article reported -

...an estimated 100,000,000,000 plastic bags are used by Americans annually.

Discarded plastic bags are prone to being transported into the marine environment by wind and stream runoff. These bags also are difficult to recycle and take an estimated 12 million barrels of oil to produce (*New York Times* 2007).

◆ Concerned civic organizations in Southern California banded together to promote a “Day Without a Bag,” a program that leveraged public and private support to encourage consumer use of reusable bags. Stores donated reusable bags and offered discounts and rebates to reusable bag users; 22 local governments designated December 20, 2007 as a day without a bag.

◆ By leveraging the support of private business and local government, these NGOs were able to directly reach consumers and spread awareness of the link between consumer activity and marine debris.

Theme 2: Response to Debris Already in the Marine Environment

Responding to debris already present in the marine environment remains a component of an overall strategy to mitigate marine debris impacts. Total prevention of all debris entering the marine environment is a long-term goal, but until that goal has been attained, it remains necessary to develop appropriate response strategies and actions for existing debris. Such response activities include nearshore and at-sea cleanups, as well as enforcement of existing environmental laws pertinent to marine debris.

5.4 Enforcement

The primary agencies responsible for enforcement of laws relevant to marine debris are:

1. the USCG;
2. the NOAA Office for Law Enforcement;
3. the MMS’ Outer Continental Shelf (OCS) Civil/Criminal Penalties Program;
4. the EPA Office of Enforcement and Compliance Assurance; and
5. the United States Department of Justice (DOJ), Environment & Natural Resources Division (ENRD).

Enforcement of illegal dumping and discharge of trash or debris into waterways and marine environments begins when a responsible government official identifies an actual or potential violation of applicable environmental laws, such as the Clean Water Act, the Marine Protection, Research, and Sanctuaries Act, the Act to Prevent Pollution from Ships, the Marine Sanctuaries Act, or other applicable laws.

Violations may come to the attention of government officials in a variety of ways: a government official may witness a violation; a violator may report its own violation; or a concerned citizen may report a violation to government officials.

◆ The USCG performs inspections for compliance with MARPOL Annex V and United States regulations. Marine Inspectors inspect United States commercial vessels annually and examine foreign vessels through the Port State Control program.

In 2006, the USCG performed MARPOL Annex V examinations onboard over 15,000 commercial vessels (US and foreign).

◆ The pollution prevention verifications include a review of vessel waste management systems and inspection of the ship to verify compliance. In addition, smaller vessels, including recreational and commercial fishing vessels that are required

by law to be inspected, are subject to random “at sea” boardings where compliance is verified. Coast Guard enforcement boardings, including domestic fisheries boardings, boardings within marine sanctuaries, and recreational boating safety boardings, allow the USCG to do its part in ensuring compliance within fishing and recreational boating communities.

The USCG enforces MARPOL Annex V obligations implemented domestically by verifying that certain domestic waterfront facilities maintain the capability of receiving garbage and waste from oceangoing ships during annual facility inspections and harbor patrol spot checks. Ports and terminals, must comply with MARPOL Annex V under the criteria established for reception facilities for Garbage in 33 C.F.R. Subpart D. For ports and terminals described in 33 C.F.R. 158.135, operation is conditioned upon meeting the requirements of a USCG issued Certificate of Adequacy.

◆ The USCG pursues various enforcement actions for MARPOL Annex V non-compliance, including written warnings, imposition of monetary civil penalties, and referral of cases to the DOJ for criminal prosecution or civil judicial enforcement action. Many pollution violation penalties are imposed through the USCG’s civil penalty and Notice of Violation process, which in essence allows the USCG to write tickets for violations. In addition, the USCG may seek to suspend or revoke merchant mariners’ credentials for willful or negligent acts associated with violations of MARPOL or APPS. For the most serious cases, the USCG refers violations to the Department of Justice for prosecution.

The NOAA Office for Law Enforcement brings both administrative and civil enforcement actions and has the authority to enforce numerous statutes and treaties relevant to the protection of marine resources.

To assure safe and environmentally sound operations on the OCS, MMS inspects all facilities under its jurisdiction and enforces its regulations through warnings, component and facility shut-ins, and a Civil and Criminal Penalties Program.

More than 600 civil penalties were collected between 1990 and 2006.

EPA’s Office of Enforcement and Compliance Assurance and EPA Regional offices often initiate referrals of violations under statutes administered by EPA for subsequent civil or criminal enforcement.

Judicial enforcement of the environmental violations is led, in the civil and criminal contexts, by the DOJ. Cases referred by agencies such as EPA, NOAA and USCG are generally handled by the ENRD working with the U.S. Attorneys’ offices. For example, in 2006, ENRD brought a civil suit on behalf of NOAA seeking compensation for natural resources damages to the Monterey Bay National Marine Sanctuary sustained as a result of the defendant’s loss of 15 shipping containers. In settling this case, the defendant agreed to pay \$3.25 million to provide compensatory restoration for damages to the Monterey Bay National Marine Sanctuary.

ENRD also prosecutes criminal violations of environmental laws regarding releases of garbage into marine waters.

◆ In March 2006, a company entered a plea agreement with the United States Attorney’s Office for the District of New Jersey. The charged company agreed to pay a \$5 million criminal fine and make a \$1.5 million community service payment to the FWS for violations of the Act to Prevent Pollution for Ships involving both illegal discharges of garbage and oil.

◆ ENRD prosecuted violations of the Act to Prevent Pollution from Ships and the Ocean Dumping Act in the Federal District Court for the District of Columbia. The defendant was found guilty by a jury for instructing employees under his supervision to dump “hundreds” of plastic bags containing asbestos into the ocean. The company pled guilty and was sentenced in March 1998 to pay a \$250,000 fine.



5.5 Cleanups

Many different types of cleanup activities are undertaken to reduce the quantity and impacts of marine debris. Local beach cleanups tend to receive the most media attention, as the public is generally involved. Activities may include the International Coastal Cleanup (ICC), community beach cleanups, or other local efforts.

Various types of cleanups are necessary in both the coastal regions and the open ocean for complete marine debris removal to be effective in the short and long term.

The majority of beach cleanups are facilitated by international and local non-profit organizations. Beach cleanups are generally driven by community involvement and contribute to the education and understanding of marine debris issues.

During the 2006 ICC, Ocean Conservancy organized over 350,000 volunteers globally, cleaning 3,175 metric tons of trash from over

30,000 miles of shoreline (Ocean Conservancy 2006). Since ICC's inception in 1986, ICC activities around the world have collected 52,617 metric tons of debris (Ocean Conservancy 2007). The ICC is funded by several federal agencies.

◆ Other initiatives, including the Adopt-A-Beach program sponsored by the California Coastal Commission, similarly engage communities for cleanups on a local level.

Beach cleanups are also led by federal agencies such as the U.S. Fish and Wildlife Service, which has coordinated all-volunteer beach cleanups in the Hawaiian Islands and Midway Atoll National Wildlife Refuges since 1990.

Federal and non-federal partners initiate and participate in cleanups at sea.

Two significant distinctions between at-sea and beach cleanups are the scale of the debris removed and the remote locations where removal occurs.

◆ Over a ten-year period, an at-sea removal campaign led by NOAA and partners including USCG in the Northwestern Hawaiian Islands has proven to be beneficial, but it is also costly to operate and requires extensive coordination among project partners. The debris is often larger (a conglomerate of derelict fishing nets versus plastic bottle caps) and at greater depths, which necessitates trained vessel operators and removal experts. Underwater marine debris removal efforts involve federal partnerships.

