SEAS OF DEBRIS

A Summary of the Third International Conference on Marine Debris

SEAS OF DEBRIS:

A Summary of the Third International Conference on Marine Debris

Written by:
Jeannie Faris and Kathy Hart
N.C. Sea Grant College Program

Sponsored by:
Intergovernmental Oceanographic Commission
U.S. National Oceanic and Atmospheric Administration
U.S. Environmental Protection Agency
U.S. Navy
U.S. Coast Guard
U.S. Marine Mammal Commission
Center for Marine Conservation
Society of the Plastics Industry

Front cover: A dump spills into adjacent waters. Nearly 80 percent of the world's marine debris is thought to have washed from land.

The Table of Contents

The **Preface**

Marine debris is a subject that, of necessity, attracts people of highly diverse backgrounds and interests, representing many disciplines, cultures and industries. Since the International Marine Debris Conferences are on a five-year cycle, participants at the third conference had much to discuss. During the week, their deliberations employed a dazzling and sometimes confusing array of technical terms, accents, jargon and acronyms.

There was concern that a large part of the relevant marine debris audience would be unable or unwilling to wade through this diversity of language and perspectives to facilitate the timely communication and use of the lessons learned at the conference. Consequently, the sponsors agreed to develop a summary booklet for broad distribution.

This summary conveys the primary messages from the conference to an audience as diverse as the attendees. It is intended to be an attractive and useful reference for policy-makers, politicians, educators and the international public. The material is drawn directly from the conference presentations and working group reports and is presented in sections corresponding to the plenary sessions.

This booklet may be referenced and quoted as desired by citing *Seas of Debris: A Summary of the Third International Conference on Marine Debris.*

The complete collection of papers and working group reports presented during the conference will be published in a separate volume.

James M. Coe,
National Marine Fisheries Service
Chairman, Third International
Conference on Marine Debris

The Introduction

People from around the world gathered in Miami, Fla., in May 1994 to discuss solutions to the problems of marine debris. Resource managers, industrial leaders, coastal cleanup organizers, waste management officials, scientists, conservationists and leaders of international organizations came to the Third International Conference on Marine Debris with papers to present and ideas about how the amounts and the impacts of marine debris could be lessened globally.

For four days, they listened to the information and debated ways to control marine debris. They talked about debris survey methods, impacts on ecosystems and organisms, sources, international treaties, legislation, cleanup strategies, new technology, education, enforcement, source reduction, recycling and waste management.

Participants discussed marine debris sources from land to sea, common debris items from product development to final disposal, legislation from international treaties to local ordinances, and educational efforts from the individual angler to multinational businesses. The problem was examined in the context of developing countries and industrialized nations.

What lies in the following pages is a summary of the information, ideas and solutions presented at the conference. They range from the drafting of simple educational messages to the development of new technologies. But all are directed at a single outcome — reduction of the debris that floats at the ocean's surface, litters its underwater habitat and mars the shorelines along its boundaries.

A trash can on an Israeli beach discourages recreational litter. Beachgoers are a leading source of plastic debris along the popular coasts of the Mediterranean Sea.

Chapter One: Amounts, Types and Distribution

Marine debris pollutes all of the world's oceans, but the problem hardly starts there. Close to 80 percent is washed, blown or dumped from shore. In the entire marine debris debate, no other point is so straightforward.

The types of debris that float in world oceans are as varied as the many cultures that generate them. Ships, winds and ocean currents carry debris in aquatic traffic patterns specific to each region of the globe. Waterborne trash off the United States' Gulf of Mexico, for instance, will travel at different speeds and directions than it would off the coast of Australia or in the Mediterranean Sea. Consequently, worldwide responses to marine debris are as diverse as the languages that give them voice.

In the United Kingdom, sewage has repeatedly washed up on beaches, prompting lawsuits and legislation to control it. China and Africa need more and better port reception facilities to dispose of ships' wastes. The same can be said for the Caribbean, a major port of call for cruise lines. Landside, Caribbean communities lack adequate collection and disposal systems for household trash — a problem common to developing countries around the globe. The United States contends with wastes that run the gamut from sewage items to commercial fishing trash to recreational litter. Sunbathers toss cosmetic containers onto Mediterranean beaches, while paint chips accumulate on the seafloor in the wake of heavy shipping traffic. Many of the same debris problems can be found in the Southern Hemisphere — Australia, New Zealand and South Africa — but they are complicated by the vastness of the waters there, strong winds, currents and sinks that collect trash on the seafloor.

From this cursory look around the world, a few conclusions can be drawn. Developing countries need to improve their waste collection systems in ports and on land, while industrialized countries must better control infrastructure failures and trash left by tourists, boaters and upland sources.

So the question becomes, how do we tackle marine debris globally when the problem is so varied worldwide? The fractured nature of the problem does not lend itself to a standard approach for everyone. Rather, the problems and solutions appear to be country-specific.

The answer — a resounding chorus from scientists, resource managers and concerned citizens of all tongues — is a global commitment to measure marine debris and its impacts, trace its sources and stop it in its path. Once the commitment is in place, perhaps strategies would be best planned by hemisphere, basin, nation or region since globally standardized strategies would be difficult.

Worldwide, we share a historical perspective of the ocean and other large bodies of water. For centuries, we viewed them as dumping grounds for waste. Trash was heaved overboard from ships, and still is, despite the London Dumping Convention (LDC) and the International Convention for the Prevention of Pollution from Ships (MARPOL). The LDC is a global tool for controlling marine pollution from dredge spoil, sewage sludge and other land-based wastes; MARPOL is an international convention for regulating the various sources of ship-generated pollution. Landside, trash continues to be dumped into creeks and rivers that flow into estuaries, draining to the sea from countless inland sources. Perhaps most troubling, however, are the many coastal contributions to marine debris — wastes that are deliberately discarded or inadvertently lost at the water's edge.

In spite of these and other abuses, marine debris was not launched as a global issue until the 1970s. Since then, we have picked up, counted, weighed and measured shoreside garbage. We have exposed the condition of trashy beaches. And we have learned about the types of litter in our seas and how they affect communities of humans, animals and even plants.

Plastics have emerged as the dominant problem worldwide. Still, our understanding of marine debris is incomplete. Twenty years into our research, efforts to identify sources are still crude. And only a few studies have looked at sources with an eye toward tracing trends and reducing debris. Collecting data on

Don Riepe, American Littoral Society

Trash left by beachgoers is a global source of marine debris. Recreationists must learn that their leisure leftovers can be deadly to wildlife and a threat to coastal businesses.

waterborne garbage for the sake of having data is not enough. Nor are beach cleanups a cure-all — at best they are a temporary fix to a complex and persistent problem.

Clearly, we need a new strategy. Monitoring must change to aggressively track sources and identify trends. It should tell us whether our pollution-control policies — education and regulations — are working. Are ships complying with MARPOL Annex V, the international pact that prohibits overboard dumping of plastics and regulates at-sea disposal of other garbage? Are land-based sources of debris changing?

Research must move from beach and platform-of-opportunity surveys (taken from boats on unrelated missions, such as fishing) to new designs that can unfold the mysteries of how litter moves across land and into the oceans, through water and along the seafloor. It must assess the impacts of marine debris and produce results that industry and government can use to change behaviors through laws, regulations, policies and investment strategies. Vague research goals must be brought into focus with well-designed studies and crisp objectives that reach beyond the simple study of litter distribution and types.

This, of course, requires time, effort and resources. But unless an aggressive, international marine debris strategy is launched and hard data are produced, scientists have concluded that laws, investments and large-scale behavioral changes will not follow.

Debris Around the World

NORTH AMERICA

- **United States**

In 1988, the United States ratified MARPOL Annex V. Since then, however, surveys and studies have been unable to measure the force of this legislation on U.S. shores. No consistent decline in the overall abundance of trash has been observed; nor have any nationwide trends emerged for plastic debris. Similarly, there is little data on land-based sources.

Studies have found, however, that plastics account for most debris (48 to 99 percent) on U.S. beaches and harbors. Marine litter was examined from 1989 to 1993 by the Center for Marine Conservation annual cleanups, National Park Service quarterly beach surveys at eight parks, a National Marine Fisheries Service debris study in Alaska and Environmental Protection Agency surveys of 10 U.S. harbors.

In most locations, these studies found that plastics were dominated by packaging (bottles, bags and lids) or miscellaneous debris (fragments and pellets). Alaska was the exception with derelict fishing gear (floats, trawl web, rope) appearing as 53 percent of the plastic litter.

Beaches on the Gulf of Mexico were most trashed, followed by those on the West and East coasts. Among the parks studied, Padre Island National Seashore on the Gulf of Mexico had the most debris; Assateague Island National Seashore on the East Coast, the least.

All locations harbored debris that could harm wildlife or human health. Rope was the most abundant entangling threat to wildlife, while plastic fragments (beaches) and pellets (harbors) were the greatest threat to animals that may ingest debris. Human health hazards were most commonly found on the East Coast, where sewage and medical debris turned up on beaches. The West Coast was relatively clean of these types of wastes.

Countries that contributed debris to U.S. shores included Mexico, Canada, Japan, Taiwan, Korea and Russia. Much of the fishing gear (gill nets and gill net floats) on Alaska beaches originated from foreign (Japan, Taiwan, Korea) fisheries.

Regional — rather than national — surveys are widely considered the best tools for studying debris problems specific to an area. Some efforts have centered on human and wildlife impacts. Others have addressed sources, correlating debris with human activities onshore and off. Regional surveys have also expanded from strictly marine surveys to aquatic surveys along major lakes such as Michigan and Huron. These efforts offer valuable information on amounts of debris, which can be used to assess the effectiveness of MARPOL Annex V and the U.S. Clean Water Act.

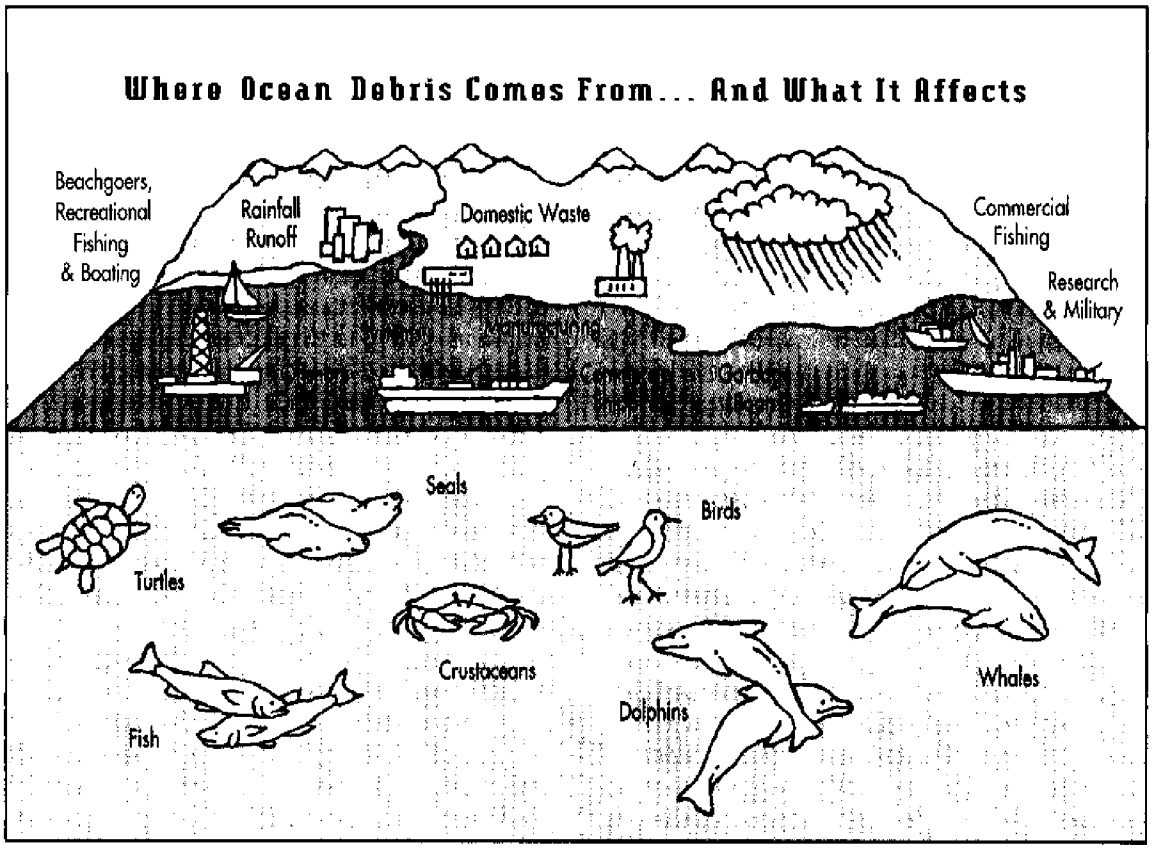
Still in development are plans to monitor changes in the amount of beach debris on national and regional scales. Specific indicator items from ocean- and land-based sources will be used to focus on trends. Some items will be source-specific; for instance, crab pots and fishing nets point to commercial fishing origins.

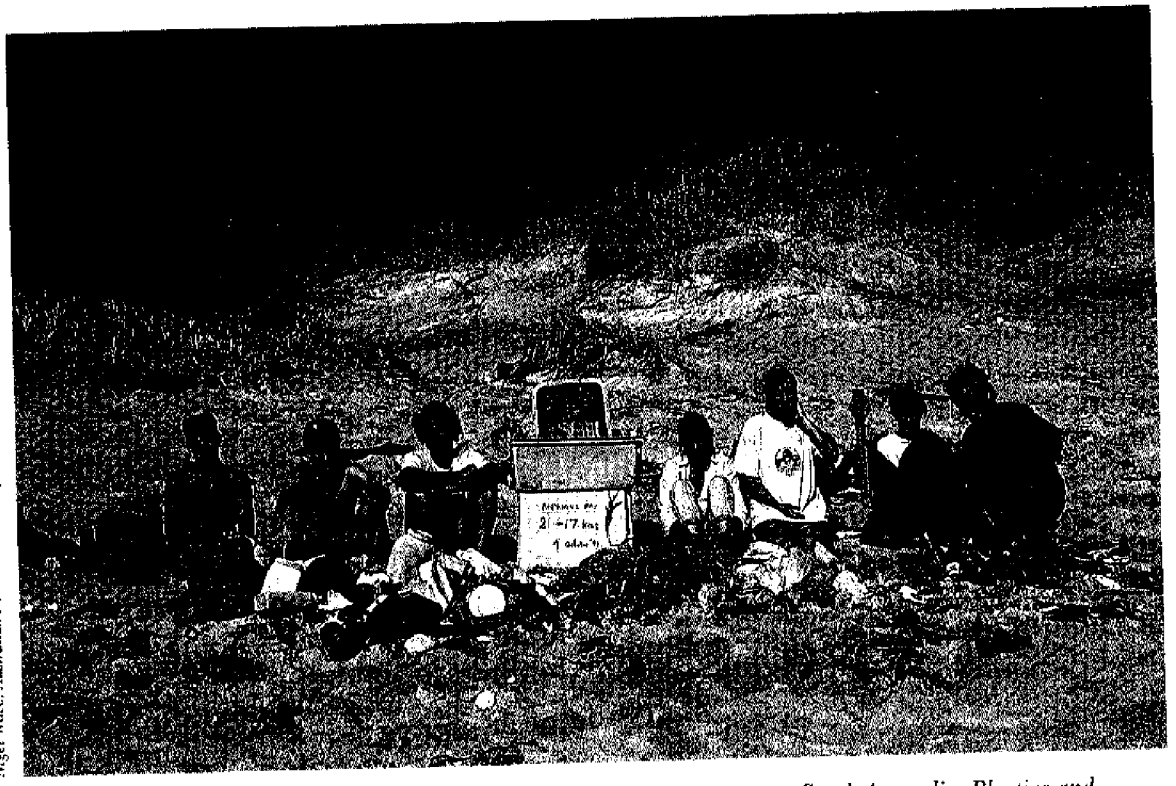
Finally, at-sea observer studies will continue in the United States, but these tend to be opportunistic with collection of marine debris information secondary to fishing.

- **Canada**

Canada boasts the longest coastline in the world, bordering on three oceans. As such, its vast stretches of remote and isolated beaches complicate the task of marine debris data collection. Coastal surveys, however, have identified debris left by boaters, beach and park visitors, fishermen, cargo and passenger vessels, sewage discharges, and oil and gas explorations.

As in other countries, trend analyses are difficult. Volunteers and environmental organizations such as Pitch-In Canada were behind early efforts to reduce marine debris in this country. They successfully pushed for the 1970 deposit-return legislation that aims to eliminate containers from the marine environment — the first direct action to reduce marine debris in Canada and the first of its kind in North America. In 1978, the





Nigel Wace, Australian National University

Beachcombers pose with litter they picked up along a coast of Anxious Bay, South Australia. Plastics and entangling items were common finds.

federal Department of Transport followed up with the Canada Shipping Act to restrict the discharge of garbage and plastics from vessels.

Today, most marine debris data originate from volunteers. Environment Canada is training volunteers through a national research project to use a standardized method that will yield more statistically sound data. Regardless of how they are gathered, however, Canadian data show that debris is in the ocean and washed ashore regularly on all coasts. The types vary with nearby activities. The Atlantic and Pacific coasts receive debris from offshore fishing, cargo and passenger vessels. Southern regions are trashed by recreational boaters. Both coasts are littered by land-based sources, which contribute about half of all debris at some sites. In the Arctic, most trash is traced to oil exploration and shoreside communities.

Plastics are the most common debris found across all sites, ranging as high as 50 to 92 percent on the east coast. But loads of glass are a special concern to the fishing industry because a catch is generally unsalable once it has been contaminated by glass. Often, the entire net catch is disposed of at sea.

Shoreside, the lack of waste reception facilities for ports, harbors and marinas is being addressed by federal, provincial and local governments. The departments of Public Works and Fisheries and Oceans manage 2,282 small craft harbors in Canada. Although efforts are improving, many small craft harbors have no waste facilities, and the costs of maintaining them have been borne locally, often through port fees. Of special note, however, was an effort by the Maritime Fishermen's Union in Nova Scotia to place barrels, cans and dumpsters at 320 small harbors.

Additionally, Canada has 535 cargo ports and terminals that receive tankers, bulk product carriers and cargo vessels. In 1990, only 67 ports reported the capability to receive garbage, while 38 had the ability to accept sewage.

- **Caribbean**

Action on the Caribbean marine debris crisis began in earnest in 1989, when regional experts cited it as a primary environmental concern. In response, the United Nations' IOCARIBE (Intergovernmental Oceanographic Commission's Subcommission for

the Caribbean and Adjacent Regions) launched a Caribbean monitoring project, which was coordinated by the University of Puerto Rico with participation by institutions in Mexico and Colombia. The project was later extended to Barbados, Cayman Islands, Cuba and St. Lucia.

