Canadian Water Quality Guidelines for the Protection of Aquatic Life

DEBRIS
(Marine)

Marine debris (floating or submerged litter and settleable matter) can be defined as litter or any material that is lost, discarded, dumped, or discharged into the marine environment, or that blows into the sea, or is carried down rivers and ends up in the sea (Eaton 1984). The National Academy of Sciences (NAS 1975) defined marine litter as solid materials of human origin that are discarded at sea or reach the sea through waterways or through domestic or industrial outfalls. While many of these solid materials are synthetic plastics, it should be noted that some litter of human origin is composed of natural materials (e.g., wood, organic matter, and sediments). "Natural litter" released into the marine environment as a result of human activity may be considered "marine debris" or "marine litter", especially if such litter is released in amounts greater than existing background levels. Because the NAS (1975) definition distinguishes between anthropogenic and natural debris, this definition is adopted for the purpose of this fact sheet. Debris may remain buoyant on the surface (floating litter), somewhat below the surface (submerged litter), or be deposited (settleable matter or residues).

Marine debris generated by human activities has been observed on all oceans, coastlines, and estuaries of the world, including very remote areas in Antarctica and on Arctic beaches (Wong et al. 1976; Ross et al. 1991). The major sources of marine debris are industrial and recreational vessels, riverborne debris of anthropogenic origin, municipal drainage systems, solid wastes dumped at sea, municipal and industrial effluent, recreational activities near or in marine areas or shorelines, nearshore and offshore industrial activities on the water (e.g., drilling platforms, log handling, and mariculture), and fishing (Shomura and Godfrey 1990).

Debris entering the marine environment can float, drift in the water column, sink to the bottom, or be washed up on beaches. Survey methods to determine the extent of contamination by materials in each of these components of the marine environment have been described (Ribic et al. 1992). However, several studies have indicated that it is not possible to extrapolate from beach surveys to the levels of debris found in other components of the marine environment (Coe 1990; Lucas 1992).

The types of anthropogenic marine debris found in a particular area depend on the specific activities that are most common to that area and to more distant sites from which debris is transported to that area. Unusual climatic episodes (such as hurricanes, tropical storms, etc.) can also affect the distribution of marine debris (Swanson and Zimmer 1990). Furthermore, the type and amount of marine debris are subject to change over time (Day and Shaw 1987), as debris input varies according to changes in shipping traffic, fishing activities, environmental regulations, the composition of materials used in packaging, and public awareness. Another source of variability in the measurement of the type and amount of marine debris lies in the choice of the survey method used in a study (Coe 1990; Ribic et al. 1992). The dominant features of marine debris reported in a study depend on whether the debris was measured by number of items or weight. Most studies measure specific marine debris by either the number of items or the weight of the debris per unit area and time, but not both (Lucas 1992).

The density and distribution of marine debris originating from human activities are primarily governed by the amount of fishing and shipping traffic, the proximity to populated coastal areas, and the patterns of oceanic circulation and surface winds (Eaton 1984). Discarded and lost fishing gear and other debris from fishing vessels are most often noted as the dominant components of marine debris (Pruter 1987; University of Alaska 1988; Coe 1990; Shaw 1990; Lucas 1992). Plastic packaging and other consumer items, as well as raw plastic pellets or

Table 1. Water quality guidelines for marine debris for the protection of aquatic life (CCME 1996).

Aquatic life–Marine
*Floating or Submerged Litter**
No solid debris, including floating or drifting materials (such as fishing gear, plastics, metals, rubber, glass, cloth, paper, wood, or other materials) should be introduced (directly or indirectly through human activities) into marine and estuarine waters
*Settleable Matter (Residues)**
No residues or other solids should be introduced (directly or indirectly through human activities) that may, alone or in combination with other substances, cause any solid, sludge, or emulsion to be deposited on the bottom, intertidal zone, or shorelines of marine and estuarine areas. The natural rate of deposition and characteristics of marine and estuarine settleable sediments and other settleable solids should not be altered.

*Interim guideline.

"nibs" provided to producers of plastic products, are also reported as major components found in most litter surveys (Gregory 1983; Eaton 1984; Pruter 1987; Ribic et al. 1992). Many other items made of plastic, paper, cloth, rubber, glass, metal, and wood have been identified and categorized by various investigators (Ribic et al. 1992). Tar balls, especially when associated with plastic litter, are often included in surveys of marine debris of human origin (Gregory 1983; Golik and Rosenberg 1987).