◆ Following the devastation resulting from Hurricane Katrina along the Gulf of Mexico coast, the U.S. Army Corps of Engineers (USACE) requested assistance from USCG to oversee the removal of submerged marine debris in navigational channels and nearshore environments.

◆ NOAA received supplemental funds to conduct side scan sonar to locate debris, and estimate its size, depth and the overall debris density. To access this underwater debris, USCG contractors used cranes tethered to a barge for spot removal (NOAA 2007a).

◆ Oil and gas infrastructures that were damaged or destroyed in the 2005 hurricane season are being addressed by MMS and industry. Obsolete platforms may have alternate uses as artificial reefs through the Rigs-to-Reefs Program, which provides habitat to marine life and is an alternative to onshore disposal.

Removal operations of submerged marine debris may necessitate the use of specially trained divers.

◆ To address this need, organizations such as the Northwest Straits Commission (NSC) have offered targeted diver training programs, conducting six classes and training 53 divers from 2002 to 2007 (NSC 2007).

Harbors are unique repositories of marine debris given the confluence of vessel traffic, recreational activities, and shoreline businesses.

◆ An example of an effective strategy to mitigate existing marine debris in harbors is the partnership of federal agencies with non-profit organizations to assess and remove debris in New Bedford Harbor, Massachusetts.

◆ Another partnership is the Boston Harbor Association (BHA), which developed a marine debris mitigation initiative that brought together public and private organizations and has removed more than 200 short tons of marine debris since 2000 (BHA 2007). In addition, many harbors use skimmer boats to collect debris on a regular basis.

Finally, many areas have watershed cleanups that are aimed at keeping parks, creeks, and rivers clean. These cleanups can remove materials from land-based sources that might otherwise become marine debris.

◆ For example, the Anacostia Watershed Society hosts an annual trash cleanup of the watershed, located in eastern Washington, DC.

◆ At a national level, the National River Cleanup, sponsored by American Rivers has removed more than 907 metric tons of litter and debris from 100,000 miles of waterways, since its launch in 1991, and has involved more than 600,000 volunteers (American Rivers 2007).

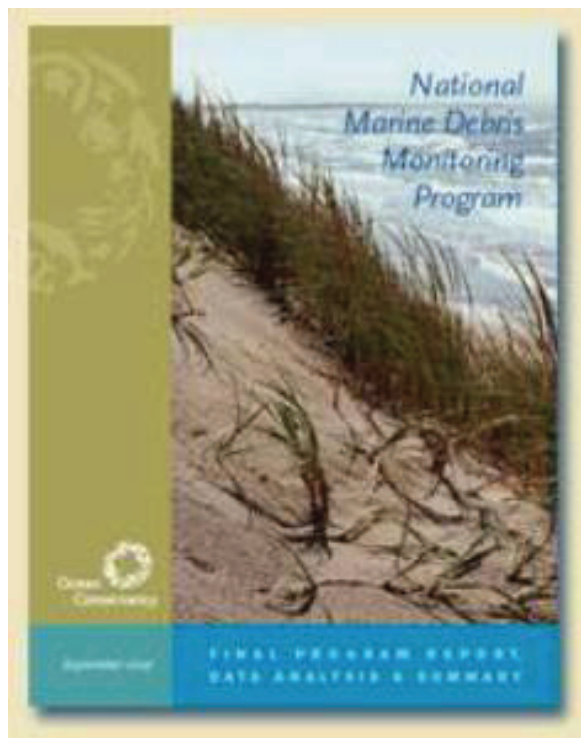
Theme 3: Research and Development

Since distribution of the 1988 Interagency Report that provided guidance regarding research focus areas, studies of sources and impacts of marine debris have continued. In order to maintain a thorough understanding of the marine debris issue, research must also focus on the impact of persistent materials on the marine environment and the development of new technologies for prevention and removal.

5.6 Research

Although marine debris research to date has not been able to provide a sufficiently comprehensive description of sources, movement, or impacts of marine debris, substantial advances have been made in our understanding of marine debris in recent years. Some of these advances likely relate to the increase in federal funding for marine debris research in recent years, while others reflect investment by other organizations or the fruition of long-term studies.

◆ The NOAA Marine Debris Program was established in 2005. This program has provided additional new funds for marine debris research projects on topics ranging from sources and composition of marine debris to impacts and approaches to mitigating those impacts through removal of debris or other approaches. Research, while focused on national concerns, is frequently conducted at a local level, such as in Puget Sound, Alaska, and Hawaii, in an effort to better understand geographic nuances.



◆ The benefit of research partnerships is demonstrated by the National Fish and Wildlife Foundation, NOAA, FWS, and Dow Chemical, who are working collaboratively to develop a scientific protocol in the Papahānaumokuākea

Marine National Monument for cataloguing plastic marine debris. The goal of the project is to determine sources of plastic debris.

The National Marine Debris Monitoring Program (NMDMP) is a key example of recent marine debris research efforts.

NMDMP was developed by Ocean Conservancy, through support from EPA, to standardize marine debris data collection and assess marine debris sources and trends in the United States.

◆ NMDMP used trained volunteers to conduct monthly marine debris surveys on designated beaches over a five-year period. The volunteers were responsible for identifying and recording the number of land-based, ocean-based, and general source items (i.e., items that originate on land or at sea) collected at each beach.

◆ The NMDMP Report indicates that approximately 49 percent of the marine debris items collected nationally during the study originated from land-based sources, 18 percent from ocean-based sources, and 33 percent from general sources (Sheavly 2007).

◆ The Report also indicates that there was no significant change in the total amount of debris collected over the five-year study period.

Better understanding of the movement and deposition of marine debris has been gained through studies in specific regions.

An improved understanding of the factors that influence marine debris distribution and deposition will improve the ability to predict which geographic regions are likely to accumulate marine debris under various conditions, as well as the likely rates of accumulation and residence time of debris in various regions of the ocean (e.g., the North Pacific Gyre).

◆ The Papahānaumokuākea Marine National Monument released information that indicates that marine debris deposition rates are higher during El Niño events than during normal years or La Niña events (Morishige et al. 2007).

◆ Marine debris dispersal models for the Gulf of Mexico can predict specific areas that are likely to accumulate debris following extreme weather events (NOAA 2007a). The development and use of these models may improve planning and response efforts to mitigate marine debris following extreme weather events.

A variety of studies have focused on the impacts of marine debris on specific habitats (e.g., coral reefs) or species (e.g., seabirds). In addition to funding research projects, some federal agencies have improved their operational ability to study and mitigate the impacts of marine debris.

◆ For example, NOAA is integrating training on the collection of marine debris data and assessment of impacts into ongoing training programs for the shoreline cleanup and assessment technique (SCAT), which historically has focused on shoreline oil spill responses.

5.7 Technology Development

Building upon the information gathered from research, development of new technologies may allow significant reductions in the impacts, longevity, and dispersal of marine debris. In particular, technology development in the fields of biodegradable materials, combined sewer and separate storm sewer systems, and debris location and removal equipment may help reduce the introduction and persistence of marine debris.

Development of new technologies for studying and monitoring marine debris will provide opportunities for improved data collection and better understanding of marine debris and its impacts.

Technologies such as rot cord—a biodegradable cord designed to degrade in the marine environment and allow trapped animals to escape from a derelict trap, pot, or creel—can make lost gear less harmful by reducing the duration of time that the gear can continue ghost fishing. However, in some fisheries rot cord has not been required and in others the rot cord was not properly implemented on the gear.