IOCARIBE meanwhile created the Caribbean Marine Pollution Assessment and Control Program in 1990 to address a growing web of pollution problems. Predictably, these assessments uncovered an abundance of plastics in the Caribbean, mostly (60 to 90 percent) from land-based sources.

Beachgoer debris and litter carried by wind, runoff and streams were the most significant contributors at almost all sampled beaches. On the water, fishing was the leading source, particularly in Puerto Rico, Colombia and Barbados. Recreational beaches on the whole had 50 percent more litter than isolated beaches. But in St. Lucia and Dominica, the reverse was true. Nonrecreational beaches had more litter — and from a wider geographic distribution — pointing to the significant role of winds and currents in moving marine debris. In Panama, Cayman Islands and Cuba, plastic, plastic foam, wood and metal were the principal items found.

Traditionally, shipping and petroleum industries have been the leading contributors to Caribbean marine debris. Cruise ships, a major source, are now changing their waste management practices to comply with MARPOL Annex V.

But a lingering issue for small islands continues to be disposal of ship waste in an environmentally sound manner. Uncontrolled landfills and indiscriminate dumping persist, while the potential for profitable recycling remains small. The World Bank's Global Environment Facility is testing technologies and waste management practices for the wider Caribbean that are expected to encourage participation in MARPOL Annex V.

To effectively combat marine debris, Caribbean countries must assess the land-based sources and address the contributors. Disposable products and packaging are at the root of the litter and waste management problems. Inadequate collection and disposal options lead to dumping and uncontrolled landfills with serious environmental repercussions. The Caribbean is preparing for a three-pronged attack: legislation and enforcement; technologies; and education and attitude changes. These elements must be coordinated and meet a variety of local conditions.

EUROPE AND THE MIDDLE EAST

• Europe: United Kingdom

Since 1988, Coastwatch Europe has dispatched volunteer survey groups to bring back a complete picture of marine debris on European beaches. The program goal is to pore through large-scale data for trends, using standard protocols and quality assurance programs. Participation has grown from eight European countries at the outset to 20 in 1993.

The most recent information available for the cleanup is from 1992, when 12,513 half-kilometer (.31-mile) sections of beach were surveyed.

The United Kingdom dominated the data with 4,371 beach units surveyed. For the past three years, the program has monitored 15 percent of the U.K. coastline. Its efforts have documented a steady increase in litter items, with amounts doubling to 350,000 between 1992 and 1993 (the most recent U.K. data). The most marked annual increases were noted for indicators of sewage contamination: sanitary materials and medical waste. Items such as condoms, sanitary towels and panty liners tripled over the previous year, from 23,000 to 84,000. Likewise, a threefold increase in medical waste such as syringes, blood bags and colostomy bags was also documented.

Additionally, litter on U.K. shores was traced to more than 30 countries of origin, similar to 1992 findings, indicating that shipborne sources continue in the face of international agreements and legislation to prevent them.

A simultaneous beach cleanup campaign by the Marine Conservation Society scoured another 200 kilometers (124 miles) of U.K. coastline, collecting 114,000 items. The combined totals present a sobering picture of almost a half-million items counted by volunteers during a two-week period.

The Tidy Britain Group, another U.K. litter-control program, began beach surveys 15 years ago in response to complaints about increasing litter, reports of injuries from glass and other hazardous objects, and declining aesthetic quality of bathing beaches. The program was refocused to evaluate the success of MARPOL Annex V, using before-and-after designs along the coastline of the northeast Atlantic Ocean, Irish Sea, North Sea and English Channel. It considers marine debris from ocean and land-based sources.

Although the results of the Tidy Britain Group cannot be strictly compared to those of Coastwatch

Center for Marine Conservation

Europe surveys, there have been striking correlations in medical waste. Coastwatch Europe found medical waste on 3 percent of beach units surveyed in 1991, 4 percent in 1992 and 7 percent in 1993. The Tidy Britain Group found medical waste on 3 percent of beaches surveyed in 1978-79 and 4 percent in 1987-1988.

• Mediterranean Sea and the Middle East

The Mediterranean Sea has unique problems compared to other waters of the world.

It is virtually landlocked. Surface water flows in at the Strait of Gibraltar, where deeper water also flows out. Around it, 135 million people live in the coastal region of 18 countries. Major shipping lanes operate there, with oil the most important cargo.

Consequently, every piece of litter that enters the Mediterranean Sea accumulates and decomposes there. It is a trap for both marine and land-derived litter.

But information about garbage in this sea is surprisingly scant in light of its uniqueness and recreational popularity. Individual studies have looked at vessel debris, lost fishing gear, floating trash and beach litter. Not until 1988, however, was the first coordinated effort to measure Mediterranean litter undertaken by the United Nations Environment Programme. It studied the coasts of Spain, Italy, Turkey, Cyprus and Israel.

The study found that quantities of debris on a Mediterranean beach are directly proportional to the distance from a population center and condition of the sea. Source identification, as in other parts of the world, was deemed critical to solving the litter problem.

For instance, bathing and recreation are known to be major debris sources because Mediterranean beaches are more popular than other western European shores. They attract millions of visitors each year. Overall, plastics accounted for about 70 percent of the total beach debris. Recreational trash — food, beverage and cosmetic containers — dominated. Little fishing-related litter was found. Likewise, Lebanese beaches had enormous amounts of plastic pellets from local factories or cargo loss at ports. And recent wars there have hindered orderly garbage collection.

Benthic trawls to check the condition of the Mediterranean seafloor found litter 70 percent of the

time. Paint chips were the most common find (44 percent), followed by plastics (36 percent). Data, however, remain sparse on seafloor debris.

• **Far East**

Much of Japan's work to evaluate types, amounts, distribution and trends of at-sea debris has focused on vessels of opportunity (operating on missions other than marine debris data collection) in the North Pacific, South Pacific, Sea of Japan, Yellow Sea, Bering Sea, South China Sea and the Indian Ocean.

From 1987 to 1991, surveys were conducted aboard 204 vessels in cooperation with research and patrol vessels of the Fisheries Agency of Japan. They covered 926,000 nautical miles and sighted 136,000 pieces of floating material, including fishing gear, wood, plastic, plastic foam, bottles and cans.

The findings pointed to a significant amount of land-based and plastic or synthetic debris (nylon, plastic foam, vinyl). Coastal waters had the most debris, with 20 to 40 pieces per square mile. By contrast, only 0.2 pieces were found per square mile in the north equatorial current area and one to three pieces per square mile in the Subarctic. However, ocean currents are important influences; the highest density of trash, mostly land-based, was found trapped in the central North Pacific by a large circular current north of the Hawaiian islands.

SOUTHERN HEMISPHERE

Floating plastics and other man-made litter are common in all ocean waters, but they are less conspicuous in the Southern Hemisphere. This is a reflection of demography, levels of industrialization and shipping, fishing activities and the dilution that distance brings.

Oceans cover 80 percent of the Southern Hemisphere, compared to 60 percent north of the equator. These vast distances of water, combined with ocean circulation and weather patterns, drive the dispersal patterns of debris and minimize the mixing of trash between hemispheres. Both the Northern and Southern hemispheres rank plastics as the leading type of marine debris, commonly more than 70 percent.

The importance of land-based sources, particularly near large population centers, is well established in the Southern Hemisphere by studies from Argentina, South Africa, Australia, New Zealand and

Abraham Golik, National (Israel) Institution of Oceanography

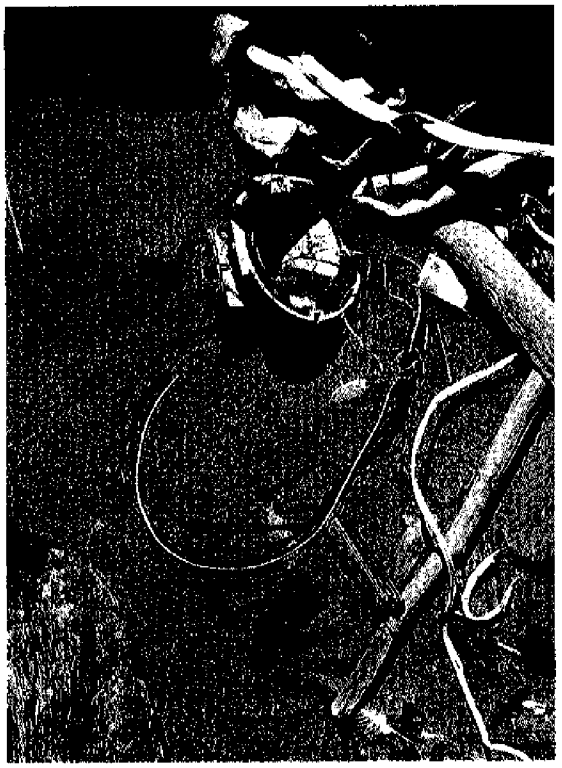
Plastics are a leading source of marine debris on Israeli beaches.

Oceania. So, too, is the significance of fishing and shipping litter for unpopulated and remote areas. Foreign material is also more conspicuous and abundant on these distant beaches.

Comparisons, however, are difficult to draw because of inconsistencies in sampling and identifying debris throughout the Southern Hemisphere. The density, in terms of numbers of items found, is highly variable. Debris is densest near population centers where local sources are dominant and packaging materials are conspicuous.

On isolated Subantarctic shores, plastics and synthetic debris of all kinds are prominent. The southern islands are influenced by winds and the strong circumpolar current of the Southern Ocean. Some debris is related to nearby fishing; other debris is from distant sources. For example, Argentinean and South African litter is found on New Zealand islands, and South American debris is found on African shores.

On South African beaches surveyed, plastic accounted for 90 percent of the litter. Researchers there noted a strong correlation between small- to medium-sized debris and pumice (an indicator of ocean travel), suggesting that inshore currents are



Paul Topping, Environment Canada

A broken speaker washes up on a Canadian beach within the Pacific Rim National Park.

more important than local point sources in placing debris on beaches. In other words, debris of this size generally arrives on currents, carried to the beaches via ocean waters from sources removed from the area. Virgin plastic pellets, which account for most of the beached small- to medium-sized litter, have recently decreased in number and proportion on South African beaches. The same is true for New Zealand beaches, where researchers speculate that manufacturers are improving their handling and transport of these pellets. Larger debris in South Africa has been traced to a combination of land- and sea-based sources.

In Oceania, plastics and other man-made debris are common on both populated and unpopulated islands. Litter is generally 70 percent plastic, comparable to developed countries in the region. But significant amounts were also reported on remote, uninhabited and seldom-visited lands.

Remote locations in the Southern Hemisphere are ideal for ongoing monitoring surveys. From these, the overall effectiveness of MARPOL Annex V, national legislation and public education and awareness campaigns might be measured. On the other hand, documenting the flux and fate of marine debris must await a more complete understanding of the dynamics of movement, degradation and deposition of these materials.

Recommendations

1. Monitoring has been at the root of efforts to control marine debris, but it has been criticized as too vague in its goals, as poorly designed and as data collection for data's sake. Objectives must be delineated. Policy could be developed through monitoring efforts to produce legislation or funding for source-reduction programs, to assess trends, to identify pathways by which debris enters water, to measure wildlife deaths from entanglement, to identify point sources and to help enforce regulations.

2. Consider the geographic area of interest. It is important to decide on the proper scale for viewing marine debris. Should it be global, hemispherical, basinwide, national, regional or local? Given the global scale of the problem, an international design has been considered to measure the effectiveness of MARPOL Annex V, to understand the entanglement issue and to evaluate education efforts such as the international cleanups sponsored by the Center for Marine Conservation. Another discussion should center on global methodology and indicator items. Groups of experts advising the United Nations Environment Programme and the United Nations Intergovernmental Oceanographic Commission would be best positioned to lead the discussion of a global study and to coordinate other international organizations such as Clean World International. Existing programs — especially in Canada, the United States and the United Kingdom — could be the bases for viewing marine debris on a global scale.

3. Lingering questions about oceanic and beach dynamics will influence our understanding of marine debris changes. Seasonal influences and weather patterns, currents and human activities will affect the amount and movement of debris on beaches and in water. Process studies could explain the dynamics of marine debris. Sources and ocean sinks could be identified, along with pathways and processes (such as degradation), to learn the fate of marine debris. Understanding current and wind patterns would also help in designing beach surveys.

4. Use key index items. Given the amounts of debris in areas, it is doubtful that every item will be of concern. More likely, specific items will be important, such as those that entangle or are sewage-related. These key index items will influence the units for measurement — numbers, weight, volume — that should be considered. For example, if entanglement is the focus, then quantity of entangling items by size may be more important than volume. But if the focus is on plastic pellets or fragments, weight should be the variable of choice.

5. Where possible, sources of marine debris should be identified by countries of origin and user groups using item codes and shapes from industry, epiphytic organisms (that travel on oceanborne debris) and cargo manifests. Also, natural markers such as pumice could indicate ocean dispersal rather than local sources.

6. Consider the role of volunteers. Before using them, it is important to understand the objectives of a study. Volunteers are best for beach cleanups that aim to educate and involve the public. But if the objective is scientific, the use of volunteers raises concerns about strict adherence to procedures. Good quality control and assurance programs are necessary. On the other hand, volunteers are plentiful and committed, especially when their efforts are rewarded with feedback.

7. Daily surveys can pinpoint the problems and sources of marine debris in a local area or specific locality with detailed information. Enforcement agencies can then use the information to stop illegal activities.

Sources of Information

• "Distribution, Type, Accumulation and Source of Marine Debris in the United States, 1989-1993." Christine A. Ribic, Environmental Protection Agency, United States; Scott W. Johnson, National Marine Fisheries Service, United States; and C. Andrew Cole, Pennsylvania State University, United States.

• "Distribution of Floating Debris in the North Pacific from Sighting Surveys, 1986-1991." Satsuki Matsumura, Keiichi Nasu and Kazuhiko Hiramatsu, National Research Institute of Far Seas Fisheries, Japan.

• "Debris in the Mediterranean Sea — Types, Quantities and Behavior." Abraham Golik, National Institution of Oceanography, Israel.

• "Marine Plastic Debris Research in Canada." Paul Topping, Allen Eade and Peter Eaton, Environment Canada, Canada.

• "Pelagic Plastics and Other Seaborne Persistent Synthetic Debris — A Review of Southern Hemisphere Perspectives." Murray R. Gregory, University of Auckland, New Zealand, and Peter G. Ryan, University of Cape Town, South Africa.

• "Programmed Coastal Litter Surveys in Europe, with Particular Reference to the U.K." Gareth Rees and Kathy Pond, Farnborough College of Technology, United Kingdom.

• "State of Pollution by Marine Debris in the Caribbean." Stefan Andersson, United Nations Environmental, Scientific and Cultural Organization — Intergovernmental Oceanographic Commission, France.

• "Working Group Report I." Third International Conference on Marine Debris, chaired by Christine A. Ribic, Environmental Protection Agency, United States.

Courtesy of University of California Sea Grant Extension

Sections are among the species of marine animals that can be entangled by marine debris. Certain kinds of wildlife are also known to ingest plastic debris.

Chapter Two: Impacts of Marine Debris

Marine debris is like the flu. It affects everybody at one time or another. But it creates the worst problems for those who are already unhealthy — particularly endangered species. Waterborne litter is yet another form of pollution weighing on the health of many species.

And like the flu, there is no quick cure for marine debris. The impacts are very difficult to measure; the sources, hard to trace. Researchers often find that sources and impacts are separated by hundreds or thousands of miles. Since debris is persistent and often buoyant, it can travel great distances.

Scattered records of interactions between marine debris and wildlife date back several decades before the 1970s. Entangled northern fur seals were spotted as early as the 1930s. By the 1960s, various seabirds were found to have plastic in their stomachs. But the problems were not fully recognized until a decade later, when floating plastic particles were found throughout the North Atlantic and North Pacific oceans.

Today, we separate the impacts of marine debris into two broad categories: biological and economic.

Biological studies tell us that waterborne litter entangles wildlife and masquerades as a food source, smothers beach and bottom-growing plants, and provides a surface for colonizing epiphytes, small organisms that travel on marine debris to distant shores, perhaps with adverse ecological consequences.

To date, research has focused on impacts to individuals or groups of animals, but little progress has been made in understanding how marine debris affects entire populations and ecosystems. This is partly because of the difficulty in studying the impacts. Sampling is almost entirely limited to land-based observations, which cannot reveal the proportion of a population that drowns from entanglement at sea. The effort to document more subtle impacts — such as the reduction in stomach capacity among birds that eat plastic — is further complicated by not knowing whether these animals are clearly disadvantaged. More study is needed.

On the economic side, we know that waterborne debris fouls ships and other marine equipment, competes with fisheries when lost or castaway gear continues to fish (called ghost fishing), reduces the value of fisheries products and causes business losses for tourism and recreation. These economic impacts have only recently emerged from behind the considerable shadow of biological impacts, but they may be easier to measure. We look at them in terms of both market value — what we pay for goods and services — and contingent value — the estimated value of amenities that have no operating market, such as clean beaches and blue whales.

Finally, there are areas of overlap, where debris takes a biological and economic toll. Ghost fishing is the most obvious example, competing with fishermen and needlessly reducing fish populations.

There are perhaps hundreds of reasons why marine debris is a problem, each with a common refrain: debris is not a natural part of the marine system. It hurts aquatic animals and plants. And it hurts beach communities and fishermen trying to make a living from the sea. As good as the reasons are for reducing waterborne debris, they may not be enough to bring about widespread change in behaviors or priorities. Hard data showing the extent and severity of biological and economic impacts will enhance the standing of marine debris among the scores of other pressing environmental concerns.

Biological Impacts

Marine debris casts a wide net of impact over marine and littoral animals, plants and perhaps even entire ecosystems. Entanglement and ingestion are best understood as maimers and killers. Other impacts remain poorly documented. We know that floating debris can carry many epiphytic species to distant shores. Microplastic litter released from abrasives may be consumed by filter-feeders. Plastic debris can smother sand-dwelling animals on the

seafloor or beaches, ferry propagules (seeds and spores) to remote areas where they become invading alien species, and transfer organochlorines and other pollutants to marine food webs.

• Entanglement

Entanglement is the most obvious of all biological impacts on aquatic animals, but even this problem is difficult to measure. We get only fleeting glimpses of entangled animals from planes and ships. Many die and sink or are eaten; others float hidden beneath debris.

To date, there have been few systematic surveys of entanglement away from shore, where most victims die or disappear. Consequently, data are almost always collected on the beaches, where survivors strand or congregate to nest, breed or molt. This information cannot accurately reflect overall entanglement rates since it is not where most incidents occur.

At least 135 species of marine vertebrates and eight invertebrates have been reported entangled in marine debris. The list now includes most of the world's sea turtle species, more than 25 percent of its marine mammal species and more than 15 percent of seabird species. However, land-based measures of the frequency of entanglement for individual species is usually low — less than 1 percent of an affected population. And though entanglement appears to be far less common than ingestion, it may be more deadly. Rates of entanglement may be an order of magnitude greater than those estimated by land-based observers.

For certain species, evidence suggests that entanglement occurs regularly.