No general assessments of the nature or extent of marine debris in Canada were found. Eaton (1984) reviewed information on persistent litter in the northwest Atlantic, with particular reference to Canada. Eaton (1984) found very little information on Canadian marine waters, with the exception of two studies on tar and plastic distributions in the Pacific Ocean and the Beaufort Sea coast (Wong et al. 1974, 1976). Wong et al. (1976) found that plastics originating from marine seismic activity studies (in particular, explosive canister fragments) were prevalent on beaches throughout the Beaufort Sea coast. Over 80% of the debris sighted on two high seas research surveys in the North Pacific were of plastic origin. Most of the debris, including gill nets, was observed in the area of the squid driftnet fishery zone (Shaw 1990).

Gregory (1983) studied the occurrence of small plastic pellets and granules and their association with tar on a number of beaches in Nova Scotia and made comparisons with other locations. In this study, much lower densities of these debris items were found on Canadian beaches than in Bermuda. The presence of this debris in Eastern Canada was attributed to distant sources, oceanic circulation patterns, and lengthy residence times, as there were no known significant local sources of these materials. Other discarded plastic items were reported to be common in most of the locations studied, however, their densities were not quantified. Somewhat greater densities of plastic pellets were observed in Halifax Harbour compared to other Canadian locations (e.g., Sable Island).

Ross et al. (1991) conducted three beach surveys of 19 randomly selected sections of shoreline in Halifax Harbour. The debris items found consisted of plastic (53.8%), metal (12.4%), styrofoam (12.0%), glass (8.4%), paper (5.2%), wood (5.2%), and rubber (3.0%). A small amount of medical waste was also reported. Based on the debris items identified in this study, recreational boating (31.9%) and land-based private sources (30.2%) were considered the most important. It was apparent that most of the debris was created by the citizens of the area, rather than by local industry or military installations. The other major sources of debris identified were untreated municipal sewage (17.4%), industry (11.4%), fishing (8.1%), shipping (0.8%), and military activities (0.2%).

Lucas (1992) investigated the nature, extent, and distribution of persistent debris on the beaches of Sable Island, Nova Scotia. Because the Canadian government restricts access on Sable Island, it was concluded that the beach debris of Sable Island was attributed to distant sources. Ninety-two percent of the items identified were plastic and consisted primarily of consumer items and fishing equipment. From these data, the author calculated the rate of persistent litter accumulation on Sable Island to be over 18 800 items per month for the whole island, or 219 items per month per linear kilometre of shoreline. The annual accumulation rate of debris on the island was estimated to be about 8 t.

Ocean disposal under permit is regulated through the Canadian Environmental Protection Act (CEPA 1985). The 1973 Convention for the Prevention of Pollution by Ships has implemented restrictions on the ocean disposal of debris by ships, including the prevention of oil or oily mixture discharge within 12 nautical miles from the nearest land (Convention for the Prevention of Pollution by Ships 1973). Ocean disposal occurs on the Atlantic, Pacific, and Arctic coasts (Waldichuk 1988). Environment Canada permitted the disposal of 6.9×10^6 t of material during the 1992–1993 fiscal year. Dredged materials including rocks, gravel, sand, silt, clay, and wood made up 92.5% of this total. Fish wastes, shells, and fish-processing wastewaters represented only 1.4%, while rocks and soils amounted to 5.9%. Other permits issued in 1992–1993 included the disposal of vessels, concrete blocks, and scrap metal, making up the remaining 0.2% of disposed materials (Environment Canada 1993).

Biological Effects

The major effects of anthropogenic marine debris on marine organisms are entanglement of and ingestion by marine mammals, seabirds, sea turtles, fish, and crustaceans. The Proceedings of the Second International Conference on Marine Debris (Shomura and Godfrey 1990) contains numerous papers and reports of working groups on entanglement in and ingestion of debris by marine life.

Ghost fishing is the entanglement of marine life in lost and discarded nets, net fragments, and traps. Incidental catches, or net-mortality, are distinguished from ghost fishing in that the nontarget marine organisms are entangled in the net during active use of the gear by the fishing industry. Net-mortality is estimated to be much greater than mortality due to ghost fishing, but the latter nevertheless has a significant biological effect (Piatt and Nettleship 1987; Breen 1990; Ribic et al. 1992).