◆ In Puget Sound where rot cord is required on crab pots, the Northwest Straits Commission is reaching out to educate commercial and recreational fishermen on proper installation of rot cord.

To mitigate the effects of combined sewer overflow and discharges from separate storm sewer systems, development and implementation of new technologies are needed.

◆ To address the problems of an aging sewer system, the Department of Justice, representing the EPA, reached an agreement in July 2007 with the City of San Diego to improve the city's aging infrastructure; the City agreed to spend \$1 billion over the following six years on new monitoring and sewage system replacement technologies (DOJ 2007).

◆ In September 2007, EPA agreed to work with the City of Muscatine, Iowa, to develop two separate systems over the next 15 years: one for stormwater and one for sanitary sewage (EPA 2007).

◆ Combined sewer systems serve roughly 772 communities containing about 40 million people in the United States (EPA 2002b). Another 6,000 communities, serving more than 150 million people, are served by separate storm sewer systems permitted under Clean Water Act permits (EPA 2008).

Investments in new or improved infrastructure will be necessary to further identify and address the sources of marine debris.

Marine debris removal is a non-trivial task, particularly for large items. Removing fishing gear, whether commercial or recreational, is dangerous to the people doing it. On land, gear is heavy and difficult to move. Underwater, lost gear poses a high entanglement risk to divers. To lessen the impact to those removing debris and to the local habitat, removal techniques would benefit from advances in technology. In addition, these advances in technology could lead to easier and increased removal efforts.



New technologies developed for multiple applications have also been applied to study marine debris movement.

In recent years, satellite imagery and Unmanned Aerial System technology have been used to identify convergence zones that concentrate floating marine debris in the ocean.

◆ These studies have initially focused on the convergence zone that influences the delivery of marine debris to the Northwestern Hawaiian Islands (Pichel et al. 2007), which accumulate an estimated 52 metric tons of marine debris annually (Dameron et al. 2007). These technologies intend to facilitate the location and removal of debris

before it comes into contact with sensitive habitat areas, such as coral reefs.

Theme 4: Cross-theme Efforts to Foster Coordination

The coordination of efforts to address marine debris issues among federal agencies and between those agencies and other involved parties (e.g., state and local governments, tribal governments, environmental non-governmental organizations, and various industries) is a key requirement for ensuring that the other thematic components (prevention, response, and research and development) are fully implemented. Such coordination comprises portions of the three aforementioned themes, but does not fit solely within them. Thus, coordination is discussed here as a “cross-theme” effort.

5.8 Fostering Coordination

Despite Congressional mandates and binding legislation, federal agencies cannot manage marine debris single-handedly. State and local partnerships, non-governmental efforts, and volunteer commitment must be coordinated to reach collective goals.

Federal coordination is necessary to leverage all agency capabilities domestically as well as internationally.

The IMDCC is currently responsible for coordinating a comprehensive program of marine debris research and activities among federal agencies, in cooperation and coordination with non-governmental organizations, industry, universities, and research institutions, states, Indian tribes, and other nations, as appropriate.

The IMDCC also ensures the coordination of federal agency marine debris activities both nationally and internationally, and recommends research priorities, monitoring techniques, educational programs, and regulatory action.

Cross-agency collaboration between federal, state, and local partners allows for leveraging to maximize the use of available resources to address marine debris issues.

- ◆ USCG and NOAA work with state and local partners in Hawaii to remove debris in the remote NWHI.

- ◆ MMS works with industry to develop standards and practices to improve platform survivability and rig station keeping during hurricanes; some standards and practices have already been incorporated into regulations.

- ◆ In Broward County, Florida, federal, state, and local governments leveraged resources to remove derelict tires that were dumped during the 1970s in hopes of creating artificial reefs. Through the Department of Defense's Innovative Readiness Training (IRT), U.S. Navy divers partner with ocean resource agencies to remove derelict debris while enhancing their own field training.

- ◆ Numerous regional meetings and conferences have been convened to foster coordination in mitigating marine debris.

- ◆ In January 2004, the Asia-Pacific Economic Cooperation convened a regional seminar in Hawaii on derelict fishing gear and marine debris, affirming the need to mitigate the impacts of marine debris through action at global, national, and regional levels (APEC 2004).

- ◆ The Department of State and NOAA co-hosted a workshop in the Caribbean in July 2007 to facilitate discussions on derelict fishing gear and any potential impacts it may be having on the wider Caribbean.

- ◆ In April 2008, the NOAA Marine Debris Program hosted a National Marine Debris Information Forum bringing together over 50 researchers from around the nation to present their marine debris projects to other scientists, federal agencies, state, non-government organizations and other interested persons.

- ◆ In order to improve monitoring and assessment of marine debris, the United Nations Environment Program (UNEP) and UNESCO/Intergovernmental Oceanographic Commission (IOC) have launched a project to develop global guidelines for the standardization of survey and monitoring of marine debris.

- ◆ In addition, an ongoing review of MARPOL Annex V by the International Maritime Organization (IMO), in consultation with relevant organizations and bodies, is assessing its effectiveness in addressing sea-based sources of marine debris. The aim is to complete the review by autumn 2008 (IMO 2007).





Section 6.0 Recommendations

The Interagency Marine Debris Coordinating Committee (IMDCC) presents recommendations intended to guide the Federal government’s strategies with respect to the problems of persistent marine debris. These recommendations are designed to be broad in scope, with the intention that federal agencies work collaboratively through the IMDCC to develop more detailed priorities and an action plan to implement these recommendations. In addition to having a federal-level focus, these recommendations attempt to address the different agency mandates and policies associated with issues related to marine debris reduction and prevention. These recommendations do not presuppose increased budgets for any specific agencies or programs, but the implementation of many of these recommendations will likely depend on support from new resources to adequately assess and address the complex problem of marine debris. They are written to allow individual agencies discretion in allocating their own resources to implement the recommendations, though the underlying goal is to enhance interagency cooperation through the activities of the IMDCC.

These recommendations also encourage agencies to increase their efforts to reduce current marine debris, prevent future marine debris, and mitigate the impacts of marine debris on navigation, human health and safety, the economy, habitats, and species. While the recommendations are general in nature, individual agencies are expected to lead coordinated efforts and work together to enhance and develop existing capacities so that individual agency efforts can work to address collective needs, threats, and challenges. Federal agencies are further encouraged to enhance their efforts to provide technical and educational materials to state, local, tribal and non-governmental entities (including industries, environmental non-governmental organizations, councils, academia, and the general public).

These recommendations address all the specific marine debris types and sources as described in Section 3, including debris from land-based and ocean-based sources. The term “marine debris” is used throughout these recommendations to encompass marine debris from all sources as well as items of terrestrial debris that are likely to become marine debris as a result of common transport (e.g., by terrestrial waterways, wave action along shorelines, or wind).

Theme 1: Prevention

6.1 Education and Outreach

6.1.1: Federal agencies should demonstrate leadership by distributing educational materials to personnel on the sources and impacts of marine debris as well as methods for prevention, with the goal of reducing the federal contribution to marine debris.

6.1.2: Federal agencies should support public awareness campaigns by providing technical expertise and educational materials and by encouraging private sector participation, when appropriate. These campaigns may target specific threats and audiences to address the diversity of the marine debris issue.

6.1.3: Federal agencies should engage and partner with state, local, tribal and non-governmental entities to support coordinated events, such as Earth Day, the International Coastal Cleanup, and other activities that have relevance to marine debris. These events should include nationwide educational and media outreach efforts to enhance awareness of sources and impacts of marine debris and to provide recommendations regarding specific actions that can be taken to prevent or reduce marine debris.