Some — gray whales, California sea lions, northern elephant seals, northern gannets, herring gulls and shags — have healthy populations that do not appear to be compromised by low levels of entanglement deaths. This is not true, however, for endangered or threatened species. Even though entanglement deaths may be low compared to other human-related causes, they add obstacles to recovery. And for a few species — Hawaiian monk seals, green sea turtles, northern fur seals, some commercially caught fish and crabs, and perhaps northern right whales — entanglement may occur often enough to have a major effect on population numbers.

The frequency of entanglement is influenced by the density of debris in an area and an animal's food preferences, feeding habits and behavior. Young seals, for instance, like to play with debris, birds use it to build nests, and turtles are often caught in debris that they try to eat. The animal's shape plays a role as well. Bony fish are less likely to be ensnared than turtles, seals, dolphins and sharks, which have limbs or stiff fins that catch on bands and straps. Oceanographic features also enhance entanglement by concentrating prey species and debris at convergence zones.

Consider, too, that the characteristics of debris, particularly shape and size, have a direct bearing on its ability to trap or harm animals. Nets and rope from commercial fishing, monofilament line from recreational fishing, strapping bands and other ring-shaped objects are often culprits.

Likewise, large debris can trap animals, drowning air-breathers, asphyxiating fish that require motion to respire, starving them or making them vulnerable to predation.

Smaller debris creates a drag on entangled animals, increasing the energy they need to move and reducing their ability to forage and escape predators. This debris can become snagged on the seafloor, injuring fish and crustaceans, or on land, trapping seabirds and seals. And it can bind tightly around an animal to restrict its growth or cut off circulation to its appendages.

• Ingestion

Plastic in the water, unfortunately, looks like food to many marine animals. Turtles mistake plastic bags for jellyfish, one of their favorite meals. Birds mistake plastic pellets for fish eggs.

Other times, plastic is accidentally eaten in association with natural food.

Marine animals appear more likely to eat plastic than become entangled in it. At least 160 species of vertebrates — including nearly 100 percent of some bird species — and two species of invertebrates have been reported to ingest debris. But it is unclear whether ingestion is a serious problem because the frequency of lethal effects is unknown and the sublethal effects are poorly understood. Seabirds and turtles appear to be more affected than mammals.

Ingestion is best understood for seabirds, which are at risk of eating debris because of their generalized diets and nonspecialized foraging habits. Petrels, storm-petrels, phalaropes and some albatrosses and auks rarely regurgitate indigestible pellets; rather, they accumulate large loads in their digestive systems.

Plastic consumption among seabirds is greatest at mid and high latitudes and least in the tropics and

A. Lawstead, National Marine Fisheries Service

A fur seal has been entangled by webbing. Lost or discarded fishing gear can needlessly injure and kill marine animals for years.

waters south of the Antarctic Convergence. From the 1960s to mid-1980s, the proportion of birds containing debris and the amount per bird increased. Over the last five to 10 years, the rate of ingestion has continued to climb in areas such as the North Pacific while remaining constant or decreasing elsewhere.

Turtles, like seabirds, are also likely to eat debris because of their indiscriminate feeding habits. And once they have swallowed a piece of trash, the papillae lining their esophagus prevents regurgitation.

A variety of ailments are suffered by sea turtles, birds and marine mammals that eat debris. It damages the digestive tract; causes starvation by blocking food and increasing buoyancy in turtles; creates a false sense of satiation, affecting their long-term fitness and ability to grow, molt, reproduce and survive adverse conditions; and perhaps releases toxic pollutants as it is digested.

Physical damage from sharp items appears to be rare and an unlikely threat to significant proportions of the marine animal population. Digestive tract blockage usually occurs in turtles, the West Indian manatee and some cetaceans, but its frequency is unknown.

Another unknown, and perhaps large, portion of debris eaten by turtles and mammals is excreted harmlessly. But animals can die from swallowing large or multiple items that block or lodge in their intestinal tract.

There is also a growing potential for small filter-feeding organisms such as invertebrates and pelagic fish to ingest the microplastic debris that enters the water from scouring operations. Although the environmental significance is still unknown, there is concern that these materials will transfer pollutants, including heavy metals, to marine animals.

Generally less than .5 millimeter across, these inconspicuous plastic fragments are entering marine waters from some hand cleaners, cosmetic preparations such as facial scrubs and exfoliants, and airblast cleaning materials. There is special concern that plastics contaminated by heavy metals from the cleaning of aircraft and machine parts can pass to the sea through sewage systems or waterways. Plastic has been substituted for sand by recently developed technology that blasts paint from metallic surfaces.

- **Others**

For some plants and animals, marine debris offers an opportunity to travel.

Drifting debris in the Pacific and Atlantic oceans has been found to carry a wide variety of epiphytic

Phyllis Grifman, University of Southern California Sea Grant Program

A caution sign on a southern California beach warns against swimming because of possibly contaminated stormwater. Tourism and beach businesses are often impacted by such warnings.

organisms: calcareous algae, bryozoans and hydroids, tube worms, barnacles, corals, millipora, fire coral, colonial cyphozoans, bivalves (jewel box clams) and sponges. Large, buoyant items such as sealed bottles and fishing floats are best for carrying new colonies of these organisms to distant shores that they otherwise may never have reached on sargassum seaweed, coconuts or other natural floating islands. Rafts of debris can also be colonized by terrestrial seeds and spores.

The possible significance of this cannot be overlooked. More than 90 percent of historical extinctions have occurred on oceanic islands with the aid of human introductions. But the impact is still unknown. In perspective, the role of debris in moving encrusting organisms is probably minor compared to transport on ship hulls and in ballast water.

Likewise, marine debris can travel across the seafloor, although little is known about how, where or even if it settles into sinks. It does not have to float to kill, however. Trash, especially plastic sheets, could potentially smother bottom fauna, such as coral on reefs, and beach infauna. Impervious sheets of plastic on the seafloor may prevent oxygenated water from reaching soft bottom substrata, creating anoxic conditions and a major shift in community structure and function. Such effects are localized, and probably trivial at current debris levels, but they could become important if debris continues to accumulate on the seafloor, especially on the productive continental shelves. On sandy beaches, debris can smother infauna, such as nematodes that burrow at the high-tide line, by cutting them off from oxygen and water.

Economic Impacts

The economic impacts of marine debris are best measured by the diminished opportunities to exploit the marine environment, for pleasure or for profit. It is perhaps easiest to think along the lines of pleasure, then profit.

Most pleasure is taken from the marine environment by recreationists. The economic impact of marine debris is measured by the reduced value of people's activities.

Beach uses are especially vulnerable. Dirty beaches no doubt cause one of the most profound economic impacts associated with marine debris. In particular, beachgoers have shown little tolerance for personal hygiene wastes and solids from poor wastewater treatment. The appearance of hazardous materials — medical wastes, explosives and noxious chemicals — can also negatively affect local tourism and recreation. And even routine household and fishing wastes can translate into fewer tourists and less business for coastal economies. Similarly, property values can drop in response to marine debris.

Like beachgoers, boaters and recreational anglers also suffer when debris ruins the aesthetic value of their sports. This is a real economic impact in the sense that the activities are worth less to them in monetary terms.

But the appeal of the marine environment is not limited to users alone. It extends to people who may never visit the coast. For them, the knowledge that the ocean has become polluted reduces its aesthetic value. People place a higher value on a clean ocean. And they are willing to pay to reduce debris there. This willingness to pay to preserve a clean ocean, even when it is not used, is known as an existence value. Willingness-to-pay estimates have been made for many kinds of marine pollution — oil spills, PCB and DDT are examples. But the same ideas hold true

Documented Worldwide Marine Debris Entanglement and Ingestion

Species Group	Total No. of Species Worldwide	No. and Percentage of Species with Entanglement Records		No. and Percentage of Species with Ingestion Records		Species with Entanglement and/or Ingestion Records	
		No.	%	No.	%	No.	%
• Sea Turtles	7	6	86	6	86	6	86
• Seabirds	312	51	16	99	32	128	41
Penguins	16	6	38	0	0	6	38
Grebes	19	2	10	0	0	2	10
Albatrosses, Petrels and Shearwaters	99	10	10	57	58	58	59
Pelicans, Boobies, Gannets, Cormorants, Frigatebirds, Tropicbirds	51	10	20	6	12	14	27
Shorebirds, Skuas, Gulls, Terns, Auks	122	23	19	36	30	48	39
• Other Birds	–	5	–	0	–	5	–
• Marine Mammals	115	31	27	24	21	47	41
Baleen Whales	10	6	60	2	20	6	60
Toothed Whales	65	4	6	19	29	20	31
Fur Seals and Sea Lions	14	11	79	1	7	11	79
True Seals	19	8	42	1	5	8	42
Manatees and Dugongs	4	1	25	1	25	1	25
Sea Otters	1	1	100	0	0	1	100
• Fish	–	34	–	33	–	60	–
• Crustaceans	–	8	–	0	–	8	–
• Squid	–	0	–	1	–	1	–
SPECIES TOTAL	–	135	–	163	–	255	–

David Laist, U.S. Marine Mammal Commission

for marine debris. And most importantly, people are willing to pay to prevent unusual mortality to marine animals. So when marine debris reduces the population of ocean birds or sea turtles, there is a real economic loss regardless of whether an animal can be watched and enjoyed. This economic loss need not show up on the market for it to be important.

In addition to the pleasures people take in the marine environment, there is the issue of exploitation for profits. Economic impacts occur when debris impairs profitable uses of the coast and its resources. For example, businesses that use boats for pleasure, transportation or fishing can lose profits to debris-related damage and time spent repairing equipment and vessels. Ropes, monofilament line and netting can entangle and incapacitate propeller shafts. Sheets of plastic can block water intake ports for propulsion or cooling systems. Large debris such as cargo pallets and shipping containers can damage vessels in collisions. Commercial fishing gear — often a source of marine debris — can also be fouled, damaged or lost.

Another cost to the commercial fishing industry is ghost fishing, which competes with watermen for their catch. Gear used by gill net and trap/pot operations is the most serious threat to marine resources. For instance, ghost fishing losses in the sablefish trap fishery off British Columbia, Canada, are estimated as high as 30 percent of the actual landings. Similarly, if a single legal-size crab was caught by each of the estimated 31,600 traps lost in the Bristol Bay king crab fishery in 1990 and 1991, annual losses would have been 205,400 pounds.

Entangling gear can also be lost by trawlers, although the impact on targeted species is low. The use and construction of other gears — fish weirs or pound nets, longline and jigging gear — make them a low initial threat in most cases. But long-term losses can be traced to pots and traps made of synthetic materials. One way to disarm these gear types is to install a degradable escape hatch.

More research on the amounts and impacts of ghost fishing gear is urgently needed. Likewise, efforts to recover lost gear in areas where it is thought to be concentrated should be investigated.

Finally, fisheries resources can be diminished in value when they are contaminated by trash. Canadian fishermen, for instance, are generally unable to sell a catch that has been tainted by glass. Across the globe, debris threatens the livelihood of fish and shellfish marketers who have promoted a health-conscious image based on clean, pollution-free oceans. Reports of marine debris reduce the appeal and market value for these products. The problem is worsened where the water is polluted by land-based sources, especially inadequately treated sewage. The costs have not been quantified.

Recommendations

Basic research is needed to assess the costs of marine debris, but not at the expense of active steps to reduce it. Understanding and quantifying the impacts are essential to avoiding unexpected population and system-level changes that may have far-reaching consequences. These efforts are needed to plan the most effective mitigation strategies and to reduce the problems through appropriate disposal behavior. It is also critical to know the magnitude of the impacts so that marine debris can be properly ranked among other environmental problems.

Fresh insights must be gained through interdisciplinary studies, using technologies in physiology, veterinary science, oceanography, sedimentology and economics. The conference working group made the following recommendations.

1. Promote and market worldwide the successful solutions to certain marine debris impacts. Substitute for products that have demonstrated impacts: Remove packing straps and plastic liners from bait boxes, use self-locking storage containers on ships to reduce strapping, use integral caps and sealing rings on bottles and replace six-pack yokes with cardboard.

2. Assess the economic costs of marine debris to educate policy-makers, affected parties and the public. Also assess costs to tourism, coastal recreation and vessel owners plagued by ship and gear fouling. Determine what people are willing to pay for a clean marine environment, even if they don't use it.

3. Explore the effectiveness of sensational appeals, which aim to reduce marine debris through graphic displays, posters or media campaigns showing animals wounded by debris or through strongly worded slogans about its effects on oceans and wildlife. Consider alternative, more stringent policy measures to reduce debris.

4. Focus on and publicize the problem of combined sewer overflows. Continue research on terrestrial sources of debris.

5. Rigorously investigate the sublethal impacts of debris ingestion among turtles and birds — how it creates a false sense of satiation, dilutes nutrients, impairs digestion and affects reproductive capacity.

6. Research and implement mechanisms to reduce fishing gear loss. These could include technological changes in gear design or incentives to recover lost gear. Given the appropriate incentives, the collection of derelict gear may be feasible.

7. Continue direct control measures (and where necessary, initiate novel programs) when marine debris is contributing to declines in a species population. For instance, clean dirty beaches and free entangled Hawaiian monk seals.

8. Explore mechanisms to reduce entanglement of marine animals and produce a guide to disentangling and rehabilitation techniques.

9. Investigate the fate of plastic and other debris after they break down into minute particles in the marine and littoral environment. Research their potential impact on marine organisms.

10. Investigate the scope and importance of organism transfers by marine debris, especially the introduction of invasive alien species that could disrupt native communities and ecosystem functions.

11. Investigate the amounts, accumulation rates and impacts of debris on the seafloor and the potential for large-scale impacts by smothering.

12. Monitor rates of entanglement and ingestion among selected species at specific sites. Collaborate with existing studies in certain regions. For instance, records of entanglement and ingestion in the Antarctic Treaty region are collated by the CCAMLR (Convention on the Conservation of Antarctic Marine Living Resources) Scheme of International Scientific Observation. Flagship species such as marine turtles and cetaceans can be used to promote field observations.

13. Establish an impact reporting system to promote and collate observations by beach users, fishermen, oceanographers, scuba divers and others. Start by compiling past records.

14. Make efforts to recover lost fishing gear in areas where it is likely to be concentrated. Also, take steps to better evaluate the kinds and amounts of fish caught and the potential effectiveness of such work to clean up hazardous ghost fishing gear. Establish a system to record gear loss by commercial fishermen.

Sources of Information

- "Marine Debris: Benefits, Costs and Choices." James Kirkley, Virginia Institute of Marine Science, United States, and Kenneth E. McConnell, University of Maryland, United States.

- "Encrusters, Epibionts and Other Biota Associated with Pelagic Plastics — A Review of Biogeographical, Environmental and Conservation Issues." Judith E. Winston, American Museum of Natural History, United States, and Murray R. Gregory and Leigh M. Stevens, University of Auckland, New Zealand.

- "Entanglement of Marine Life in Marine Debris." David W. Laist, U.S. Marine Mammal Commission, United States.

- "Ghost Fishing Gear: Have Fishing Practices During the Past Few Years Reduced the Impact?" H. Arnold Carr and Jessica Harris, Massachusetts Division of Marine Fisheries, United States.

- "The Highest Global Concentrations and Increased Abundance of Oceanic Plastic Debris in the North Pacific: Evidence from Seabirds." Martin D. Robards, ENSR Consulting and Engineering, United States, and Patrick J. Gould and John F. Piatt, Alaska Fish and Wildlife Research Center, United States.

- "Plastic Scrubbers in Hand Cleansers and Other Microlitter: A Further (and Minor) Source for Marine Pollution Identified." Murray R. Gregory, University of Auckland, New Zealand.

- "A Socioeconomic Theory of Controlling Marine Debris (Is Moral Suasion a Reliable Policy Tool?)." Jon G. Sutinen, University of Rhode Island, United States.

- "Working Group Report II." Third International Conference on Marine Debris, chaired by Peter G. Ryan, University of Cape Town, South Africa.

Despite the fact that 69 countries have ratified MARPOL Annex V, it is estimated that commercial vessels — merchant ships, freighters, cruise liners, commercial fishing vessels, naval ships, ferries, research vessels, tugboats, barges and offshore petroleum platforms — are responsible for 10 to 20 percent of the world's marine debris.

Chapter Three: Vessel Debris

Since the onset of ocean travel, world sailors have used the seas as a vast, seemingly bottomless hole in which to toss their garbage. But today, we understand that the oceans are not limitless trash receptacles, especially where the accumulation of nonbiodegradables such as plastic, glass and aluminum is concerned. The debris that is dumped into marine waters can damage sensitive ecosystems and kill the organisms that inhabit and utilize the ocean and shoreline environment.

Realizing the global environmental impacts of marine debris and targeting the commercial maritime users who ply the seas, the United Nations International Maritime Organization (IMO) drafted a treaty — the International Convention for the Prevention of Pollution from Ships (MARPOL) and five annexes — designed to halt at-sea disposal of wastes.

MARPOL Annex V specifically prohibits the at-sea disposal of all plastics. It also limits the ocean discharge of other types of vessel-generated garbage to specified distances from land and prohibits it entirely in designated Special Areas such as the Baltic Sea, the Mediterranean Sea and the Caribbean region including the Gulf of Mexico. The at-sea disposal restrictions apply to commercial and publicly owned vessels of all types and sizes, including merchant ships, freighters, cruise liners, commercial fishing vessels, naval ships, ferries, research vessels, tugboats, barges and offshore petroleum platforms. Recreational vessels are also subject to Annex V restrictions (see page 33).

Sixty-nine countries had adopted Annex V as of June 1994. Once a nation ratifies this annex, the ships that bear its flag and navigate its waters must comply with the guidelines. Additionally, the country must provide adequate port reception facilities for the disposal of ship wastes.

Vessels complying with MARPOL Annex V have three options. They can dispose of nonplastics at sea within the legal restrictions. They can incinerate wastes onboard. Or they can hold wastes for shoreside disposal at ports or terminals.

