

MARINE DEBRIS: A FOCUS FOR COMMUNITY ENGAGEMENT

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by

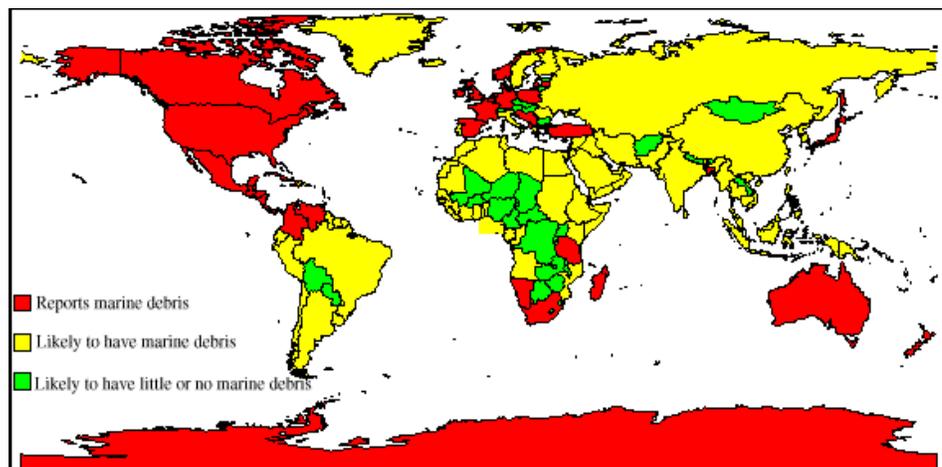
Paul Topping, Environment Canada

Background

Since the introduction of synthetic materials and disposable products into general use, they have found their way into debris accumulating in the marine environment around the world (Coe and Rogers, 1996). As seen in Figure 1, Canada and many other nations have a problem with persistent debris in the marine environment. Its sources are varied, ranging from beach-visitors and boaters to commercial vessels and municipal sewage. Once released, it remains and accumulates, and can kill marine life through entanglement, snaring, or being mistaken for food. People are affected when debris fouls boat propellers, clogs water intakes, blocks pumping systems or causes injuries in beaches and parks. As well, the presence of debris along shorelines can lead to serious economic problems for regions that are dependent on tourism (Buxton, 1990). Such concerns can also lead to higher maintenance costs for resorts, parks and communities.

Figure 1.

Distribution of the marine debris problem around the world.



The Extent of Marine Debris in Canada

In Canada, estimating the extent of the marine debris problem, its annual trends, and relationship to causal sources has been difficult and poses some unique challenges. Canada has the longest coastline in the world, some 244,000 km along three oceans, the vast majority of which is remote and isolated. Acquiring any data to examine the problem is difficult and these conditions influence the available data and the methods in which it is collected.

Historically, marine debris data has been provided through community clean-ups and some research from Environment Canada, Fisheries and Oceans and provincial governments (Topping, 1997, Topping, *et al*, 1994a). While this raised awareness of the problem, it did not produce trends data, as the number of sites or volunteers varied with each time period. These efforts, however, succeeded in consistently showing that a problem existed in Canada and that statistically valid trends data was needed to assist decision makers.

Since 1994, Pitch-In Canada - a national environmental organisation-has managed the National Marine Debris Surveillance Program. Under this program, trained volunteers conduct shore side

surveys to measure trends in marine debris using internationally accepted method. By using this accepted method, comparisons can be made between sites within Canada and with other countries. Details on the development of this program are provided in a previous paper (Topping, 1997)

As the survey work continues, some general trends are beginning to emerge. Table 1 presents and compares results from the 1995-96 pilot phase to the most recently available data from 1999. The most prevalent types of debris found were food and alcoholic beverage related which are associated with shore-side recreational activities. The next most common type was the “unknown” category, as heavily weathered material is material often unidentifiable. Automotive products (such as motor oil bottles and engine parts) which can be from shore-side repairs or from boat repairs contributed to a significant portion of observed debris over the last 4 years (Pitch-In Canada, 2000). Awareness efforts to address these sources will help reduce a significant portion of the all debris released into the marine environment.

Table 1. Most common types of debris found at all sites during the pilot phase and the ongoing survey phase

Type of debris	-Data from Pitch-In Canada, 2000	
	Average percent found in pilot phase 1995-1996	Average percent found in survey phase 1999
Food packaging	36.8	33.4
Unknown	31.1	29.9
Automotive products	10.8	16.3
Alcoholic beverages	8.2	5
Cleaning products	5.7	7

As well, most of the debris observed originates from land; from 1999 data, 7 of 9 sites reported major sources to be land-based (Pitch-In Canada, 2000). Given the world-wide estimate that 80% of all marine pollution originates from land-based activities, this is not surprising (UNEP, 1995). Many awareness programs, traditionally, have focused on marine-based sources such as fishers, boaters, cargo vessels and cruise ships. While these efforts must continue, a new emphasis on land-based activities is warranted and should be directed to shore-side commercial activities, tourists, beach and park visitors, and shore-side communities.