Entanglement in discarded net fragments and other debris has particularly affected marine mammals, including several species of seals, sea lions, and whales (Eaton 1984; Stewart and Yochem 1990; Ribic et al. 1992). Seabirds, turtles, fish, and crustaceans have also been reported to be subject to entanglement and ghost fishing (Breen 1990; Ribic et al. 1992). The impact of these mortalities on populations has been the subject of debate (Ribic et al. 1992), but there is little doubt that these effects occur over broad geographic areas and affect a wide variety of marine organisms.

Ingestion of plastic spherules and other debris has been reported most commonly for seabirds and somewhat less frequently for fish, sea turtles, marine mammals, and invertebrates (Eaton 1984; Ribic et al. 1992). Physiological effects related to the ingestion of plastics include gastrointestinal obstruction, blockage of gastric enzyme secretion, diminished feeding stimulus, lowered steroid hormone levels, delayed ovulation, and reproductive failure (Azzarello and Van Vleet 1987).

In addition to the physiological effects previously described, marine debris may also be indirectly toxic to aquatic organisms (Eaton 1984). For example, tar ball leachates and other chemical toxicants associated with wood debris may adversely affect fish and wildlife in marine ecosystems (Pease 1974; Buchanan et al. 1976; Peters et al. 1976; O'Clair and Freese 1985; Freese and O'Clair 1985).

It is possible that benthic species transported on floating debris could alter dispersion patterns and, subsequently, species composition at affected sites (Winston 1982; Gregory 1991). For example, Harms (1990) reported that marine plastic litter promoted the establishment and growth of sessile hard-bottom organisms in soft-bottom environments. Moosleitner (1983) observed fish spawning on a plastic bag in a sea-grass meadow, but noted that this substrate was unstable, limited in area, and unprotected. Floating and drifting litter is often reported to be encrusted with marine organisms, often thought to have originated at great distances from where the litter was found (Gregory 1983; Gregory 1991; Lucas 1992).

Settleable matter physically alters the suitability of bottom habitats, particularly for benthic invertebrates. Detrimental effects have been documented for the accumulation of sunken logs and wood debris from log booming and storage, wood wastes from pulp milling, mine tailings from mining activities, and also for the accumulation of solid materials from marinas, ferry terminals, and other shoreline activities (McDaniel 1973; Pease 1974; Levy et al. 1982; Waldichuk 1988). On both Pacific and Atlantic coasts, ships have been sunk for recreational diving observation (S. Sullivan 1994, Environment Canada, Dartmouth, Nova Scotia, pers. com.; G. Méthot 1994, Excursions Baie des Chaleurs Enr., Baie des Chaleurs, Quebec, pers. com.). Such activities did not cause any negative effects on water quality and created new habitat for marine life (Kim 1994). The immersion of concrete blocks, rubber tires, pebbles, and rocks for the creation of lobster habitat has also proved to be a valuable use of debris in coastal areas and has enhanced biomass and density of lobster and other marine species (Belles-Isles 1995).

Floating or Submerged Litter (Interim Guideline)

No solid debris, including floating or drifting materials (such as fishing gear, plastics, metals, rubber, glass, cloth, paper, wood, or other materials) should be introduced (directly or indirectly through human activities) into marine and estuarine waters (CCME 1996).

Settleable Matter (Residues) (Interim Guideline)

No residues or other solids should be introduced (directly or indirectly through human activities) that may, alone or in combination with other substances, cause any solid, sludge, or emulsion to be deposited on the bottom, intertidal zone, or shorelines of marine and estuarine areas. The natural rate of deposition and characteristics of marine and estuarine settleable sediments and other settleable solids should not be altered (CCME1996).

Rationale

Significant biological effects of anthropogenic debris in the marine environment have been documented for a wide variety of marine organisms (Shomura and Godfrey 1990; Ribic et al. 1992). Because of the nature of the material and the difficulty in quantitatively measuring marine debris, it is unlikely that a "safe" or "no effect" level could be defined for floating, drifting, or submerged litter or settleable matter originating from human activities. Therefore, these interim guidelines recommend the absence of such anthropogenic debris from Canadian marine and estuarine waters. Because sediment deposition is a natural process in aquatic environments (e.g., through land runoff), no change in deposition rates or characteristics of settleable solids is recommended. This recommendation is based largely on the guideline recommended by the State of California (1990). It should be noted that controlled introduction of some materials may be permitted under CEPA, Part VI (Ocean Dumping), or for beneficial purposes such as artificial reef creation.