6.2 Legislation / Regulation / Policy

6.2.1: The IMDCC should review the findings from the National Academy of Sciences (NAS) study that will assess the effectiveness of international and national measures to prevent and reduce marine debris and its impacts, and federal agencies should take action, as appropriate.

6.2.2: Federal agencies should seek ways to strengthen and enhance their ability to fulfill both regulatory and non-regulatory mandates for marine debris prevention, where appropriate. Table 2, which lists federal marine debris related authorities, may be used for review and assessment of existing authorities.

6.2.3: The IMDCC should coordinate a correspondence group of state, local, and tribal governments to determine the marine debris-related authorities and policies at those levels, including both those that address land-based sources of marine debris and those that address ocean-based sources. The correspondence group will be an important component in the IMDCC's gap analysis of regulatory and non-regulatory authorities that can be used to promote marine debris prevention.

6.2.4: Federal agencies, coordinating through the IMDCC, should review existing international policies and strategies regarding marine debris from both land-based and ocean-based sources, and develop a white paper outlining possible policies or actions for consideration by the United States.

6.3 Incentive Programs

6.3.1: Federal agencies should support voluntary, incentive-based programs that encourage communities to adopt environmentally responsible practices. Examples may include Heal the Bay's "A Day Without a Bag" Program (a southern California non-profit organization) and the Clean Marina Program, an initiative involving federal agencies and state governments.

6.3.2: Federal agencies should work with state, local, tribal, and non-governmental entities to develop efficient recycling incentive programs for municipalities or appropriate venues.

6.3.3: Federal agencies, where appropriate, should evaluate methods by which users of products that contribute significantly to marine debris can be given an incentive to select environmentally friendly alternatives or improve use of recycling infrastructure. Such incentive programs or pilot projects should include regular monitoring and evaluation of their effectiveness.

Theme 2: Response to Debris Already in the Marine Environment

6.4 Enforcement

6.4.1: Federal agencies should continue to review enforcement authorities regarding marine debris and items that may become marine debris, enhance the effective use of those authorities as needed and appropriate, and ensure a coordinated approach to enforcement of relevant authorities.

6.4.2: In appropriate cases, federal agencies should refer violations of federal law, such as the Act to Prevent Pollution from Ships, Clean Water Act, and Ocean Dumping Act, to the Environment and Natural Resources Division of the U.S. Department of Justice for civil or criminal enforcement action.

6.5 Cleanups

6.5.1: Federal agencies should work together and contribute to coordinated removal efforts of marine debris and items that can become marine debris in areas under federal jurisdiction, with priority given to heavily impacted areas.

6.5.2: Federal agencies should examine how existing programs can be targeted to support difficult marine debris removal efforts.

6.5.3: Federal agencies should partner with state, local, tribal, and non-governmental entities to continue to support and conduct cleanup efforts.

Theme 3: Research and Development

6.6 Research

6.6.1: Federal agencies, coordinating through the IMDCC, should sponsor and conduct research to characterize the nature of marine debris and further investigate reducing, mitigating, preventing, and controlling marine debris and assessing its impacts, with a particular focus on developing cost-benefit analyses for these actions.

6.6.2: Federal agencies, cooperating through the IMDCC, should improve efforts to monitor marine debris, including shoreline, floating, and submerged debris, using lessons learned from previous federally funded monitoring efforts.

6.6.3: The IMDCC should convene a special session at least once a year to share and discuss the latest research findings on marine debris, with summaries and identified gaps to be passed to the Subcommittee on Integrated Management of Ocean Resources (SIMOR) and the Joint Subcommittee on Ocean Science and Technology (JSOST).

6.6.4: Federal agencies, coordinating through the IMDCC, should sponsor and conduct research regarding the attitudes and practices of users of products that contribute to marine debris. In particular, such research should (a) investigate the willingness to alter attitudes and practices in a manner that would reduce marine debris; (b) identify preferences with regard to potential incentive programs and which types of incentives are most likely to produce positive responses; and (c) develop and test incentive programs intended to alter attitudes and/or practices among users of products that contribute to marine debris.

6.7 Technology Development

6.7.1: Federal agencies should partner with state, local, tribal, and non-governmental entities to encourage the development of specific technologies that could prevent or reduce the amount of debris entering the marine environment or that could mitigate the impacts of marine debris on navigation, human health and safety, the economy, habitats, and species.

6.7.2: Federal agencies should support research, technology development, and use of materials that will not persist in the marine environment.

Theme 4: Cross-theme Efforts to Foster Coordination

6.8 Fostering Coordination

6.8.1: Federal agencies should help sponsor and participate in workshops, conferences, and lectures that address issues related to marine debris and sources of marine debris to encourage the exchange of information that can inform the development of guidelines and implementation of actions to mitigate marine debris impacts.

6.8.2: Federal agencies should participate in ongoing international activities to mitigate the impacts and reduce the amount of marine debris. Federal agencies also should support efforts to increase the awareness of such international marine debris efforts and encourage participation of other nations and international organizations in those efforts, as well as consider options for new international activities and initiatives to mitigate the impacts and reduce the amount of marine debris.

6.8.3: The IMDCC should serve as a central point for coordination of federal efforts to develop new policies, strengthen existing policies, identify new research topics or projects, and address requests from Congress for specific information or actions related to marine debris.

6.8.4: Federal agencies should pursue partnerships, as appropriate, with non-governmental entities to develop, promote, and implement strategies for preventing, reducing, or mitigating the impacts of marine debris.

APPENDIX I

Detailed Description of Authorities as related to Marine Debris

Detailed Description of Authorities as related to Marine Debris

Authority	Explicitly states marine debris in the authority	Authorities that address sources and items that may become marine debris	Authorities that address entities that may be impacted by marine debris	Regulatory	Agency
<p>Marine Debris Research, Prevention and Reduction Act, 33 U.S.C. 1951 et seq.</p>	<p>Establishes a Marine Debris Program within NOAA to conduct research, monitoring, prevention, and reduction activities.</p> <p>Under the Act, the Coast Guard and NOAA will define Marine Debris, in consultation with the Interagency Committee, for the purposes of this Act. This definition will be utilized for the purposes of this report.</p> <p>In addition, the Act requires the Coast Guard to obtain a report from the National Research Council on the effectiveness of international and domestic measures to prevent and reduce marine debris and its impact.</p> <p>In fulfillment of the Act, the Coast Guard will maintain its voluntary reporting program, report damage to vessels and disruption to navigation caused by marine debris and increase international cooperation to reduce marine debris. The Act also required the Coast Guard to submit to Congress a report evaluating the Coast Guard's progress on these initiatives.</p> <p>Reactivates the Interagency Committee (originally established by MPPRCA 1987) and designated NOAA as chairperson. NOAA thereafter appointed EPA as co-chair. The Act requires the Committee to provide a report identifying the sources of marine debris, its impact, costs, and recommendations. Progress reports from the Committee will be submitted to Congress not later than three years after the enactment of the Act, and every two years thereafter.</p>				NOAA, USCG