Figure 2.
Average amount of debris most prevalent type found for west coast sites of the National Marine Debris Surveillance Program

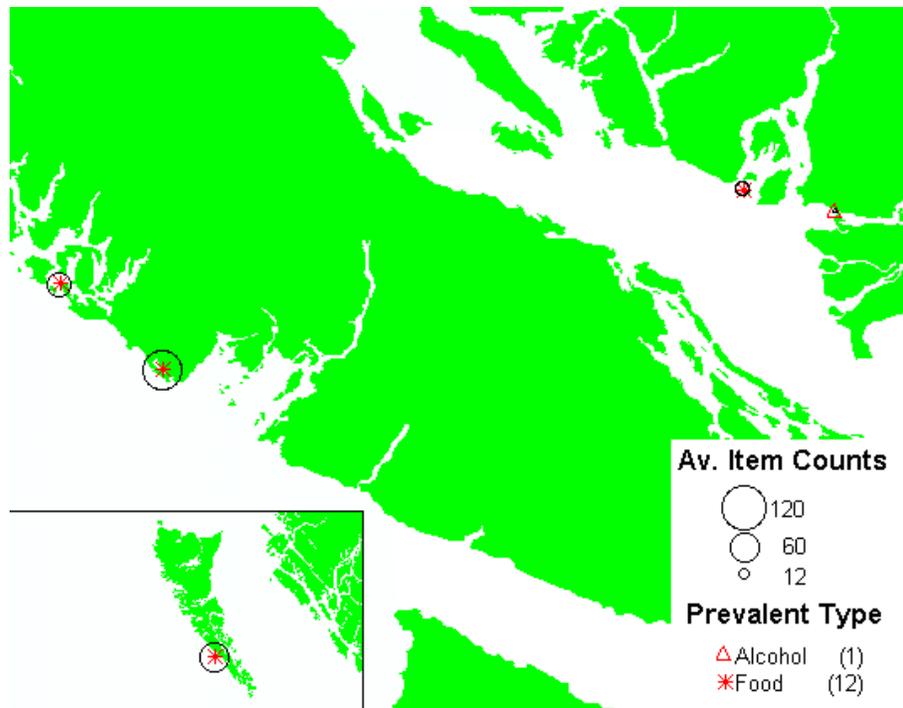
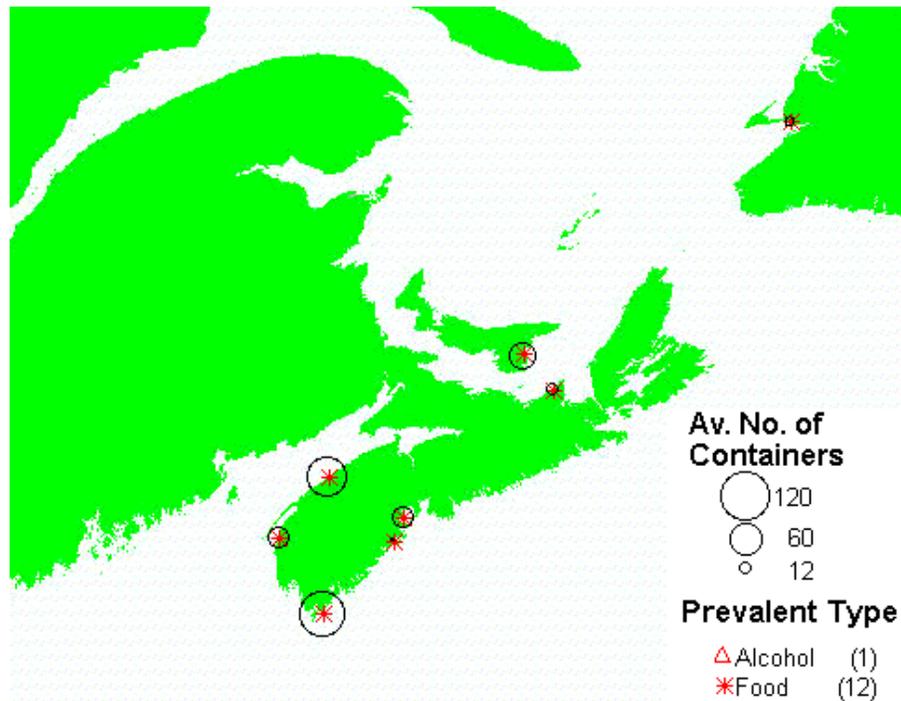


Figure 3.

Average amount of debris most prevalent type found for east coast sites of the National Marine Debris Surveillance Program



A key success of the National Marine Debris Surveillance Program is that it is the first time in the world that statistically valid long-term trends data for marine debris has been collected using volunteers. This adds to previous successes in engaging volunteers to acquire data in other fields notably for wildlife population data and weather data. Key factors to continuing success will be communication and training to manage succession and turn-over of volunteers.

Action To Date

The majority of marine debris is released as a result of human behaviour - such as littering or dumping - behaviour which has been historically accepted in many communities. Raising public awareness to encourage people to choose better options, is an important part of government's response to the issue.

Canadian municipalities are responsible for a wide range of basic services from water purification and distribution, to wastewater treatment, and waste collection and disposal. The costs remain large and these funding arrangements can only address a few of the requirements. Community-based initiatives, are often the most effective means to address environmental issues, including marine debris, but require support to build and maintain networks and have access to sound science.

Ecosystem initiatives respond to the unique problems of regions and communities to address environmental, economic, and social concerns. They help Canadians achieve environmental results through partnerships, focusing science, coordinating efforts, sharing information, and generating a broad basis of support. Environment Canada works with a spectrum of partners in the design and implementation of these initiatives. Measures to address marine debris and reduce solid waste are often carried out by communities under initiatives such as the 13 sites of the Atlantic Coastal Action Program, or the ZIP Committees (Zone d'Intervention Prioritaire) of the Saint Lawrence Vision 2000 Program. (Environment Canada, 2000)

As most marine debris is litter or garbage, improving local solid waste management is another key element to addressing this problem. Governments have been active; introducing measures first to reduce the generation of wastes at source, then to properly manage wastes once generated. This includes programs from the National Packing Protocol to the "green infrastructure" program. The

National Packaging Protocol; a partnership between governments and industry which achieved a 51.2% reduction in total packaging from 1988 to 1996 (CCME, 1998). Under the Government of Canada's "green" infrastructure program opportunities are available for communities to improve their solid waste management systems. \$700 million has been allocated in 1999-2000 and 2002-2003 to develop new environmental technologies and improved practices (Government of Canada, 2000). As well, through Budget 2000, an endowment worth \$125 million was provided to the Federation of Canadian Municipalities to supplement other investments (Government of Canada, 2000).