References

Azzarello, M.Y., and E.S. Van Vleet. 1987. Marine birds and plastic pollution. Mar. Ecol. Prog. Ser. 37:295–303.

Belles-Isles, M. 1995. Essai d'augmentation de la biomasse du homard par l'installation de récifs artificiels. Prepared by Roche Ltée. Groupe-conseil, for the Programme d'essai et d'expérimentation halieutiques et aquicoles, Fisheries and Oceans, Quebec.

Breen, P.A. 1990. A review of ghost fishing by traps and gill nets. In: Proceedings of the Second International Conference on Marine Debris, 2–7 April 1989, NOAA-TM-NMFS-SWFSC-154. R.S. Shomura, and M.L. Godfrey, eds. Honolulu, HI.

Buchanan, D.V., P.S. Tate and J.R. Moring. 1976. Acute toxicities of spruce and hemlock bark extracts to some estuarine organisms in southeastern Alaska. J. Fish. Res. Board Can. 33:1188–1192.

CCME (Canadian Council of Ministers of the Environment). 1996. Appendix XXII—Canadian water quality guidelines: Updates (December 1996), interim marine and estuarine water quality guidelines for general variables. In: Canadian water quality guidelines, Canadian Council of Resource and Environment Ministers. 1987. Prepared by the Task Force on Water Quality Guidelines.

CEPA (Canadian Environmental Protection Act), R.S., 1985. c. 16 (4th Supp.).

Coe, J.M. 1990. A review of marine debris research, education, and mitigation in the North Pacific. In: Proceedings of the Second International Conference on Marine Debris, 2–7 April 1989. NOAA-TM-NMFS-SWFSC-154. R.S. Shomura, and M.L. Godfrey, eds. Honolulu, HI.

Convention for the Prevention of Pollution by Ships. 1973. Chapter II. Requirements for Control of Operational Pollution. Regulation 9; Control of Discharged Oil (1)(b)(ii).

Day, R.H., and D.G. Shaw. 1987. Patterns in the abundance of pelagic plastic and tar in the North Pacific Ocean, 1976–1985. Mar. Pollut. Bull. 18 (6B):311–316.

Eaton, P.B. 1984. Persistent litter. In: Health of the northwest Atlantic, R.C.H. Wilson and R.F. Addison, eds. Depts. of the Environment/Fisheries and Oceans/Energy, Mines and Resources, Dartmouth, NS.

Environment Canada. 1993. A summary of permits issued under part VI of the Canadian Environmental Protection Act. CEPA Information Report to Parliament.

Freese, L., and C.E. O'Clair. 1985. Condition of Dungeness crabs, *Cancer magister*, at a benthic deposit of decomposing bark: Physical trauma and reduced reproductive success. In: Proc. Symp. Dungeness Crab Biology and Management., Oct. 9–11, 1984, B.R. Melteff, ed., Sea Grant Rep. No. 85-3. Anchorage, AK.

Golik, A., and N. Rosenberg. 1987. Quantitative evaluation of beach-stranded tar balls by means of air photographs. Mar. Pollut. Bull. 18(6):289–293.

Gregory, M.R. 1983. Virgin plastic granules on some beaches of eastern Canada and Bermuda. Mar. Environ. Res. 10:73–92.

———. 1991. The hazards of persistent marine pollution: Drift plastics and conservation islands. J. R. Soc. N. Z. 21(2):83–100.

Harms, J. 1990. Marine plastic litter as an artificial hard bottom fouling ground. Helgol. Meeresunters. 44:503–506.

Kim, K. 1994. HMCS Chaudière monitoring survey results, February, 1994. Regional Data Report DR 94-01. Environment Canada, Environmental Protection Branch, Pacific and Yukon Region, Vancouver.

Levy, D.A., T.G. Northcote, and R.M. Barr. 1982. Effects of estuarine log storage on juvenile salmon. Westwater Research Centre Tech. Rep. 26. University of British Columbia, Vancouver.

Lucas, Z. 1992. Monitoring persistent litter in the marine environment on Sable Island, Nova Scotia. Mar. Pollut. Bull. 24 (4):192–199.

McDaniel, N.G. 1973. A survey of the benthic macroinvertebrate fauna and solid pollutants in Howe Sound. Fish. Res. Board Can. Tech. Rep. No. 385.