Authority	Explicitly states marine debris in the authority	Authorities that address sources and items that may become marine debris	Authorities that address entities that may be impacted by marine debris	Regulatory	Agency
Coral Reef Conservation Act of 2000, 16 U.S.C. 6401 et seq.	Requires NOAA to provide assistance through grant programs to states in removing abandoned fishing gear, marine debris, and abandoned vessels from coral reefs to conserve living marine resources.				NOAA
Coastal Zone Management Act of 1972 (P.L. 92-583; 16 U.S.C. 1451 et seq.), as amended. (Specifically the Reauthorization Amendments of 1990, 16 U.S.C. 1455b)	Provides for management of the nation's coastal resources through the development of state coastal zone management programs and National Estuarine Research Reserves. Under section 309 of the act, states are eligible to receive grants for "reducing marine debris entering the Nation's coastal and ocean environment by managing uses and activities that contribute to the entry of such debris."	Under the Reauthorization Amendments of 1990 16 U.S.C. 1455b, it encourages states with federally approved coastal zone management programs to prepare and submit a Coastal Nonpoint Pollution Control Program for approval by NOAA and the EPA. The purpose of the program is to develop and implement management measures for nonpoint source pollution to restore and protect coastal waters.			NOAA, EPA
Marine Plastic Pollution Research and Control Act 33 U.S.C. 1914-1915	The Secretary of Commerce (NOAA) shall establish a Marine Debris Coordinating Committee. NOAA will serve as the Chairperson of the Committee; the Committee shall meet at least twice a year to provide a forum to ensure the coordination of national and international research, monitoring, education, and regulatory actions addressing the persistent marine debris problem. Monitoring - The Secretary of Commerce, acting through the Administrator of the NOAA, in cooperation with the Administrator of the EPA, shall utilize the marine debris data derived under title V of the Marine Protection, Research, and Sanctuaries Act of 1972 (33 U.S.C. 2801 et seq.) to assist the Committee in ensuring coordination of research, monitoring, education and regulatory actions; and the United States Coast Guard in assessing the effectiveness of this Act and the Act to Prevent Pollution from Ships [33 U.S.C. 1901 et seq.] in ensuring compliance under section 1913 of this title.	The Administrator of the NOAA and the Administrator of the EPA shall jointly commence and thereafter conduct a public outreach program to educate the public (including recreational boaters, fishermen, and other users of the marine environment) regarding the harmful effects of plastic pollution; the need to reduce such pollution; the need to recycle plastic materials; the need to reduce the quantity of plastic debris in the marine environment; and the requirements under this Act and the Act to Prevent Pollution from Ships with respect to ships and ports, and the authority of citizens to report violations of this Act and the Act to Prevent Pollution from Ships. Calls for Citizen Pollution Patrols as a joint responsibility of NOAA, Coast Guard and EPA, and public outreach and citizen awards for reported violations. Required the Administrator of EPA, in consultation with Secretary of Commerce, to study the adverse effects of improper disposal of plastic articles on the environment and waste disposal, and the various methods to reduce or eliminate such adverse effects (42 U.S.C. 6981 note).			NOAA, EPA, USCG

Authority	Explicitly states marine debris in the authority	Authorities that address sources and items that may become marine debris	Authorities that address entities that may be impacted by marine debris	Regulatory	Agency
Driftnet Act Amendments of 1990, 16 U.S.C. 1826		The Driftnet Act directs the Secretary of the Interior (FWS), in cooperation with the Secretary of Commerce (NOAA) and the Secretary of State, to provide information on the impacts of large-scale driftnet fisheries on seabirds in the North Pacific Ocean. Requires Commerce to collect statistical information on number of US marine resources killed, retrieved, discarded, or lost by foreign government, driftnet fishing vessels which are fishing beyond EEZ of any nation. Commerce has a permit program for foreign fishing vessels that enter U.S. waters, which takes gear type into consideration.		X	NOAA, FWS, DOS
Marine Protection, Research and Sanctuaries Act, 33 U.S.C. 1401–1445		Prohibits the dumping of material into the ocean that would unreasonably degrade or endanger human health or the marine environment. EPA is the permitting agency for all materials dumped in the ocean except dredged material, which is permitted by USACE with EPA environmental criteria and concurrence. EPA is also responsible for designating recommended ocean dumping sites for all types of materials.		X	EPA
Shore Protection Act, 33 U.S.C. 2601-2609		Applicable to transportation and reception of municipal and commercial wastes in coastal waters. Vessel permitting program administered by the Coast Guard. Designed to minimize trash, medical debris and other harmful materials from being deposited into coastal waters as a result of inadequate waste handling procedures by vessels transporting such waste. EPA, in consultation with the Coast Guard, is responsible for developing regulations governing the loading, securing, offloading, and cleaning up of such wastes from waste sources, reception facilities, and vessels.		X	EPA, USCG

Authority	Explicitly states marine debris in the authority	Authorities that address sources and items that may become marine debris	Authorities that address entities that may be impacted by marine debris	Regulatory	Agency
<p>Clean Water Act, 33 U.S.C. 1251-1385, including 33 U.S.C. 1346(f) as amended by Beaches Environmental Assessment and Coastal Health Act of 2000, Pub.L.No. 106-284, (114 Stat. 876)</p>		<p>Section 402 requires EPA to develop and implement the National Pollutant Elimination Discharge System (NPDES) program . Sections 301 and 304 authorize EPA to set effluent limits on an industry-wide (technology-based) basis and on a water-quality basis to ensure protection of the receiving water. NPDES program administered primarily by states with EPA oversight.</p> <p>EPA's Harbor Studies Program and the Combined Sewer Overflow (CSOs) Studies Program supplement existing information on CSOs and municipal separate storm sewer discharges as sources of floatable debris through monitoring of combined and municipal separate sewer systems and characterizing debris from those discharges.</p> <p>Section 406(f) directs EPA to provide technical assistance to states and local governments for the assessment and monitoring of floatable material. The EPA guidance document implementing this statutory mandate uses the terms "floatable debris," "floatable materials," and "marine debris" interchangeably to address marine debris.</p>		X	EPA, USACE
<p>Resource Conservation and Recovery Act, 42 U.S.C. 6941-6949</p>		<p>Directs EPA to develop guidelines for solid waste management plans. Administered by states with EPA assistance.</p>			EPA
<p>Pollution Prevention Act of 1990, 42 U.S.C. 13101-13109 et seq.</p>		<p>Declares a national policy that pollution should be prevented or reduced at the source whenever feasible; pollution that cannot be prevented should be recycled in an environmentally safe manner, whenever feasible; pollution that cannot be prevented or recycled should be treated in an environmentally safe manner whenever feasible; and disposal or other release into the environment should be employed only as a last resort and should be conducted in an environmentally safe manner.</p>			EPA

Authority	Explicitly states marine debris in the authority	Authorities that address sources and items that may become marine debris	Authorities that address entities that may be impacted by marine debris	Regulatory	Agency
Act to Prevent Pollution from Ships (APPS), 33 U.S.C. 1901 et seq. as amended by the Marine Plastic Pollution Research and Control Act		<p>Combats marine pollution by regulating the at-sea disposal of ship-generated garbage (“all kinds of victual, domestic and operational waste, excluding fresh fish and parts thereof, generated during the normal operation of the ship and liable to be disposed of continuously or periodically except those substances which are defined or listed in other Annexes to MARPOL 73/78.”) under the authority of the APPS and its implementing regulations found in 33 Code of Federal Regulation (CFR) Subchapter O, “Pollution,” Parts 151.51 through 151.77.</p> <p>Under APPS, the discharge of plastics from vessels is subject to complete prohibition. APPS establishes minimum distances for the discharges of other types of garbage.</p> <p>In addition, APPS and the regulations under it regulate reception facilities and require garbage management record books, placarding, and planning aboard vessels according to size.</p>		X	USCG
Rivers and Harbors Act of 1899, 33 U.S.C. 401 et seq.		<p>Section 13 of the 1899 Act prohibits the discharge of refuse matter into or affecting navigable waters, except as permitted by the Corps of Engineer. Modified and superceded by Clean Water Act section 402(a)(4).</p> <p>The Rivers and Harbors Act also gives USACE and USCG authority to respond to marine debris large enough to pose a hazard to navigation.</p>		X	USACE, USCG
Amended Section 2 of the Flood Control Act of 1954, Sec 208		<p>Section 208 of the 1954 Flood Control Act provides authority for the U.S. Army Corps of Engineers to make improvements providing flood control by removing accumulated snags and other debris. The Secretary of the Army is authorized to allot resources, for removing accumulated snags and other debris, and clearing and straightening of the channels in navigable streams and tributaries thereof, when in the opinion of the Chief of Engineers such work is advisable in the interest of flood control.</p>		X	USACE
Outer Continental Shelf Lands Act, 43 U.S.C. 1331 et seq. and Amendments 43 U.S.C. 1801 et seq.		<p>MMS’ regulations and explanatory notices (NTL’s), issued in accordance with the Act, target “Pollution Prevention and Control” (30 CFR 250.300) which includes prevention of and response to sources and items that could become marine debris.</p>		X	MMS