Provincial governments have played major roles through setting regulatory controls and providing the capacity to manage solid wastes. British Columbia has had a waste management strategy since 1989 that adopted a consumer-based approach to reduce the amount of waste generated from consumers (BC Ministry of Environment, Lands and Parks, 1995). In New Brunswick, the provincial government has introduced a new system of 6 regional landfills and 5 transfer stations with state of the art design which replaced substandard dumps (Government of New Brunswick, 1999). As well, programs such as the Environmental Trust Fund, have provided funds for hundreds of community projects, many of which address solid wastes (Government of New Brunswick, 2000)

Complementing existing federal, provincial and territorial action, Canada's National Programme of Action for the Protection of the Marine Environment from Land-based Activities -or NPA- was released June 8, 2000. Development of NPA was lead by Environment Canada and Fisheries and Oceans Canada in collaboration with provincial and territorial governments. It responds to an international agreement signed in 1995 by 105 nations, including Canada -the Global Programme of Action. The value of the NPA lies in its co-operative and collaborative approach among all orders of government to preventing pollution from land-based sources and protecting habitat in the near shore or coastal zone. The NPA actions include: monitoring existing actions when they are deemed adequate; strengthening existing actions when they are deemed inadequate; and proposing new actions for immediate preventative and remedial actions based on existing knowledge, resources, plans and processes (Government of Canada, 2000). Canada is the first country to release a National Programme of Action in response to the Global Programme of Action (UNEP, 2000). Marine debris is a key issue addressed by both the NPA and the GPA.

Non-Government Initiatives

Many non-government groups have worked over the years to promote awareness and take action addressing marine debris.

Each year, since 1995, the Canadian Wildlife Federation produces an Oceans Education Kit centred on World Oceans Day, June 8 —in collaboration with the Canadian Association of Principals, Canadian Museum of Nature, Environment Canada, Fisheries and Oceans Canada, Intoinfo Inc., North American Wetlands Conservation Council (Canada), Parks Canada Agency, and Scouts Canada (CWF, 2000). The kit is received in over 20,000 Canadian schools and acts to spread the word regarding our connection to, and human impact on, marine ecosystems. In 1988 - the International Year of the Ocean - the CWF and its partners launched the Blue School Program to encouraging positive action from youth. Participating schools carry out a range of projects from organising shoreline cleanups, to helping conserve aquatic habitat, or celebrating World Oceans Day. Limited project funding is available to schools and students which must be followed up by promotional work within their communities.

Pitch-In Canada, in addition to the National Marine Debris Surveillance Program, also responds to the needs identified by volunteers to support and encourage pro-active environmental action. Programs, such as Civic Pride, Pitch-In Week and the International Coastal Clean-Up Program form the basis of partnerships working towards addressing various environmental issues. Their

concern for the effects of debris on the marine environment led to what has become Canada's largest volunteer campaign to clean-up both land and marine environments.

In 1995, Pitch-In Canada began to work with the US Center for Marine Conservation to promote the international Coastal Clean-up Program (Pitch-In Canada, 1996). The 1998 clean-up initiative, of which Pitch-In Canada was a participant, operated in 74 countries and involved 509,004 people who collected a combined 5,300,484 pounds of debris over 12,169.2 miles (CMC, 1998). More recently, Pitch-In Canada organised the British Columbia Shoreline Clean-Up which took place in May 2000. Information kits were distributed to over 7,000 schools, Scout and Guide groups, environmental and outdoor groups, Chambers of Commerce, Service Clubs, Local Governments and other organisations throughout British Columbia (Thom, 2000). A total of 16,000 volunteers participated in 119 communities scouring approximately 383 kilometres of shoreline and collecting just over 26 metric tonnes of debris (Thom, 2000).

Similar initiatives have been undertaken by other Canadian organisations, such as the Clean Nova Scotia Foundation who's Moosehead Maritime Beachsweep Campaign, each year, finds over 100,000 items across over 260 projects totalling hundreds of kilometres of coast line in the Maritimes (Clean Nova Scotia, 2000a). A guide is available to the public on how to carry out a beach sweep (Clean Nova Scotia, 2000b). The Conservation Council of New Brunswick (CCNB), a non-profit organisation that has been active since 1969 in monitoring problems concerned with New Brunswick's land, air, and sea. Their findings of an intensive four-year study (1990-1993) of the Bay of Fundy gave rise to a long term Marine Conservation Program which seeks to raise awareness of the range of issues that collectively threaten the long term sustainability of this marine environment (CCNB, 2000).

In addition to governments and environmental organisations, industry and the private sector have voluntarily taken on often sweeping changes to their practices to reduce their wastes. The plastics industry has introduced measures to reduce leakage of resin pellets in shipping and handling and supported plastic recycling in communities (CPIA, 1998). Pulp and paper companies have supported paper recycling in communities (CPPA, 2000). Packaging companies have introduced recycled materials, reusable bulk packaging, and new designs that use less material in both industrial and retail sectors. Many of these changes introduced, also happen to improve the efficiency of industrial and retail operations and reduce costs which makes them attractive for companies and ensures they are readily adopted.

By reducing pollution from land-based activities, through actions from governments and non-government parties, marine environmental quality will improve for future generations.

Future Action

From the trends data of the National Marine Debris Surveillance Program and clean up data, we find the majority of marine debris arises from deliberate acts of littering or waste dumping by individuals -human behaviour. As with most problems that arise from human behaviour, there are natural influences or tendencies that drive the specific behaviour. In the case of littering, the natural tendency is the need to be rid of one's garbage. A product when purchased, results in garbage once consumed -garbage that most of us typically wish to be rid of as soon as possible. If there are no garbage cans or recycling bins near by, the average person on the street will hold onto his or her garbage for only short period of time and afterwards drop it.