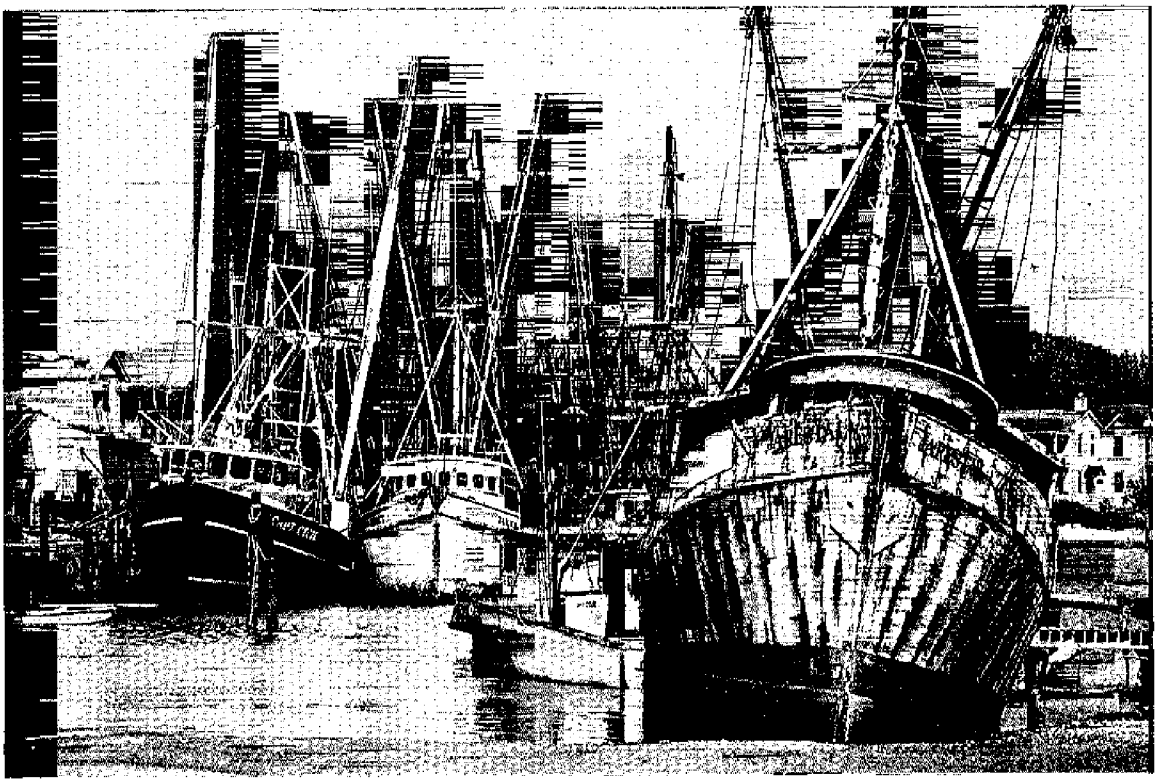
The IMO realized that vessel debris wasn't just the responsibility of the maritime community. Shoreside, ports, terminals and docks must provide containers to receive the increased quantities of garbage now being retained by ships and boats. Ultimate disposal, which is required for successful implementation of Annex V, is not explicitly addressed by MARPOL. But waste management systems must be in place for final disposal of garbage to prevent its return to the sea.

Despite the best laid plans of the IMO, vessel debris remains a problem. Many nations have not yet been persuaded to ratify MARPOL Annex V. Developing countries often don't have the facilities and stable economies needed to support the treaty. That's why the IMO, the World Bank and the United Nations Environment Programme have worked to establish funding, cooperative agreements and regional programs and initiatives aimed at providing cost-effective methods for handling vessel debris.

In many cases, individual vessel operators choose to ignore the restrictions of the international treaty, claiming they don't have adequate equipment, space or personnel to hold or dispose of their wastes properly. Others claim ignorance. However, many collectively owned vessels, such as cruise liners and shipping vessels, are being forced by company policy to adhere to MARPOL Annex V. In some cases, these companies are devoting funds toward the development of technology needed to handle shipboard wastes.

Despite the feel-good reward of doing the right thing, there are few incentives for vessel compliance and few repercussions for noncompliance. Enforcement responsibility rests with the ratifying country, and this enforcement tends to be universally cursory.

If little is done to enforce waste restrictions, then survey methods must be developed to link the debris that washes ashore with its source. In the case of common debris items such as foam cups and beverage cans, the sources are ubiquitous. But other items can be tentatively linked to their sources. Salt



Scott D. Taylor

At private docks, shoreside disposal facilities such as dumpsters and bins are often nonexistent.

bags, bait boxes, fish baskets and net floats are associated with commercial fishing. Small containers of toiletries, shoe polish and plastic cups are indicative of cruise garbage. Plastic write protection rings and hard hats are characteristic of the offshore petroleum industry. And other debris — wooden pallets, plastic sheeting and galley wastes such as vegetable sacks and egg cartons — are used by many ocean vessels and are typically categorized as ship debris.

Making these linkages requires more than speculation. Sound data are needed from beach surveys, observer programs and surveillance efforts to directly connect debris to its source. Only then can resource managers begin the effort to educate and regulate specific segments of the maritime industry.

It's clear: Vessel debris remains a problem. Just what percentage of marine debris originates from commercial vessels is uncertain. Percentages vary, but in most countries, surveys and beach cleanups put the figure between 10 and 20 percent.

So what's the next step? How does the global community put a halt to vessel debris? Participants at the Third International Conference on Marine Debris believe a comprehensive global strategy built on cooperation and coordination is the answer. And the first step in that strategy lies with lawmakers around the world.

Legislation

More pressure needs to be applied to countries that have not adopted MARPOL Annex V to ratify this important treaty. Beyond that, governments also need to incorporate its provisions into domestic law. Only then can countries ask their own commercial shipping interests and those of other countries to stop the flow of vessel debris.

The Caribbean provides an example of a region that could benefit from wider adoption of MARPOL Annex V. Only 40 percent of the nations in the region have ratified the treaty. Yet the Caribbean was recently designated a Special Area — a no-litter zone — by the IMO. To give teeth to this Special Area designation, more governments in the region need to ratify MARPOL Annex V. Without adoption and incorporation of the treaty into domestic law,

noncontracting countries have no justification for enforcing the Special Area restrictions.

To encourage ratification, countries need to be shown the benefits they can accrue individually and regionally from adopting the treaty. In many cases, however, noncontracting nations are developing countries. Their needs go beyond encouragement. These countries need financial and technical assistance, especially for infrastructure needs such as ports, terminals and waste management. In some circumstances, these problems must be tackled on a country-by-country basis; in others, regional plans and initiatives are more suitable.

In the interlinked Caribbean environment, the problems of vessel debris demand regional solutions. Despite the diversity of governments in the area, the IMO, the World Bank and other United Nations agencies have launched several successful regional initiatives that have sought to develop a framework of environmental regulations and an integrated approach to solid waste management. They include the Wider Caribbean Initiative on Ship-Generated Waste, the Caribbean Marine Debris Workshops, the Citizen Ambassador Program Waste Management Delegation, the Organization of Eastern Caribbean States Solid Waste Management Project, and the Regional Program for the Assessment and Control of Marine Debris.

As governments across the globe enact legislation to implement MARPOL Annex V, lawmakers need to understand that enforcement is an important part of the formula for reducing marine debris. In the United States, for example, researchers, resource managers and environmental organizations want Congress to put more enforcement teeth into the domestic legislation implementing Annex V. They want to see the U.S. Coast Guard given the personnel and power to target, pursue and fine violators who improperly dispose of their vessel debris.

Implementaion

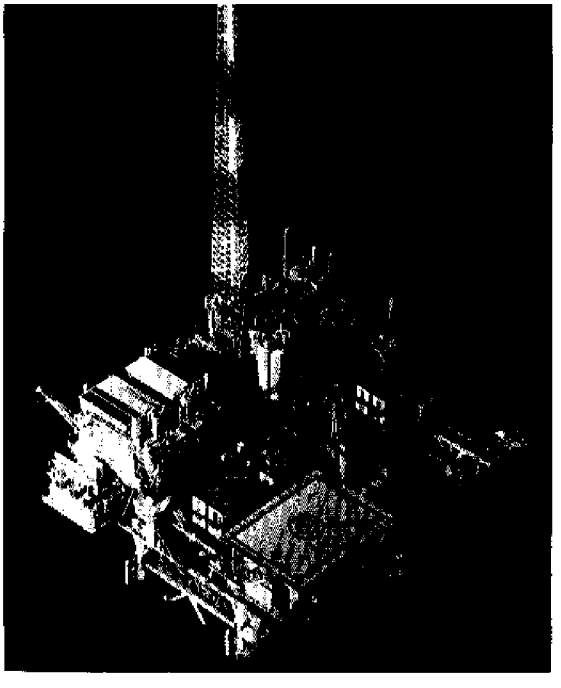
Once a nation ratifies MARPOL Annex V, then it must implement its provisions. Implementation involves reducing and eliminating at-sea garbage disposal, upgrading port and terminal facilities to better handle vessel debris and enhancing land-based solid waste management.

- **Shipboard**

The maritime industry must be informed of its responsibility for maintaining the marine environment and adhering to MARPOL Annex V restrictions. Governments need to target shipping companies and maritime industry trade associations with educational information about at-sea disposal regulations. Once educated, it is then imperative that these companies and trade associations become accountable for complying with MARPOL Annex V through a bona fide enforcement program.

To reduce shipboard garbage, mariners should look first to the source of their wastes. Product packaging is often excessive, nonrecyclable or individualized, generating mounds of unnecessary garbage. Reducing packaging waste, therefore, offers a solid first step toward waste reduction.

Princess Cruises, one of the world's largest cruise lines, has instigated a model source-reduction effort. Cruise ships can load as much as 40 to 60 tons of provisions for a seven-day cruise. To lessen wastes, Princess switched from plastic shampoo bottles to paper containers. They moved away from using individual containers for dairy creamers,



Offshore oil platforms such as this one in the Gulf of Mexico can be sources of marine debris. Hard hats and write protection rings are indicator debris items for this industry.

preserves and butter to offering these items in bulk serving containers. To reduce aluminum can use and packaging, Princess offers passengers soft drinks and mixers from the fountain. Likewise, the U.S. Navy also instigated a source reduction plan, seeking to reduce plastic use by eliminating and changing the packaging specifications for its supplies. Naval officers estimate that this effort has reduced onboard plastic use by 475,000 pounds annually.

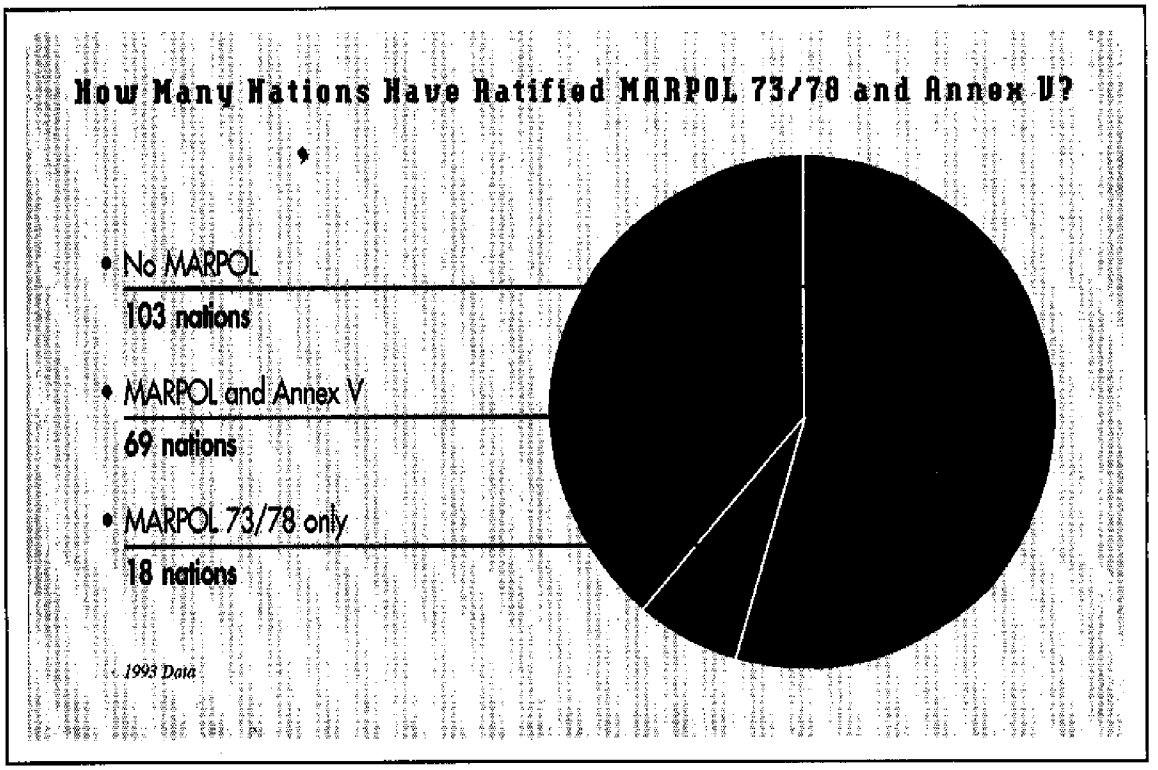
Recycling offers another option for lessening at-sea debris disposal. Given the space and the inclination, vessels of all sizes can sort their refuse for recycling on shore. Princess Cruises has begun separating wastes for recycling or proper disposal. Ships recycle some or all glass, plastic, paper, cardboard, aluminum and tin. In addition, Princess installed incinerators, shredders, compactors and bailers. This equipment will shred combustibles to sizes for easy incineration and compact materials for more efficient storage and transport for onshore disposal.

To handle food-contaminated plastic waste, a health hazard for long-term storage, the U.S. Navy is now testing a custom-built plastic waste processor that will densify and sanitize plastic wastes. The cruise industry is awaiting the results of the Navy tests, hoping this new technology can be adapted for its use too.

Industries and governments need more information exchange about new technology and innovative waste-handling practices for shipboard wastes. The IMO and the National Oceanic and Atmospheric Administration's Marine Debris Information Offices offer formal channels for information exchange and technology transfer. Information also needs to be channeled through informal outlets such as trade associations, publications, conferences and workshops.

Before new technology can be introduced or changes implemented, vessel operators and their parent companies need to document vessel waste amounts and disposal methods. Only then can operators and owners pinpoint improvement areas and develop vessel waste management plans. If used worldwide, vessel management plans and waste records could demonstrate compliance with MARPOL regulations.

And the records could provide the basis for establishing a "green" vessel program — an incentive effort to reward vessels that discharge no solid



wastes. Already, the Center for Marine Conservation has tested a pilot zero solid waste discharge program and developed a manual that can be used throughout the maritime industry.

• **Ports and Terminals**

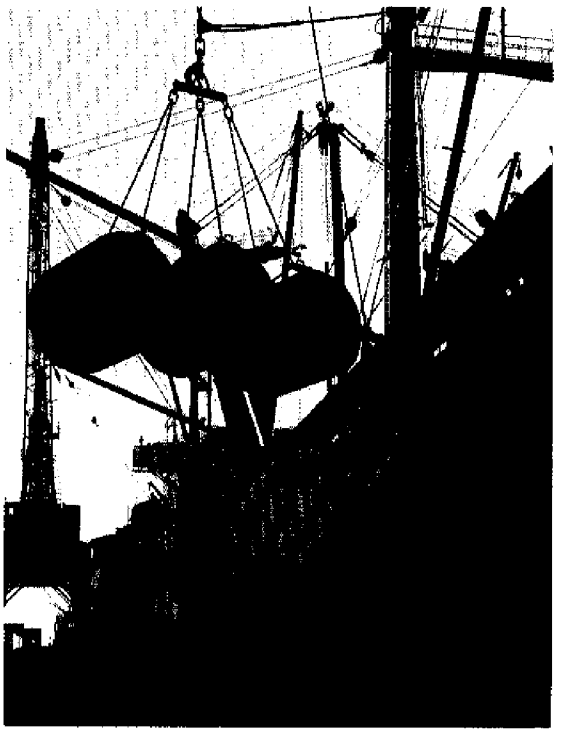
Even if properly handled and stored at sea, vessel debris still presents a problem when it reaches the dock. According to MARPOL Annex V, ratifying countries must maintain adequate port and terminal facilities for receiving vessel-generated waste. Then the burden for waste disposal swings from the maritime industry to shoreside ports, terminals, docks and marinas. Wastes must be off-loaded from vessels and handled promptly and appropriately at these land-based facilities. There must be adequate receptacles for receiving the waste and a plan in place for its removal to a recycling center or final disposal location. In some countries, including the United States, food and food-contaminated foreign wastes must be handled specially — sterilized or incinerated — to prevent the introduction of animal and plant diseases or vermin.

At sea, it is obvious who answers for a vessel's debris. But once a ship docks, it is not so clear who is responsible for providing the containers needed to receive a ship's waste. Is it the ship's responsibility? The port facility's? And who pays?

A U.S. study of Texas and Louisiana Gulf port facilities sought to answer these questions. A similar study was also conducted in the United Kingdom. Researchers found that larger ports in the Gulf and United Kingdom rely on ships' agents to arrange with third-party waste management contractors to collect and dispose of vessel waste. In almost all cases, the ship pays these garbage collection fees.

However, vessel operators indicated a dislike for the current port system for waste disposal. They complained about the lack of availability of dumpsters and other waste reception facilities, and the high cost and lack of convenience in handling garbage. Perhaps because of these problems, only 10 to 15 percent of the surveyed vessels that docked at the ports in either country used the waste reception facilities.

It's clear, therefore, that even developed countries have port facility problems and payment questions to answer. Governments need to do a better job of assessing port use, providing adequate waste disposal facilities, and implementing a fair and balanced fee structure.

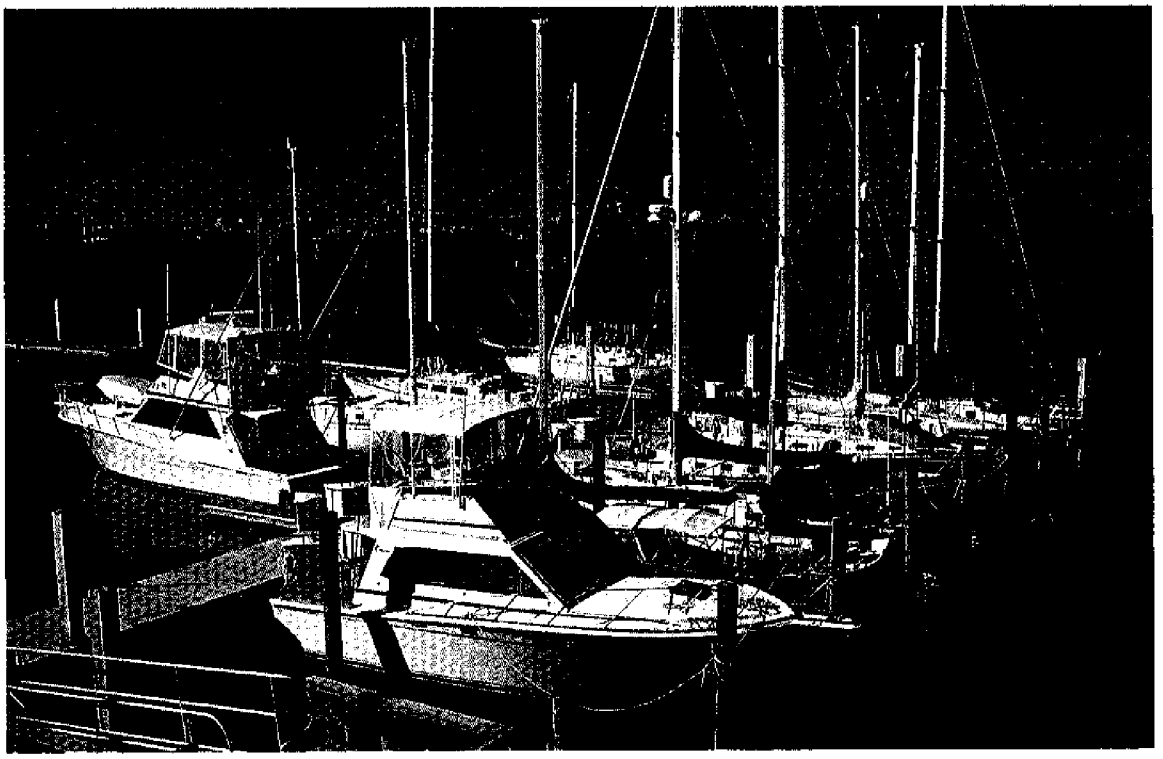


Clay Nolen, N.C. Department of Environment, Health and Natural Resources

Wastes must be off-loaded from vessels and handled promptly at ports. There should be adequate receptacles for receiving the wastes and a plan for removing them to a recycling center or disposal site.