Authority	Explicitly states marine debris in the authority	Authorities that address sources and items that may become marine debris	Authorities that address entities that may be impacted by marine debris	Regulatory	Agency
Energy Policy Act of 2005, 42 U.S.C. 15801 et seq.		The Act amends Section 8 of the OCSLA to include alternate energy-related uses of the OCS (i.e., new facilities for renewable energy development and alternate uses of existing facilities). MMS is developing regulations and explanatory notices in accordance with the Act to address marine pollution including prevention and response of sources and items that could become marine debris.		X	MMS
Magnuson-Stevens Fishery Conservation and Management Act, 16 U.S.C. 1801 et seq.		The Act is the primary law governing marine fisheries management in United States federal waters, administered by NOAA. Regulations developed under this Act include a prohibition from disposal in the EEZ of fishing gear and other articles by operators of foreign fishing vessels (50 CFR 600.510(c)): “(1) The operator of an FFV in the EEZ may not dump overboard, jettison or otherwise discard any article or substance that may interfere with other fishing vessels or gear, or that may catch fish or cause damage to any marine resource, including marine mammals and birds, except in cases of emergency involving the safety of the ship or crew, or as specifically authorized by communication from the appropriate USCG commander or other authorized officer. These articles and substances include, but are not limited to, fishing gear, net scraps, bale straps, plastic bags, oil drums, petroleum containers, oil, toxic chemicals or any manmade items retrieved in an FFV’s gear. (2) The operator of an FFV may not abandon fishing gear in the EEZ. (3) If these articles or substances are encountered, or in the event of accidental or emergency placement into the EEZ, the vessel operator must immediately report the incident to the appropriate USCG Commander indicated in tables 1 and 2 to § 600.502, and give the information required in paragraph (b) of this section”. In addition under section 303(b)(2)(A)&(B) of the Act, one of the discretionary provisions of fishery management plans is that zones may be designated where fishing shall be limited, not permitted, or permitted only to specified types of fishing vessels or gear. These zones may be designated to prevent loss or damage to fishing gear from interactions with deep sea corals.	National Standard 9 of the Act states that “conservation and management measures shall, to the extent practicable, (A) minimize bycatch and (B) to the extent bycatch cannot be avoided, minimize the mortality of such bycatch.” Ghost fishing can result in bycatch.	X	NOAA

Authority	Explicitly states marine debris in the authority	Authorities that address sources and items that may become marine debris	Authorities that address entities that may be impacted by marine debris	Regulatory	Agency
National Marine Sanctuaries Act, 16 U.S.C. 1431 et seq.		Sanctuary protection and management efforts include addressing threats to sanctuary resources. The program uses a number of management tools including education and outreach, research, and permitting and enforcement.	Authorizes the Secretary of Commerce (NOAA) to designate and protect areas of the marine environment with special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archeological, educational, or esthetic qualities as national marine sanctuaries. Day-to-day management of national marine sanctuaries delegated to NOAA's National Marine Sanctuary Program. The primary objective of the NMSA is to protect marine resources, such as coral reefs, sunken historical vessels or unique habitats.	X	NOAA
National Wildlife Refuge System Administration Act of 1966 & National Wildlife Refuge System Improvement Act of 1997, 16 U.S.C. 668dd			Requires the Department of the Interior (FWS), in developing comprehensive conservation plan for refuges, to identify and describe significant problems that may adversely affect the populations and habitats of fish, wildlife, and plants and the actions necessary to correct or mitigate such problems.		FWS
Anadromous Fish Conservation Act, 16 U.S.C. 757a et seq.			Requires the Secretary of the Interior (FWS), on the basis of studies, to make recommendations to the Secretary of Health and Human Services concerning the elimination or reduction of polluting substances detrimental to fish and wildlife.		FWS
Endangered Species Act of 1973, 16 U.S.C. 1531 et seq.			In consultation with and with the assistance of the Secretary of Commerce (NOAA) and Secretary of the Interior (FWS), each federal agency shall, insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of critical habitat.	X	NOAA, FWS

Authority	Explicitly states marine debris in the authority	Authorities that address sources and items that may become marine debris	Authorities that address entities that may be impacted by marine debris	Regulatory	Agency
Marine Mammal Protection Act, 16 U.S.C. 1402			NOAA and FWS regulate and enforce taking of marine mammals; determines the condition of marine mammal stocks and methods for their protection and conservation; develops measures necessary for the protection and conservation of marine mammals; and conducts or funds research it deems necessary for protection and conservation of marine mammals. MMC reviews U.S. activities pursuant to laws and conventions relevant to marine mammals and the condition of marine mammal stocks and methods for their protection and conservation. MMC recommends to other federal agencies steps it deems necessary for the protection and conservation of marine mammals and conducts or funds research it deems necessary for protection and conservation of marine mammals.	X	NOAA. MMC. FWS