Governments and communities seeking to address litter and marine debris problems must account for these natural tendencies in their actions. Marine debris, with its complexity, must be addressed by all orders of government. The legal complexity of the issue and various government interests involved makes the NPA an ideal venue to co-ordinate action. There is general agreement that marine debris should be addressed and is best done so at the community level. Table 3 presents a

framework of options to address the issue of marine debris from its most common sources. It attempts to identify the sources, the natural tendencies that drive the sources, followed by the key societal messages, communications approaches, regulatory and technological options to address the natural tendencies.

Another feature of marine debris is that its high visibility in many communities has motivated many coastal clean up activities which engage millions of people across Canada (Pitch-In Canada, 2000, Clean Nova Scotia, 2000). This can be used as a means to promote other coastal issues, notably the issues addressed in the NPA and to illustrate this, Table 4 presents the NPA issues and their relation to marine debris. Furthermore, the concepts of the framework presented in Table 3 could be used equally to address other NPA issues: sources, tendencies, key messages, communication approaches, regulatory and technological options.

As many sources contribute to marine debris and require a concerted approach to address them, joint activities with organisations addressing other issues can be effective and lead to improved synergy within community organisations. For example, a conservation group seeking improvements to a river front, benefits from another group organising a public clean up of the shoreline. People in the event contribute to a positive solution, see first hand the effects of marine debris and the importance of habitat conservation.

From the above a number of concepts emerge that form the basis of solutions to address marine debris.

*Natural Tendencies:
work with them not against them*

Most sources of marine debris are related to human behaviour (the desire to bid rid of garbage) therefore, cost-effective measures account for and accept natural human tendencies rather than confront them directly. In other words, they make it easy for people to avoid littering or dumping. Ideally, facilities should be as readily available as possible. Often this requires creative approaches to collection to control costs and one approach is to use existing collection routes. For example in an urban area, placing collection receptacles on parking meters, which are then emptied by staff maintaining the meters, works the waste collection activity into an existing collection activity. Another example, in a more rural situation, would be to locate a waste collection facility where it is convenient for people to use -such as near a general store, which people routinely visit instead of a location that requires a “special” trip.

Garbage is a fact of life in our society no matter where you live and the main problem with managing solid waste is the high costs for both collecting it and its ultimate recycling or disposal. Reducing the wastes generated in the first place, is the most cost effective means to address the issue, as less waste reduces both the costs of managing it and the chances for debris being released. Achieving waste reduction, however, involves three basic steps that can require considerable effort; first to identify the sources of waste, second to identify practical alternatives, then third to implement them. The first step can often be readily achieved; examining the solid wastes from and activities within a community can identify products or activities that generate the wastes. Finding alternatives, can be challenging, but many can be readily found. Implementing them, however, is the most difficult.

Most challenges to implementing waste reduction result from the alternative product or activity being contrary to public desires and expectations for convenience. While some of the public may be swayed by moral arguments, most will resist change that introduces inconvenience or costs. This is a *natural tendency* that must be acknowledged for a waste reduction initiative to succeed and often requires partnerships within the community to do so. For example, when communities sought to reduce garbage generated by disposable diapers (which took up a lot of landfill space)

they encouraged the use of old fashioned reusable cloth diapers - which was not well received by most parents. The clear preference for disposable diapers lay not only in their convenience once “used”, but also in the simplicity to use. Communities that successfully reduced the amount of disposed diapers, had local businesses available to offer diaper services -which provided delivery and pickup and well designed products that are as easy to use as disposable products. In other words, the convenience was there.