In developing countries, the needs are much greater. Port facilities are often grossly inadequate, and disposal often means transporting wastes from ports through densely populated cities in open-bed trucks to open-pit, leaking landfills scavenged by people and animals. A World Bank study of Caribbean port authorities showed that officials there are concerned about vessel-generated waste because of the potential import of disease, the additional burden it places on municipal waste management and the risk it poses to workers handling uncontrolled wastes.

There is no question that port facilities and waste management systems in many nations require upgrading. But where is the money to come from? Should port authorities directly charge the waste producer? Should general port charges be increased? Should the country or municipality bear the costs of handling and disposing of vessel wastes? Caribbean countries, for example, cannot afford to provide reception facilities free of charge, but they also must be careful not to turn away the cruise and ship traffic that fuels their economies. These nations must identify cost-efficient methods for handling ship



Scott D. Taylor

MARPOL Annex V requires government and privately owned marinas to provide waste receptacles at their docks.

debris and determine ways to make waste generators pay the disposal costs. In determining fees, island officials must also factor the costs for transporting wastes and for the landfills or incinerators needed for ultimate disposal.

The lack of adequate port facilities and funds to improve them keeps many developing countries from ratifying MARPOL Annex V. To answer these needs, United Nations agencies and the World Bank are working extensively with developing countries individually and regionally to introduce MARPOL port guidelines and to search for innovative, economical methods to achieve compliance. In the Caribbean, one innovative solution involved a new incinerator in Barbados.

In the early 1990s, the Barbados Port Authority began constructing an incinerator designed to solve several problems — limited landfill space and the government requirement to sterilize ship-generated waste before disposal. The port authority had been burning ship waste in the open, but clouds of billowing smoke created an unattractive greeting for cruise ships and a health hazard for residents. Now completed and operating, the port authority incinerator is fed a steady 15-hour diet of ship-generated garbage, converting about 340 cubic meters of trash to approximately 18 cubic meters of sterile landfilled ash daily. Ships are charged $75 to incinerate three 1.5-meter bins of waste, and officials expect the project to pay for itself in seven to eight years.

• Land-Based Solid Waste Management

As more countries ratify MARPOL Annex V and the amount of vessel-generated waste handled at ports increases, an extra burden is placed on land-based solid waste management systems. Port authorities need to work closely with solid waste managers to ensure awareness of the amounts and types of wastes arriving at the docks. Only then can managers plan for adequate, safe disposal.

Commercial maritime users, port authority officials and solid waste managers also need to jointly consider alternative options for reducing and handling wastes. Recycling is one option. It does no good for a ship to sort and hold its recyclables at sea if there is no recycling program at port. All countries should consider establishing a recycling system and building markets for recyclables as a viable method of reducing waste streams. And landfills aren't the only option for solid waste disposal. Incinerators and composting also

offer viable, cost-efficient disposal methods, especially for island countries that have limited space available for landfills. A $12 million high-technology composting project is being designed now in Nassau to convert 95 percent of the solid nonhazardous waste into usable agricultural/horticultural material.

To help developing countries structure their waste management systems, United Nations agencies and international economic organizations need to develop a framework of environmental regulations and/or management plans that could be adapted by these countries. Such a prototype could promote the universal acceptance of the concepts of source reduction, reuse, recycling and proper disposal of waste. In addition, technical and financial support is needed for building the infrastructures required to handle solid wastes from all sources. Without outside assistance, effective waste disposal practices will be very slow to develop in many nations.

Compliance

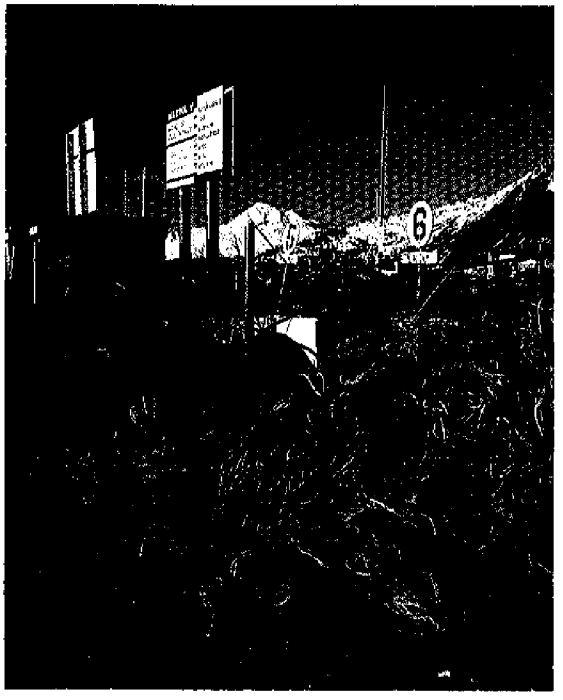
Compliance is the final element in the formula for controlling vessel-generated waste, and the first step toward compliance is education and training. Commercial maritime users, waste management agencies, port authority officials and enforcement personnel need to know and understand the regulations for at-sea disposal of debris. A concerted effort must be made to disseminate information about marine debris and its impact on the environment. Although this education must begin at the government level, it is also the responsibility of maritime trade associations and companies to spread the message among members and employees.

Princess Cruises and the U.S. Navy have begun educating their crews about marine debris. Princess developed company waste management policies. It is educating its personnel about these policies and formulating penalties for noncompliance. Princess asserts that waste management involves everyone from the company president to the galley worker.

Likewise, the U.S. Navy is training its crews and instigating new policies. All Navy ships separate and store plastic waste onboard for shore disposal when at sea less than three days. For ships on extended offshore tours, food-contaminated waste is stored at least 20 days and sometimes longer. Today, the Navy reports that it is in full compliance with the nonplastic waste requirements of MARPOL Annex V except in Special Areas. For plastic discharge, the Navy reports 70 percent compliance overall and full compliance when ships are at sea three days or less.

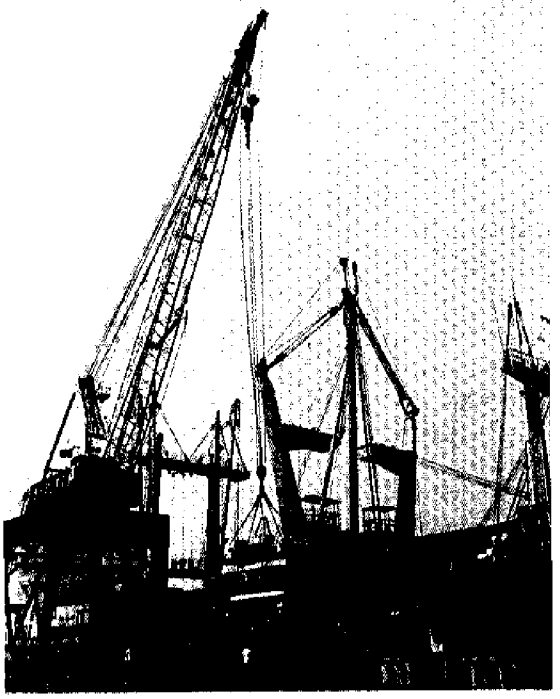
In Canada, a shipboard observer program enlightened the commercial fishing industry about its contribution to the marine debris problem. Observers aboard vessels plying the coast off Nova Scotia found that 96 percent of the Canadian fleet disposed of garbage bags at sea. Once aware of these statistics, the Nova Scotia Maritime Fishermen's Union, supported by Environment Canada, began a campaign encouraging fishermen to bring their wastes ashore. In addition, several major fishing companies banned the discharge of garbage from their factory vessels. Because of these educational efforts, at-sea disposal dropped to 57 percent among the Canadian fleet during the last five months of the monitoring effort.

But education efforts should be more than just a lesson about marine debris. Governments, companies and trade associates should offer training about source reduction, reuse, recycling and existing waste-handling technologies. At ports, workers also need to be trained in proper waste management, and manag-



Kurt Byers, University of Alaska Sea Grant College Program

At this Alaska port, commercial fishermen dump old or torn nets at dockside locations for proper disposal or recycling.



Courtesy of North Carolina Sea Grant College Program

To comply with MARPOL Annex V, ratifying countries must provide dumpsters at ports to receive garbage being retained by ships at sea.

ers need to make vessel waste disposal a priority, developing management plans and fee structures for adequate handling. To help vessels from all countries understand and comply with waste reception procedures and regulations, port officials should develop manuals or post signs outlining their rules. And vessel operators should be encouraged to report inadequate waste reception facilities at ports to local, state or national governments or the IMO.

To reward maritime users and ports for complying with MARPOL Annex V, governments could begin green vessel or green port programs to designate, recognize and publicize those ships and facilities that are actively improving the marine environment through better waste management.

Sometimes compliance requires more than education. Enforcement must also be used. Without the threat of repercussions, some vessel operators will never comply with MARPOL Annex V regulations. In enacting legislation to implement the treaty, countries must add a strong enforcement element and adequately fund the enforcement agency to do its job. If fines are used to punish violators, then they should be levied according to the seriousness of the offense and the size of the offender. A $200 fine means nothing to a shipping company or a cruise line, but a $200,000 fine might.

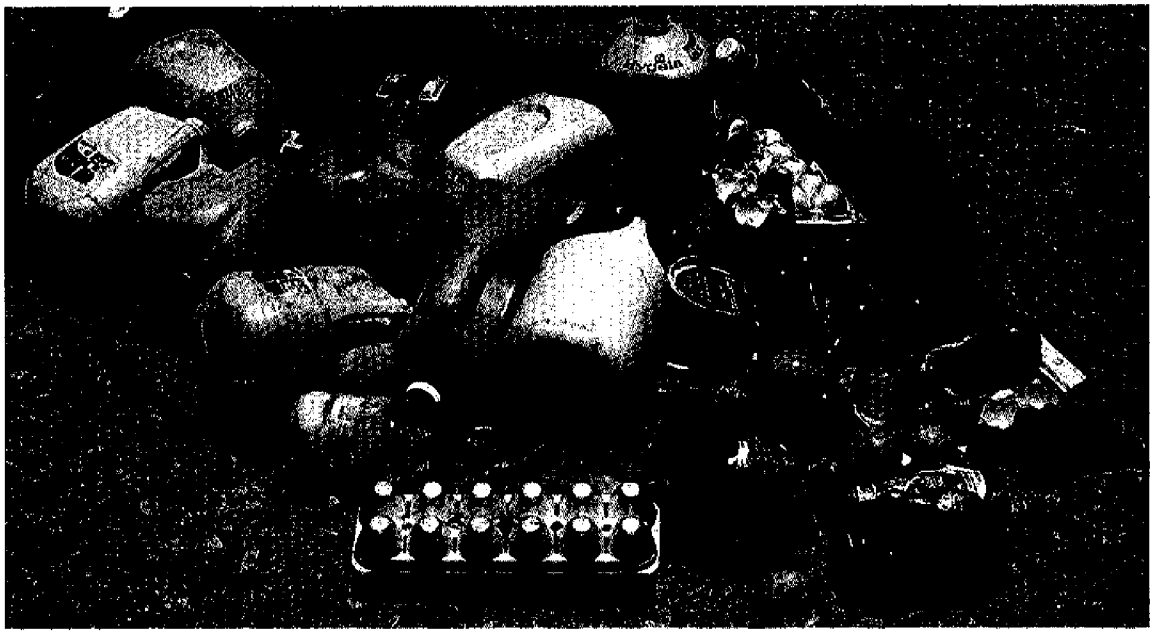
Participants at the Third International Conference on Marine Debris strongly urged all countries to upgrade their enforcement efforts. Worldwide, the enforcement of MARPOL Annex V is lax.

Even if enforcement is strong and education efforts have been effective, how do countries know whether their vessel disposal laws are making a difference? Are vessels adhering to regulations? Does MARPOL Annex V decrease the amount of vessel-generated debris littering beaches? If not, can management officials link certain debris items to specific segments of the maritime industry so that more education, regulation or enforcement can be applied?

These questions might best be answered with reliable data from scientific beach surveys, vessel observer programs and surveillance efforts. As mentioned earlier, Canada's fisheries observer program yielded data that motivated a fishermen's trade association to encourage its members to change their waste disposal habits. In the United States, Padre Island National Seashore officials in Texas developed a daily beach survey method that sought to link 11 types of debris to a particular source — the inshore shrimping fleet. Concurrently, park officials began an undercover operation in conjunction with the U.S. Federal Bureau of Investigation, the U.S. Coast Guard and the Texas General Land Office aimed at documenting illegal offshore disposal. Using high-technology surveillance equipment, enforcement officers were able to catch shrimpers in the act of illegal disposal.

Summary

The recommendations from the Third International Conference on Marine Debris clearly address the need for international agreements and domestic legislation to restrict at-sea disposal of vessel-generated wastes, including regulations for implementation and compliance. They also recognize the linkage between vessel debris and land-based solid waste management. And finally, they realize that special efforts are needed to help developing countries build institutions and infrastructures to handle vessel-generated wastes. Important to all the recommendations are the issues of technology, training,



Roddy W. Wilder, Padre Island National Seashore

At the Padre Island National Seashore in Texas, U.S. Park Service officials linked debris items such as rubber gloves, egg cartons, light bulbs and gallon jugs to the commercial shrimping fleet through a rigorous beach survey effort and undercover surveillance.

education, enforcement and economics. Achieving the goals outlined by the recommendations will involve coordination and cooperation at the international, regional, national and local levels.

Sources of Information

• "The Challenges of Ship-Generated Garbage in the Caribbean." Barry A. Wade, Caribbean Shipping Association, Jamaica.

• "Comparison of Port Reception Facilities of MARPOL Annex V Garbage in U.S. Gulf of Mexico and the United Kingdom." Dewayne Hollin, Texas A&M Sea Grant College Program, United States, and Duncan F. Shaw, University of Liverpool, United Kingdom.

• "Dealing with Ship-Generated Plastic Waste on Navy Surface Ships." Lawrence J. Koss, U.S. Navy, United States.

• "Environmental Concerns Relating to the Cruise Industry." Richard L. Wade, Princess Cruises, United States.

• "Marine Debris Point Source Investigation, Padre Island National Seashore, Texas." John E. Miller, Darrell L. Echols, Sean Baker, Rick Martinez, Bruce Sternberg and Charlie McCarley, Padre Island National Seashore, United States.

• "Shipping and Marine Debris in the Wider Caribbean: Answering a Difficult Challenge." F.G. Barnett, United Nations International Maritime Organization, Puerto Rico.

• "Waste Disposal Practices of Fishing Vessels Off Canada's East Coast 1990-1991." Paul Topping, Environment Canada, Canada; David Morantz, Department of Fisheries and Oceans, Canada; and Glen Lang, University of Waterloo, Canada.

• "Working Group Report III." Third International Conference on Marine Debris, chaired by Barbara Wallace, A.T. Kearney Inc., United States.

• "Zero Solid Waste Discharge Program." Jill Zilligen and Barbara Miller, Center for Marine Conservation, United States.

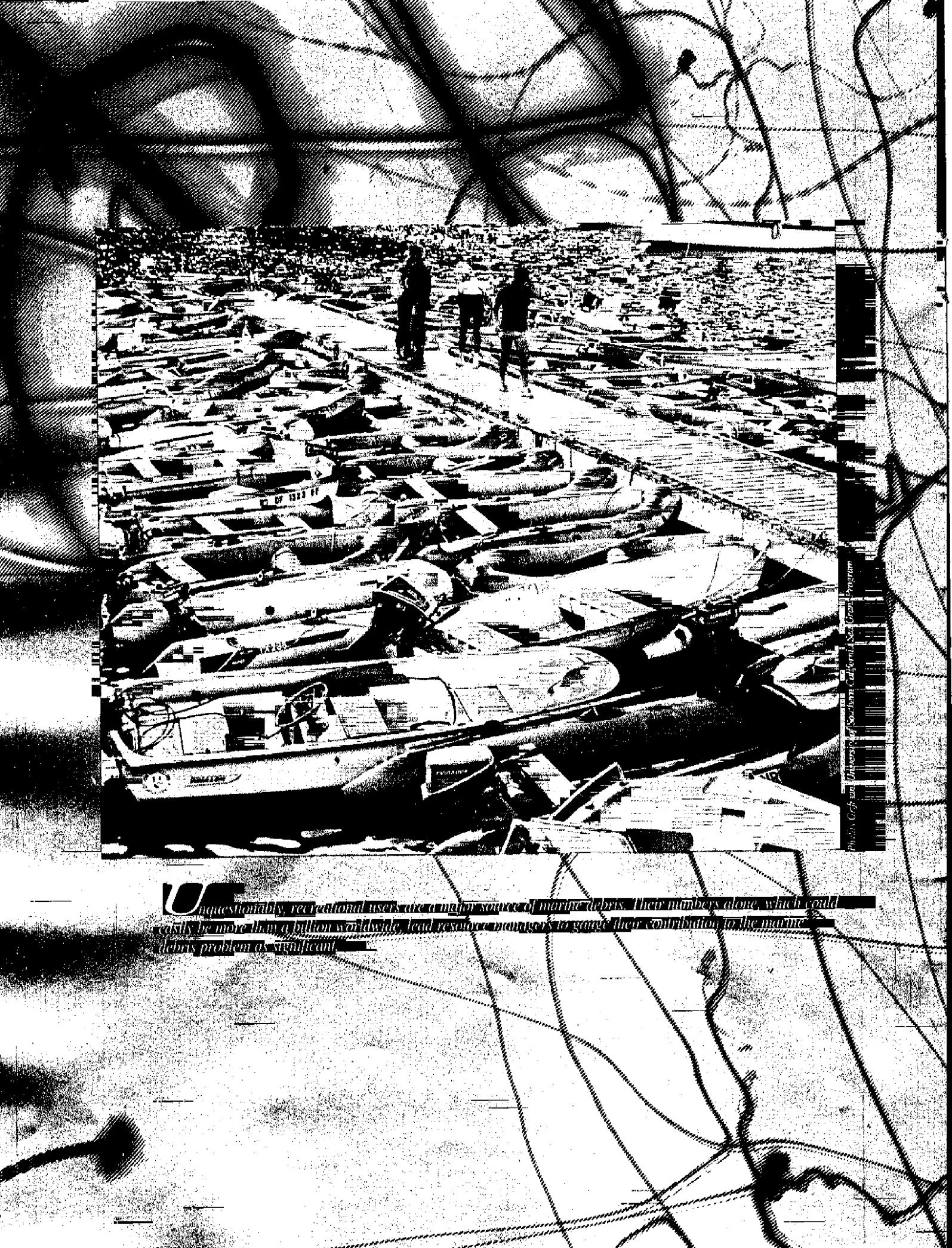


Photo: Courtesy University of Southern California Sea Grant Program

Unquestionably, recreational users are a major source of marine debris. Their numbers alone, which could easily be more than a billion worldwide, lead resource managers to regard their contribution to the marine debris problem as significant.