Moosleitner, V.H. 1983. Ein Plastiksack als Laichplatz für *Chromis chromis*. Zool. Anz. Jena 210(3/4):175–179.

NAS (National Academy of Sciences). 1975. Marine litter. In: Assessing potential ocean pollutants. A report of the Study Panel on Assessing Potential Ocean Pollutants to the Ocean Affairs Board, Commission on Natural Resources, National Research Council, National Academy of Sciences, Washington, DC.

O'Clair, C.E., and L. Freese. 1985. Responses of Dungeness crabs, *Cancer magister*, exposed to bark debris from benthic deposits at log transfer facilities: Survival, feeding, and reproduction. In: Proc. Symp. Dungeness Crab Biology and Management., Oct. 9–11, 1984, Rep. No. 85-3, B.R. Melteff, ed. Sea Grant Anchorage, AK.

Pease, B.C. 1974. Effects of log rafting and dumping on the marine environment of southeast Alaska. U.S. Dep. Agric. For. Serv. Tech. Rep. PNW-22.

Peters, G.B., H.J. Dawson, B.F. Hrutfiord, and R.R. Whitney. 1976. Aqueous leachate from western red cedar: Effects on some aquatic organisms. J. Fish. Res. Board Can. 33:2703–2709.

Piatt, J.F., and D.N. Nettleship. 1987. Incidental catch of marine birds and mammals in fishing nets off Newfoundland, Canada. Mar. Pollut. Bull. 18(6B):344–349.

Pruter, A.T. 1987. Sources, quantities, and distribution of persistent plastics in the marine environment. Mar. Pollut. Bull. 18(6B):305–310.

Ribic, C.A., T.R. Dixon, and I. Vining. 1992. Marine debris survey manual. NOAA Technical Report NMFS 108. U.S. Department of Commerce.

Ross, J.B., R. Parker, and M. Strickland. 1991. A survey of shoreline litter in Halifax Harbour 1989. Mar. Pollut. Bull. 22 (5):245–248.

Shaw, W. 1990. Summary of marine debris sightings during Canadian high seas research surveys, 1989–1990. Department of Fisheries and Oceans, Biological Sciences Branch, Pacific Biological Station, Nanaimo, BC. Unpub.

Shomura, R.S., and M.L. Godfrey (eds.). 1990. Proceedings of the Second International Conference on Marine Debris, 2–7 April 1989, NOAA-TM-NMFS-SWFSC-154. Honolulu, HI.

State of California. 1990. California ocean plan. Water quality control plan, ocean waters of California. State Water Resources Control Board, Sacramento, CA.

Stewart, B.S., and P.K. Yochem. 1990. Pinniped entanglement in synthetic materials in the Southern California Bight. In: Proceedings of the Second International Conference on Marine Debris, 2–7 April 1989, NOAA-TM-NMFS-SWFSC-154. R.S. Shomura and M.L. Godfrey, eds. Honolulu, HI.

Swanson, R.L., and R.L. Zimmer. 1990. Meteorological conditions leading to the 1987 and 1988 washups of floatable wastes on New York and New Jersey beaches and comparison of these conditions with the historical record. Estuarine Coastal Shelf Sci. 30:59–78.

University of Alaska. 1988. Oceans of plastic. Report on a Workshop on Fisheries-Generated Marine Debris and Derelict Fishing Gear, February 9–11, 1988. Alaska Sea Grant Rep. No. 88-7. Portland, OR.

Waldichuk, M. 1988. The nature and extent of marine contamination caused by land-based sources in Canada. In: Canadian Conference on Marine Environmental Quality: Proceedings, 29 February–3 March 1988, P.G. Wells and J. Gratwick, eds. International Institute for Transportation and Ocean Policy Studies, Halifax.

Winston, J.E. 1982. Drift plastic: an expanding niche for a marine invertebrate? Mar. Pollut. Bull. 13 (10):348–351.

Wong, C.S., D.R. Green, and W.J. Cretney. 1974. Quantitative tar and plastic waste distribution in the Pacific Ocean. Nature 247:30–32.
Wong, C.S., D. MacDonald, and W.J. Cretney. 1976. Distribution of tar and other particulate pollutants along the Beaufort Sea coast. Beaufort Sea Tech. Rep. No. 13, Beaufort Sea Project, Victoria, BC.

Reference listing:

Canadian Council of Ministers of the Environment. 1999. Canadian water quality guidelines for the protection of aquatic life: Debris (Marine). In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

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