Table 3. Suggested management options to address litter by source

Sources	Natural tendencies	Key messages	Communication approaches	Regulatory options	Infrastructure & technology
<ul style="list-style-type: none"> Littering general public Individuals 	<ul style="list-style-type: none"> Disposable, highly packaged products lead to more wastes Sense that one's own actions do not matter in the "big picture" Strong need to be rid of trash leads to littering or dumping if no facilities are readily available 	<ul style="list-style-type: none"> Reduce and recycle your waste Don't litter You can make a difference You benefit from a clean environment: <ul style="list-style-type: none"> ⇒better quality of life ⇒higher tourism and real estate values support efforts to manage waste properly in your community 	<ul style="list-style-type: none"> Deliver messages as close to the source as possible Put messages on disposable products and packaging Reduction encouraged at source (signs in stores) Communications tools (web sites, posters, brochures, PSAs) Links to schools 	<ul style="list-style-type: none"> Community bylaws prohibiting littering and dumping Provide model bylaws for communities to adopt Provincial statutes Increased enforcement Promote compliance before legal action on first offence Citizen reporting of offences 	<ul style="list-style-type: none"> Public receptacles Access to facilities for landfills / sorting facilities Provide appropriate collection mechanisms Provide appropriate disposal / sorting / recycling options for large to small communities
<ul style="list-style-type: none"> Poor waste management practices communities ports shore side commercial properties homes 	<ul style="list-style-type: none"> Seen as simplest means to manage garbage by communities and individuals seeking to avoid costs No facilities may be available, therefore perceive no other option 	<ul style="list-style-type: none"> Proper management protects your environment from which you benefit Approaches can recover some costs in some cases (selling bulk materials) Regional approaches are cost effective 	<ul style="list-style-type: none"> Guidelines codes of practice Encourage solutions based in the communities (e.g. Reuse piles) Technology transfer and training workshops Conferences Articles in professional journals Work with Federation of Canadian Municipalities 	<ul style="list-style-type: none"> Provincial statutes Community bylaws requiring facility use Provide model bylaws for communities to adopt 	<ul style="list-style-type: none"> Shared regional landfills and material sorting facilities with collection and transport mechanisms Cost effective small-scale systems Cost sharing and funding plans to maintain facilities Closing the loop on recycling
<ul style="list-style-type: none"> Construction debris shore side construction industry home renovators 	<ul style="list-style-type: none"> Avoid disposal costs Sometime related to accidental loss 	<ul style="list-style-type: none"> Maintain a clean job-site Store materials securely Contain and properly dispose of C&D wastes Material recycling opportunities Use low waste materials and packaging 	<ul style="list-style-type: none"> Best Management Practices and industry standards Guidelines & Codes of Practice for better site management Messages on construction products and hardware retail stores. 	<ul style="list-style-type: none"> Bylaws Provincial statutes and model bylaws for communities CEAA Increased enforcement Citizen reporting 	<ul style="list-style-type: none"> On site management practices and systems Commercial collection systems Disposal / sorting / recycling options
<ul style="list-style-type: none"> Sewage and storm water discharges communities homes 	<ul style="list-style-type: none"> Need to dispose of material or drain water flows "Out of sight, out of mind" 	<ul style="list-style-type: none"> Don't throw trash down storm drains or toilets Use septic systems over direct discharge 	<ul style="list-style-type: none"> Messages on storm drains, public restrooms Communications tools (web sites, posters, brochures, PSAs) 	<ul style="list-style-type: none"> Bylaws: <ul style="list-style-type: none"> ⇒ septic systems or on site treatment ⇒ prohibiting disposal down storm drains Fisheries Act Provincial Statutes Sewage control regulations Increased enforcement Citizen reporting 	<ul style="list-style-type: none"> Basic treatment appropriate to community Individual septic systems
<ul style="list-style-type: none"> Accidental loss ports shore side commercial properties homes 	<ul style="list-style-type: none"> Not deliberate acts Unforeseen Storm debris Largely affects fishing, recreational boating, tourist activities 	<ul style="list-style-type: none"> Accidents can be prevented Secure items on boats and shorelines 	<ul style="list-style-type: none"> Best Management Practices and industry standards Communications tools (inclusion in web sites, posters, brochures, PSAs) Messages incorporated into products and packaging 	<ul style="list-style-type: none"> Community bylaws on shore-side activities to reduce accidental loss Fishing gear regulations Increased enforcement Citizen reporting 	<ul style="list-style-type: none"> Ruggedized gear Product design factors environmental fate after release
<ul style="list-style-type: none"> Sea discharges shipping fishing boating 	<ul style="list-style-type: none"> Avoid disposal costs Convenience 	<ul style="list-style-type: none"> Bring it back Offload and dispose of it properly Marine debris affects your community and livelihood 	<ul style="list-style-type: none"> Communications tools (inclusion in web sites, posters, brochures, PSAs) Messages incorporated into products and packaging Work with relevant associations 	<ul style="list-style-type: none"> Annex V MARPOL Canada Shipping Act Fisheries Act CEPA-Disposal at Sea Increased enforcement Citizen reporting 	<ul style="list-style-type: none"> On board treatment Shore side reception facilities integrated with local waste management plans

Another tool to achieve waste reduction are incentives. If people perceive a benefit from an action, they will readily undertake it or support it. Beverage container deposit-return systems in Canada and the US have had a major success in significantly removing them from marine debris and litter, people see value in empty bottles or cans and retain them for refunds rather than discard them. This was observed in the Gulf of Maine region when beach clean up data from Canadian provinces and US states with bottle return system in place were compared to clean up data from US states without. (WHOI, 1997)

*Key Messages and Communication Approaches:
Getting the message out*

For any approach that requires people to change their behaviour effective communication is essential. For a public awareness campaign to be successful there are two elements: a clear message and a means to deliver it.

As most marine debris results from human decisions and behaviour, continual reinforcement in public messages is required. This can be costly, to get messages into traditional mass-media and a more focused approach can yield better results. Again, the two elements of the message itself and means of delivery must be carefully considered from the point of view of the intended audience. For example, if the message is complex for a broad audience-such as detailing recycling procedures to households- distributing brochures and flyers may be good method for delivery. Consideration then must focus on the delivery mechanism. Printing costs and distribution (e.g. direct mailing, posting in government offices, stores, community parks, etc.) Alternatively, written printed material (brochures) may not be effective for some intended audiences and personal visits and presentations may be have more impact.

A simple and cost effective approach for communities to reach large numbers of people is the “piggy back messages” concept where businesses or organisations are invited to include short and simple messages on routinely printed materials such as company brochures, receipts, invoices, letterhead or product packaging. The concept here is the message delivered for no additional cost as the intended materials are routinely printed anyway. This can effectively distribute messages to intended audiences -e.g. asking a fishing line manufacturer to print a message for sports fishers not to discard fishing line on their packaging. It can also provide continual and subtle reinforcement as messages become established on a widening range of products.

Another approach is co-messaging either when the same message benefits two or more issues or a public awareness campaign addressing complementary issues. Under this concept, rather than perceiving other environmental issues as competing elements, they are regarded as opportunities for complementary action. For example, the Canadian Wildlife Federation’s education kit series “Learning About Our Oceans” that reaches 20,000 schools each year, draws the support of a range of partner organisations with different interests from Environment Canada promoting awareness on marine debris to Scouts Canada promoting youth citizenship (CWF, 2000). By drawing these complementary partners together all the partners benefit. Table 4 illustrates how in general terms the NPA issues complement and relate to marine debris.