Chapter Four: Recreational Debris

Our oceans offer more than tonight's dinner or a highway for global travel. They provide hours of leisure for boaters, recreational anglers, divers and beachgoers — everyone from the sunbather to the surfer to the camper.

But in pursuit of sun, fun and ocean spray, recreationists often leave behind or toss overboard the byproducts of their day on the water or at the beach. Boaters drop ice bags, food wrappings and eating utensils into the water. Likewise, anglers cast discarded fishing line, bait bags, floats and lures overboard. Landside, beachgoers leave behind the trappings of their picnics, the contents of their coolers or the remnants of their leisure — fireworks, suntan lotion bottles and toys.

Because of sheer numbers — 70 million boaters in the United States, 4 million certified scuba divers worldwide, 250 million American anglers and untold millions who visit beaches from the Mediterranean to Australia to the United States — this group of litterers offers resource managers an unmitigated challenge. In many countries, including the United States, recreationists could be the number-one source of marine debris. However, no reliable quantitative data exist for the exact amount of litter they generate. Still, their numbers alone make them suspect.

As daunting as their number is their diversity, varying from the owner of a multimillion-dollar yacht to the angler fishing for his next meal. And few recreationists belong to organizations such as fishing clubs, dive organizations and boating groups where they can be reached collectively. This diversity and lack of organization can mean only one thing. Efforts aimed at controlling recreational debris will have to be multifaceted and individualized.

But efforts must be made. Resource managers agree that recreational litter has the likelihood for the greatest impact on wildlife because of where it is discarded. Most recreational activities occur near shore, the very area where wildlife concentrations are greatest. Wildlife and litter are often a deadly combination, especially when the litter is fishing line or plastic bags.

Numbers, diversity and impacts aside, recreational users have one common bond — their love of the environment they recreate in and, in some cases, the animals that inhabit it. This commonality may be the basis for reaching such a diverse group and for gaining the cooperation needed to reduce recreational sources of marine debris worldwide.

Value of Beaches

Indeed, people do value clean recreational beaches, even if they don't use them yearly. According to an economic resource valuation study, people surveyed in North Carolina and New Jersey indicated a willingness to pay extra in income taxes or user fees to keep beaches litter-free. And their willingness to pay was not affected by how frequently they visited there. Those who hadn't seen a sandy shoreline in more than a year prior to the survey were just as eager to reach for their wallets as those who had dipped their toes in the sand within the last 12 months.

The study indicates that people value their leisure time and the environment they recreate in. When people do have time to cast their lines, hoist their sails or roll out their beach towels, they want the environment to be as pristine as possible and, if need be, they'll pay for this cleanliness.

Types of Recreational Debris

Two types of debris — packaging and activity-specific — are linked to recreational use in the marine environment. Packaging from food and domestic goods — plastic cups, plates, eating utensils, beverage cans and bottles, bags and wrap-

pers, six-pack rings, and foam containers — is associated with, but not entirely attributable to, recreational users. These items are also discarded by other marine users or washed into coastal waters from land-based sources. Because packaging debris has multiple sources, it is difficult to get quantitative information about how much of this litter is attributable to recreational users.

Activity-specific litter is more easily linked to the recreational community. It includes items such as fishing line and bait cups from anglers, cyalume light sticks from divers, motor oil containers from boaters and suntan lotion bottles from beachgoers.

And debris experts have recently identified a new recreational marine-litter category — cigarette filters. These 1- to 2-inch filters are the most abundant single item collected by volunteers worldwide during the Center for Marine Conservation's International Coastal Cleanup. More than 1.5 million cigarette butts were gathered during the 1992 cleanups, leading experts to surmise that recreational marine users, particularly beachgoers, are using beaches as ashtrays. Some filters may also wash into coastal waters from storm drains.

Reducing Recreational Debris

Reducing recreational debris in the marine environment is a monumental task. To address the problem adequately, a diverse array of actions must be employed. Although many actions will be directed at recreationists and how they dispose of their wastes, social scientist Shirley Laska says there are "upstream" points of intervention — product design, packaging, retail methods, legal actions, education — for reducing all wastes, including recreational debris. Managing marine debris, she says, does not have to focus only on handling waste once it is produced.

In the environment, six-pack rings pose an entanglement danger for wildlife. ITW Hi-Cone, a worldwide manufacturer of plastic six-pack rings, has attempted to tackle the problem at the product design and manufacture stage. Hi-Cone first produced a photodegradable six-pack ring that is designed to degrade in four to five weeks under average sunlight conditions. Then the company incorporated tear tabs so that each ring could be broken when the can is removed. Hi-Cone determined ways to modify its

Scott D. Taylor

Divers offer an untapped source for fighting marine debris. When it's not dangerous, divers can remove below-surface trash, and they can monitor ocean floors for amounts and types of marine debris.

product design to reduce the potential impact on wildlife. More manufacturers of common marine debris products should use their design expertise to look for solutions.

But clearly, product design cannot eliminate marine debris; it can only lessen the impact. The burden of the problem still lies squarely on the shoulders of product users. People must be made to understand that their product wastes — bottles, cans, cups, plastic wrappers and bags — must not be discarded in the marine environment. Modifying recreationists' behavior requires a three-pronged approach — awareness, attitude and action. First, you build an awareness of the problem and an understanding for how a person's behavior contributes to it. That awareness can change an attitude, causing a person to take action to eliminate the behavior.

In designing marine debris messages for recreationists, resource managers should know their audience and involve them in developing solutions. Managers should speak the language of their audience and research how they share information within their group. Does the target audience belong to organized groups, subscribe to magazines or share information among themselves at the docks? Solution actions must be tailored. Educational campaigns developed for boaters, for example, should be different from those for recreational anglers or divers. And even within specific groups, such as the boating community, actions may need to target sailors apart from motorboaters. The key to overcoming the size and diversity of marine recreational users is to divide the group into manageable segments. Broad-based efforts are often ineffective and time-consuming.

North Carolina Big Sweep, an organization devoted to reducing aquatic litter, recently targeted boaters with an effective educational product — a boat litterbag. The 12-by-24 inch mesh bag was designed as a functional but attractive way to stow trash onboard a recreational vessel. The drawstring bag — which is printed with the message "Don't Splash Your Trash" — allows boaters to stow a day's trash securely. Boaters helped design the bag, and consequently, more than 10,000 were distributed in six months statewide. Now, boaters are clamoring for more.

Based on these approaches for reducing recreational marine debris, participants at the Third International Conference on Marine Debris developed the following five bases of action.

Legal Actions

All countries were encouraged to ratify, enact and enforce MARPOL Annex V. Particular emphasis was placed on enforcement. The need for local support of litter regulations and stiffer fines was stressed. And citizens were encouraged to report MARPOL infractions to enforcement officers.

New laws or regulations could ban the use of certain items or materials in the marine environment. For instance, the use of glass bottles or plastic containers might be prohibited on beaches. Regulations governing recreational licenses, such as those for boating and fishing, could require marine debris training before certification.

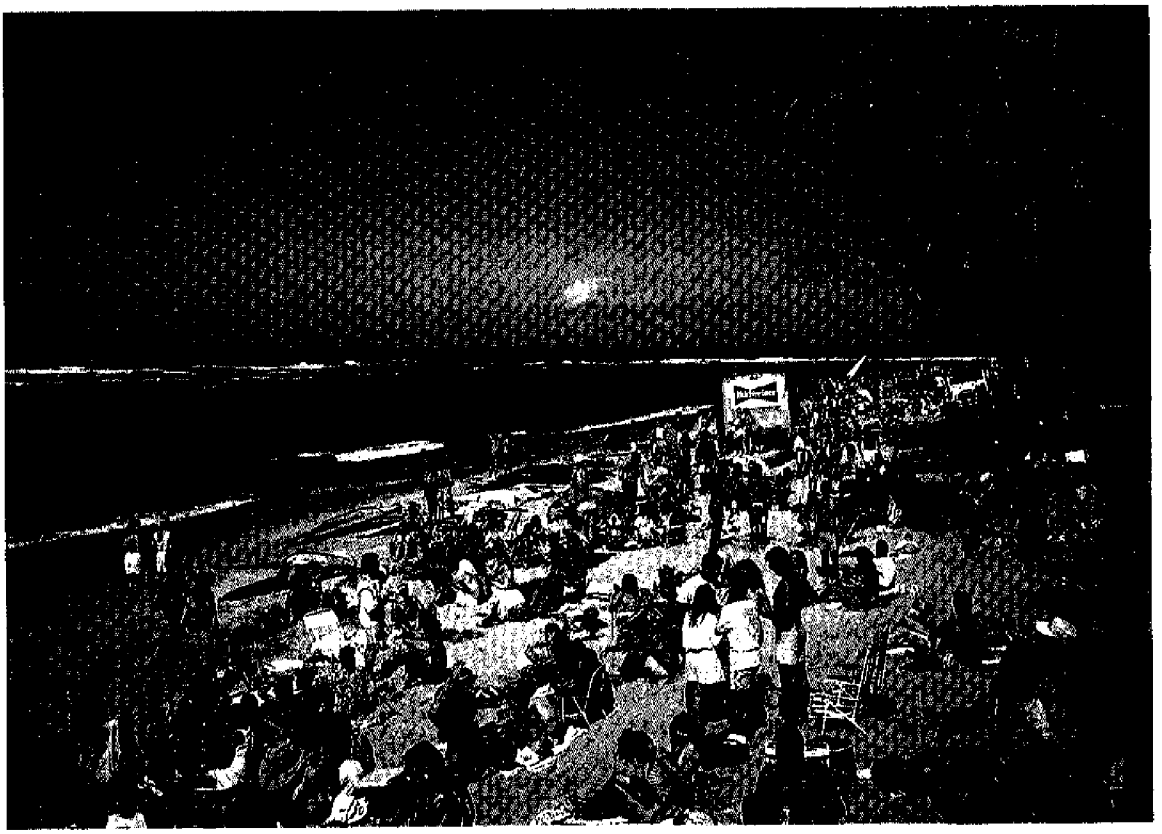
Locally, municipalities were encouraged to include marinas and boat ramps in their solid waste management plans and disposal systems. And more trash bins and waste receptacles were requested along public beaches and at government-owned docks and boat ramps.

Finally, realizing that money is needed to provide the educational programs and enforcement efforts to stem the tide of marine debris, government funding was requested specifically for these efforts.

Technological Actions

Manufacturers of goods used specifically by marine recreational users were asked to reduce packaging and consider new product designs that lessen the impact of their products. Hi-Cone was cited as an example of how willing companies can alter product design, reduce the impact of their goods and improve their public image.

Alternatively, if unable to change product designs, marine product companies can implement innovative recycling programs such as the one developed by Berkley Tackle, a fishing line manufacturer. Discarded fishing line has been identified and documented as a primary source of entanglement among marine wildlife. To reduce the threat, Berkley has placed 13,000 cardboard collection bins for recycling at fishing tackle retailers throughout the United States. Anglers have dropped more than 4 million miles of used fishing line into the bins. Berkley collects the line and recycles it into other plastic products.



Courtesy of University of Puerto Rico Sea Grant College Program

Beachgoers are a major source of marine debris worldwide. Often they leave behind the trappings of their picnics, the contents of their coolers or the remnants of their leisure.

As for new technology, trash compactors or other solid waste handling equipment could and should be designed for use on pleasure craft, particularly larger boats.

Educational Actions

Educational options for reducing recreational marine debris are centered largely on the concept of creating awareness of the problem.

One large worldwide educational effort is the International Coastal Cleanup sponsored by the Center for Marine Conservation. In 1993, the cleanup, which was begun in the United States, included more than 39 countries and about 222,000 people who collected more than 5 million pounds of marine debris. The cleanup is designed not only to remove litter but to obtain data on the types and amount of debris collected and to increase public awareness of the problem. Although data collection is informal, it is useful in documenting the scope of the problem and building awareness. The cleanup data was used to gain support from the U.S. Congress for ratification of MARPOL Annex V. In addition, the statistics are useful on the state and local levels. For example, several U.S. states are considering banning balloon releases based on the cleanup statistics.

Cleanup data also spurred manufacturers of debris items to change their packaging or design and to develop educational programs. In the Gulf of Mexico, Morton Salt realized fishermen were discarding the plastic bags from its "Ship n' Shore Salt." As a result, the company test marketed a paper package printed with the message: "Don't Be a Litter Boat." Likewise, R.J. Reynolds Tobacco Co. saw statistics showing that cigarette butts were the number-one debris item collected during North Carolina beach cleanups. It began an awareness campaign — "Don't Leave Your Butt on the Beach" — and gave away thousands of pocket ashtrays to reduce the number of cigarette filters dropped on state beaches. Now, the company is expanding its educational efforts nationally and internationally.

Outside the United States, the international cleanup has spurred awareness of the marine debris problem among governments and people in developing and industrialized nations. In Venezuela, for instance, the cleanup fostered the development of World Beach Day and the Beaches for Life Program. The Beaches for Life Program seeks to instill a sense of coastal stewardship among Venezuelan citizens and promotes such efforts as adopt-a-beach and recycling.

To create easy recognition of the International Coastal Cleanup, the Center for Marine Conservation was asked to develop an internationally identifiable symbol. And because land-based debris has now been recognized as a major marine debris contributor, it was proposed that the Center for Marine Conservation encourage cleanups of inland waterways. Similar to coastal cleanups, adopt-a-beach programs were seen as a way for all countries to create awareness of the coastal environment and develop a sense of local pride and stewardship for its health.

Other steps to reduce marine debris from recreational users include:

- Providing marine debris educational materials to all certification programs for recreational users, including divers, dive instructors, lifeguards, boaters and boat captains.
- Creating partnerships with manufacturers of products frequently used in the marine environment, such as sunscreen and fishing tackle, to imprint anti-litter messages on containers, sales tags, in-store displays and print advertisements.
- Inserting marine debris information in boater registration and licensing packets. Maryland and New Jersey officials have launched such efforts.
- Encouraging boaters and anglers to take a pledge to bring their debris and that of others ashore. Boater pledge programs are operating in South Carolina, Florida, Alabama, Mississippi, Louisiana and Texas. Boaters and anglers who take the pledge are given stickers that identify them as good coastal stewards. In some states, pledge-takers can win prizes or receive discounts from marine suppliers such as marinas or tackle shops.
- Developing marine debris educational materials for children. Start young and develop an awareness for the problem. Unlike adults who have already developed their environmental attitudes, children can be reached in their formative years to encourage the concept of coastal stewardship. To increase access to such materials by educators worldwide, it was suggested that an international resource guide be developed and maintained.

Larry Earley, N.C. Wildlife Resources Commission

In the United States, 250 million anglers fish our nation's waters. Resource managers must reach this large, diverse audience with anti-litter messages.

Organizational and Operational Actions

A fourth method for reducing recreational litter should be aimed at organizations affiliated with recreational users and businesses that make or sell items that frequently become marine debris.

For instance, recreational equipment manufacturers and other businesses that supply goods or services to the coastal recreational community should be encouraged to reduce packaging of their products. Retailers such as bait and tackle shops and marinas should be asked to substitute paper bags for plastic. And hotels, motels, resorts and beach property rental companies should be requested to place marine debris information via tent cards, pamphlets or cards in rooms, houses or lobbies.

To reach recreationists collectively, information could be provided to organizations representing these sports enthusiasts and delivered via speakers, videos,

John Miller, Padre Island National Seashore

These recreationists sunbathe and fish on trashed beaches.

slide shows or written materials. Also, many recreational users subscribe to magazines devoted specifically to their sport. These magazines loosely bind recreationists and offer another avenue for reaching this diverse group.

Marine recreationists participate in collective activities such as boat races, fishing tournaments, volleyball matches, surfing competitions and beach parties. These events provide another outlet for delivering the marine debris message. Likewise, marine recreational businesses — charter boats, dive boats, piers, equipment rental companies — and recreational instructors associate with large numbers of the leisure community. These people and businesses should be enlisted to address the problem.

Economic Actions

Economic incentives offer yet another technique for reducing marine debris. Marine product manufacturers could be provided incentives to reduce packaging and encourage reuse. This could range from actual taxes on excess packaging to a program that rewards companies for innovative designs that reduce packaging. Conversely, consumers could be offered incentives to purchase products that use less packaging or are recyclable. Glass bottle refunds are a good example of an incentive that encourages recycling. Also, companies that reduce packaging could label their products with an international symbol recognizing their "environmentally friendly" efforts. Many environmentally conscientious consumers would choose these products.

As an economic disincentive, fines for violations of marine debris regulations are an effective means for delivering the no-litter message.

And One Other Solution

Divers offer an untapped source for fighting the marine debris problem. When it's not dangerous, scuba divers can remove below-surface trash, and they can be enlisted to monitor ocean floors for amounts and types of marine debris. Also, their access to this undersea environment provides opportunities for scuba divers to document the breadth, depth and impact of marine debris via photography and videography.

Summary

Unquestionably, recreational users are a major source of marine debris. Their numbers alone, which could easily be more than a billion worldwide, leads resource managers to gauge their contribution to the marine debris problem as significant. Equally problematic is the diversity of the group.

So it's understandable that the solutions aimed at reaching recreational users are almost as multifaceted as the users themselves. But that's good. Because only by targeting specific segments of this group with directed messages can resource managers create awareness of the marine debris problem, change attitudes and ultimately alter waste disposal behaviors.

But not all the solutions are aimed at recreationists — the end users and disposers. Other points in a product's pathway between demand and disposal can be altered to lessen or eliminate its impact on the marine environment. Consequently, manufacturers and retailers of marine recreational products were frequently targeted as sources for marine debris solutions.

And finally, an economic valuation study placed value on an intangible — a clean beach. People want

their beaches litter-free and are willing to pay to make them so. This economic information opens the door for government support of debris reduction programs and industry efforts to protect the environment valued by their customers.

Sources of Information

• "Characterizations of Recreational Boaters/Fishers as a Source of Marine Debris." Jim Ellis, BOAT/U.S. Clean Water Trust, United States, and Margaret Podlich, Center for Marine Conservation, United States.

• "Developing a Commitment of the Full Array of Marine Waste Reduction Opportunities: The Case of Recreational Users." Shirley Laska, University of New Orleans, United States.

• "Divers as a Source and Solution to Marine Debris." Hillary Viders, National Association of Underwater Instructors/Professional Association of Dive Instructors, United States.