Literature Cited

- ACC (American Chemistry Council - Plastics Division) and the Society of the Plastics Industry, Inc. 2007. Operation Clean Sweep: Pellet Handling Manual. 42 pp. Available: <http://www.opcleansweep.org/manual/OCSmanual.pdf> (accessed May 30, 2008).
- American Rivers. 2007. About – 2007 National River Cleanup Statistics. Available: http://www.americanrivers.org/site/PageServer?pagename=AR7_NationalRiverCleanup_About (accessed May 30, 2008).
- American Shipper. 2007. The Monthly Journal of International Trade and Logistics. Vol. 49, No. 11, p. 76.
- APEC (Asia Pacific Economic Cooperation). 2004. Derelict Fishing Gear and Related Marine Debris Seminar. Available: <http://www.wpcouncil.org/documents/APECSeminar/> (accessed May 30, 2008).
- Asoh, K., T. Yoshikawa, R. Kosaki, and E. Marschall. 2004. Damage to cauliflower coral by monofilament fishing lines in Hawaii. *Conservation Biology* 18 (6): 1645–1650.
- Boland, R., and M. Donohue. 2003. Marine debris accumulation in the nearshore marine habitat of the endangered Hawaiian monk seal, *Monachus schauinslandi*, 1999–2001. *Marine Pollution Bulletin* 46 (11): 1385–1394.
- Boston Harbor Association (BHA). 2007. What We Do: The Boston Harbor Association's Marine Debris Cleanup Initiative. Available: http://www.tbha.org/programs_marinedebris.htm (accessed May 30, 2008).
- Brown, J., G. Macfadyen, T. Huntington, J. Magnus, and J. Tumilty. 2005. Ghost Fishing by Lost Fishing Gear. Final Report to DG Fisheries and Maritime Affairs of the European Commission. Fish/2004/20. Institute for European Environmental Policy / Poseidon Aquatic Resource Management Ltd joint report. 132 pp.
- Bugoni, L., L. Krause, and M.V. Petry. 2001. Marine debris and human impacts on sea turtles in Southern Brazil. *Marine Pollution Bulletin* 42 (12): 1330–1334.
- Bullimore, B., P. Newman, M. Kaiser, S. Gilbert, and K. Lock. 2001. A study of catches in a fleet of “ghost fishing” pots. *Fishery Bulletin* 99 (2): 247–253.
- Butt, N. 2007. The impact of cruise ship generated waste on home ports of call: A study of Southampton. *Marine Policy* 31: 591–598.
- Carr, A. 1987. Impact of nondegradable marine debris on the ecology and survival outlook of sea turtles. *Marine Pollution Bulletin* 18 (6, Supplement 2): 352–356.
- Chiappone, M., H. Dienes, D. Swanson, and S. Miller. 2005. Impacts of lost fishing gear on coral reef sessile invertebrates in the Florida Keys National Marine Sanctuary. *Biological Conservation* 121 (2): 221–230.
- Cho, D. 2006. Evaluation of the ocean governance system in Korea. *Marine Policy* 30 (5): 570–579.
- Dameron, O., M. Park, M. Albins, and R. Brainard. 2007. Marine debris accumulation in the Northwestern Hawaiian Islands: An examination of rates and processes. *Marine Pollution Bulletin* 54 (4): 423–433.
- Derraik, J. 2002. The pollution of the marine environment by plastic debris: A review. *Marine Pollution Bulletin* 44 (9): 842–852.

- Dickerman, R., and R. Goelet. 1987. Northern gannet starvation after swallowing styrofoam. *Marine Pollution Bulletin* 18 (6): 293.
- Donohue, M., R. Boland, C. Sramek, and G. Antonelis. 2001. Derelict fishing gear in the Northwestern Hawaiian Islands: Diving surveys and debris removal in 1999 confirm threat to coral reef ecosystems. *Marine Pollution Bulletin* 42 (12): 1301–1302.
- Georgakellos, D. 2007. The use of the deposit-refund framework in port reception facilities charging systems. *Marine Pollution Bulletin* 54 (5): 508–520.
- Gramentz, D. 1988. Involvement of loggerhead turtle with the plastic, metal, and hydrocarbon pollution in the central Mediterranean. *Marine Pollution Bulletin* 19 (1):11–13.
- Green, A., J. Burgett, M. Molina, D. Palawski, and P. Gabrielson. 1997. The Impact of a Ship Grounding and Associated Fuel Spill at Rose Atoll National Wildlife Refuge, American Samoa. U.S. Fish and Wildlife Service. Honolulu, Hawaii. 60 pp.
- Harrison, C., T. Hida, and M. Seki. 1983. Hawaiian seabird feeding ecology. *Wildlife Monographs* 85:75.
- Henderson, J. 2001. A pre- and post-MARPOL Annex V summary of Hawaiian monk seal entanglements and marine debris accumulation in the Northwestern Hawaiian Islands, 1982–1998. *Marine Pollution Bulletin* 42 (7): 584–589.
- International Maritime Organization. 2007. Air pollution, ship recycling and ballast water management on MPEC agenda. Available: http://www.imo.org/Safety/mainframe.asp?topic_id=1472&doc_id=8207 (accessed May 30, 2008).
- June, J. 2007. A Cost-Benefit Analysis of Derelict Fishing Gear Removal In Puget Sound, Washington. Report prepared for The Northwest Straits Foundation, September 29, 2007. 14 pp.
- Mallory, M., G. Roberston, A. Moenting. 2006. Marine plastic debris in northern fulmars in Davis Strait, Nunavut, Canada. *Marine Pollution Bulletin* 52 (7): 813–815.
- Maryland Department of Natural Resources. 2002. *Maryland Clean Marina Guidebook*. 102 pp.
- Matsuoka, T., T. Nakashima, and N. Nagasawa. 2005. A review of ghost fishing: Scientific approaches to evaluation and solutions. *Fisheries Science* 71:691–702.
- Morishige, C., M. Donohue, E. Flint, C. Swenson, and C. Woolaway. 2007. Factors affecting marine debris deposition at French Frigate Shoals, Northwestern Hawaiian Islands Marine National Monument, 1990–2006. *Marine Pollution Bulletin* 54 (8): 1162–1169.
- National Oceanic and Atmospheric Administration (NOAA). 2007a. Gulf of Mexico Marine Debris Project, 2006. Available: <http://gulfofmexico.marinedebris.noaa.gov> (accessed May 30, 2008).
- National Oceanic and Atmospheric Administration (NOAA). 2007b. Reducing threats to monument resources. Monument Draft Management Plan. Available: http://www.hawaiiireef.noaa.gov/management/mp/dmmp_vol1_web.pdf (accessed May 30, 2008).

National Oceanic and Atmospheric Administration (NOAA). 2007c. Recovery Plan for the Hawaiian Monk Seal (*Monachus schauinslandi*). Second Revision. National Marine Fisheries Service. Available: <http://www.nmfs.noaa.gov/pr/pdfs/recovery/hawaiianmonkseal.pdf> (accessed May 30, 2008).

New York Times. 2007. “Human Behavior, Global Warming, and the Ubiquitous Plastic Bag,” September 30, 2007.

Northwest Straits Commission. 2007. Derelict Gear Removal – Program Accomplishments. Available: <http://www.nmstraits.org/PageID/174/default.aspx> (accessed May 30, 2008).

Ocean Conservancy. 2006. International Coastal Cleanup Report 2006: A World of Difference. Available: http://www.oceanconservancy.org/site/DocServer/Final_ICC_report_2007_release.pdf?docID=2841 (accessed May 30, 2008).

Ocean Conservancy. 2007. A Day Dedicated to Saving Marine Wildlife and Habitats Around the World. Available: <http://www.oceanconservancy.org/site/DocServer/2007ICCFactSheet.pdf?docID=2842> (accessed May 30, 2008).

Ofiara, D., and B. Brown. 1999. Assessment of economic losses to recreational activities from 1988 marine pollution events and assessment of economic losses from long-term contamination of fish within the New York Bight to New Jersey. *Marine Pollution Bulletin* 38 (11): 990–1004.

Oigman-Pszczol, S., and J. Creed. 2007. Quantification and classification of marine litter on beaches along Armacao dos Buzios, Rio de Janeiro, Brazil. *Journal of Coastal Research* 23 (2): 421–428.

Page, B., J. McKenzie, R. McIntosh, A. Baylis, A. Morrissey, N. Calvert, T. Haase, M. Berris, D. Dowie, P. Shaughnessy, and S. Goldsworthy. 2004. Entanglement of Australian sea lions and New Zealand fur seals in lost fishing gear and other marine debris before and after Government and industry attempts to reduce the problem. *Marine Pollution Bulletin* 49 (1-2): 33–42.

Pawson, M. 2003. The catching capacity of lost static fishing gears: Introduction. *Fisheries Research* 64 (2-3): 101–105.

Pichel, W., J. Churnside, T. Veenstra, D. Foley, K. Friedman, R. Brainard, J. Nicoll, Q. Zheng, and P. Clemente-Colon. 2007. Marine debris collects within the North Pacific Subtropical Convergence Zone. *Marine Pollution Bulletin* 54 (8): 1207–1211.