Table 4. Marine debris linkages to NPA issues

Contaminant Issues	Link to marine debris	Physical Alteration and Destruction of Habitat Issues	
		Habitat Issues	Link to marine debris
Sewage	<ul style="list-style-type: none"> • untreated discharges a source of marine debris 	Shoreline construction/ alteration	<ul style="list-style-type: none"> • Shore side construction activity a source of marine debris. • Marine debris further impacts habitat
POPs	<ul style="list-style-type: none"> • specific items of marine debris (chemical or pesticide containers) a source of POPs 	Mineral and sediment extraction/ alteration	<ul style="list-style-type: none"> • Existing debris on sea floor and be disturbed and mobilised. • Marine debris further impacts habitat
Radionuclides	<ul style="list-style-type: none"> • specific items of marine debris (discarded smoke detectors) a source of radionuclides 	Wetland and saltmarsh alteration	<ul style="list-style-type: none"> • Activities on some structures (e.g. road traffic on causeways) can be a source of marine debris. • Marine debris further impacts habitat
Heavy metals	<ul style="list-style-type: none"> • specific items of marine debris (chemical containers) a source of heavy metals 	Marine waters and coastal watershed alteration	<ul style="list-style-type: none"> • Major alteration activities can be a source of marine debris • Marine debris further impacts habitat
Oils/ hydrocarbons	<ul style="list-style-type: none"> • specific items of marine debris (oil bottles) a source of oils and hydrocarbons 	Biological alteration	<ul style="list-style-type: none"> • Marine debris can be a vector for invading organisms
Nutrients	<ul style="list-style-type: none"> • specific items of marine debris (fertiliser containers) a source of nutrients 	Inter-tidal and sub-tidal alteration	<ul style="list-style-type: none"> • Fixed fishing gear, through accidental loss, is a major source of debris in some areas. • Activities on floating docks and certain aquaculture devices a source of marine debris • Marine debris further impacts habitat
Contaminated sediments	<ul style="list-style-type: none"> • marine debris on sea floor often found in polluted sediments 		

*Regulatory Controls:
Walk softly but carry a big stick*

Although it is always preferable to work with the “natural tendencies” through moral suasion and providing means to reduce litter, there are always individuals who cannot be reached and they require a strong deterrence. Most communities have regulations prohibiting indiscriminate littering and dumping as do most provinces. The marine community (boaters, fishers and ships) is subject to the Canada Shipping Act and provincial boating regulations that prohibit discharges of garbage and other harmful things such as sewage. Bylaws and regulations, however, are only as effective as their enforcement. Highway speed limits illustrate this; in Canada, many highways with 100 km/h speed limits can find average traffic speeds exceeding 120 km/h. In such cases, the posted speed limit is not very effective. Even when patrolled, many motorists exceed the posted speed limit by 10 to 20 km/h because they perceive no action will be taken.

Such is the case for dumping or littering. Many communities see litter as a minor nuisance hence fines are minor and enforcement activity is not seen as a priority. Prosecutions are rare as often the cost to governments to bring a case to trial dramatically exceeds the fine. Again, even

significant fines are ineffective if people perceive that they won't get caught. Furthermore, laws that provide significant fines and penalties may not provide a deterrent, if the courts -governed by precedents- are reluctant to set major fines. For example, The *Canadian Environmental Protection Act* -or CEPA- provides a maximum fine of one million dollars and jail time up to three years (CEPA, 1999). However, the largest fine ever set under CEPA was \$100,000 and no case of an offence under CEPA has ever resulted in jail time for any guilty party (Environment Canada, 1999).

There is, however, an emerging form of effective legal deterrence, for pollution related issues: civil litigation which can introduce legal costs and penalties that exceed millions of dollars for companies, organisations and individuals. Often previously belligerent polluters adopt better practices and comply with laws, not to avoid prosecution -which risks minimal costs- but to avoid a civil suit that could bring enormous legal and business costs.

*Infrastructure and technology:
Equipping communities with the means to manage*

Even with a willing public and community, sound laws and enforcement, marine debris and other solid waste issues cannot be resolved if communities lack technical means. From 1990 to 1991, fisheries observers from the the Department of Fisheries and Oceans aboard Canadian and Foreign vessels recorded the waste disposal practices of fishing vessels off Nova Scotia's east coast. During the same time the Maritime Fisherman's Union of Nova Scotia, lead a campaign to establish facilities and encourage fishers to offload their garbage in port. The observer's data indicated, as more facilities became available, that there was a 75 percent increase in Canadian fishers offloading their garbage in port from 1990 to 1991 (Topping, *et al*, 1994b).

Infrastructure presents the greatest costs, however, communities are encouraged to view them as investments towards improvements in their quality of life. As well, many technical approaches afford revenue opportunities for communities and others pose limited costs. Table 5 summarises some of the infrastructure approaches available to communities address marine debris.

Table 5 Summary of technical approaches for communities to address marine debris			
Approach	Description	Relative Costs	Possible Partners
Litter abatement			
Public receptacles	<ul style="list-style-type: none"> Placing and maintaining recycling bin or garbage cans in public places (town squares, parks, beaches etc.) Material is collected and sent for recycling or final disposal 	<ul style="list-style-type: none"> Medium (depends on coverage) Purchasing receptacles Waste collection vehicle and staff time 	<ul style="list-style-type: none"> Chambers of commerce Service clubs Provincial and federal programs
Loss control programs	<ul style="list-style-type: none"> Systemically examining activities in the marine and shore-side environment to identify and reduce the risks of accidental loss 	<ul style="list-style-type: none"> Low to medium Could be done in house, but may some expertise 	<ul style="list-style-type: none"> Academia Business associations Provincial and federal agencies
Clean up programs	<ul style="list-style-type: none"> Volunteers routinely clean up designated areas e.g. Adopt a Road, Adopt a River programs Staff or contractors may carry out work 	<ul style="list-style-type: none"> Low to medium Promotion and awareness 	<ul style="list-style-type: none"> Service clubs Volunteer organisations Chambers of commerce
Waste reduction			
Home composters	<ul style="list-style-type: none"> Small scale composters for household organic solid wastes Compost used gardens on site 	<ul style="list-style-type: none"> low-medium production of composters distribution can be on commercial basis 	<ul style="list-style-type: none"> Composter manufacturer Business community for distribution and marketing Service clubs
Home waste audits	<ul style="list-style-type: none"> Kit provided to households to examine their waste generation habits and identify opportunities to reduce waste 	<ul style="list-style-type: none"> low-medium production of documents commercial distribution 	<ul style="list-style-type: none"> Printing and design firm Specialised expertise on waste audits