• "International Coastal Cleanup Program." Dan Rolleri, Center for Marine Conservation, United States; Susan Bartholomew, North Carolina Big Sweep, United States; and Diego Diaz-Martin, Center for Marine Conservation, United States.

• "Measuring the Total Value of Marine Debris Control for Coastal Resources." Xiaolong Zhang and V. Kerry Smith, North Carolina State University, United States.

• "Mitigation of Marine Debris — Industry Efforts: Berkley." Janis Bowles, Berkley Tackle, United States.

• "Mitigation of Marine Debris — Industry Efforts: ITW Hi-Cone." James Cathcart, ITW Hi-Cone, United States.

• "Working Group Report IV." Third International Conference on Marine Debris, chaired by Kathryn O'Hara, Center for Marine Conservation, United States.

Scott D. Taylor

Placing trash receptacles along the beaches helps to reduce, but not eliminate, marine debris.

Storm drains often serve as collection sites for urban street litter that washes into the drain and is dumped into nearby streams, rivers and estuaries.

Chapter Five: Urban Debris

Urban means city, city means people and people mean trash. Add an adjacent ocean to the equation, and trash means marine debris.

Worldwide, coastal cities are leading land-based sources of ocean litter. Urban debris washes off city streets, overflows from waste treatment plants during heavy rains and drains from industries. The debris varies from the cigarette filter tossed on the sidewalk to the tampon applicator flushed down the toilet to resin pellets used in the manufacture of plastic products.

Unfortunately, despite the technological and educational efforts of governments, many of these debris items ultimately drain into coastal waters and form floating webs of waste or wash ashore to mar beaches.

Like other litter sources, resource managers are unsure of exactly what percentage urban wastes contribute to the overall problem. In many cases, city litter is indistinguishable from vessel debris or recreational byproducts. Only a few items — tampon applicators, condoms, syringes and resin pellets — can be directly linked to the sewer overflows and industrial wastes indicative of urban waste problems.

Despite the lack of quantitative data, urban refuse is nonetheless considered a major marine debris contributor, especially in coastal waters adjacent to major cities. For example, the U.S. Environmental Protection Agency's (EPA) Floatables Action Plan for New York/New Jersey Harbor removed more than 1,000 tons of floating debris during year-round collection in 1993. Meanwhile, New Jersey's Operation Clean Shores swept 5,700 tons of trash from 67 miles of nearby beaches in the same year.

And while urban debris poses some of the same problems as trash from other sources— wildlife entanglement and ingestion, visual eyesores, navigation hazards, vessel damage — it also elevates the potential for human health threats. Because city wastes sometimes contain used syringes and other medical wastes, the potential does exist for disease transmission.

Also, the appearance of medical waste creates economic impacts when it washes ashore. Although beachgoers tend to tolerate shores littered with cans, foam cups and fishing line, they stay away from beaches contaminated with used syringes and vials of blood, even if these items are present in small quantities. In the summers of 1987 and 1988, New York and New Jersey beaches were occasionally closed when small amounts of medical wastes washed ashore. Because of the publicity generated by the closures, people stayed away from these beaches by the droves, costing the New York/New Jersey economy almost $2 billion in lost revenues.

Since then, state, federal and local governments in the United States have initiated programs in cities such as New York and Miami to reduce urban debris. They've increased stormwater management efforts, launched adult and youth education campaigns, employed new and old technologies to sweep streets and skim waters, promoted recycling and reuse, instigated industrial cleanup programs and begun volunteer beach debris pickup efforts.

But the problem of urban debris persists in the United States and in countries throughout the world. Urban marine debris needs to become a higher priority on government agendas, and governments worldwide need to devote more attention and resources to the regulation and management of persistent solid wastes from cities and industries.

Urban Sources of Marine Debris

Urban debris is largely attributable to three sources. In some cities, stormwater sewers are connected to municipal wastewater treatment systems. As a result, heavy rains can cause the capacity of the treatment plants to be exceeded. When this happens, nondegradable debris and raw sewage bypass the treatment process and flow into coastal

Courtesy of University of Minnesota Sea Grant Program

Shorelines in close proximity to cities often receive heavy doses of urban debris.

rivers and bays. Resource managers call this combined sewer overflow. Tampon applicators, condoms and syringes are indicator items for this problem.

Stormwater itself is another avenue for ocean litter. Rains often wash trash — cigarette filters, foam cups, plastic wrappers, toys — directly into coastal waters or storm drains that dump into oceans and coastal rivers.

Lastly, malfunctioning sewage treatment plants and improper industrial waste management practices result in urban marine debris. The tiny plastic resin pellets that are ubiquitous in the world's oceans are indicative of widespread industrial mishandling.

Urban Debris Reduction

There are four points — source generation, on-land management, transport and deposition — in the lifeline of urban marine debris where actions can be taken to reduce or eliminate it. These actions include source reduction, improved industrial and municipal waste and wastewater management, and cleanup of waterways, beaches and ocean bottoms. And to accomplish these actions, resource managers can use a variety of tools — technological improvements, legislation, education, economic incentives, enforcement and increased funding.

Source Reduction

Source reduction is the most cost-effective and efficient way to prevent urban debris from entering the waste stream. Manufacturers can reduce refuse and lessen its effects by reducing packaging, changing product design and using less environmentally harmful or more easily recyclable raw materials. Economic incentives and/or government regulation could be an effective means for encouraging such alternative manufacturing. Or fees could be incorporated in product prices that would cover cleanup costs or fund alternative product development through university research.

Industrial waste management practices should be scrutinized and, in many cases, improved to eliminate the unintentional disposal of products. The EPA study of land-based sources of plastic resin pellets identified points in the manufacturing process where the potential existed for inappropriate pellet disposal. Using this information, the Society of the Plastics Industry initiated Operation Clean Sweep, a multimedia educational program designed to heighten industry awareness and promote zero-pellet discharge.

On-Land Material Management

If source reduction isn't an alternative, then proper management and disposal of trash before it becomes waterborne is the next most cost-efficient and effective point at which to halt marine debris. The use of silt fences and improved trash management practices at construction, commercial and industrial sites can decrease the flow of trash to the water.

Municipal wastewater treatment facilities can build catch basins, settling ponds and other control methods to prevent sewage outfalls, storm drain runoff and combined sewer overflows. Such methods have already been employed in New York City, where wastewater management officials are experimenting with holding the spillage from combined sewer overflows during heavy rains. It is processed later during dry weather.

Besides catch basins, wastewater treatment plants in coastal cities also need to install controls to harness debris before it drains into offshore waters.

Emmett Durram, Washington, D.C., Department of Public Works

This trash-skimmer collects and stores solid debris floating on top of or just below the surface of the Anacostia River in Washington, D.C. The trash-skimmer can hold up to 150 cubic feet of aquatic litter.

Since 1989, New York has used floating curtains at its marine transfer stations to stop the flow of debris.

And municipalities need to be reminded that city streets — a prime source of stormwater runoff debris — need more effective, efficient cleaning to diminish the flow of litter via storm drains and runoff. Likewise, the use of finer gratings for storm drains could prevent litter from entering the rainwater drainage system.

Surface Water, Shoreline and Underwater Cleanup

Removing refuse from surface waters, shorelines and ocean bottoms is the final opportunity for eliminating urban marine debris from the environment. However, this is also the most costly and resource-intensive point at which to lessen its impact. By then, the debris has already affected the environment and the wildlife that inhabits it.

To remove floating marine debris, governments can use boat skimmers and other removal technologies to sweep trash from surface waters. The Anacostia River Floating Debris Program and the Floatables Action Plan for New York/New Jersey Harbor, both sponsored by the EPA, evaluated the use of equipment such as skimmers, nets and containment booms in collecting and removing floating debris. Both projects also used helicopters to spot areas where floating marine debris collects. Such surveillance pinpoints debris slicks and minimizes collection costs.

On beaches, volunteers, court-ordered community service workers, minimum-risk prisoners and machines can be employed to sift the sands for ocean litter. Along Miami Beach, a mechanical device sifts through the top 6 inches of sand twice a year to remove any object more than 1 inch in diameter.

In Florida, Dade County officials take a

countywide approach to marine debris control in Biscayne Bay. More than half of the county's departments participate in programs to reduce ocean litter. These programs include stormwater management efforts through the wastewater treatment facility, water-based debris control and removal programs administered through the public works department, and educational and cleanup activities sponsored by the parks department.

Education

Education must be a significant component of an effective urban marine debris control program. The residential, commercial and industrial communities should be informed of the importance of debris control, the impacts it has on the marine environment and the actions that can be taken to lessen its flow to coastal waters.

Private citizens, young and old, should be taught how their actions impact the marine environment. They should be introduced to the concepts of waste minimization, recycling, reuse, packaging reduction, stormwater management and surface runoff. To deliver these educational messages, governments can instigate storm drain stenciling programs, fund educational materials for children and adults, and sponsor volunteer opportunities for cleanup of land, beaches and waterways.

In New York, the Clean Streets/Clean Beaches campaign sponsored by the city and EPA links street debris to beach litter using educational tools such as a newsletter for children, television public service announcements, storm drain stenciling efforts and cleanup activities. Campaign designers believe that people are grasping the simple, straightforward message and altering their behavior. Such a program can be an international model for urban debris awareness, showing how local governments can educate themselves and their citizens about the sources of this problem.

Jamey Tidwell, Texas A&M Sea Grant College Program

In many city sewer systems, rainwater washes into storm drains that dump directly into streams, rivers and estuaries. Rarely is the stormwater treated or filtered.

But citizens aren't the only ones who need an education in marine debris. Commercial businesses and industries need to understand how they contribute to the problem of ocean litter. Efforts such as Operation Clean Sweep directed at the plastic resin industry and the Clean Streets/Clean Beaches campaign being developed for small businesses are prime examples of ways industries and businesses can be taught to lessen their impact.

Enforcement

No marine debris control effort can be effective without an enforcement component. In any population, there are individuals, institutions and industries that will not conform to established norms and are not affected by peer pressure. In these instances, enforcement is necessary for compliance across the board.

Urban marine debris problems cry for stronger enforcement measures, better trained enforcement officers, stiffer fines for noncompliance, and stronger regulations for stormwater control and industrial and municipal wastewater disposal. And to increase enforcement, better and more sophisticated surveillance methods are needed to identify companies and wastewater plants that are noncompliant or defiant of wastewater management statutes and regulations.

Implementation

To effectively limit urban marine debris, funding and implementation of control and education programs must be made a priority of government. The public, industry and all levels of government must recognize the need for action on this problem.

To support cleanup efforts, items that frequently become marine debris could be taxed at the producer, handler, seller or consumer level. Alternatively, financial incentives such as tax breaks could encourage packaging alternatives, new product design or recycling efforts for such products or materials.

Stormwater utility programs and municipal wastewater treatment systems should be adequately funded and encouraged to implement controls related to urban ocean litter. Likewise, government enforcement efforts, waterway and beach cleanup programs, and land-based waste disposal systems should be sufficiently funded to handle the problems associated with marine debris.

Summary

Effective control of urban marine debris requires support and commitment from citizens, government and industry. Citizens must be willing to alter their personal behavior, and municipal governments and industry must be willing to change their wastewater management practices and consider new and alternative technologies. And when all else fails, governments must step in with regulations and enforcement efforts to stem the tide of marine debris.

Sources of Information

- "Clean Streets/Clean Beaches." Peter B. Brandt, U.S. Environmental Protection Agency, United States.

- "Comparison of Results of Two EPA Marine Debris Studies." Wayne R. Trulli, Roy K. Kropp and Heather K. Trulli, Battelle Ocean Sciences, United States, and David P. Redford, U.S. Environmental Protection Agency, United States.

- "Implementation and Assessment of a Floatables Action Plan for New York/New Jersey Harbor Complex." Paul J. Molinari, U.S. Environmental Protection Agency, United States.

- "Local Government Controls and Management Efforts for Coastal Marine Debris in Biscayne Bay, Florida." Brian Flynn, Dade County, United States.

- "New York/New Jersey Beaches — It Was a Very Good Year." R.L. Swanson and Marci L. Bortman, University at Stony Brook, United States.

- "Sources of Plastic Pellets in the Aquatic Environment." David P. Redford, U.S. Environmental Protection Agency, United States, and Heather K. Trulli, Battelle Ocean Sciences, United States.

- "Working Group Report V." Third International Conference on Marine Debris, chaired by Bob Howard and Christopher McArthur, U.S. Environmental Protection Agency, United States.

Trash piles up at the edge of a coastal community in Puerto Rico. Education, adequate trash collection and stricter enforcement are the first steps in reducing marine debris in these developing areas.

Chapter Six: Rural Coastal and Upland Discharges

Effective waste disposal is a luxury that many parts of the world cannot afford.

In the Caribbean, a small hotelier tips his garbage over a precipice and into the sea. He tells a World Bank mission that he doesn't have a waste disposal problem — it just disappears. This, from a man who relies on the appeal of a clean sea for his living.

Trash is generally tolerated in developing countries, which tend to de-emphasize environmental quality in their urgent quest to improve the social and economic status of their citizens.

But waste disposal problems should not be mistaken as the sole domain of developing countries. Industrialized nations generate an estimated 75 percent of the world's pollutants and wastes. Consequently, they have their own troubles with overburdened wastewater treatment plants and throwaway habits.

Worldwide — in developing and industrialized countries — most of the land-based garbage that seeps into marine waters was once terrestrial litter or municipal and industrial wastes. The content varies from country to country, from city to town to rural crossroads. It is influenced by the degree of industrialization in an area, the density of nearby populations and the extent of maritime and other offshore activities. The single biggest difference between rural and urban sources, particularly in developing regions, is access to solid waste management systems.

Though urban centers have better access to disposal services, those on the coast are the most offensive and obvious sources of marine debris because of their size and proximity to water. Wastes can also be traced back to people who don't live near the sea or, for that matter, even visit the beaches. Trash from rural and upland sources travels to the coast along waterways and through storm drains. Its sources, however, are difficult to identify because they are so widely dispersed.

Given what we know about the contributions of land-based litter, we can expect our marine debris problems to compound globally if population growth estimates are accurate. Coastal communities worldwide are predicted to double in size over the next generation. Already, six out of every 10 people live within 60 kilometers (37 miles) of the coast. In the United States alone, half of the population lives within 50 miles (80 kilometers) of the ocean or one of the Great Lakes. Consider also that 53 percent of the continental United States drains into the Gulf of Mexico through the Mississippi River. Untold amounts of land-based garbage travel through rivers, drainage systems and estuaries into the ocean, where an estimated 9 million tons of U.S. solid wastes are also dumped each year.

Worldwide, some of the most difficult solid waste and sewage disposal problems are found at the ocean's edge. But developing governments, particularly, have found it difficult to translate debris-control solutions into effective policy because of political pressures; formidable financial, institutional and infrastructural obstacles; absence of data and knowledge; and lack of local participation in finding solutions.

In reply, a variety of global strategies are addressing the causes of land-based marine debris, especially plastic and other man-made litter, through legal tools, education and awareness-building efforts, infrastructure improvements and research.

Managing Wastes Worldwide

Local waters are a fairly reliable indicator of whether a community's trash collection and disposal system is operating effectively.

Where a system is good, the shores are less likely to be strewn with debris. Wastes are collected and disposed of properly. By contrast, poor systems are marked by open and unregulated dumps that allow debris to be blown or washed into local waters. These dumps are now the greatest source of marine debris from rural coastal and upland sources in developing countries.

Unbridled development in these regions contributes to their waste management problems. The low labor and environmental costs of doing business have attracted firms from the industrialized world. Legal and illegal disposal into coastal and nearshore waters is now common practice as ever-increasing wastes are produced by households, industries and the expanding tourism and cruise sectors. Additionally, persistent plastics and other synthetic materials are replacing organic materials as waste.

Industrialized nations, on the other hand, have different waste disposal problems. Coastal pollution is usually caused by deficient storm drain and sewage disposal infrastructure, inadequate solid waste management regulations or lax enforcement. Land-based debris becomes a problem when disposal systems fail or people refuse to use them. In New York Harbor, a survey from 1989 to 1991 found that 85 percent of floating debris came from combined sewer overflows and storm sewers. This is generally the case throughout industrialized countries, where the leading sources of marine debris are large cities with antiquated sewer and storm drain systems.

Sewage obviously poses a nearshore pollution problem in the world's major population centers. But sewage discharges also pose a problem for smaller population hubs in the more remote areas of many countries. A 1984 report by the United Nations Environment Programme found that fewer than 10 percent of the sewage systems around the Caribbean had treatment facilities, and little debris was filtered out.

In developing countries worldwide, most coastal liquid wastes are discharged into oceans through outfalls or natural drainage, and vast quantities of debris are contained in this poorly treated sewage.

Legal and Institutional Improvements

In the wider Caribbean region, many states lack laws to deal with environmental pollution. They simply don't have the legal tools to prevent land-based discharges. And where anti-littering laws do exist, enforcement is difficult if not impossible because the laws are woefully outdated and ineffective.

For example, a state cannot ratify the International Convention for the Prevention of Pollution from Ships (MARPOL) if it lacks the laws to enforce the international convention. To date, MARPOL has been ratified by 13 of the 28 wider Caribbean states.

In other nations, such as Mexico, India and Colombia, the influence of regulations has been limited by the scarce resources of enforcement agencies, inefficient legal processes and low fines.

Governments should correct these shortcomings by adopting and enforcing administrative and legal measures. Effective laws and regulations would help. They should be accompanied by national environmental actions plans, including solid waste management and reduction objectives, a responsible coordinating agency within the government and effective enforcement.

Consideration should also be given to fees or taxes on litter-generating activities to ensure that consumers and manufacturers take into account the true costs in their waste disposal decisions.

Additionally, waste management institutions should be strengthened through technical and informational assistance to ensure the long-term sustainability of emerging systems. This requires financing mechanisms to maintain and operate the system; manpower technical training; enforcement monitoring; proper siting, construction and equipment; comprehensive waste management and reduction; and partnerships with local agencies, the private sector and other organizations.

Infrastructure Development

Even if the regulatory systems were adequate in many developing countries, they would serve little purpose for controlling solid waste dumping and littering. This is because the infrastructure is either grossly inadequate or nonexistent.

These countries often lack the basic systems to collect, store and dispose of trash. They may not have adequate trucks or landfills. City streets are narrow, limiting collection systems. The problem only worsens outside urban areas, where rural communities are beyond the reach of trash collection and disposal services. And remarkably, many public officials still need to be persuaded that investments in landfills, plants, equipment and manpower for waste disposal are important for sustainable development.

Under these constraints, the trash that is collected is unlikely to be disposed of properly because small,

dispersed communities cannot afford to build and manage sanitary landfills. Almost 40 to 50 percent of all wastes generated by cities of the Organization of Eastern Caribbean States (OECS) does not reach official landfills or dump sites, according to data from six member nations.

This trend can be seen throughout developing countries.