Porter, J. 2008. Carriers join forces to prevent box losses. *Lloyd’s List*, January 08, 2008.

Proceedings of the International Marine Debris Conference: Derelict Fishing Gear in the Ocean Environment. Ed. Naomi McIntosh et al. Honolulu, HI. August 2000.

Redford, D., H. Trulli, and W. Trulli. 1997. Sources of plastic pellets in the aquatic environment. In: Coe, J. and Rogers, D., Editors, 1997. *Marine Debris: Sources, Impacts, and Solutions*, Springer-Verlag, New York, pp. 335-343.

Seitz, J., and G. Poulakis. 2006. Anthropogenic effects on the smalltooth sawfish (*Pristis pectinata*) in the United States. *Marine Pollution Bulletin* 52 (11): 1533–1540.

Sheavly, S. 2007. National Marine Debris Monitoring Program: Final program report, data analysis and summary. Prepared for U.S. Environmental Protection Agency by Ocean Conservancy, Grant Number X83053401-02. 76 pp.

- United States Department of Commerce, National Oceanic and Atmospheric Administration, et al. 1988. Report of the Interagency Task Force on Persistent Marine Debris. Chair, Interagency Task Force, Department of Commerce, National Oceanic and Atmospheric Administration, Washington, DC. 170 pp.
- United States Department of the Interior, Fish and Wildlife Service. 1996. Piping Plover (*Charadrius melodus*), Atlantic Coast Population, Revised Recovery Plan. Hadley, Massachusetts. 258 pp.
- United States Department of the Interior, Fish and Wildlife Service. 2006. Testimony of H. Dale Hall Director, U.S. Fish and Wildlife Service, U.S. Department of the Interior, before the House Subcommittee on Fisheries and Oceans regarding natural resource impacts and restoration of National Wildlife Refuges and other lands across the Gulf Coast, March 16, 2006.
- United States Department of the Interior, National Park Service. 2001. *Green Marina Guidebook*. Available: <http://concessions.nps.gov/document/NPSNationalCapitalRegion.pdf> (accessed May 30, 2008).
- United States Department of Justice. 2007. San Diego Agrees to Estimated \$1 Billion for Sewage System Improvements and Maintenance. Press release dated July 31, 2007. Available: http://www.usdoj.gov/opa/pr/2007/July/07_enrd_564.html (accessed May 30, 2008).
- United States Department of Transportation, Bureau of Transportation Statistics. 2002. Summary of Cruise Ship Waste Streams. In: Maritime Trade & Transportation 2002. 89 pp. Available: http://www.bts.gov/publications/maritime_trade_and_transportation/2002/ (accessed May 30, 2008).
- United States Environmental Protection Agency. 1993a. Pilot Study to Characterize Floatable Debris Discharged from Combined Sewer Overflows and Storm Drains September 1989 through May 1990.
- United States Environmental Protection Agency. 1993b. Plastic Pellets in the Aquatic Environment: Sources and Recommendations. EPA 842-S-93-001. Washington, DC. 108 pp.
- United States Environmental Protection Agency. 2002a. Assessing and Monitoring Floatable Debris. EPA-842-B-02-002. Washington, DC. 57 pp.
- United States Environmental Protection Agency. 2002b. Combined Sewer Overflows Demographics. Available: http://cfpub.epa.gov/npdes/cso/demo.cfm?program_id=5 (accessed May 30, 2008).
- United States Environmental Protection Agency. 2007. EPA and Muscatine, Iowa, Agree on Plan to Fix City Sewers. Press release dated September 5, 2007. Available: http://yosemite.epa.gov/opa/admpress.nsf/names/r07_2007-9-5_compliance_and_water (accessed May 30, 2008).
- United States Environmental Protection Agency. 2008. Stormwater Discharges From Municipal Separate Storm Sewer Systems (MS4s). Available: <http://www.epa.gov/npdes/stormwater/municipal> (accessed May 30, 2008).
- Wilkinson, C., D. Souter, and J. Goldberg. 2006. Status of Coral Reefs in Tsunami Affected Countries: 2005. Australian Institute of Marine Science. 154 pp.
- Yoshikawa, T., and K. Asoh. 2004. Entanglement of monofilament lines and coral death. *Biological Conservation* 117 (5): 557–60.

Photography Credits and Captions

Front Cover: (Top left) *A researcher takes in debris littered across the uninhabited beaches of the Northwestern Hawaiian Islands.* NOAA

(Bottom left) *Derelict fishing gear, nets and ropes wrap around natural debris along the shorelines of Unalaska, Alaska.* NOAA

(Top right) *A crab gets caught up in derelict netting.* NOAA

(Bottom right) *Trash and debris are collected in the sand dunes on a beach in Puerto Rico.* NOAA

Page 3: *Monofilament line wraps around benthic coral habitat.* NOAA

Page 6: *Debris left in the wake of Hurricane Katrina.* NOAA

Page 12: (left) *Microplastics collected from a beach in Hawaii.* NOAA

(middle) *A sea lion entangled in derelict fishing net hauls out on the beach.* NOAA

(right) *Bags collected during the International Coastal Cleanup.* EPA

Page 14: *Coastal resorts are not immune to marine debris and litter on their beaches.* EPA

Page 18: *Storm drain warning.* EPA

Page 20: *Hurricane damage in a marina in the Gulf of Mexico.* NOAA

Page 21: *Derelict nets smother a coral reef.* NOAA

Page 23: *Carelessly tossed trash can wind up in the ocean and into the mouths of marine animals. (left) EPA, (right) NOAA.*

Page 24: *An Albatross mother and chick forage for food amongst the trash in the Northwestern Hawaiian Islands.* NOAA

Page 25: *A Humpback whale strands because of net entanglement.* NOAA

Page 27: (left) *Deputy Undersecretary for NOAA Tim Keeney surveys tire reef debris in Florida.* Coastal America

(middle) *Coast Guard Seaman Brian Grebe (CGC Walnut WLB-205) offloads fishnet from the CG Cutter Walnut.* USCG

(right) *Debris and bags collected during Ocean Conservancy's International Coastal Cleanup.* EPA

Page 28: *Mokupapapa Discovery Center marine debris exhibit.* NOAA

Page 33: *Microplastics sampling from beach.* NOAA

Page 34: *Debris along the C&O Canal.* NOAA

Page 35: *Derelict pots wash up on the shore of a rocky beach.* NOAA

Page 36: *Derelict nets and pots are unloaded into a bin and recycled into energy through the Fishing for Energy Program.* NOAA

Page 39: *Members of the USCG Cutter Walnut offload 28 tons of marine debris collected from the NWHI.* USCG

Page 41: *National Marine Debris Monitoring Program Report.* EPA

Page 43: *NOAA Researchers prepare to launch an Unmanned Aerial Vehicle (UAV) to search for derelict nets in the Pacific Ocean.* NOAA

Page 44: *A cameraman documents the debris scattered from a failed tire reef.* Coastal America

Page 45: *The remnants of a devastated marina highlight the irony of a sign that remains after Hurricane Katrina.* NOAA



Carlos M. Gutierrez

Secretary, U.S. Department of Commerce

Vice Admiral Conrad C. Lautenbacher, Jr., USN (Ret.)

Under Secretary for Oceans and Atmosphere and NOAA Administrator

John H. Dunnigan

Assistant Administrator, Ocean Services and Coastal Zone Management

NOAA Ocean Service