Table 5 Summary of technical approaches for communities to address marine debris			
Approach	Description	Relative Costs	Possible Partners
	<ul style="list-style-type: none"> Option to use municipal staff to conduct audits 	<ul style="list-style-type: none"> can be on basis use of staff 	<ul style="list-style-type: none"> Service clubs
Commercial waste audits	<ul style="list-style-type: none"> Kit provided to commercial establishments to examine their waste generation habits and identify opportunities to reduce waste Option to use municipal staff to conduct audits Option to encourage use of expert advice to realise business cost savings 	<ul style="list-style-type: none"> low-medium production of documents distribution can be on commercial basis use of staff 	<ul style="list-style-type: none"> Business associations Chambers of commerce Industry associations Provincial or federal programs
Waste Collection (for recycling and disposal)			
Curb side pickup	<ul style="list-style-type: none"> Boxes are provided to households for recyclable materials (glass, aluminium, paper) in them for pick up curb site. Trash is collected from households in approved containment 	<ul style="list-style-type: none"> medium to high generally supported by larger tax bases requires purchasing collection vehicles and hiring staff or contracting services out 	<ul style="list-style-type: none"> Box manufacturer Business community for distribution and marketing Service clubs Provincial or federal programs Collection contractors
Disposal and Recycling depots	<ul style="list-style-type: none"> Local depots (large sorting boxes) are provided for people to sort and deposit their materials for recycling or for depositing waste for disposal Operate on a regional basis Material is collected and transported to central / regional material sorting and storage facility or disposal facility 	<ul style="list-style-type: none"> medium can be implemented in smaller communities still requires collection vehicles and staff, but those costs may be shared with neighbouring communities. 	<ul style="list-style-type: none"> Business community for distribution and marketing Service clubs Provincial or federal programs Collection contractors
Commercial collection systems	<ul style="list-style-type: none"> Collection services for construction sites or other industrial activities that generate waste material which could be recycled send material to recycling, reuse, or disposal facility Many community require businesses over a certain size to arrange such services Operate on a commercial basis 	<ul style="list-style-type: none"> medium operation of facility 	<ul style="list-style-type: none"> Business community for implementation Specific industry organisations Provincial or federal programs
Transfer stations	Controlled access facilities that permit shipments of waste materials to be consolidated into either larger shipments or single materials depending on requirements.	<ul style="list-style-type: none"> Medium Permits cost savings in collection systems 	<ul style="list-style-type: none"> Haulage contractors Service clubs Provincial or federal programs
Reuse and Recycling			
Local deposit/ refund systems	<ul style="list-style-type: none"> Retailers collect and reuse containers by charging a deposit and paying a refund upon container's return This is a voluntary measure beyond existing systems (e.g. beverages) 	<ul style="list-style-type: none"> low staff time for negotiations 	<ul style="list-style-type: none"> Business community for implementation Provincial or federal programs
Material sorting and storage facility	<ul style="list-style-type: none"> Permanent building with facilities for sorting materials by type (metals, glass, paper), bulk compacting and storing materials followed by arranging sale of materials as bulk commodities. 	<ul style="list-style-type: none"> high generally supported by larger tax bases sale of materials can offset some of the costs but rarely supports entire operations 	<ul style="list-style-type: none"> Business community Provincial or federal programs Collection contractors
Multi material extruder*	<ul style="list-style-type: none"> Experimental technology Plant that uses thermal and pressure processes to form multiple types of material into one 	<ul style="list-style-type: none"> Undetermined, medium to high Potential to recover some 	<ul style="list-style-type: none"> Technology licensee Business community Provincial or federal

Table 5 Summary of technical approaches for communities to address marine debris			
Approach	Description	Relative Costs	Possible Partners
	<p>material that can be formed into shapes and structural components which can be then used within the community.</p> <ul style="list-style-type: none"> • Eliminates most material sorting requirements and the need to arrange sale of materials outside the community. 	<p>costs with sale of useful building materials or use in public structures</p>	<p>programs</p>
Central composting	<ul style="list-style-type: none"> • Centralised composting facility for collected organic wastes reduces demand for landfill space on average by 50% • Material can be either sold or donated to farmers. 	<ul style="list-style-type: none"> • Medium • Requires equipment and staff to operate 	<ul style="list-style-type: none"> • Business community • Farming associations • Provincial or federal programs • Collection contractors
Re-use facilities	<ul style="list-style-type: none"> • Permanent structures that may be covered or exposed which permit various different types of materials to be stored. E.g. scrap lumber from demolition activities, wire, old furniture • Public has access (free to controlled) to deposit or take materials for their use 	<ul style="list-style-type: none"> • Low to medium • May or may not require staff for liability reasons 	<ul style="list-style-type: none"> • Service clubs • Volunteer organisations • Business community • Farming associations • Provincial or federal programs
Final disposal			
Engineered Landfill	<ul style="list-style-type: none"> • Designed landfill with leachate collection, gas collection, waste material is covered daily, site is managed 24 hours / day. • Tip fees may cover operational costs • Power generation from landfill gas may provide some revenue 	<ul style="list-style-type: none"> • High • Generally supported by larger tax bases 	<ul style="list-style-type: none"> • Provincial or federal capital programs • Operating and maintenance contractors
Covered landfill	<ul style="list-style-type: none"> • Garbage is buried or covered on a regular basis • Site access can be restricted to specific times 	<ul style="list-style-type: none"> • Medium costs to operate equipment 	<ul style="list-style-type: none"> • Provincial or federal capital programs • Maintenance contractors
Waste incinerators	<ul style="list-style-type: none"> • Waste is burned under controlled conditions, subject to air emission controls • Reduces volume of generated wastes • Power generation from incineration process can offset construction and operating costs • Often opposed by various community interests 	<ul style="list-style-type: none"> • High • Generally supported by larger tax bases 	<ul style="list-style-type: none"> • Provincial or federal capital programs • Operating and maintenance contractors • Community associations

Conclusions

Marine debris has multiple and complex sources and there is no single solution. Rather, gradual improvements will be realised by adopting a concerted approaches. The approaches to address the issue in this paper are presented as options for communities themselves to best determine. Essential elements of a successful approach include, working with the waste disposal needs of the community, getting key messages to the public and special audiences, backing concerns with sound bylaws and enforcement, and ensuring the technical means are available for compliance.