On the island of Grenada, garbage is collected from only 45 percent of the 91,000 residents. Collection is still confined to towns. Jamaica, similarly, offers solid waste services only in urban centers and built-up rural areas, while 60 percent of the 3 million residents live in unserved rural communities. It lacks the equipment and funds to serve the entire island. In St. Lucia, where 60 percent of waste is collected, budgetary restrictions are blamed for poor maintenance and operation of disposal systems.

The solid waste and sewage disposal problems are especially difficult in the Caribbean, where most rural communities are on the ocean's edge. Poorly treated sewage and open dumps send vast quantities of debris down outfalls and creeks into rivers that eventually empty into the ocean.

And even where public works have been improved and sanitary landfills are in place, litter remains a major problem. It is washed from streams and low-lying areas into the sea. Storm drains that have replaced earthen ditches often become choked with garbage. In areas where sewerage is provided, there are accounts of manhole covers being removed to ease garbage dumping. The sewers then become blocked. In other areas where special dumps or public receptacles are provided, the garbage is heaped outside.

In Indonesia, very little wastewater that is discharged into waterways is treated. Many of the outlying areas are served by systems of concrete-lined, open channels that clog with street refuse and debris. The rivers of the Indian subcontinent are notorious for the quantity of sewage and other debris that they receive and deliver to the ocean.

Changes in Attitudes

In the absence of collection, the advantages of throwing trash and other wastes into waterways, rivers or the sea are obvious. Dump it one day, and it's gone the next. But trash eventually returns on storm tides and waves to pollute beaches, marshes and mangroves. People occasionally try composting organic waste and

Diego Díaz-Martín, Center for Marine Conservation

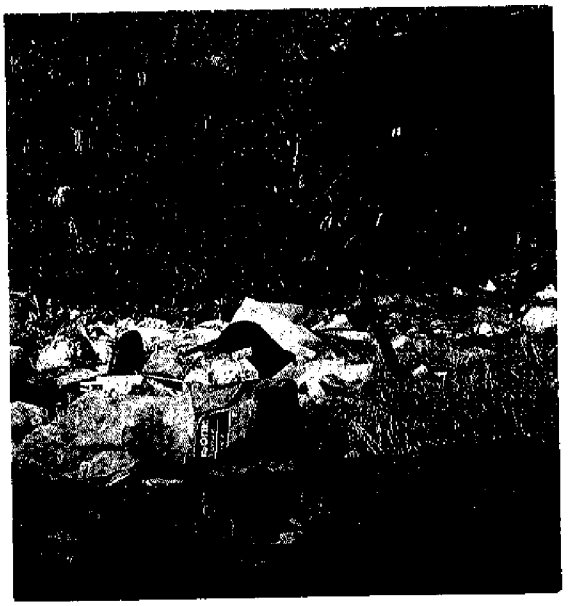
Trash is dumped on a Venezuelan beach. Where services are poor, people tend to dump their wastes in unregulated heaps.

reusing materials, but a great deal of trash is also used to fill ravines, old quarries and valleys, and wetlands, most notably marshes and mangroves. Unregulated dumps flourish along developing coastlines, where they destroy productive plant communities, displace wildlife and reduce water quality through surface runoff and toxic leachates.

Half of the problem, beyond lack of services and infrastructure, is apathy about debris and its environmental effects. Garbage is commonly dropped and dumped in developing countries without thought for where it might end up.

Indifference of this magnitude can be combated through education and heightened awareness of the hazards of land-based litter and marine debris. Many efforts have been undertaken in the last decade to address education, awareness and outreach. They should be intensified to target and reward local governments, community-based organizations and rural audiences, particularly children. Efforts should also focus on the private sector, including agricultural interests, manufacturers, the construction industry and other groups that exploit natural resources and contribute to the problem. All education, however, should be sensitive to local cultures and promote a sense of ownership in the natural resources.

Public awareness strategies are critical to islands



Courtesy of University of Puerto Rico Sea Grant College Program

The beauty of Caribbean coastlines can be marred by marine debris. Many developing countries, however, place a low priority on a clean coastal environment.

such as Puerto Rico, where an estimated 80 to 85 percent of marine debris is tossed by upland residents or beachgoers. The island experienced widespread dumping along its rivers after four coastal dumps were closed, waste disposal was consolidated and new charges were levied for solid waste management.

Government Recognition

Governments of developing countries must be made aware of the dire economic implications of ignoring land-based debris, especially given the trends in population growth, industrialization, tourism development and growing dependency on the coastal areas.

Many Caribbean countries have come to appreciate the potential impact of waste handling and disposal on coastal resources in spite of their infrastructural and institutional difficulties. For example, a waste management project for the OECS nations demonstrates how international bodies are seeking to address the issue with financial and technical assistance. The World Bank and Global Environment Facility have agreed to fund waste reception and disposal facility projects in the OECS nations and the wider Caribbean.

This project was launched in response to growing problems with cruise ship waste, designation of the region as a Special Area under MARPOL Annex V and the urgent need to invest in port reception facilities. But the off-loading of solid waste from cruise ships has merely transferred additional problems to the island nations and compounded their longer-term solid waste management problems. Investments in infrastructure are intended to relieve such problems. Existing dumps will either be closed or converted to sanitary landfills, new sanitary landfills will be built, and recycling and composting will be promoted.

But infrastructure financing, construction and technical assistance is only the beginning. Tremendous amounts of external aid will not solve the solid waste and marine debris problems without strong governmental and civic support and ongoing public education efforts. There must be a commitment to carry on once the aid ceases.

The Dominican government confronted its solid waste troubles in 1989 with a new community-based collection method using refuse storage bins, called skips. But the success was short-lived. About 215 skips were distributed to a portion of the island where 45 percent of the population lived; other parts of the island were not served and continued to use dumps. The system was embraced by the participating communities, which abandoned the open dumps and carried their wastes to the skips. As a result, close to 90 percent of the dump sites were closed on the island's west coast. But the program took a turn for the worse in mid-1992, when the skips had deteriorated and were not replaced. People reverted to dumping their household wastes along the coastline, rivers and slopes.

Likewise, lack of resources crippled a once-efficient waste collection system in Georgetown, Guyana, where 260,000 people live. The system ran smoothly until the early 1970s, when Greater Georgetown was added without an accompanying budget or staff increase. Where refuse had been collected as often as three times per week, it has now dropped to once a month in several service areas. As a result, there has been a growth in illegal minidumps and dumping into narrow and shallow drains.

Political commitment must be built at national and local levels, in particular. The will to address the marine debris issue is a precondition to all other efforts. Internationally, consensus on principles and strategies for reducing land-based debris, as well as financial and technical assistance, can help build national commitments. The United Nations will hold a 1995 intergovernmental meeting on pollution of the marine environment from land-based activities.

Scheduled Oct. 30 to Nov. 9 in Washington, D.C., this conference will offer an opportunity to set the stage for controlling marine debris in the 21st century.

Monitoring the Sources

Monitoring is critical to tracking upland sources of marine debris and linking them to impacts on coastal communities and ecosystems.

Developing countries could monitor for specific wastes using the example set by the Intergovernmental Oceanographic Commission's Subcommission for the Caribbean and Adjacent Regions (IOCARIBE). Nationally coordinated surveys should evaluate waste composition and disposal methods; photograph beaches; assess roadsides, streams, lakes and beaches; and establish transport via rivers, quantity of materials and mobility of waste. Further, international monitoring programs should be developed, strengthened and continued to assess the effects of debris on regional ecosystems and to identify any transboundary effects of marine debris.

Summary

The entire issue of controlling land-based sources of marine pollution is not new. Most nations are aware that the problem is beyond unilateral action. During the last three decades, great attention has been given to protecting the coastal waters of one country from the pollutants of another. Bilateral and, to a considerably lesser extent, regional agreements to protect seas have met with varying degrees of success. For the most part, countries have dealt with land-based marine pollution on a national level.

But land-based sources are not adequately addressed, and serious degradation of the marine environment will continue without concerted new actions. A worldwide, strategic approach is advocated by most international marine pollution, legal and policy experts.

At present, there are only two global conventions to combat marine pollution: MARPOL 73/78 and the London Dumping Convention (LDC). MARPOL addresses the problems of shipborne pollution and the LDC, those of direct disposal. Both are relatively small sources. Land-based sources are only covered by the legally nonbinding and very generally formulated Montreal Guidelines on Marine Pollution from Land-Based Sources of 1985. Additional international agreements are needed to address land-based aspects of marine pollution.

The legal authorities that apply or could apply to the solid waste and debris problems are inadequate. A global strategy on land-based sources, scheduled for adoption in 1995, offers an excellent opportunity for a comprehensive approach.

Overall, solid waste management is not receiving enough attention from many national decision-makers. What little attention there is has focused on urban areas, where services are superior to those of rural areas. Many developing countries are facing serious socioeconomic difficulties, and waste management issues are low priorities despite the implications for public health, environmental degradation and a sustainable economy.

Sources of Information

- "Land-Based Sources of Marine Debris and Contamination of the Coastal Areas of the Caribbean Islands of St. Lucia, Dominica and the British Virgin Islands." Joth G. Singh, Caribbean Environmental Health Institute, St. Lucia, and Boniface Xavier, Ministry of Health and Social Security, Dominica.

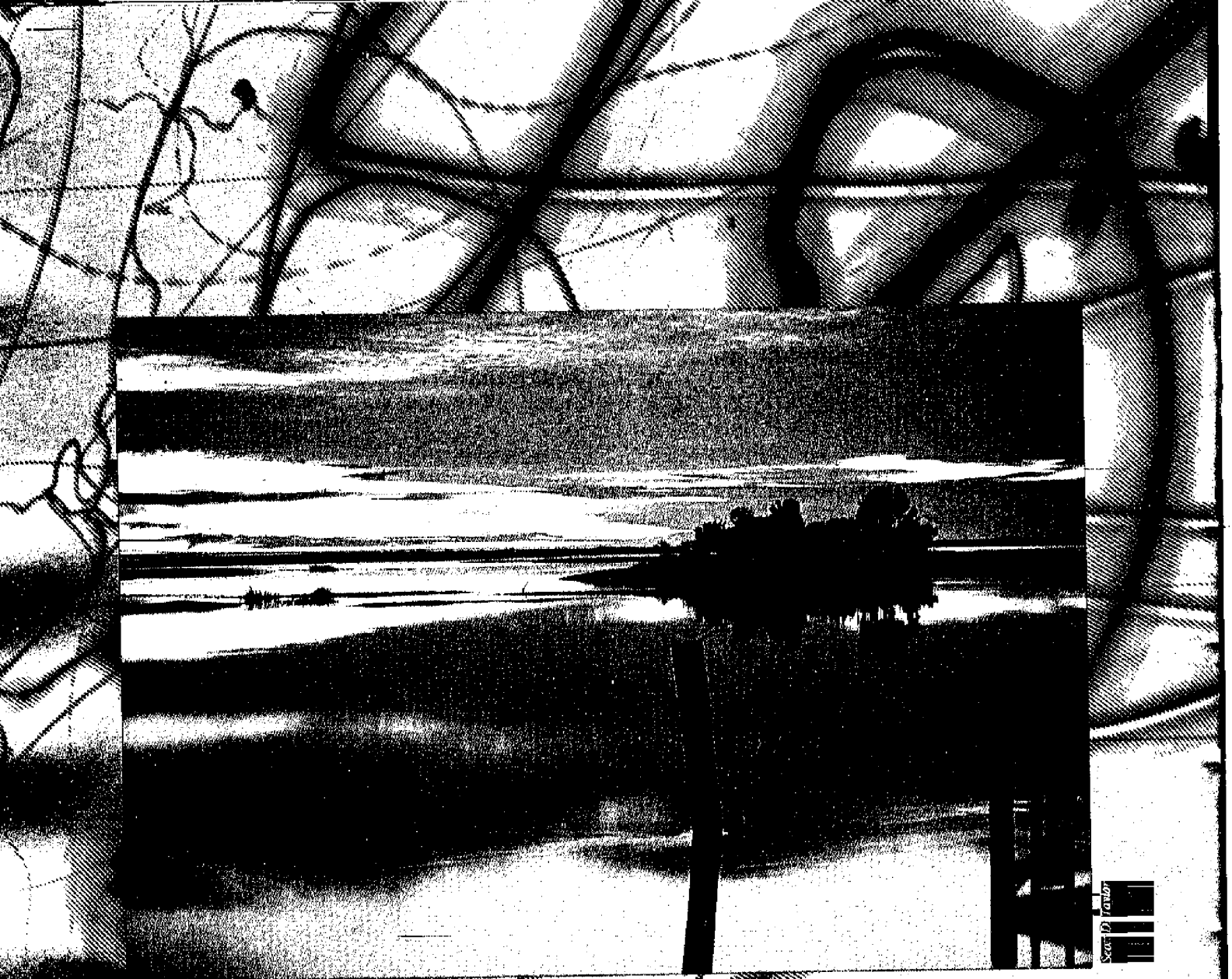
- "Legal Regulation of Upland Discharges of Marine Debris: From Local to Global Controls and Back." André Nollkaemper, Erasmus University, the Netherlands.

- "Linkages Between Land-Based Sources of Pollution and Marine Debris." Michael Liffmann and Laura Boogaerts, Louisiana Sea Grant College Program, United States.

- "MARPOL and Port Reception Facilities: Making it Work." Ellen Ninaber, North Sea Foundation, the Netherlands.

- "Upland Sources of Marine Debris on the Shorelines of Puerto Rico." Ruperto Chaparro, University of Puerto Rico Sea Grant College Program, Puerto Rico.

- "Working Group Report VI." Third International Conference on Marine Debris, chaired by Michael Liffmann, Louisiana Sea Grant College Program, United States, and André Nollkaemper, Erasmus University, the Netherlands.



It pays to keep coastal areas clean. A marine environment free of debris is not only beautiful, it is safe for marine animals and recreationists. People who make their living from these natural resources — from fishermen to business men — also depend on a litter-free environment.

Appendix: Glossary

1. Caribbean Marine Debris Workshops — A series of workshops begun in 1991 aimed at creating a marine debris network, promoting implementation of MARPOL Annex V and addressing broader waste management issues in the wider Caribbean region.

2. Citizen Ambassador Program Waste Management Delegation — Created in 1956 by President Eisenhower, the Citizen Ambassador Program uses a people-to-people approach to solving problems. Plans call for assembling a waste management delegation in late 1994 and sending the delegation to a Caribbean country to share proposed solutions to pollution problems, including ship-generated wastes. Exchange of technical information between the visiting delegates and those from the host country is facilitated through a series of workshops and seminars. This program is privatized, and delegates must pay their own expenses or arrange for sponsorships.

3. Convention for the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (1972 London Dumping Convention [LDC]) — The global instrument to control marine pollution from dumping of dredge spoil, sewage sludge and other types of land-based wastes.

4. Global Environment Facility (GEF) — Jointly managed by the World Bank and the United Nations Development Programme, the GEF is a financial mechanism for providing grants and concessional funds to developing countries for projects and activities related to global environmental protection.

5. Intergovernmental Oceanographic Commission (IOC) — Founded in 1960, the IOC is the United Nations body responsible for promoting stewardship of the world's ocean resources through scientific research and related ocean services, training, education and dissemination of data.

6. Intergovernmental Oceanographic Commission's Subcommission for the Caribbean and Adjacent Regions (IOCARIBE) — A regional subbody of the IOC that implements and coordinates IOC activities in the wider Caribbean region.

7. International Convention for the Prevention of Pollution from Ships 73/78 (MARPOL) — An international convention that establishes regulations covering the various sources of ship-generated pollution. The convention contains five annexes, each dealing with a different type of cargo or operational waste and establishing limitations and controls for overboard discharge of those pollutants. The convention applies to all vessels operating in the marine environment except warships and other vessels owned and operated by the government.

8. International Maritime Organization (IMO) — The United Nations body responsible for maritime activities. Established in 1948, IMO was the first international body devoted exclusively to maritime matters. Through its committees, IMO administers international conventions on navigation, safety and pollution, including MARPOL 73/78. It has 147 members.

9. MARPOL Annex V — Regulations to prevent garbage pollution from vessels of all sizes. Prohibits the discharge of plastics at sea and limits the distance from the nearest land that other types of vessel-generated garbage may be discharged; requires port reception facilities for garbage.

10. Montreal Guidelines on Marine Pollution from Land-Based Sources of 1985 — Legally nonbinding guidelines developed at a meeting sponsored by the United Nations Environment Programme to help governments develop national legislation and bilateral, regional and multilateral agreements to prevent marine pollution from land-based sources.

11. Organization of Eastern Caribbean States (OECS) — Established in 1981 to enhance political, economic and functional cooperation among eight member island states. Members are Antigua and Barbuda, Dominica, Grenada, Montserrat, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines. The British Virgin Islands is an associate member.

12. OECS Solid Waste Management Project — Initiated in 1992 by the OECS to improve the quality of solid waste management in OECS countries, taking into account compliance with MARPOL Annex V. This is a cooperative effort with the World Bank and GEF.

13. Regional Program for the Assessment and Control of Marine Pollution (CEPPOL) — One of five programs forming the Caribbean Environment Program (CEP) Action Plan drafted by IOCARIBE and jointly sponsored by IOC and the United Nations Environment Programme. One of 10 CEPPOL activities is the monitoring and control of pollution by marine debris, particularly plastics.

14. Special Areas — Areas designated by MARPOL where all overboard discharges (except ground-up food wastes) are prohibited due to unique oceanographic, ecological or traffic conditions. Food wastes may not be discharged within 12 nautical miles of the nearest land in Special Areas. As of June 1994, designated Special Areas are the Mediterranean Sea, the Baltic Sea, the Black Sea, the Red Sea, the Persian Gulf, the Gulf of Aden, the North Sea, the Antarctic area and the wider Caribbean region (including the Gulf of Mexico). Special Area protections are not implemented until the bordering nations certify to the IMO that their ports have adequate waste reception facilities.

15. United Nations Environment Programme (UNEP) — Established in 1972 by the United Nations General Assembly, UNEP provides the machinery for international cooperation in matters relating to the environment, monitors significant environmental changes, and encourages and coordinates sound environmental practices.

16. World Bank (International Bank for Reconstruction and Development [IBRD]) — Created in 1945 as a body of the United Nations Economic and Social Council, the World Bank promotes capital investments for productive purposes through internationally backed loans.

17. Wider Caribbean Initiative on Ship-Generated Waste (WCISW) — A cooperative project started in 1994 by the World Bank and IMO to promote the legal framework to allow compliance with MARPOL Annex V and installation of adequate waste reception facilities at all major ports throughout the wider Caribbean region.

This work was partially supported by Grant NA46RG0087 from the National Sea Grant College Program, National Oceanic and Atmospheric Administration, to the North Carolina Sea Grant College Program. Funding was provided by the NOAA Marine Entanglement Research Program.

For additional copies of Seas of Debris,
write the Alaska Fisheries Science Center, NOAA/NMFS,
7600 Sand Point Way NE,
Seattle, WA 98115-0070.

SEAS OF DEBRIS:

A Summary of the Third International Conference on Marine Debris

UNCSG-95-01