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References

- BC-MELP, British Columbia Ministry of Environment, Lands and Parks (1989) *Municipal Solid Waste Management Strategy*. Victoria, B.C.
<http://www.elp.gov.bc.ca/epd/epdpa/mwr/mswms.html>.
- Buxton, R., (1990) *Plastic Debris and Lost and Abandoned Fishing Gear in the Aquatic Environment*, A Background Paper from a Canadian Perspective for A Workshop Held in Halifax, May 1989, Department of Fisheries and Oceans, Ottawa, Ont.
- CCME, Canadian Council of Ministers of Environment (1998) *National Packaging Protocol: 1996 Milestone Report*. CCME National Task Force on Packaging.
- CCNB, Conservation Council of New Brunswick (2000) *Marine Conservation Program for the Bay of Fundy*. May 2000 <http://www.web.net/~ccnb/marine.htm>.
- CPIA, Canadian Plastics Industry Association
- CPPA, Canadian Pulp and Paper Association and PPPEC, Paper and Paperboard Packaging Environmental Council (1998) *Guide to the Paper Recycling Mills in Canada*.
<http://www.cppa.org/english/wood/guide/overviee.htm>
- Clean Nova Scotia (2000a) *Moosehead Maritimes Beachsweep*. Clean Nova Scotia Foundation, 126 Portland St, Dartmouth Nova Scotia.
<http://www.clean.ns.ca/programs/annual/beach.html>
- Clean Nova Scotia (2000b) *Moosehead Maritimes Beachsweep - Guide*. Clean Nova Scotia Foundation, 126 Portland St, Dartmouth Nova Scotia.
http://www.clean.ns.ca/programs/annual/beach_guide.html
- CMC, Center for Marine Conservation, (1998) *1998 Coastal Clean Up Totals*. Washington, DC.
<http://www.cmc-ocean.org/cleanupbro/98intlppm.php3>.
- Coe, J. and Rogers, D., (1996) *Marine Debris Sources, Impacts, and Solutions*, Springer-Verlag, New York, ISBN 0-387-94759-0
- CWF , Canadian Wildlife Federation (2000) *Blue School Program*. CWF Wild Education Programs, Ottawa, Ontario, June 2000.
<http://www.wildeducation.org/program/oceneduc.htm>.
- Environment Canada (2000). *Budget 2000: Helping Municipalities Take Action*. The Green Lane: Environment Canada and Budget 2000. Ottawa Ont.
http://www.ec.gc.ca/budget/cc2_e.htm.
- Environment Canada (1999) *Guiding Principles for Ecosystem Initiatives*. Ottawa, March 1999
<http://www.ec.gc.ca/ecosyst/gdprecin/contents.html>
- Environment Canada and Fisheries and Oceans Canada (2000). *National Programme of Action for the Protection of the Marine Environment from Land-based Activities (NPA)*. Prepared by the Federal, Provincial, Territorial Committee on Canada's NPA. Ottawa, June 8 2000. <http://www.ec.gc.ca/marine/npa-pan.htm>.

- Government of New Brunswick (2000) *2000-2001 Environmental Trust Fund Awards*.
Fredericton, July 2000 <http://www.gov.nb.ca/cnbnews/elg/2000e0566el.htm>
- Government of New Brunswick (1999), *Department of the Environment 1998-1999 Annual Report*. Fredericton N.B., <http://www.gnb.ca/ELG-EGL/ARReport/english/index2.html>
- Pitch-In Canada (2000). *National Marine Debris Surveillance Program (NMDSP) Report on the Third Research Year of the program ending March 31, 2000*. Prepared for Marine Environment Division, Environment Canada by Pitch-In Canada, Whiterock, B.C.
- Pitch-In Canada (1996) *Description of the Coastal Clean Up/Marine Pollution Count Program and List of Regional Coordinators*". Pitch-In Canada Whiterock BC.
<http://www.pitch-in.ca/Coastal/E-Coastal11.html>
- Thom, Valerie (2000). *Statistical Findings from the BC Shoreline Clean-up Conducted by Pitch-In Canada and Sponsored by BRITA Water Filtration Systems*. Pitch-In Canada, Whiterock BC.
- Topping, P (1997) *Environment Canada's Marine Debris Program: A Progress Report*. Presented at the 19th Canadian Waste Management Conference, St. John's Newfoundland October 1997.
- Topping, P., Eade, A., Eaton, P (1994a) *Marine Debris Research in Canada*., Presented at the Third International Conference on Marine Debris, Miami, Florida, May 1994
- Topping, P., Morantz, D., Lang, G., (1994b) *Waste disposal practices of fishing vessels off Canada's East Coast*., Presented at the Third International Conference on Marine Debris, Miami, Florida, May 1994.
- UNEP, United Nations Environment Programme (1995) *Global Programme of Action for the Protection of the Marine Environment from Land-based Activities*. Note by the secretariat. UNEP (OCA) /LBA/IG.2/7
- WHOI, Woods Hole Oceanographic Institute (1997) *Characterization and Mitigation of Marine Debris in the Gulf of Maine* prepared for the US Gulf of Maine Association by the Woods Hole Research Consortium, Woods Hole, Massachusetts
<http://www.gulfofmaine.org/library/debris/gomdeb.htm>

